Central venous catheter insertion by clinical nurse consultant or anaesthetic medical staff: A single centre observational study.

Nic Yacopetti[1], Evan Alexandrou[2,3,4,5], Tim Spencer[2], Steven A Frost[2,3,5] Patricia M Davidson[1,4] , Greg O'Sullivan[1], Ken M Hillman[4,6]

[1]St Vincent's Hospital NSW, [2]Liverpool Hospital NSW. [3]University of Western Sydney, NSW. [4]Centre for Cardiovascular & Chronic Care. Curtin University of Technology, Sydney. [5]University of New South Wales.

Corresponding author:
Evan Alexandrou
Intensive Care Liverpool Hospital
Locked 1871 Liverpool BC 2170
Phone: 612+ 9828 3603
Fax: 612+ 9828 3551
Mobile: +61418453650
evan.alexandrou@sswahs.nsw.gov.au

Nominated Back Up: P.Davidson@curtin.edu.au

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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: Prospective audit of a convenience sample for consecutive CVC insertions from July 2005 to October 2007.

Setting: Metropolitan University affiliated hospital providing acute, chronic and outpatient services.

Participants: Out-patients and inpatients requiring a CVC for both acute and chronic conditions.

Main Outcome Measures: Number of CVC lines inserted, patient groups, complications during and after insertion.

***Results*:** There were 245 CVCs inserted by AMS and 123 by the CNC over a 28 month period. 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%). Parenteral nutrition (PN) (2%), and other therapies (10%) accounted for other indications. There was no significant difference in complications on insertion between groups. Anaesthetic medical staff failed to obtain access in five attempted procedures compared to one by the CNC. The rate of CVCs investigated for infection was twice as high in the AMS group compared to those placed by the CNC (19% versus 8%).Confirmed catheter related blood stream infection was 2.5 per 1000 catheters in the AMS group and 0.4 per 1000 catheters in the CNC group (p=0.04).

Conclusion: Both the AMS and CNC had favourable insertion outcomes. Infection outcomes differed between the AMS and CNC with a higher rate of CRBSI in the AMS group.

INTRODUCTION:

Catheter related blood stream infection (CRBSI) related to central venous catheters (CVCs) are associated with increased morbidity, mortality and health care utilisation(1, 2). A CRBSI is defined by the Centres for Disease Control and Prevention (CDC) as a blood stream infection in a patient whom has a CVC in place for which other sources for infection were excluded by the examination of 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. (3)

In Australia, the reported incidence of CRBSI is over 3500 annually with an associated mortality of 12%.(4) Nurse led clinical services such as those in gerontology and oncology have been shown to improve patient safety and hospital efficiency. (5-7) Nurses trained for inserting CVCs have the potential to reduce catheter related complications and reduce CRBSI. (8, 9) The adherence to standardised protocols, operator expertise and high procedural rates within an individual are factors which have been attributed to favourable outcomes.(10-12)

Aims: The aim of this study was to evaluate the characteristics and clinical outcomes associated with CVCs inserted by a CNC compared to those inserted by AMS within the same hospital.

METHODS

Setting and Patients: The setting for this study was a University affiliated hospital in metropolitan 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 based in the ICU was recruited to undertake this role. All CVCs in this study, regardless of operator, were elective procedures, inserted in a general recovery room, adjacent to the operating room, using similar products, equipment and standardised protocols.

Post insertion CVC care was not controlled for and was according to the hospital protocols. This care included changing transparent occlusive dressings using an aseptic technique twice weekly or more frequently if the dressing's integrity was compromised. Cleaning the skin was achieved using an alcoholic chlorhexidine solution and the application of a chlorhexidine impregnated disk at the catheter insertion site.

Catheter type, and site for insertion was also not controlled for and was according to decision of the operator at the time and based upon 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 and stem cell transplantation, or those having prolonged (>11 days) antibiotic or cytotoxic therapy.

