REVIEW

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# A review of the nursing role in central venous cannulation: implications for practice policy and research

Evan Alexandrou, Timothy R Spencer, Steve A Frost, Michael JA Parr, Patricia M Davidson and Kenneth M Hillman

**Aims and objectives.** The aim of this article is to review published studies about central vein cannulation to identify implications for policy, practice and research in an advanced practice nursing role.
**Design.** Modified integrative literature review.
**Methods.** Searches of the electronic databases: Cumulative Index of Nursing and Allied Health Literature (CINAHL); Medline, Embase, and the World Wide Web were undertaken using MeSH key words. Hand searching for relevant articles was also undertaken. All studies relating to the nurses role inserting central venous cannulae in adult populations met the search criteria and were reviewed by three authors using a critical appraisal tool.
**Results.** Ten studies met the inclusion criteria for the review, all reported data were from the UK. There were disparate models of service delivery and study populations and the studies were predominantly non experimental in design. The results of this review need to be considered within the methodological caveats associated with this approach. The studies identified did not demonstrate differences in rates of adverse events between a specialist nurse and a medical officer.
**Conclusions.** There were only a small number of studies found in the literature review and the limited availability of clinical outcome data precluded formal analysis from being generated.
**Relevance to clinical practice.** Central vein cannulation is potentially an emerging practice area with important considerations for policy practice and research. Training specialist nurses to provide such a service may facilitate standardising of practice and improving surveillance of lines, and possibly improve the training and accreditation process for CVC insertions for junior medical officers. For this to occur, there is a need to undertake well-conducted clinical studies to clearly document the value and efficacy of this advanced practice nursing role.

**Key words:** central venous cannulae, critical care, Health Services Research, multiprofessional care, nurses, nursing

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## Introduction

### Central venous access in contemporary clinical practice

Central venous cannulae (CVCs) are used for delivering vesicant medications, long term intravenous therapy, parenteral nutrition, and in some instances for individuals with poor peripheral venous access. The CVC is also used in critical care settings for haemodynamic monitoring (Taylor & Palagiri 2007). While traditionally confined within specialised areas such as intensive care units and operating theatres, central venous cannulation is being adopted across

**Authors:** *Evan Alexandrou*, RN, B.Health, ICU Cert, MPH, PhD Candidate, Clinical Nurse Specialist, Centre for Cardiovascular and Chronic Care, Curtin University of Technology, Sydney, NSW, Australia; *Timothy R Spencer*, RN, B.Health, ICU Cert, Clinical Nurse Consultant, Sydney South West Area Health Service, Intensive Care, Sydney, NSW, Australia; *Steve A Frost*, RN, ICU Cert, MPH, PhD Candidate, Associate Lecturer, School of Nursing, Sydney, University of Western Sydney, NSW, Australia; *Michael JA Parr*, FRCP, FRCA, FANZCA, FJFICM, Director of Intensive Care, University of NSW, Sydney, NSW, Australia; *Patricia Mary Davidson*, RN, PhD, Professor, Centre for cardiovascular and Chronic Care, Curtin University of Technology, Chippendale, NSW, Australia; *Kenneth M Hillman*, MD, MBBS, FRCA, FANZCA, FJFICM, Professor, University of NSW, Sydney, NSW, Australia
**Correspondence:** Evan Alexandrou, Liverpool Hospital, Intensive Care, Locked bag 7203, Liverpool BC, Sydney, NSW 1871, Australia. Telephone: +02 98283603.
**E-mail:** e.alexandrou@uws.edu.au

 
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many specialist in-patient settings, and more recently in community practice (Hamilton 2005). The nursing role in inserting CVCs is being developed in response to local organisational factors, such as medical workforce shortages and increasing demand coinciding with the development of the advance practice nursing role (Dowling *et al.* 1995).

Complications from CVC insertion include arterial puncture, pneumothorax, haematoma, cardiac arrhythmias and venous perforation and are associated with mortality rates as high as 47% (Comfere & Brown 2007). These procedural risks possibly explain why traditionally CVC insertions have been performed by medical officers (Table 1).

