

# Central venous catheter insertion by a clinical nurse consultant or anaesthetic medical staff: a single-centre observational study

Nic Yacopetti, Evan Alexandrou, Tim R Spencer, Steven A Frost, Patricia M Davidson, Greg O'Sullivan and Ken M Hillman

Catheter-related bloodstream infections (CRBSIs) related to central venous catheters (CVCs) are associated with increased morbidity, mortality and health care utilisation.<sup>1,2</sup> A CRBSI is defined by the United States Centers for Disease Control and Prevention (CDC) as a bloodstream infection in a patient who has a CVC in place, for which other sources of infection have been excluded by examining patient clinical records, and where a culture from a portion of the catheter has demonstrated substantial growth of an organism identical to those found in the bloodstream.<sup>3</sup>

In Australia, the reported incidence of CRBSIs is over 3500 annually, with an associated mortality of 12%.<sup>4</sup> Nurse-led clinical services, such as those in gerontology and oncology, have been shown to improve patient safety and hospital efficiency.<sup>5-7</sup> Nurses trained in inserting CVCs have the potential to reduce catheter-related complications and reduce CRBSI.<sup>8,9</sup> Factors that enhance favourable outcomes include operator expertise, adherence to standardised protocols, and high procedural volume by individuals.<sup>10-12</sup>

The aim of our study was to compare the characteristics and clinical outcomes associated with CVC insertion by a clinical nurse consultant (CNC) and anaesthetic medical staff (AMS) within the same hospital.

## Methods

### Design, setting and participants

We conducted a prospective audit of a convenience sample of consecutive CVC insertions performed between July 2005 and October 2007 at a university-affiliated hospital in Sydney, Australia. The facility provides a range of acute, chronic and outpatient services. Historically, CVCs were inserted by the medical staff from the anaesthetic department for both inpatients and outpatients. Increasing demands for catheter placements and limited availability of anaesthetists led to the implementation of a nurse-led model for CVC insertion. In 2005, a critical care nurse who was based in the intensive care unit and had experience with peripherally inserted central catheter insertion was recruited to undertake this role. All CVC insertions included in our study, regardless of operator, were elective procedures. The CVCs were inserted in a general recovery room

## ABSTRACT

**Objective:** To compare clinical outcomes of elective central venous catheter (CVC) insertions performed by either a clinical nurse consultant (CNC) or anaesthetic medical staff (AMS).

**Design, setting and participants:** Prospective audit of a convenience sample of consecutive CVC insertions between July 2005 and October 2007 at a metropolitan teaching hospital in Sydney, Australia. The sample included all outpatients and inpatients requiring a CVC for either acute or chronic conditions.

**Main outcome measures:** Number of CVC lines inserted; differences between outcomes in the CNC and AMS groups; complications during and after insertion.

**Results:** Over a 28-month period, 245 CVCs were inserted by AMS and 123 by the CNC. The most common indications for CVC placement in both groups were for the treatment of oncology and autoimmune disorders (61%) and for antibiotic therapy (27%). Other indications were parenteral nutrition (2%) and other therapies (10%). There was no significant difference in complications on insertion between the CNC and AMS groups. AMS failed to obtain access in 12 attempted procedures compared with eight by the CNC. The rate of CVCs investigated for infection was twice as high in the AMS group as in the CNC group (19% v 8%). The confirmed catheter-related bloodstream infection (CRBSI) rate was 2.5/1000 catheters in the AMS group and 0.4/1000 catheters in the CNC group ( $P=0.04$ ).

**Conclusion:** Insertion outcomes were favourable in both the AMS and CNC groups. Infection outcomes differed between groups, with a higher rate of CRBSI in the AMS group.

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adjacent to the operating room, using similar products, equipment and standardised protocols.

Post-insertion CVC care was carried out according to hospital protocols and was not controlled for. This care included changing transparent occlusive dressings using an

aseptic technique twice weekly, or more frequently if the dressing's integrity was compromised. The skin was cleaned by using an alcohol-based chlorhexidine solution and applying a chlorhexidine-impregnated disk at the catheter insertion site.

Catheter type and site of insertion were also not controlled for, varying according to the decision of the operator at the time and based on clinical assessment, operator preference and catheter availability. In addition, the hospital's microbiology department stipulated that antibiotic-coated catheters were to be inserted only in patients at high risk of catheter-related infection. This included all patients receiving parenteral nutrition; those undergoing heart, renal, lung or stem-cell transplantation; or those having prolonged antibiotic or cytotoxic therapy (> 11 days).

