Establishing a Nurse-Led Central Venous Catheter Insertion Service

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Abstract

***Background*:** *Health care systems promote care models that deliver both safety and quality. Nurse-led vascular access teams show promise as a model to achieve hospital efficiencies and improve patient outcomes.*

***Objectives*:** *The aim of this paper is to discuss the process of establishing a nurse-led central venous catheter (CVC) insertion service in a university affiliated hospital using a process evaluation method.*

***Method*:** *Archival information, including reports, communications and minutes of departmental meetings were reviewed. Key stakeholders involved in establishing this nurse-led service at the time were interviewed.*

***Results*:** *A nurse-led CVC insertion service was first established in 1996 and has increased in service provision over 13 years. Initially there was scepticism from some medical practitioners about the feasibility of a nurse performing a traditional medical procedure. The service currently provides central venous access across the hospital including critical care areas. The service places up to 500 catheters per annum.*

***Conclusions*:** *Establishing a nurse-led CVC insertion service has increased organizational efficiencies and provided an infrastructure for support of best practice. The support of senior management and medical practitioners was crucial to the successful implementation of this model of care.*

Introduction

Central venous catheters (CVCs) are commonly indicated for intravenous medications unsuitable for peripheral administration (Horattas et al., 2001) and have traditionally been placed by medical practitioners. The insertion of CVCs has become a common outpatient procedure for the administration of medication in the community setting, particularly for chemotherapy and parenteral antibiotic administration. They can be inserted via the central veins or via peripheral access (peripherally inserted central catheter - PICC) (Sharpe, 2006). Adverse events related to CVC insertion have been reported to be as high as 15% (Taylor & Palagiri, 2007) and serious complications can have an associated mortality as high as 47% (Comfere & Brown, 2007).

Experience by the health care professional is important in reducing CVC insertion complications. An experienced professional who has inserted more than 50 CVCs is estimated to have half the complication rate of one that has inserted fewer than 50 (Taylor & Palagiri, 2007). Achieving this experience can be challenging when clinicians have multiple roles and responsibilities. Nurse-led models for CVC insertion have shown promise in addressing workforce shortages of medical practitioners and improving health outcomes that are related to specialization (Alexandrou et al, 2009).

Increasingly, advanced nurse-led models of care have improved patient outcomes across a range of clinical areas in many health care settings (Cowan et al., 2006; Ritz et al., 2000; Ryden et al., 2000). In a recent integrative review describing nurse-led CVC insertion services, it was found that they had been introduced to overcome delay in CVC insertion that had resulted from shortages of physicians. (Alexandrou, et al, 2009). Other reasons for introducing these services included unacceptable rates of infection, misplaced catheter tips; increased costs associated with repeat attempts by other physicians and increased length of stay (Fitzsimmons et al., 1997; Hamilton, 2004, 2005).

Patient outcomes from nurse-led CVC insertion compared well with published rates of common CVC insertion complications (Comfere & Brown, 2007; Boland, Haycox, Bagust, & Fitzsimmons, 2005; Casey & Davies, 2003; Goral, Fitzsimmons, & Lawrance, 2006; Kelly, 2003; Waterhouse, 2002).

In our hospital similar issues and concerns led to a nurse-led central venous access service (CVAS) being established in

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DOI: 10.2309/java.15-1-5

1996. The CVAS has remained in operation with over 4200 catheter placements. It currently employs two advanced practice nurses with critical care backgrounds who insert CVCs for hospital patients and assist in managing parenteral nutrition (PN) for patients outside the intensive care unit (ICU).

Aim

This paper aims to discuss the establishment of a nurse-led CVAS in a university affiliated hospital and presents the rationale for its implementation, the process of service development, the ongoing adjustment and the current status of the service.

Method

Setting

The site is a 650-bed university affiliated hospital in south west Sydney, Australia with major trauma, surgical and medical services. The hospital has a 28-bed Intensive Care Unit (ICU) which also provides a Medical Emergency Team (MET) response (Lee, Bishop, Hillman, & Daffurn, 1995).

Data

Analysis of archival information, such as reports, electronic communications and minutes of departmental meetings were undertaken using thematic content analysis (Marconi & Rudzinski, 1995; Smith, 1992). Key stakeholders from nursing, medicine and hospital administration involved in establishing this nurse-led service who were currently still employed in the hospital were interviewed using a semi-structured questionnaire (See Table 1).

Descriptive analyses of data generated from an administrative data set were undertaken to describe patient characteristics. Ethical approval for this study has been granted by the institution's human ethics committee for the protection of human subjects.