Due to the potential for iatrogenic events associated with CVC insertion, the procedure requires trained clinicians that can assess a patient's vascular access and determine the most appropriate insertion site, accommodating a variety of clinical conditions as well as consideration of patient comfort. The type and duration of therapy, will determine the choice of catheter material, the number of lumens, and the tunnelling requirement (Hamilton 2004a). In some instances the use of ultrasound guidance, particularly in the obese or coagulopathic patient can minimise procedural complications (Bishop *et al.* 2007).

### Advanced practice nursing roles

In health care settings the boundaries between medical and nursing clinicians in respect to their clinical work and accountabilities is constantly being challenged due to advancing technologies and increased specialisation that is also changing the mode of health care delivery (Dowling *et al.* 1995). Since the advanced clinical nurse career path was first described in the 1980's, there has been much written in the literature in regard to the role of specialist nurses (Wright 1997, Pearson & Peels 2002a). In addition to formalising the advanced practice nursing role, the clinical nurse specialist has also evolved in response to workforce and practice changes in health care delivery as well as providing support for the workload of junior medical officers (Pearson & Peels 2002b).The advanced practice nursing role is defined by the International Council of Nursing as a registered nurse who has acquired the expert knowledge base, complex decision-making skills and clinical competencies for expanded practice (Schober & Affara 2006). Specialist nurses across a range of practice settings are a critical link in providing continuity and coordination of care. There is increasing high quality evidence that specialist nurses can provide efficient, cost effective care that directly influences patient outcomes (Wright 1997). Additionally, as a greater emphasis is placed upon cost effectiveness and quality of care, nurse specialists will be integral in the development and shaping of future health policy, particularly within the realm of health outcomes and health outcomes research (Chornick 2008).

**Table 1** Complication rates from cvc insertion

| Complication | I. Jugular (%) | S/Clavian (%) | Femoral (%) |
|---|---|---|---|
| Arterial puncture | 6·3–9·4 | 3·1–4·9 | 9·0–15 |
| Haematoma | 0–9·4 | 1·2–2·1 | 3·8–4·4 |
| Pneumothorax | 0–0·7 | 1·2–3·1 | NA |
| Venous perforation | 0·2 | 1·2 | 0 |
| Total | 6·3–12·1 | 6·2–10·7 | 12·8–19·4 |

Source: (Comfere & Brown 2007)

### The nursing role in the insertion and management of central venous catheters

Dedicated vascular access teams have, historically, been limited to peripheral cannulation with some teams having the ability to insert peripherally inserted central catheters (PICCs). Dedicated vascular access teams have demonstrated improvement in patient safety, better catheter outcomes and a reduction in catheter related nosocomial infections (Sharpe 2006). Nurse-led vascular access teams have also demonstrated improvements in hospital efficiency (Hunter 2003).

Successful insertion rates for PICCs by nurses have been reported to be >93% (Funk *et al.* 2001, Burns 2005, Gamulka *et al.* 2005). Nurse-led teams also provide important follow up for consultancy and education which traditionally are not available with medical services due to competing demands. This consultancy and education role can include clinician and patient education, line follow up and management of complications (Fong *et al.* 2001, Ean *et al.* 2006).

Although the risks associated with CVC insertion are well documented, the nursing role in relation to insertion and line management is not as well described in published literature, nor is the role delineation with medical colleagues well defined. This integrative literature review seeks to describe the state of the science in relation to the advanced practice nursing role in the insertion and management of CVCs in order to inform policy, practice, education and research strategies.

## Methods

The integrative review is a method that allows for the inclusion of varying designs, in order to provide a comprehensive review of the research of interest (Whittemore & Knafl 2005). An integrative review is of particular benefit in scoping of a problem or issue and empirically documenting a


 

plan of action and/or considering implications for policy, practice and research. We extended this predominately narrative method of analysis by generating forest plots for complication rates (Lewis & Clarke 2001). A forest plot is a graphical display that shows the strength of the evidence. Although initially developed for formal meta analysis, this method is also used in observational studies (Lewis & Clarke 2001). We did not undertake a formal meta-analysis as the complication rates were reported as crude rates and there was heterogeneity of study methods. Following consultation with a health care librarian, the electronic databases CINAHL, Medline, Embase and the Internet were searched using key words including 'central venous catheter, 'catheterisation', 'nursing role', 'advanced practice nurses', 'clinical nurse specialists', 'nurse practitioner', 'clinical nurse consultant' and 'advanced practice roles'. The reference lists of published materials were searched for additional literature. Journals held locally were hand searched for relevant articles. The World Wide Web was searched using the Google Scholar and Yahoo search engines for related electronic documents (Table 1).