### Data collection

Routine data collected included age, sex, indication for catheter insertion, and type of catheter used. Data were then entered into an electronic spreadsheet. All microbiological

testing of catheters (CVC tip and blood cultures) after insertion was reviewed, and information was categorised to ascertain clinical outcomes using a standardised data extraction tool (Appendix).

Patients were classified into five groups according to the indication for catheter insertion: oncology and autoimmune disorders, parenteral nutrition, antibiotic therapy, drug therapy (excluding antibiotics), and other (any indication not related to the other four groups). Catheter dwell time was calculated as the interval between the date of insertion and the date of removal (the date the CVC tip was sent for microbiological investigation and culture).

Complications associated with insertion were divided into nine categories: uneventful (no complications on insertion), multiple passes, arterial puncture, failed venous access, misplaced CVC tip, difficult feed of the catheter or guide wire, difficult venous access, pneumothorax and haematoma. Catheter-related thrombosis (the development of a thrombus in the catheterised vein)<sup>13</sup> was used as a long-term outcome.

Infection data on CVCs after removal were divided into three categories: (a) no sign of infection, with no peripheral blood or CVC tip sent for culture; (b) no sign of infection, with the CVC tip only sent for culture (this was routine practice for some ward areas [eg, oncology]); and (c) signs of infection where the CVC could not be excluded as a source, with both the CVC tip and peripheral blood sample sent for culture (this was used to diagnose CRBSIs according to CDC guidelines).<sup>3</sup>

**Table 1. Group characteristics**

	Clinician type		P*
	Anaesthetic medical staff	Clinical nurse consultant	
Catheters inserted, <i>n</i>	245	123	
Patients, <i>n</i>	148	84	
Mean age in years (SD)	50 (15)	49 (18)	0.59
Male sex, <i>n</i> (%)	130 (53%)	75 (61%)	0.12
Indications for insertion, <i>n</i> (%):			
Oncology and autoimmune disorders	145 (59%)	81 (66%)	0.24
Parenteral nutrition	6 (2%)	3 (2%)	0.99
Antibiotic administration	74 (30%)	27 (22%)	0.09
Drug therapy	9 (4%)	3 (2%)	0.52
Other	11 (4%)	9 (7%)	0.25
Insertion site, <i>n</i> (%):			
Internal jugular	125 (51%)	81 (66%)	<0.01
Subclavian	115 (48%)	42 (34%)	<0.01
Femoral	5 (2%)	0	0.11
Catheter type, <i>n</i> (%):			
Vascath	29 (12%)	18 (15%)	0.55
Single lumen	42 (17%)	24 (20%)	0.68
Double lumen	23 (9%)	4 (3%)	0.06
Triple lumen	151 (62%)	77 (63%)	0.95

\* Continuous data analysis using *t*-test and categorical data analysis using Fisher's exact test.

**Table 2. Catheter characteristics**

Catheter type, <i>n</i> (%)	Clinician type		P*
	Anaesthetic medical staff	Clinical nurse consultant	
Antiseptic-coated catheter (first-generation) <sup>†</sup>	123 (50%)	78 (63%)	0.01
Antiseptic-coated catheter (second-generation) <sup>‡</sup>	81 (33%)	3 (2%)	<0.01
Antibiotic-coated CVC	7 (3%)	22 (18%)	<0.01
Non-coated CVC	27 (11%)	20 (16%)	0.16
Tunnelled CVC (non-coated)	7 (3%)	1 (1%)	0.24

CVC = central venous catheter. \* Categorical data analysed using Fisher's exact test. † Catheters coated with chlorhexidine and silver sulfadiazine on the external surface of the catheter only. ‡ Catheters coated with a three-fold increase in the concentration of chlorhexidine and silver sulfadiazine on the external surface of the catheter (incorporates coating of the luminal surface, extension and hubs of the catheter).

### Statistical analysis

Descriptive statistics are presented as frequencies and proportions. Details of patient demographics, indications for insertion, site of insertion and type of line were documented for the CNC and AMS groups. Differences in outcomes between the two groups were also assessed using the Student *t*-test for analysis of continuous data and the Fisher's exact test for categorical data. The comparative incidence of CRBSIs was calculated using a  $\chi^2$  distribution. We were unable to capture catheter-days for the CVCs that were not sent for microbiological testing. The comparative incidence of CRBSIs was therefore calculated per 1000 catheters.