Table 1. Sample questions for stakeholders

- What do you think was the impetus for setting up a nurse-led central line service?
- What were some of the strategies and processes used to implement the service?
- What barriers were faced and how were they resolved?
- What do you consider to be the facilitators to the service implementation?
- What were the administrative and funding concerns in service development?

Results

Documents and reports were reviewed from 1996 and 1997. Staff identified as key stakeholders at the time of the CVAS development and who were currently still employed in the hospital (6 in total, 2 medical practitioners, 3 nursing personnel and 1 administrative staff member) were interviewed.

Rationale for service implementation

In the late 1990s, the hospital underwent significant re-development which impacted greatly on the workload of the ICU. This was compounded by its commitment to trauma services and the MET system. As the hospital grew in size, the ICU medical practitioners' capacity to provide a timely and efficient CVC placement service for non-emergent (ward-based) patients became less reliable. Patients from general wards requiring CVC insertion would be transferred to the ICU to a vacant bed area and the catheter placed by one of the ICU doctors. Often, because of competing work demands the patient would be transferred back to the ward without catheter placement. This delay resulted in frustration of patients and clinicians alike, with additional cost to ICU for the goods and services spent on procedural set up that were eventually not used.

The increased workload was complicated by the perception from senior medical practitioners that there was less time to coordinate the supervision of junior medical practitioners in CVC placement due to increased demands on their time. Without standardized procedures or processes for monitoring of operator performance such as insertion complications and infection rates, it was not uncommon for patients to undergo multiple attempts for catheter placement.

The lack of an organized approach to monitoring and supporting PN also led to unnecessary delays and poor management. To address this problem, the ICU medical directors applied for funding through medical administration for an extra medical staff training position to assist with the workload. This application was declined due to lack of funding, and it was decided to use in-house resources and train a senior ICU nurse to undertake some duties to relieve medical staff workload.

The plan aimed to provide a dedicated person to coordinate CVC insertion at an organizational level, and improve efficiencies and outcomes. To ensure the nurse possessed the necessary knowledge and experience, certain pre-requisites for the role were identified. These included: a critical care background, critical care qualification, and peripheral venous and arterial cannulation skills. In December 1996, a dedicated Central Venous Access Service (CVAS), with an advanced practice nurse in the lead role, was created within the Intensive Care Department.

Service model

The service initially ran with one operator 3 days a week. It was soon apparent that the service demand warranted 5 day a week coverage. The service operated in this manner for 7 years, until in 2003 when a second nurse was employed to accommodate increased needs. Currently there are two advanced practice nurses who have been trained and credentialed to insert CVCs throughout the hospital. A third nurse is in the process of becoming credentialed to support the CVAS.

The service currently operates 5 days a week with a full-time equivalent (FTE) of 1.2 nurses. They report to the medical director of the ICU for administrative and clinical issues. Outcome data is reported to the ICU medical and nursing directors on a yearly basis as part of the performance appraisal process. The education role of the service includes hospital wide teaching for medical and nursing staff along with competency based

Table 2. Central venous catheter insertion competency assessment checklist

COMPETENCY ASSESSMENT CHECKLIST – Central Venous Cannulation (Landmark Technique)

Site of insertion: _____

The following criteria must be successfully achieved during assessment.
Unsuccessful attempts must also be recorded and assessed.

Criteria **Candidates Name**: _____	**Achieved** ☐ or ☐ (or n/a)	**Re-assessment** (If required) &/or Comments
Procedure		
Explains procedure to patient and obtains consent – if applicable		
Organizes equipment (ensure sharps container is on hand)		
Identifies patient and performs safety checklist		
Ascertains if patient has any allergies (e.g. to antiseptic solutions, local anesthetic agents or dressings)		
Assesses and selects suitable site for cannulation		
Prepares equipment and accessories for catheter insertion		
Positions patient to maximize access to desired area of insertion		
i.e. Trendelenberg position if required		
Attaches monitoring (ECG & SpO2)		
Applies protective equipment (gloves, mask & eyewear or face shield) as per standard precautions policy		
Washes hands using sterile hand-wash technique (2 mins)		
Prepares skin area appropriately (with antiseptic solution)		
Drapes patient with large sterile drapes to maximize sterile barrier		
Inspects catheter and equipment to ensure it is not damaged/remains intact & checks that the guide wire works		
Flushes/primes each lumen with 0.9% normal saline		
Palpates anatomical landmarks correctly		
Correctly anesthetizes skin and deeper tissue with local anesthetic		
Inserts cannula/needle with bevel facing upwards, advancing slowly while maintaining slight negative pressure with syringe		
Checks for "flashback" and advances guide wire to desired length		
Dilates skin and vessel with vessel dilator		
Inserts catheter over guide wire to desired or measured length whilst maintaining grip on guide wire at all times		
Removes guide wire & connects transducer line. Checks & acknowledges for NON-ARTERIAL waveform on monitor.		
Secures catheter at insertion site appropriately and applies sterile transparent occlusive dressing to insertion site		
Records date & time on dressing.		
Disposes all sharps material in sharps container		
Removes drapes and accessories from patient		
Correctly disposes general/contaminated waste materials		
Removes protective equipment and washes hands		
Documents procedure in patient's health care record		
Date: / /		