Studies were included for the review if they described the role of nurses in the advanced practice role of CVC insertion in an adult population, using either tunnelled or non tunnelled techniques. Articles relating to the nursing role in PICC insertion were excluded. In light of the small number of studies, all published manuscripts whether using experimental or non-experimental methods were included in the review. The literature review strategy was supervised by a health librarian with expertise in undertaking integrative and systematic literature reviews. All articles meeting the search criteria were reviewed by the primary author and two co-authors using a critical appraisal tool.

The complications reported in the retrieved manuscripts were pneumothoraces, sepsis, arterial puncture and misplaced tip. Percentages from the papers were tabulated and then calculated at 95% confidence intervals. Forest plots were generated (using random effects) to exemplify the results of individual studies as point estimates to give an overall estimate with the combined results. The forest plot was used for the results of the four complications to facilitate comparison of events using STATA Version 7 (STATA Corporation, College Station, TX, USA).

## Findings

A total of 525 papers were identified using the search strategy described. Abstracts of these papers were reviewed by the primary author (EA) to assess whether the papers met the inclusion criteria. This process identified ten papers that met the inclusion criteria. These papers were then reviewed by co-authors to confirm that they met the inclusion criteria. Data were then extracted from the papers by three reviewers and are summarised in Table 2. Following a narrative analysis, three themes emerged from this review relating to: (i) development of a nurse-led service; (ii) Outcomes of nurses inserting central lines; and (iii) Educational requirements for nurse credentialing. These are discussed below:

### Development of a nurse led service

The majority of articles (seven in total) were a retrospective report of the development of the nursing CVC insertion roles within each author's respective facilities. All ten articles, some including common authors, described care models in the UK.

Of interest, two articles discussed that one of the major determinants for service development was the delay in central line insertion. Delay times were reported from Waterhouse (2002) for a permanent dialysis catheter to be up to 48 days. This was reduced to a waiting period of between 2–5 days with the implementation of the nurse led service. Fitzsimmons *et al.* (1997) also showed that with the implementation of a nurse led service there was an increase from 80% of patients to 97% of patients acquiring their CVC on the same day.

Hamilton (2005) discussed issues associated with junior surgeon based line placement and why a nurse led service was developed in her facility. Issues included insertion risk, unacceptable rates of infection, misplaced lines, increased costs associated with repeat attempts by other clinicians and increased stress to the patient along with increased length of stay.

Kelly (2003) derived a multidisciplinary approach to developing a nurse led CVC service. This included the disciplines of microbiology, radiology, pharmacy, auditing department and bio engineering in assisting in the initial set up.

These reports illustrate that the nurse-led services have emerged based on a pressure to increase organisational efficiencies and improve patient outcomes. Such was the case also with Benton and Marsden (2002) where the medical CVC insertion service through the interventional radiology department grew rapidly and placed limitations on the service availability.

### Outcomes of nurses inserting central lines

Complication rates were discussed and presented as crude rates in six of the ten articles. No weighting or statistical