### Results

Between July 2005 and October 2007, 232 patients had a CVC placed by either the CNC or AMS (of which there were 40 altogether). A total of 368 CVCs were inserted, with some patients having multiple insertions (range, 1–8) (Table 1). The mean age of patients was similar in the AMS and CNC groups (50 years and 49 years, respectively;  $P=0.6$ ); There were more males in the CNC group (61% v 53%), but the difference was not significant ( $P=0.1$ ). The average catheter dwell time was similar in both groups (19 days and 21 days, respectively). There were 123 CVCs inserted by the CNC and 245 inserted by AMS. The difference in the number of catheters between the two groups relates to the availability of either operator at any given time during the study period, and was the major reason why a convenience sample was used.

**Table 3. Outcomes on insertion of central venous catheters (CVCs)**

Complications on insertion, <i>n</i> (%)	Clinician type		<i>P</i>
	Anaesthetic medical staff	Clinical nurse consultant	
Uneventful	194 (79%)	96 (78%)	0.91
Multiple passes	18 (7%)	5 (4%)	0.32
Arterial puncture	1 (< 1%)	0	1.00
Failed venous access	12 (5%)	8 (7%)	0.69
Misplaced CVC tip	1 (< 1%)	0	1.00
Difficult feed*	4 (2%)	4 (3%)	0.53
Difficult access	11 (4%)	9 (7%)	0.33
Pneumothorax	2 (1%)	0	0.55
Haematoma	2 (1%)	1 (1%)	0.56

\* Difficult feed refers to difficulty in feeding either the guide wire or the catheter itself after vessel cannulation.

Catheter selection varied between the two groups, although the differences were not significant. This reflected the availability of different catheters during the study period. The characteristics of the CVCs inserted in both groups also differed. The CNC inserted more first-generation antiseptic-coated CVCs than the AMS (63% v 50%;  $P=0.01$ ), but less second-generation antiseptic-coated catheters (2% v 33%;  $P<0.01$ ).<sup>14</sup> The CNC also inserted more antibiotic-coated CVCs (18% v 3%;  $P<0.01$ ), reflecting differences in catheter availability and hospital policy for the use of antibiotic-coated CVCs (Table 2).

Oncology and autoimmune disorders were the primary reasons for a CVC insertion (59% [AMS group] and 66% [CNC group]). Antibiotic administration was the next most common reason for CVC placement (30% [AMS group] and 22% [CNC group]). These two categories accounted for most CVC insertions in both groups (89% and 88%, respectively). The least common indication for CVC insertion was parenteral nutrition (2% in both groups).

Insertion sites differed between the two groups. Insertion sites in the AMS group were equally distributed between internal jugular and subclavian sites (51% and 48%, respectively), with a small proportion of femoral lines (2%). The CNC inserted a higher proportion of internal jugular CVCs than subclavian CVCs (66% v 34%) and no femoral

**Table 4. Outcomes of central venous catheter (CVC) tip surveillance**

	Clinician type		<i>P</i> <sup>†</sup>
	Anaesthetic medical staff*	Clinical nurse consultant*	
Routine CVC tip surveillance <sup>‡</sup> ( <i>N</i> = 159)	103 (42%)	56 (58%)	
No tip growth	79 (77%)	51 (91%)	0.01
Tip growth	24 (23%)	5 (9%)	< 0.01
Clinically indicated CVC tip surveillance, <sup>§</sup> ( <i>N</i> = 56)	46 (19%)	10 (8%)	< 0.01
No tip growth	20 (44%)	9 (90%)	0.04
Tip growth only	7 (15%)	0	0.33
BC growth only	3 (6%)	0	1.00
CRBSI	16 (35%)	1 (10%)	0.24
CRBSIs/1000 catheters	2.5	0.4	0.04
Catheter-related thrombosis	1 (< 1%)	0	1.00

BC = blood culture. CRBSI = catheter-related bloodstream infection.

\* Figures are number (%), except where otherwise indicated.

† Continuous data analysis using *t*-test and categorical data analysis using Fisher's exact test. ‡ No blood culture. § Tip and blood culture.

catheters (Table 1). Sixty-two per cent of CVCs inserted were triple lumen catheters.