Data Collection: Routine data collected included age, gender, indication for and type of catheter used. Data were then entered into an electronic Microsoft Excel ™ spreadsheet. All catheter microbiology (CVC tip and blood cultures) following insertion were reviewed and information categorised to ascertain clinical outcomes using a standardised extraction data tool. (Appendix 1)

Five groups were used for patient classification: Oncology and autoimmune (OA), parenteral nutrition (PN), antibiotic therapy (AB), Drug Therapy (DT) (excluding antibiotics) and other (O) (any indication not related to the four groups). Catheter days were calculated using the date of insertion and the date of removal (the date the CVC tip was sent for microbiology investigation and culture).

Complications associated with insertion were categorised into nine groups: uneventful (UN) (no complications on insertion), multiple skin passes (MP), arterial puncture (AP), failed venous access (FA), misplaced CVC tip (MT), difficult feed of the catheter or guide wire (DF), difficult venous access (DA), pneumothorax (PTX), and haematoma (HTM). Catheter related thrombosis (13) (CRT) (refers to the development of a thrombus in the catheterised vein), was used as a long term outcome.

Infection data collected included: (A) Removal of CVC where no peripheral blood or tip were sent for cultures (no sign of infection). (B) CVC tip only sent for cultures (with no sign of infection), this was routine practice for some ward areas (e.g. oncology). (C) CVC tip along with peripheral blood sent for cultures. This last group had signs of infection where the CVC could not be excluded as a source, and used to diagnose CRBSI as per the guidelines of the CDC. (3, 14)

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 both groups. Differences in outcomes between the CNC and AMS were also assessed using the Student *t*-test for the analysis of continuous data, and the Fishers exact test for all categorical data. The comparative incidence of CRBSI was calculated using chi square distribution. We were unable to capture catheter days on the CVCs which were not sent to microbiology. The comparative incidence of CRBSI was therefore calculated per 1000 catheters.

RESULTS

Between July 2005 and October 2007, 232 patients had a CVC placed by either the CNC or a total of 40 AMS. Some patients had multiple CVC insertions (range 1 – 8) for a total of 368 CVCs **(Table 1)**. Mean age of patients among the AMS and CNC group was similar (50 years versus 49 years, respectively; $p = 0.1$); There were more males in the CNC group (61% versus 51%, $p = 0.1$). The average catheter dwell time was similar in both the groups (19 and 21 days respectively). There were 123 CVCs inserted by the CNC and 245 CVCs 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 the major contributing factor for why a convenience sample was used.

Catheter type varied between the two groups ($p < 0.01$), these differences reflected the availability of different catheters during the study, which also differed between the groups. A larger proportion of triple lumen catheters being inserted by the CNC whereas AMS had a larger proportion of double lumen catheters **(Table 1)**. The characteristics of the types of CVCs inserted in both groups also differed ($p < 0.001$). The CNC inserted more first generation antiseptic coated CVCs than the AMS (63%

vs. 50%), but less second generation antiseptic catheters (15) (2% vs. 33%). The CNC also inserted more antibiotic coated CVCs (18% vs. 3%), This difference again reflected catheter availability and hospital policy for the use of antibiotic coated CVCs **(Table 4)**.

Oncology and autoimmune (OA) disorders were the primary reasons for a CVC (AMS 59% versus CNC 66%). Antibiotic (AB) administration was the next most common reason for CVC placement (AMS 30% versus CNC 22%). These two categories accounted for the majority of CVCs in both groups (AMS 89% versus CNC 88%). Central venous catheters inserted for PN accounted for 2% of CVCs in both groups.

Insertion site differed between the two groups (p = 0.01). Anaesthetic medical staff insertion sites were equally distributed between internal jugular (IJ) and subclavian (SC) (48% versus 51%), with a small proportion of femoral lines (2%). The CNC inserted a larger proportion of IJ CVCs (66% versus 34% for SC), and no femoral (FEM) catheters **(Table 1)**. 48% of CVC's inserted were triple lumen catheters.

There were low complication rates for CVC insertion in both groups. 81% of those performed by AMS and 79% of those performed by CNC were uneventful with no difference between groups (**Table 2**). During the study period, two PTX events were recorded by AMS . Haematoma and AP were seen in both the AMS and CNC group (two patients versus one patient respectively). Anaesthetic medical staff failed to obtain access in five attempted procedures compared to one by the CNC. One CRT was confirmed in the medical group on routine follow up.