**Table 2** Reviewed papers

| Study type | Participants | Interventions | Outcome |
|---|---|---|---|
| Author(s): Kelly (2003) | | | |
| Review article | Oncology patients requiring tunnelled CVC insertions for therapy<br>160 catheters placed by nurses<br>Country: UK | Implementation of a tunnelled CVC service to reduce insertion waiting times<br>Development of training and credential ing course for clinical nurse specialists to insert central venous catheters | From an audit of 20 patients the average waiting time was three days and no complications in 89% of catheter placements<br>Changes in practice for the insertion of catheters included the use of chlorhexidine antisepsis, rationing catheter lumens (using single lumens where possible) and antibiotics not routinely given |
| Author(s): Hamilton *et al.* (1995) | | | |
| Review article | Surgical patients requiring tunnelled CVC insertions for TPN<br>Medical patients requiring tunnelled CVC insertions for oncology therapy<br>559 Patients<br>Country: UK | Implementation of a tunnelled CVC service to reduce insertion waiting times and improve patient outcomes<br>Development of training and credentialing course for clinical nurse specialists to insert central venous catheters | Complication / Number (*n*) / Percent (%)<br>Pnuemothorax 6 1<br>Sepsis 6 1<br>Nil 548 98<br>Total 560 100<br>Training given to medical and nursing staff in management of CVCs |
| Author(s): Casey and Davies (2003) | | | |
| Case/control study | Renal dialysis patients requiring CVC insertions for dialysis therapy<br>289 Patients<br>Country: UK | Comparative analysis between advanced practice nurses and medical officers on the insertion of dialysis CVCs<br>Patients were studied over a 24 month period, the outcomes examined included type of CVC used, insertion site, line survival rates and reason for removal | Analysis between advanced practice nurses and medical officers<br>Category / *p*-value<br>Age 0·517<br>Sex 0·783<br>Perm vs. temp CVC 0·387<br>Elective removal 0·323<br>Non elective removal 0·938<br>Removal for infection 0·1437<br>No statistical difference found between the two groups |
| Author(s): Gopal *et al.* (2006) | | | |
| Descriptive article | Patients requiring sub clavian CVC insertion for TPN and oncology therapy<br>348 Patients<br>Country: UK | Prospective study over a 6 month period where information was recorded that included:<br>Indication, diagnosis, type and position of catheter, complications during procedure and patient satisfaction | Complication / Number (*n*) / Percent (%)<br>Pnuemothorax 3 1<br>Arterial puncture 16 4<br>Misplaced tip 29 8<br>Failed procedure 3 1<br>Nil 294 86<br>Total 345 100<br>98% of CVCs were inserted at the bedside and 76% of CVCs used were single lumen |

 

**Table 2** (Continued)

| Study type | Participants | Interventions | Outcome |
|---|---|---|---|
| Author(s): Waterhouse (2002) | | | |
| Review article | Renal dialysis patients requiring CVC insertions for dialysis therapy<br>103 Patients<br>Country: UK | Non analytic comparison of between advanced nurse practitioner's and medical officers on the insertion of dialysis CVCs<br>Tertiary qualification and clinical training given to experienced renal nurse for the development of a service to insert renal dialysis catheters | Complication / Number (*n*) / Percent (%)<br>Pnuemothorax 1 1<br>Primary failure 1 1<br>Infection in 72 hours 1 1<br>Nil 67 98<br>Total 70 100<br>Significant difference in average waiting times between medical officers and nurses (48 days vs. 7 days). Minimal difference in complication rates between the two groups |
| Author(s): Benton and Marsden (2002) | | | |
| Descriptive article | Cancer patients requiring CVC insertion for oncology therapy<br>No of Hickman lines: 45<br>Country: UK | Development of a training program and the appointment of a two nurses to safely place tunnelled CVCs<br>Operating protocols were written and received trust board approval<br>Training for the nurses included theory and practice. The practical component involved phantom techniques (turkey breasts) using ultrasound guidance | 45 Hickman lines had been placed at time of publication by nurses under ultrasound guidance<br>The development of an *in vitro* model for clinical practice will aid other nurses and junior doctors the opportunity to gain experience in the insertion of tunnelled CVCs |
| Author(s): Boland *et al.* (2005) | | | |
| Randomised controlled trial | Cancer patients requiring Hickman line insertion for therapy that were over 18 years of age<br>158 Blind insertions<br>197 Image guided insertions<br>Country: UK | Two interventions were investigated: (i) blind insertion of a Hickman line and (ii) image guided insertion of a Hickman line<br>Both interventions involved the use of the landmark technique for access to the subclavian vein<br>The image guided arm involved the use of fluoroscopy for catheter placement | Complication / Blind (%) / Image guided (%)<br>Pnuemothorax 7 (3) 2 (1)<br>Line infection 10 (4) 14 (16)<br>Tunnel infection 11 (5) 4 (2)<br>Arterial puncture 15 (16) 13 (5)<br>Misplaced tip 32 (14) 1 (1)<br>Haematoma 2 (1) 4 (2)<br>Nil 158 (67) 197 (83)<br>Total 235 235<br>At low costs, the image guided approach was favourable. Evidence showed that nurses can be trained to competently insert Hickman lines within a three month period |

 