proficiency assessment in CVC placement for ICU medical trainees (See Table 2).

Characteristics of service delivery

From December 1996 to October 2008, 4212 catheters have been placed by the CVAS in 3055 patients. Two hundred forty six catheters were inserted in the first full year (1997).Since then the service has inserted up to 500 catheters per annum. The most common indication for catheter placement was for antibiotics (n=2598, = 61.7%), with the second highest indication being for oncology and autoimmune disorders (n=759, 18%). Over half (53%) of insertions used the subclavian vein while, the upper peripheral veins (for PICCs) were the next common (41.5%) access site. For the CVAS, these two routes of access represented just over 94% of total insertions. As an elective service, with minimal emergency insertions, the CVAS uses these two preferred anatomical sites to optimize catheter longevity and infection outcomes (Maki, Kluger, & Crnich, 2006). Characteristics of service are presented in Table 3.

Barriers and Facilitators to Service Implementation:

Four themes emerged from the data that identified barriers to service implementation: 1) opinions of medical clinicians, 2) medico-legal concerns, 3) risk minimization strategies, and 4) negotiating funding models.

Barriers:

Opinions of medical clinicians

While the intensive care physicians supported the concept, some other medical specialists expressed concern at nursing staff performing a procedure traditionally performed by medical practitioners. Initially, there was hesitation from surgeons who refused to refer their patients for CVC placement; and it took time before surgical patients were seen by the CVAS. Any incident was scrutinized for apparent deficiency in clinical skill or knowledge.

The medical directors of the ICU were required to intervene and assure other specialties that patient safety would not be compromised by making representation at specialty departmental meetings.

Medico-legal concerns

Medico-legal liability was a key concern and was discussed with both the hospital administration and the Medical Defence Union (MDU). While the MDU did not deny the feasibility of the role, it stated that there should be adequate training and protocols in place to prevent risk and that the procedure was to be scrutinized thoroughly before implementation. Once an appropriate training and credentialing program was developed, the hospital administration was satisfied and stated: "*a nurse is covered by public and professional liability for performing this role as for any other healthcare professional working within the area health service*." (Sydney South West Area Health Service, 1996)

Risk minimization strategies

The risks associated with this service were seen to be a barrier to implementation. In order to facilitate quality and patient safety and comply with the medico-legal obligations for the hospital, operating protocols were developed in consultation with medical specialists and introduced as part of a formal hospital wide policy and procedures program. Part of the operating protocol development included documentation and practice around coagulation levels; ensuring that consent was valid; and the monitoring of patients during procedure with pulse oxymetry, cardiac monitoring and confirming catheter position by venous waveform and radiology.

The operating protocol stipulated that senior ICU medical staff in the ICU at the time of line placement would be available for assistance if required. More recently with the availability of ultrasound guidance, the CVAS has used this technology where appropriate to facilitate vascular assessment and access.

Table 3. Characteristics of the CVAS

Patient Characteristics		
Number of Catheters	4,212	
Number of Patients	3,055	
Age mean (SD)	56 (19)	
Males %	58%	
Indication	**%**	**(N)**
Antibiotics	61.7	(2598)
Oncology / Autoimmune	18	(759)
Other	7.9	(332)
Poor Vascular Access	7.2	(305)
Parenteral Nutrition	5.2	(218)
Insertion Site	**%**	**(N)**
Subclavian	52.8	(2225)
Upper Peripheral Veins	41.5	(1748)
Femoral	3.6	(151)
Internal Jugular	2.0	(86)
Catheter Type	**%**	**(N)**
CVC	55.3	(2330)
PICC	38.9	(1635)
High Flow / Dialysis Catheter	3.5	(149)
Midline	2.2	(92)
Clinical Category of Patients	**%**	**(N)**
Medical	55.2	(2325)
Surgical	43.5	(1831)
Women & Child Health	1.0	(42)
Critical Care	0.3	(14)

Negotiating funding models

Funding for the service was an issue and required the ICU medical and nursing directors to think laterally. The eventual funding model involved a collaborative approach. The ICU accepted the fiscal responsibility for the nurse position as well as physically housing the service within an ICU office. As the service was developed in response to ward patient need, agreement was made between specialties that billing for consumables would be made to the clinical division for which the patient was assigned. A database was also developed at the inception of the service so that a record of all patients who had a CVC placed by the CVAS would be recorded and archived to facilitate billing, research and quality improvement.

