Alexandrou, E., Spencer, T., Frost, S.A., Parr, M., Davidson, P.M., Hillman, K.M. (2010). Establishing a nurse-led central venous catheter insertion service. Journal of the Association for Vascular Access, 15 (1), 2127

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: 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 organisational 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.

Central venous catheters 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).

Operator experience is important in reducing CVC insertion complications. An experienced operator who has inserted more than 50 CVCs is estimated to have half the complication rate of one that has inserted less than 50 (Taylor & Palagiri, 2007). Achieving this experience can be challenging when clinicians are undertaking diverse roles. Nurse-led models for CVC insertion have shown promise in addressing workforce shortages of medical practitioners and improving health outcomes that are related to specialisation (Alexandrou, Accepted for Publication January 16th 2009).

Increasingly, nurse-led models of care using advance practice roles 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 review undertaken to describe existing nurse-led models for CVC insertions, it was found that services had been introduced to overcome delay in CVC insertion due to shortages of doctors, particularly in elective placement and because of a perception of increased risk resulting from less experienced medical staff placing CVCs (Alexandrou, Accepted for Publication January 16th 2009). Other reasons for introducing these services were unacceptable rates of infection, misplaced catheter tips; increased costs associated with repeat attempts by other clinicians and increased length of stay (Fitzsimmons et al., 1997; Hamilton, 2004, 2005). Patient outcomes from nurse led CVC insertion compared well, including published rates of common complications (Boland, Haycox, Bagust, & Fitzsimmons, 2005; Casey & Davies, 2003; Goral, Fitzsimmons, & Lawrance, 2006; Kelly, 2003; Waterhouse, 2002).

In our hospital similar issues and concern led to a nurse-led central venous access service (CVAS) being established in 1996. The CVAS has remained in operation with over 4500 catheter placements. It currently employs two advanced practice nurses with a critical care background who insert CVCs for hospital patients and assist in managing parenteral nutrition (PN) for patients outside the intensive care unit (ICU).

Aim

The paper aims to discuss the establishment of a nurse led CVAS in a university affiliated hospital. The paper presents the rationale for implementation, the process of

service development, the ongoing adjustment and the current status of the service.

Method

Setting

The study 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).

Analysis of policy documents and meeting minutes was undertaken using thematic content analysis (Marconi & Rudzinski, 1995; Smith, 1992). Interviews were undertaken with key stakeholders from nursing, medicine and hospital administration using a semi-structured questionnaire **(Table 1).** Descriptive analysis of data generated from an administrative data set was undertaken to describe patient characteristics. Ethical approval for this study has been granted by the institutions human ethics committee.

Results

Documents, administrative data and reports between 1996 and 1997 were reviewed. Staff identified as being 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 1990's, 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 standardised 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 organised approach to monitoring and supporting PN administration also led to unnecessary delays and poor management.

To address this problem, the ICU medical directors at the time, applied for funding through medical administration for an extra medical staff training position to assist with the workload. This application was declined due to of 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 organisational level, and improve efficiencies and outcomes. To ensure the nurse possessed this knowledge and experience, certain pre-requisites for the role were identified; these included: a critical care background, a 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 service demand warranted 5 day week coverage. The service operated in this manner for 7 years, until in 2003 a second nurse was employed to accommodate increased demand. Currently there are two advanced practice nurses who have been trained and credentialed to insert CVCs throughout the hospital. A third nurse is also 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 proficiency assessment in CVC placement for ICU medical trainees **(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 and 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 optimise 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 delivery: Opinions of medical clinicians; medico-legal concerns; risk minimisation strategies; and 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 scrutinised 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 scrutinised 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*".

- *Risk minimisation 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 also 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.

- *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: *Clinical Leadership, mentoring and education; organisational*

support; as well as prospective methods for 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 standardised approach for catheter placement that would reduce catheter insertion complications and also reduce CVC associated bacteraemia. A skill based program including theoretical and practical teaching and assessment was developed.

The theoretical component involved tutorial and bedside teaching for the nurse by ICU physicians, including anatomy and physiology, contraindications for catheterisation, intra-procedural problems, as well as post insertion complications and treatment. An oral viva 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.

- *Organisational 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 organisational efficiencies and the recognition by clinicians that a single point of contact was available for advice and support quickly led to an organisational 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 has 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 **(Table 4).**

The structured competency based approach to clinical assessment and outcome review has given external organisation 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 bacteraemia (CLAB) project run by the Clinical Excellence Commission (CEC) in NSW has involved the CVAS in many aspects of the project 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 trolley 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. **(Table 1).** Once the medical trainees have been accredited they are permitted to insert CVCs within the ICU.