**Table 2** (Continued)

| Study type | Participants | Interventions | Outcome |
|---|---|---|---|
| Author(s): Fitzsimmons *et al.* (1997) | | | |
| Descriptive article | Cancer patients requiring CVC insertion for oncology therapy<br>200 CVC's inserted<br>Country: UK | Development of a training program and the appointment of a clinical nurse specialist to insert CVC'. Training was provided by experienced medical officers including tutorials<br>Data was collected prospectively over a 12 month period. Standard operating procedures were developed | Between January 1996 and January 1995 the clinical nurse specialist inserted 200 CVCs with a 97% success rate<br>The 3% failure rate was associated with obesity and upper mediastinal disease<br>Overall there was a 1% pneumothorax rate |
| Author(s): Hamilton (2004b) | | | |
| Descriptive article | Medical/surgical patients requiring tunnelled CVC insertion for therapy<br>390 patient complications<br>Country: UK | Development of a learning contract for a nurse specialist to insert CVCs. Training was provided by a consultant anaesthesiologist who was appointed as a tutor<br>Ten components were developed for the learning contract<br>Data on complications were collected prospectively over a three month period | Complication / Number (*n*) / Percent (%)<br>Pnuemothorax 3 0·8<br>Malposition 35 9·0<br>Systemic infection 4 1<br>Other 348 89<br>Total 390 100<br>Nurse led team remove all CVCs<br>Increasing demand has increased number of specialist nurses being trained to insert CVCs |
| Author(s): Hamilton (2005) | | | |
| Descriptive article | Medical/surgical patients requiring tunnelled CVC insertion for therapy<br>212 patient complications<br>Country: UK | Development of a learning contract for a nurse specialist to insert CVCs<br>Training was provided by a consultant anaesthesiologist who was appointed as a tutor | Complication / Number (*n*) / Percent (%)<br>Pnuemothorax 2 4<br>Infection 1 1<br>Nil 209 95<br>Total 212 100<br>Expansion of the service to incorporate community focused antibiotic service |

 

testing was undertaken in four of these, rather percentages were presented as findings.

A prospective randomised control trial was undertaken by Boland *et al.* (2005) to examine the clinical and cost effectiveness between blind Hickman Line insertions and Hickman Line insertions inserted under image guidance. The study concluded that specialist nurses inserting Hickman lines were safe and effective when appropriate training was given.

Boland *et al.* (2005) was the only study that prospectively identified inclusion and exclusion criteria and defined complications rates. Five studies documented rates of pneumothorax (Fitzsimmons *et al.* 1997, Waterhouse 2002, Boland *et al.* 2005, Hamilton 2005, Gopal *et al.* 2006). The crude rate of pneumothorax was reported as between 1–4%. Confidence intervals were calculated and varied between studies as population samples were varied in size. However the average rate when computed was between 0·5–2·5% as seen on the forest plot.

Three authors discussed arterial puncture and misplaced tip as documented complications (Fitzsimmons *et al.* 1997, Boland *et al.* 2005, Gopal *et al.* 2006), the crude rates for arterial puncture ranged between 3–16%. The average calculated rates were between 2–6% (95%CI). The crude percentage for misplaced tip ranged between 0–14% and once analysed using confidence intervals ranged between 0–9% (Fig. 1).

Casey and Davies (2003) undertook a small case control study, using non parametric two group comparative testing, between specialist nurses and medical officers. Outcome measures included: types of lines inserted; site selection for insertion; longevity of line and reason for removal. This study concluded that no significant difference was noted between the two groups examined in relation to baseline characteristics, insertion sites and catheter days.

## Educational requirements for nurse credentialing

A key theme emerging from the retrieved articles was the discussion around the credentialing process for nurses to be accredited to insert CVCs. The article by Waterhouse (2002) discussed how a relevant master's degree course was developed by the affiliated hospital university. This course combined clinical and course work over a period of two years. The course work emphasised the medical and legal issues that accompany such an advanced practice role and in particular the issue of professional accountability.