Facilitators:

In response to the challenges discussed above a number of facilitators were also identified including: 1) clinical leadership, mentoring and education, 2) organizational support; 3) outcome assessment and quality assurance

Clinical Leadership, mentoring and education

As with most programs of change, clinical leadership and support was integral. Senior nursing and medical staff from the ICU had a vision and enabled it. Education and accreditation processes were implemented within a collegial framework. This format provided a standardized approach for catheter placement that would reduce catheter insertion complications and also reduce CVC associated bacteremia. A learning program was developed that included theory, clinical teaching and competency based assessment.

The theoretical component involved tutorial and bedside teaching for the nurse by ICU physicians, including anatomy and physiology, contraindications for catheterization, intra-procedural problems, as well as post insertion complications and treatment. An oral viva (a method of examination where students are asked a question by an examiner and are required to verbalize the answer) was used to assist in the theoretical assessment along with a written examination that included multiple choice and short answer questions.

As part of the program, the nurse observed ICU physicians insert CVCs; then, inserted 20 CVCs under direct supervision, including subclavian, internal jugular, femoral, and upper peripheral vein approaches using competency based proficiency assessment. All attempts at the time were recorded as part of the credentialing process. Pre- and post-procedure debriefing occurred as part of the supervised insertions with ICU physicians that included review of abnormal anatomy, physiological anomalies such as deranged coagulation and previous medical history. Chest x-ray interpretation for optimal catheter tip placement and review for pneumothorax also formed an important component of the practical assessment. Over time this model became a framework for junior medical staff training.

Organizational support

Initial scepticism and hesitancy related to the service was balanced by significant support by a range of other professionals, including administrators, nurses from the ICU and the general wards. The achievement of organizational efficiencies and the recognition by clinicians that a single point of contact was available for advice and support quickly led to an organizational shift in attitude.

Key stakeholders such as the general manager of the hospital at the time were integral in service success by giving the position full support. A key facilitator also has been prominent CVAS representation at hospital orientation for new medical and nursing staff and the routine education of existing clinical staff. This role has facilitated a cultural and attitudinal change within the hospital.

Prospective methods for outcome assessment and quality assurance

The CVAS primarily provides an elective (non emergent) catheter placement service with dedicated follow-up and consultation. Time is invested in data collection, collation and review of outcomes on a regular basis so that there is a continuous quality improvement program for vascular access within the hospital. This has led to an infrastructure for monitoring of patients with CVCs across the hospital and as such, there is a defined contact point for clinical staff that have enquiries concerning vascular access devices (VADs). In addition, clinicians have access to specialists in central venous access who have the ability to address catheter issues and as a consequence increase catheter longevity (See Table 4).

The structured competency based approach to clinical assessment and outcome review has given external organization prominence for the CVAS and is seen as a key opinion leader in dedicated central venous access services within Australia. The competency based approach for CVC assessment has been adopted as a framework for a state-wide project within New South Wales (NSW). The central line associated bacteremia (CLAB) project run by the Clinical Excellence Commission (CEC) in NSW has involved the CVAS in many aspects of the project

Table 4.

CVAS calling criteria

- Patients requiring intravenous access for longer than 2 weeks
- Patients needing specific IV drug therapy that is phlebogenic (e.g. chemotherapy / Parenteral Nutrition / IV antibiotics / IV medication with ph<6.5)
- Patients with poor vascular access
- Patients with a blocked Central Venous Catheter (CVC) lumen
- Patients that have signs of infection who have a CVC insitu
- Patients that have pain associated with the CVC
- Any other issues related to a CVC

Table 5. Advantages of a nurse-led CVAS

- Allows timely response to requests for elective CVC insertions that may be delayed due to the acute care focus of anesthetic and critical care services
- Provides an infrastructure for support of CVC best practice across the organization
- Facilitates individualized patient assessment and continuity of care
- Affords capacity for data collection and management to monitor for clinical outcomes
- Presents a framework for interdisciplinary collaboration

Table 6. CVAS pre-insertion check criteria

- Valid signed informed consent
- Consultation form
- APTT 35 – 45 seconds (Activated Partial Thromboplastin Time)
- INR <1.5 (International Normalised Ratio)
- Platelets > 50,000 x 10^9 / L
- Oxygen requirements (Litres / Minute)
- Anticoagulant medication (Type / Dose)
- Allergies (Type / Response)
- Is this a high risk patient (such as abnormal body habitus)?
- Availability of senior ICU medical staff if required

which has aimed to reduce CLABs and promote quality and safety in central venous access (Clinical Excellence Commission).