The service is contacted by phone and by pager. 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 **(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 (**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 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 organisational workload and the need to improve staff skill mix. The concept required cultural change within the hospital. Full acceptance took time to achieve. Clinical and organisational 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 organisational and professional boundaries to improve patient care and capacity to monitor patient outcomes. .The CVAS is 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 optimising 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.

Summary of key points:

Central venous catheters are associated with immediate and delayed adverse patient outcomes and have traditionally been placed by medical practitioners. Competing work demands and increased medical specialisation has brought forward the concept of nurse-led central venous access teams and appear to be a viable health service

delivery model. This study's key points are:

- Workforce innovation and multidisciplinary care can have positive patient outcomes and improve organisational efficiencies.
- Implementing an advanced nurse led clinical practice model can be confronting to medical practitioners. It is vitally important that key clinicians within an organisation assist to champion the role.
- Critical care nurses with there 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 leads to a broad range of patients across the hospital being seen and therefore making the service an important adjunct to the organisation.

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?*

TABLE 2: CENTRAL VENOUS CATHETER INSERTION COMPETENCY ASSESSSMENT CHECKLIST

COMPETENCY ASSESSMENT CHECKLIST – Central Venous Cannulation

Site of insertion: _____

The following criteria must be successfully achieved during assessment.

Unsuccessful attempts must also be recorded and assessed.

Criteria **Assessee's Name: _____**	**Achieved** ✔ or ✕ (or n/a)	**Re-assessment (If required) &/or Comments**
Procedure		
Explains procedure to patient and obtains consent – if applicable		
Organises equipment (ensure sharps container is on hand)		
Identify's patient and performs safety checklist		
Ascertains if patient has any allergies (eg. to antiseptic solutions, local anaesthetic agents or dressings)		
Assesses and selects suitable site for cannulation		
Prepares equipment and accessories for catheter insertion		
Position's patient to maximise access to desired area of insertion i.e. Trendelenberg position if required		
Attaches monitoring (ECG or SpO^2) if available		
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 maximise sterile barrier		
Inspects catheter and equipment to ensure it is not damaged/remains intact & checks that the guidewire works		
Flush/prime each lumen with 0.9% normal saline		
Palpates anatomical landmarks correctly		
Correctly anaesthetises skin and deeper tissue with local anaesthetic		
Inserts cannula/needle with bevel facing upwards, advancing slowly while maintaining slight negative pressure with syringe		
Checks for "flashback" and advances guidewire to desired length		
Dilates skin and vessel with vessel dilator		
Inserts catheter over guidewire to desired or measured length whilst maintaining grip on guidewire at all times		
Removes guidewire & 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 Date & time must be recorded on dressing.		
Dispose of all sharps material in sharps container		
Removes drapes and accessories from patient		
Correctly dispose of general/contaminated waste materials		
Remove protective equipment and wash hands		
Document procedure in patients health care record		

Date: / /

TABLE 3: CHARACTERISTICS OF CVAS

CHARACTERISTICS	
No. of Catheters	4,212
No. of patients	3,055
Age mean (SD)	56 (19)
Males %	58%
Indications % (N)	
Oncology / Autoimmune	18.0 %(759)
Parenteral Nutrition	5.2% (218)
Antibiotics	61.7% (2598)
Poor Vascular Access	7.2% (305)
Other	
Insertion Site %(N)	
Subclavian	52.8% (2225)
Internal Jugular	2.0% (86)
Femoral	3.6% (151)
Upper Peripheral Veins	41.5% (1748)
Catheter Type	
CVC	55.3% (2330)
PICC	38.9% (1635)
VASCATH	3.5% (149)
MIDLINE	2.2% (92)
Clinical Category of Patients	
Medical	55.2% (2325)
Surgical	43.5% (1831)
Women & Child Health	1.0% (42)
Critical Care	0.3% (14)

TABLE 4: CENTRAL VENOUS ACCESS SERVICE CALLING CRITERIA:

CVAS CALLING CRITERIA

- Patients requiring intravenous access for longer than 2 weeks
- Patients needing specific IV drug therapy that is phlebogenic (E.g. chemotherapy / PN / IV antibiotics / IV medication with ph<6.5)
- Patients with poor vascular access
- Patients with a blocked 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 PICC / CVC

LEGEND:
PN - Parenteral Nutrition
PICC - Peripherally inserted Central Catheter
CVC - Central Venous Catheter

TABLE 5: ADVANTAGES OF A NURSE-LED CENTRAL VENOUS ACCESS SERVICE

- Allows timely response to requests for elective CVC insertions that may be delayed due to the acute care focus of anaesthetic and critical care services
- Provides an infrastructure for support of CVC best practice across the organisation
- Facilitates individualised 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 $\geq$ 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

Alexandrou, E. Spencer, T. Frost, S. Parr, M. Davidson, P. Hillman, K. (Accepted For Publication January 16th 2009). The nursing role in central venous cannulation: implications for practice, policy and research. . *Journal of Clinical Nursing*.