Hamilton (2004b, 2005), Hamilton *et al.* (1995) discussed in two of her articles the learning contract that was

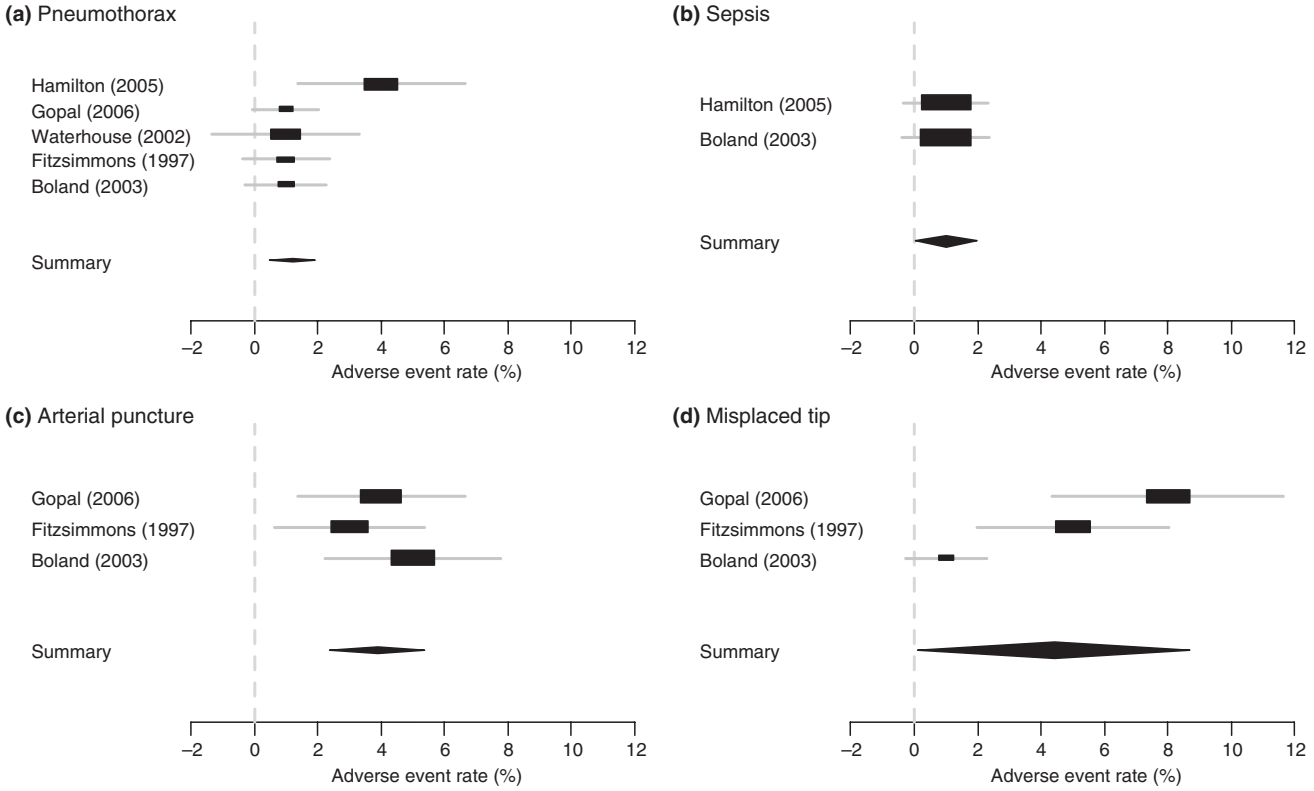


**Figure 1** Forest plots depicting the four major complication rates reported.

established where a consultant anaesthesiologist was appointed as a tutor. The learning contract was multi faceted and involved supervised insertions of CVCs, review of anatomic structures associated with CVC insertions, clinical examination and assessment, chest x-ray interpretation and advanced cardiac life support.

This training process was similar to that discussed by Gopal *et al.* (2006) in relation to their CVC service development. They discussed the training process involved 50 central line insertions, observation of trainers inserting CVCs and formal assessment (Gopal *et al.* 2006).

Guidelines for the scope of practice were discussed by Fitzsimmons *et al.* (1997), this including acceptable haemoglobin levels and coagulation profiles. Operating protocols were developed as part of the nurse led service which was established by (Kelly 2003). Competency standards were developed and accreditation was gained where standards were met, this included essay writing, oral discussion with trainers and practical assessment. Standard operating protocols were developed similar to that of Fitzsimmons *et al.* (1997) and extended to patient referrals, consent for procedure, sedation and patient information.

Benton and Marsden (2002) discussed how a two part training and credentialing process was developed through the hospital operating protocols. The training incorporated a theoretical component on anatomical structures, basic physics of ultrasound and pharmacology. The practical aspects of the training involved supervised practice sessions on an *in-vitro* model (turkey breast), then supervised insertions.