There were low complication rates for CVC insertion in both groups, with no significant difference between the groups: 79% of insertions performed by AMS and 78% of those performed by the CNC were uneventful ( $P=0.91$ ) (Table 3). During the study period, two instances of pneumothorax were recorded in the AMS group and none in the CNC group. Two patients in the AMS group and one in the CNC group had haematomas. AMS failed to obtain access in 12 attempted procedures, compared with eight by the CNC ( $P=0.69$ ). One catheter-related thrombosis was confirmed in the AMS group on routine follow-up.

The proportion of CVCs sent for microbiological investigation with no signs of infection were similar in the two groups (42% [AMS] v 58% [CNC]). AMS recorded a higher rate of colonised catheter tips from this routine surveillance than the CNC (23% v 9%;  $P < 0.01$ ) (Table 4). The average time from insertion to an infectious event for both groups was 22 days (range, 6–69 days).

The proportion of CVC tips sent for microbial investigation for suspected infection (where the catheter could not be excluded as a source) was higher in the AMS group than the CNC group (19% v 8%;  $P < 0.01$ ). Confirmed CRBSIs within this subset were also higher in the AMS group (35% [AMS] v 10% [CNC]), but the difference was not significant ( $P=0.24$ ). The CRBSI rate between the two groups differed. The rate of confirmed catheter infections (as defined by CDC guidelines) was 2.5/1000 catheters in the AMS group compared with 0.4/1000 catheters for the CNC group ( $P=0.04$ ) (Table 4).

One CRBSI (from a non-coated catheter) was identified in the CNC group. Sixteen CRBSIs were identified in the AMS group: one from a second-generation antiseptic-coated CVC, six from antibiotic-coated CVCs and nine from non-coated CVCs.

## Discussion

Our results show that outcomes of insertion of CVCs between the two groups were similar, with approximately 80% of all catheter placements being uneventful. AMS failed to obtain access in 12 attempted procedures compared with eight by the CNC. The CNC also had a smaller proportion of multiple passes (4% v 7%), but the difference was not significant. Although our results compare favourably with those in the international literature,<sup>15</sup> particularly for the CNC group, the small number of patients and the elective context for insertion may have contributed to this finding.

The difference in infection rates between the two groups is of note, and, although the study design prohibits attribu-

tion of causality, there are some interesting points for discussion. All CVCs inserted by both groups were elective (non-emergency) cases. Management of CVCs after insertion was not controlled for. Catheters were managed in accordance with hospital-wide policy, with no differentiation in CVC care between the two groups. As we were unable to collect information on CVCs that were removed but not sent for microbiological testing, we measured the comparative incidence per 1000 catheters rather than per 1000 catheter-days.

One possible explanation for the difference in infection rates between the two groups could be a more rigorous application of full-barrier precautions and sterile technique during catheter insertion by the CNC. Some authors have reported that attention to these precautions is lower among medical staff than among nursing staff.<sup>16–18</sup> The higher proportion of antibiotic-coated catheters placed by the CNC may also have contributed to the result.<sup>19–21</sup> Of a total of 23 instances of multiple passes in both groups, only one (in the AMS group) was implicated in a CRBSI.

Our study took place in a metropolitan teaching hospital that cares for patients with many specialty and subspecialty illnesses. As a consequence, there was heterogeneity in the indications for catheter placement in both operator groups. For both groups, the same designated section in the recovery room was used, similar equipment was used for CVC insertion, and the procedure was performed under the same organisational policies.

Our study was observational, and as it was based on a convenience sample, patient selection for both groups could not be controlled for. Thus, there may have been bias in either group in relation to patient selection. Despite this, patient age, catheter-days of use and indications for CVC insertion were very similar in both groups.

The lower number of subclavian approaches by the CNC could be attributed to site choice as a matter of caution and safety. It could also be that the patients seen by the CNC may have been assessed as being at risk of bleeding during catheter placement. These parameters were not recorded as part of the study data collection, but were assessed prior to insertion as routine clinical practice.

The outcomes of nurse-led CVC insertion in this evaluation require consideration of wider implementation and further outcome review. Implementing and managing such a service requires a specialised set of skills, developed by training and mentoring within an interdisciplinary context.<sup>9–11</sup>

## Conclusion

We have shown that central venous catheter insertion by a clinical nurse consultant is a viable clinical option in both inpatient and outpatient settings. Nurse-led CVC placement

was equal to placement by anaesthetic medical staff with respect to the level of complications, and as such, has potential organisational advantages. Lower rates of CRBSIs/1000 catheters were found in the CNC insertion group, suggesting that a dedicated person with a critical care nursing background is suitable for this role and may help to improve standards.