Boland, A., Haycox, A., Bagust, A., & Fitzsimmons, L. (2005). Randomized controlled trial to evaluate the clinical-and cost-effectiveness of Hickman line insertions in adult cancer patients by nurses. *International Journal of Technology Assessment in Health Care, 21*(01), 145-146.

Casey, J., & Davies, J. (2003). A nurse led central line insertion service. *EDTNA/ERCA journal (English ed.), 29*(4), 203.

Clinical Excellence Commission, N. S. W., Australia Central Line associated Bacteraemia in Intensive Care Units Project. from www.cec.health.nsw.gov.au/programs/clab-icu.html

Comfere, T. B., & Brown, D. R. (2007). Central Venous Catheters: Considerations Regarding Placement and Clinical Use. *Contemporary Critical Care, 5*(1), 1.

Cowan, M. J., Shapiro, M., Hays, R. D., Afifi, A., Vazirani, S., Ward, C. R., et al. (2006). The effect of a multidisciplinary hospitalist/physician and advanced practice nurse collaboration on hospital costs. *Journal of Nursing Administration, 36*(2), 79.

Fitzsimmons, C. L., Gilleece, M. H., Ranson, M. R., Wardley, A., Morris, C., & Scarffe, J. H. (1997). Central venous catheter placement: extending the role of the nurse. *Journal of the Royal College of Physicians of London, 31*(5), 533.

French, J. L. H., Raine-Fenning, N. J., Hardman, J. G., & Bedforth, N. M. (2008). Pitfalls of ultrasound guided vascular access: the use of three/four-dimensional ultrasound. *Anaesthesia, 63*(8), 806.

Gopal, K., Fitzsimmons, L., & Lawrance, J. A. L. (2006). *Nurse-led central venous catheter service: Christie experience* o. Document Number)

Hamilton, H. C. (2004). Advantages of a nurse-led central venous vascular access service. *The Journal of Vascular Access, 5*, 109 - 112.

Hamilton, H. C. (2005). A nurse-led central venous vascular access service in the united kingdom. *Journal of the association of vascular access, 10*(2), 77 - 80.

Horattas, M., Trupiano, J., Hopkins, S., Pasini, D., Martino, C., & Murty, A. (2001). Changing concepts in long term venous access: catheter selection and cost savings. *American Journal of Infection Control, 29*(1), 32 - 40.

Kelly, L. J. (2003). A nurse-led service for tunnelled central venous catheter insertion. *Nursing times, 99*(38), 26.

Lee, A., Bishop, G., Hillman, K. M., & Daffurn. (1995). The medical emergency team. *Shock, 7*, 3.

Maki, D. G., Kluger, D. M., & Crnich, C. J. (2006). *The risk of bloodstream infection in adults with different intravascular devices: a systematic review of 200 published prospective studies.*

Marconi, K. M., & Rudzinski, K. A. (1995). A Formative Model to Evaluate Health Services Research. *Evaluation Review, 19*(5), 501-510.

Ritz, L. J., Nissen, M. J., Swenson, K. K., Farrell, J. B., Sperduto, P. W., Sladek, M. L., et al. (2000). *Effects of advanced nursing care on quality of life and cost outcomes of women diagnosed with breast cancer*.

Ryden, M. B., Snyder, M., Gross, C. R., Savik, K., Pearson, V., Krichbaum, K., et al. (2000). Value-added outcomes: The use of advanced practice nurses in long-term care facilities. *The Gerontologist, 40*(6), 654.

Sharpe, E. L. (2006). Developing a Nurse-Directed Peripherally Inserted Central Catheter Team in the Neonatal Intensive Care Unit. *Newborn and Infant Nursing Reviews, 6*(4), 225-229.
Smith, C. P. (1992). *Motivation and personality: Handbook of thematic content analysis*: Cambridge Univ Pr.
Taylor, R. W., & Palagiri, A. V. (2007). Central venous catheterization. *Critical care medicine, 35*(5), 1390.
Verghese, S. T., McGill, W. A., Patel, R. I., Sell, J. E., Midgley, F. M., & Ruttimann, U. E. (1999). Ultrasound-guided internal jugular venous cannulation in infants: a prospective comparison with the traditional palpation method. *Anesthesiology, 91*(1), 71.
Waterhouse, D. (2002). Vascular access: a role for a renal nurse clinician. *EDTNA/ERCA journal (English ed.), 28*(2), 64.