## Discussion

### Implications for nursing practice

Advanced practice nursing is emerging as an important strategy in improving patient safety and improving patient health outcomes. The insertion of a CVC by a trained specialist nurse clinician may promote efficiencies and potentially minimise adverse events. The training methods for nurse clinicians as discussed by Gopal *et al.* (2006), Waterhouse (2002), Hamilton (2004a) and Kelly (2003) emphasise that appropriate training and supervision along with standard operating protocols can decrease rates of adverse outcomes including risks of insertion and the reduction of CVC associated infection rates. It is apparent that close cooperation and support from medical colleagues is essential and the accessibility to mentorship and clinical supervision is critical for developing these advance practice clinical roles.

Educational facilities and course developers need to also take into account or be mindful of current clinical need, the health care context and stakeholder needs in course developments. It is also important that course developers take into account the complexity and dynamic health care system and develop advanced practice nurses with analytical skill that can be used within their scope of practice (Chornick 2008). In order for this to occur, courses need to be developed to support emerging advance practice roles. The process employed by Waterhouse (2002) in the development of a post graduate course reflecting the advanced role undertaken by specialist nurses is one example.

The implications for further training in the management of complications from CVC placement should be addressed as part of a clinical credentialing program. In particular in clinical facilities where appropriate 24 hours medical cover (such as rural and regional hospitals) is not available, a clinician should be available to manage complications such as inter-costal catheter placement for pneumothorax and first line treatment in case of a medical emergency.

### Implications for health policy and research

Workforce shortages with junior medical officers and increased compartmentalisation of specialities will increasingly challenge the practice boundaries between traditional nursing and medical roles. How this is managed within a regulatory framework is yet to be clearly defined. On the basis of reported cases of advanced practice nursing roles in CVC insertion, it appears the support of local medical specialists is an important component for local policy development.

The blurring of accountability between advanced practice nurses and medical clinicians will need to be an important component in the development of local policy and government legislation. Local policies and operating protocols such as those discussed by Kelly (2003) are an example of how health policy at a local level has been tailored to ensure that a nurse specialist providing a crucial role within the hospital is legally covered to practice.

### Strengths and limitations

A clear limitation of this review is the small number of studies, they are quasi experimental in design, precluding definitive conclusions. The fact that all the articles were from the UK has allowed for the confounder of health care system characteristics. It may be that there are many more nursing roles in existence but were not accessible using the search strategies described above. The comparison of studies presented was challenged by the heterogeneity of methods. We recognise the limitations in comparing adverse event rates


 

across different study populations. However, we think this is a critical step in developing benchmarking criteria for advance practice nursing roles in CVC insertion. The exclusion of articles related to PICC line insertion is both a strength and a weakness. Excluding these articles has potentially excluded discussion of advanced practice nursing roles in vascular access. However the focus of this review pertained specifically to the nursing role in CVC insertion. In spite of this, the review was undertaken using a prospective and systematic process clearly documenting implications for policy, practice and research.

## Conclusion

This article describes an emerging practice area with important considerations for policy, practice and research. The studies discussed in this article have described the evolution of the advanced practice roles and the mechanisms for training and credentialing. Traditionally, inserting a CVC has been the domain of a medical practitioner, and articles discussing the role of nurses inserting CVCs described the transition to a collaborative, interdisciplinary model. There is a need to undertake well-conducted clinical studies to clearly document the value and efficacy of this advanced practice nursing role. Generating normative data in key diagnostic groups will facilitate benchmarking as well as undertaking of quality improvement initiatives. When complication rates are reviewed as an overall performance indicator for advance practice nurses inserting CVCs, the rates are similar to the wider and largely medical literature. These data are encouraging and underscore the value of the careful description and development of this advanced practice nursing role.

Finally, an important conclusion is that successful implementation of such an advanced practice nursing role is dependent on obtaining specialised knowledge and skills through the support of senior medical colleagues particularly for education and mentoring.

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## Contributions

Study design: EA, PD, KH; Data collection and analysis: EA, TS, SF, PD; Manuscript preparation: EA, PD, MP.

## References

Benton S & Marsden C (2002) Training nurses to place tunnelled central venous catheters. *Professional Nurse* **17**, 531–533.