### Author details

Nic Yacopetti, Clinical Nurse Consultant<sup>1</sup>

Evan Alexandrou, Clinical Nurse Specialist,<sup>2</sup> and Lecturer<sup>3</sup>

Tim R Spencer, Clinical Nurse Consultant<sup>2</sup>

Steven A Frost, Clinical Nurse Specialist,<sup>2</sup> and Lecturer<sup>3</sup>

Patricia M Davidson, Professor of Cardiovascular and Chronic Care<sup>5</sup>

Greg O'Sullivan, Director of Anaesthetics<sup>1</sup>

Ken M Hillman, Professor of Intensive Care,<sup>4</sup> and Director<sup>6</sup>

1 Department of Anaesthetics and Critical Care, St Vincent's Hospital, Sydney, NSW.

2 Department of Intensive Care, Liverpool Hospital, Sydney, NSW.

3 School of Nursing and Midwifery, University of Western Sydney, Sydney, NSW.

4 Faculty of Medicine, University of New South Wales, Sydney, NSW.

5 School of Nursing and Midwifery, Curtin University of Technology, Sydney, NSW.

6 The Simpson Centre for Health Services Research, University of New South Wales, Sydney, NSW.

**Correspondence:** E.Alexandrou@uws.edu.au

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**CENTRAL VENOUS CATHETER DATA FORM**

**1: Insertion** Date: \_\_\_\_\_ Name & Classification of Inserting Practitioner: \_\_\_\_\_

• Area:  ITU  Recovery  Anaesthetics  ACCA  Other: \_\_\_\_\_

• Indication for CVC: Patient diagnosis: \_\_\_\_\_  
 Long term access  Pressure monitoring  
 No peripheral access  Parenteral nutrition  
 Drug administration  Resuscitation  
 Haemodialysis  Line change  
 Other: \_\_\_\_\_

• Type of device:  Single lumen/ impregnated  Single lumen PICC  
 Triple lumen/ impregnated  Dual lumen PICC  
 Other: \_\_\_\_\_  Vas Cath

Specify product brand name: \_\_\_\_\_

• Type of solution used during insertion:  Povidone-iodine  Chlorhexidine/ Alcohol

• Insertion details:  1-3 passes  Multiple passes/ sites  Other: \_\_\_\_\_

• Insertion site:  Subclavian  Jugular  Femoral  Peripheral {L / R} Arm Circumference (cms) \_\_\_\_\_

• Insertion-related complications (please specify): \_\_\_\_\_

**2: Maintenance** \* Please Complete Daily \* IV Maintained by: IV Team \_\_\_\_\_ Ward \_\_\_\_\_

• Patient risk factors:  Other invasive devices ~ specify  Immune suppression  Other: \_\_\_\_\_

• **Insertion Site and Dressing Description:**\*

*Each small box represents one day. Enter appropriate date & code number(s).*

- 1 = No erythema, tenderness or discharge
- 2 = Tenderness at insertion site
- 3 = Erythema < 5mm in diameter
- 4 = Erythema > 5mm in diameter
- 5 = Discharge/ exudate
- 6 = Febrile >38.5, CVC most likely cause
- 7 = Febrile >38.5, other cause most likely
- 8 = Dressing dry and intact
- 9 = Dressing soiled/ lifting
- 10 = Dressing changed
- 11 = Catheter removed

eg 1/5/00	1,9,10			

\* More than one response may apply

**3: Removal** Date: \_\_\_\_\_

\* Please Document Reason for Removing Line \*

• Reason for line removal:  Treatment complete  Blocked Catheter  
 Suspected infection  Routine change  
 Accidental removal  Other: \_\_\_\_\_

• Evidence for infection:  Fever  +ve tip culture  
 Site inflammation  +ve blood culture  
 +ve insertion site swab

• Infecting organism:  Staph epidermidis  Staph aureus  Candida  Other: \_\_\_\_\_

• Concurrent antibiotic therapy: \_\_\_\_\_

**When the CVC is removed, complete as much of this form as possible. See over for mailing details**