The proportion of CVCs sent for microbiology investigation with no signs of infection were similar among the two groups (AMS 42% vs. CNC 47%, $p = 0.4$). Anaesthetic medical staff recorded a higher the rate of colonised catheter tips from this routine surveillance compared to the CNC (24% vs. 12%, $p = 0.07$). The average time from insertion to an infectious event for both groups was 22 days (range 6-69 days).

Central venous catheter tips sent for microbial investigation for suspected infection (where the catheter could not be excluded as a source), were higher in the AMS group (19% vs. 8%, $p < 0.01$). Confirmed CRBSI within this subset were also higher in the AMS group (medical 34% versus CNC 10% $p = 0.07$). The CRBSI rate between the two groups differed. The rate of confirmed catheter infection (as defined by CDC guidelines) was 2.5/1000 catheters in the AMS group and 0.4/1000 catheters for the CNC (p=0.04) (**Table 3)**.

From the infected CVCs, one CRBSI was associated with the CNC which was a non-coated catheter. In the AMS group, nine infected catheters were identified, 11% (1) were second generation antiseptic coated, 67% (6) were antibiotic coated and 22% (2) were non-coated CVCs.

DISCUSSION

In this evaluation, outcomes during insertion of CVCs between the two groups were comparative with 80% of all catheter placements being uneventful. The AMS had failed to obtain access in five attempted procedures compared to one by the CNC. The CNC also had a smaller proportion of multiple passes (4% versus 7%). Although the results are favourable, compared to international literature (16), particularly for the CNC, 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 attribution of causality, there are some interesting points for discussion. All CVCs inserted by both groups were elective (non emergent) cases. Management of CVCs post insertion was not controlled. Catheters were managed as per hospital wide policy with no differentiation in CVC care, between the two groups. We measured the comparative incidence per thousand catheters rather than per thousand catheter days as we were unable to collect information on CVCs that were removed and not sent to microbiology. Of interest, the comparison in our two population groups for the incidence of CRBSI was 5.4 per 1000 catheter days in the AMS group and 0.69 in the CNC group.

One possible explanation for the difference in infection rates could be a more rigorous application of full barrier precautions and a sterile technique during catheter insertion by the CNC. Some authors report that attention to these precautions is lower among medical staff. (17-19) The impact of the larger proportion of antibiotic coated catheters placed by the CNC may have also contributed to the result. (20-22) However, it was of interest to see that the majority of catheters implicated in CRBSI in the AMS (67%) were antibiotic coated. Of the total number (23) of MP in both groups, one was implicated in a CRBSI (in the AMS group).

This study was conducted over a 28 month period, where consecutive CVCs were reported. The study took place in a metropolitan teaching hospital that cares for many specialty and sub specialty illnesses. As a consequence heterogeneity in indication for catheter placement was seen by both operator groups. Both groups used the same designated section in the recovery room; used similar equipment for CVC insertion and performed the procedure under the same organisational policies.

This study was observational, and using a convenience sample, patient selection for both groups were unable to be controlled for. As such, there may have been particular bias in either group in relation to patient selection. Despite this, patient age, catheter days of use and indication for CVC were very similar in both operator groups.

The lower number of SC 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. The specialisation required to implement and manage such a service requires a specialised set of skills, training and mentoring within an interdisciplinary context.(9-11)

CONCLUSION:

This comparison has shown that CVC insertion by a CNC is a viable clinical option for all patients across the hospital and outpatient settings. The nurse led CVC placement service has shown organisational advantage in that it is equal to AMS staff in respect of complications. Lower CVC infection rates and CRBSI were found in the CNC insertion group suggesting a dedicated individual with a critical care nursing background is suitable for this role and improves standards.

AUTHORS' CONTRIBUTIONS

NY planned and conducted the study with the assistance of EA. EA managed and analysed the data with the assistance of SAF. TS had an active role in data interpretation. PMD had an active role in the interpretation of the data and preparation of the final manuscript. KH and GOS assisted with data interpretation and manuscript preparation. All authors contributed to the drafting and completion of the manuscript.