Bishop L, Dougherty L, Bodenham A, Mansi J, Crowe P, Kibbler C, Shannon M & Treleaven J (2007) Guidelines on the insertion and management of central venous access devices in adults. *International Journal of Laboratory Hematology* **29**, 261–278.

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**, 145–146.

Burns D (2005) The Vanderbilt PICC service: program, procedural, and patient outcomes successes. *Journal of the Association for Vascular Access* **10**, 183–192.

Casey J & Davies J (2003) A nurse led central line insertion service. *European Dialysis and Transplant Nurses Association Journal* **29**, 203–205.

Chornick N (2008) Advanced practice registered nurse educational programs and regulation: a need for increased communication. *JONA's Healthcare Law, Ethics, & Regulation* **10**, 9–11.

Comfere B & Brown D (2007) Central venous catheters: considerations regarding placement and clinical use. *Contemporary Critical Care* **5**, 1–10.

Dowling S, Barrett S & West R (1995) With nurse practitioners, who needs house officers? *British Medical Journal* **311**, 309–313.

Ean R, Kirmse J, Roslien J, Dickerson K, Grimes E, Lowrie A & Woodman K (2006) A nurse-driven peripherally inserted central catheter team exhibits excellence through teamwork. *Journal of the Association for Vascular Access* **11**, 135–138.

Fitzsimmons CL, Gilleece MH, Ranson MR, Wardley A, Morris C & Scarffe JH (1997) Central venous catheter placement: extending the role of the nurse. *Journal of the Royal College of Physicians of London* **31**, 533–535.

Fong NI, Holtzman SR, Bettmann MA & Bettis SJ (2001) Peripherally inserted central catheters: outcome as a function of the operator. *Journal of Vascular & Interventional Radiology* **12**, 723–729.

Funk D, Gray J & Plourde PJ (2001) Two-year trends of peripherally inserted central catheter-line complications at a tertiary-care hospital: role of nursing expertise. *Infection Control and Hospital Epidemiology* **22**, 377–379.

Gamulka B, Mendoza C & Connolly B (2005) Evaluation of a unique, nurse-inserted, peripherally inserted central catheter program. *Pediatrics* **115**, 1602–1606.

Gopal K, Fitzsimmons L & Lawrance JAL (2006) Nurse-led central venous catheter service: Christie experience. *British Journal of Radiology* **79**, 762–765.

Hamilton H (2004a) Central venous catheters: choosing the most appropriate access route. *The British Journal of Nursing* **13**, 862–870.

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

Hamilton HC (2005) A nurse led central venous access service in the United Kingdom. *Journal of the Association of Vascular Access* **10**, 77–80.

Hamilton H., O'Byrne M. & Nicholai L (1995) Central lines inserted by clinical nurse specialists. *Nursing Times* **2**, 38–9.

Hunter MR (2003) Development of a vascular access team in an acute care setting. *Journal of Infusion Nursing* **26**, 86–91.

Kelly LJ (2003) A nurse-led service for tunnelled central venous catheter insertion. *Nursing Times* **99**, 26–29.

Lewis S & Clarke M (2001) Forest plots: trying to see the wood and the trees. *British Medical Journal* **322**, 1479–1480.

Pearson A & Peels S (2002a) Clinical nurse specialists. *International Journal of Nursing Practice* **8**, S11–14.

Pearson A & Peels S (2002b) The nurse practitioner. *International Journal of Nursing Practice* **8**, S5–9.

Schober M & Affara F (2006) *International Coucil of Nurses: Advanced Nursing Practice*. Blackwell Publishing, Oxford.

Sharpe EL (2006) Developing a nurse-directed peripherally inserted central catheter team in the neonatal intensive care unit. *Newborn and Infant Nursing Reviews* **6**, 225–229.

Taylor R & Palagiri A (2007) Central venous catherization. *Critical Care Medicine* **30**, 1390–1396.

Waterhouse D (2002) Vascular access: a role for a renal nurse clinician. *European Dialysis and Transplant Nurses Association Journal* **28**, 64–66+69.

Whittemore R & Knafl K (2005) The integrative review: updated methodology. *Journal of Advanced Nursing* **52**, 546–553.

Wright KB (1997) Advanced practice nursing: merging the clinical nurse specialist and nurse practitioner roles. *Gastroenterology Nursing* **20**, 57–60.


 