Current operational aspects of the CVAS

The CVAS uses a cart that stocks all consumables including a variety of CVCs. The trolley is wheeled to any one of the 28 bed spaces in the ICU that may be vacant and available to use for catheter placement. If all ICU beds are occupied which sometimes occurs, the trolley allows the service to be more mobile and provide the service at the ward bedside. In cases where CVC insertion occurs at the ward bedside, a portable monitor is used.

During hospital orientation and mandatory education days, new hospital clinical staff are educated about the CVAS and what services it can provide. The CVAS provides training and accreditation on the insertion of CVCs for medical trainees joining the ICU. These staff are expected to complete a workbook and questionnaire prior to being assessed clinically. Clinical accreditation involves competency-based assessment. (See Table 2). Once the medical trainees have been accredited they are permitted to insert CVCs within the ICU.

The nurses in the CVAS are contacted by phone and by pager. Ward nursing staff are encouraged to contact the CVAS if they identify a patient whom they feel will benefit from a CVC and in cases like these the CVAS acts as a consultancy to the admitting team advising of the best VAD for the patient (See Table 5). Patients are brought to a vacant bed area in the ICU by the hospital ward orderly department. Prior to commencement of procedure the patient is given information regarding the procedure; clinical notes are checked for a valid consent form. A number of pre-insertion checks are undertaken and documented such as a brief review of clinical history and presenting problems of the patients. The medication chart is reviewed to ascertain any medications that may influence the safety of the procedure and the electronic records are then reviewed for recent pathology results including platelet count and coagulation profile (See Table 6).

Most CVC insertion requests are actioned within 24 hours. Typically catheter placement is undertaken either the same day or the following day dependant on service activity and the time of initial phone consultation. The CVAS is responsible for all patients who are receiving PN outside of the ICU. Patients are reviewed daily and solution rate is adjusted accordingly. The CVAS works in conjunction with a senior ICU doctor, a pharmacist and a dietician to manage patients that are on PN. This multidisciplinary approach has enabled a more effective approach to PN and also ensures that patients are monitored more closely with daily assessment and review.

The service has continued to evolve and develop in response to therapeutic advances. In recent years, the role of ultrasound and its benefits have greatly influenced how vascular access is attained (French, Raine-Fenning, Hardman, & Bedforth, 2008; Verghese et al., 1999). Both nurses within the CVAS have undergone formal training in the use of ultrasound and this technology has improved vascular assessment and in aiding catheter placement where appropriate.

Discussion

This review has provided an historical account of the implementation of a nurse-led CVAS and in particular, the challenges faced and how these were overcome. Our nurse-led CVAS was developed out of increased organizational workload and the need to improve staff skill mix. The concept of a nurse-led CVAS required cultural change within the hospital. Full acceptance took time to achieve. Clinical and organizational leadership from senior clinical and administrative staff played a significant role in the success of the service.

Conclusion

The CVAS has been well accepted and widely used since its inception in 1996. The service is used across hospital settings including general wards, operating theatres, the Emergency Department and the ICU. The implementation of the CVAS has challenged traditional organizational and professional boundaries to improve patient care and capacity to monitor patient outcomes. The CVAS staff are involved extensively in education, quality improvement, research and policy development at

a local, state and international level. This evaluation has demonstrated that through systematic attention to barriers and optimizing enabling factors, innovative, nurse-led service models can be promoted to improve patient care.

Acknowledgements

Professor Ken Hillman, Associate Professor Gill Bishop and Associate Professor Kathy Daffurn for their vision and faith in the clinical competence of ICU nurses to perform such a role. The primary author wishes to thank Tim Spencer, Clinical Nurse Consultant in the CVAS for his mentorship and guidance.

Summary of key points:

- Workforce innovation and multidisciplinary care can have positive patient outcomes and improve organizational efficiencies.
- Implementing an advanced nurse-led clinical practice model can be confronting to medical practitioners. It is vitally important that key clinicians within an organization assist to champion the role.
- Critical care nurses with their broad clinical and assessment skills are ideal candidates for such an advanced practice role.
- Having a nurse-led CVAS that is skilled in various vascular accesses techniques, can lead to a broad range of patients across the hospital being seen and therefore making the service an important adjunct to the organization.

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