Table 1. Group Characteristics.

	Clinician	

	Anaesthetic Medical Staff	Clinical Nurse Consultant	P-value[1]
No. of Catheters	245	123	
No. of patients	148	84	
Age mean (SD)	50 (15)	49 (18)	0.59
Gender % (N)			
Males	53% (130)	61% (75)	0.12
Indications	**no. (%)**	**no. (%)**	
OA	145 (59)	81 (66)	0.24
PN	6 (2)	3 (2)	0.99
AB	74 (30)	27 (22)	0.09
DT	9 (4)	3 (2)	0.52
O	11 (4)	9 (7)	0.25
Insertion site			
IJ	125 (51)	81 (66)	<0.01
SC	115 (48)	42 (34)	<0.01
FEM	5 (2)	0	0.11
Catheter type			
Vascath	29 (18)	18 (17)	0.44
Single lumen	42 (26)	23 (21)	0.71
Double	23 (14)	4 (4)	0.03
Triple	65 (41)	63 (56)	<0.01

Note: [1] continuous data analysis using t-test and categorical data analysis using Fisher's exact test. OA= Oncology / Autoimmune, PN= Parenteral nutrition, AB= Antibiotics, DT= Drug therapy, O= Other. IJ = internal jugular, SC = subclavian, FEM = femoral.

Table 2: Outcomes on insertion of CVCs

	Clinician	

	Anaesthetic Medical Staff no. (%)	Clinical Nurse Consultant no. (%)	P-value
Complications on insertion % (N)			P = 0.5
UN	198 (81)	97 (79)	0.6
MP	18 (7)	5 (4)	0.2
AP	2 (1)	1 (0)	0.9
FA	5 (2)	1 (0)	0.6
MT	1 (0)	0	1.0
DF	4 (2)	4 (3)	0.4
DA	11 (4)	9 (7)	0.3
PTX	2 (1)	0	0.5
HTM	2 (1)	1 (0)	1.0

*** Difficult feed refers to difficulty in the feeding of either the guide wire or actual catheter after vessel cannulation. UN= Uneventful, MP= Multiple passes, AP= Arterial puncture, FA=failed access, MT= Misplaced CVC tip, DF= difficult feed, DA= Difficult access, PTX= Pneumothorax, HTM= Haematoma**

Table 3: Outcome from CVC tip surveillance

	Clinician

	Anaesthetic Medical Staff no. (%)	Clinical Nurse Consultant no. (%)	P-value
Routine CVC tip surveillance (No B/C's) % (N) N= 162	104 (42)	47 (58)	0.43
No tip growth	76 (76)	51 (88)	0.02
Colonised tip	25 (24)	7 (12)	0.06
Clinically indicated CVC tip surveillance (tip and blood cultures) % (N) N = 57	47 (19)	10 (8)	0.01
No tip growth	21 (45)	9 (90)	<0.01
Tip growth only	7 (15)	0	0.33
Blood culture growth only	3 (6)	0	1.00
CRBSI	16 (34)	1(10)	0.25
CRBSI per 1000 catheters	2.5	0.4	0.04
Catheter related thrombosis (CRT)	1 (0)	0	1.00

Note: [1] continuous data analysis using t-test and categorical data analysis using Fisher's exact test

Table 4. Catheter Characteristics.

	Clinician		p-value
Catheter Type	**Anaesthetic Medical Staff no. (%)**	**Clinical nurse consultant no. (%)**	**<0.001[3]**
Antiseptic coated catheter (first generation)[1]	123 (50)	78 (63)	0.01
Antiseptic coated catheter (second generation)[2]	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

Note: [1] Catheters coated with chlorhexidine and silver sulfadiazine on the external surface of the catheter only. [2] Catheters coated with a 3-fold increase in the concentration of chlorhexidine and silver sulfadiazine on the external surface of the catheter and incorporates coating of the luminal surface, extension and hubs of the catheter. [3] Categorical data analysed using Fisher's exact test.

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