

Clinical Communiqué

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Next Edition: September 2016

EDITORIAL

In this issue we are going to focus on the single theme of risks associated with central venous catheter insertions. A common procedure in complex patients with some recurring errors that should be amenable to system change.

First though, a chance to examine an example of real systemic change towards safer practice. You may recall the case we described in our last issue of the patient who died from complications that occurred following a liposuction procedure (Volume 3, Issue 1: Post-operative pain – When to worry). What we did not know at the time was that the Medical Board of Australia was about to issue guidelines on clinical practice for registered medical practitioners who perform cosmetic medical and surgical procedures.

The Board consulted widely with the medical profession, the industry and the community about the best way to protect consumers seeking cosmetic medical and surgical procedures. The new [guidelines](#) were published in May 2016 and will come into effect on the 1st October 2016 and apply to all medical practitioners, including specialist plastic surgeons, cosmetic surgeons and cosmetic physicians regardless of their qualifications.

Among the key points are:

- A seven-day cooling off period for all patients before major procedures,
- For all persons under 18 years there is a three-month cooling off period before major procedures and a mandatory evaluation by a registered psychologist, general practitioner or psychiatrist,
- The treating medical practitioner is to take explicit responsibility for post-operative patient care and for making sure there are emergency facilities when they are using sedation, anaesthesia or analgesia.

The guidelines also provide direction on the issues of patient assessment and informed consent, and communication about the risks and possible complications of cosmetic procedures. What is particularly encouraging is the role that clinical staff, health professional regulators, and medico-legal mortality reviews played in the development of these guidelines.

In this issue, we present three cases where complications arose following central venous catheter insertion. One catheter migrated too far, another catheter went the wrong way, and the last caused damage to its adjacent structures. Each of these are recognised albeit uncommon complications of central venous catheters, yet the cases continue to illustrate the many difficulties in the recognition of catheter misplacement.

The Clinical Communiqué welcomes a new case author from Tasmania, Ms Libby Newman, who has over ten years' experience working with the Coroners Court of Tasmania, and we are privileged to include an expert commentary from Professor David Story who is Professor and Chair of Anaesthesia at the The University of Melbourne.

Finally, we are thrilled to announce the launch of our new website in the near future. We hope you will enjoy navigating around the site and will continue to use and recommend the site to your colleagues. Please let us know if there is anything else you would like to see on our site, and we will continually endeavour to upgrade and improve our content for our readers.

CASE #1 A LINE TOO LONG

Case Number:
1027/08 NSW

Case Précis Author:
Dr Adam O'Brien
MBBS, GDipForensMed, DRANZCOG,
DDU, FACEM

CLINICAL SUMMARY

A previously well six month old boy developed periorbital cellulitis requiring intravenous (IV) antibiotics for three days at a tertiary paediatric hospital. The infection recurred when he was ten months old and again required IV antibiotics for ten days. During this latter hospitalization, peripheral IV access proved difficult so a left femoral central line was utilised. This was pulled out by the infant, but because he was improving, he was discharged to home with oral antibiotics.

Unfortunately, the periorbital cellulitis worsened and he required re-admission to hospital the following day, once again requiring IV antibiotics. Due to difficulties inserting another femoral central line, a Peripherally Inserted Central Catheter (PICC) was inserted via a cubital fossa vein.

The coroner heard that the risks associated with PICC lines are generally regarded as being low

The PICC procedure was performed by two anaesthetists while the infant was under general anaesthesia. The length of line was estimated according to the distance from the insertion site to the heart. Using a guide-wire, the line was advanced until ventricular ectopic beats (VEBs) were seen on the cardiac monitor, after which the PICC was withdrawn 5cm. The position was checked with an image intensifier, confirming that the tip was at the junction of the superior vena cava and the right atrium. The line was secured with a dressing and the guide-wire removed. A post-insertion x-ray also confirmed correct positioning of the tip.

Four days later the infant had a cardiac arrest from which he could not be resuscitated.

PATHOLOGY

A post-mortem examination revealed that the PICC had migrated, causing the end of the line to coil in the right ventricle, which resulted in focal ventricular myocarditis and myonecrosis.

INVESTIGATION

A number of questions were raised at inquest: why was the PICC line procedure adopted? How was it carried out? Was it carried out appropriately? How did a length of line migrate? Should the line have been secured by suture? and what had been done to prevent a recurrence?

The coroner heard that the risks associated with PICC lines are generally regarded as being low and there were a number of advantages to inserting a PICC in this case. There had been previous difficulties with peripheral and central IV access, and IV antibiotics were necessary to treat the periorbital cellulitis.

One anaesthetist gave evidence that the tip of a PICC line is usually advanced beyond the point where it should rest and then retracted so as to minimise the possibility of loops in the line and to enhance the prospect of accurate final placement. Two independent experts agreed that overshooting the target was a widespread practice, but not the preferred option. Advancing the PICC until VEBs are seen is not the safest method of insertion. Rather, the PICC's position should be visualised with an image intensifier until the target position is achieved.

It was most likely that the PICC migrated during an undocumented dressing change of the PICC insertion site. This caused the PICC to coil within the right ventricle.

There was evidence presented at the inquest that the adhesive 'sandwich' dressing and security tape used at the time of the PICC insertion must have been changed at a later stage.

However, there was no record of who or why or when the dressings had been replaced. Securing the PICC at the insertion site can be achieved by several methods. The adhesive sandwich technique used in this case was considered appropriate. Other methods include the use of adhesive fasteners and suturing, although the latter may occlude the lumen in the smaller paediatric sized PICCs.

State-wide policies regarding insertion and post-insertion care of central venous access devices occurred after this death.

Clinical Governance staff from the hospital presented the root cause analysis conducted by the hospital. This resulted in a number of changes to the hospital's policies.

The hospital introduced trained nurses to monitor, re-dress and, if necessary, adjust PICCs, all of which was to be recorded in the progress notes. A PICC line factsheet for parents was developed as was a PICC line daily checklist for ward staff.

CORONER'S FINDINGS

The coroner found that the decision to insert the PICC line had been appropriate and reasonable. It was most likely that the PICC migrated during an undocumented dressing change of the PICC insertion site. This caused the PICC to coil within the right ventricle.

State-wide policies regarding insertion and post-insertion care of central venous access devices occurred after this death.

RESOURCES

Central Venous Access Device Insertion and Post Insertion Care. NSW Health Policy Directive, September 2011. Available at: http://www0.health.nsw.gov.au/policies/pd/2011/pdf/PD2011_060.pdf.

KEYWORDS

PICC, procedure, ventricle, cellulitis, dressings, central venous access

CASE #2 AN ELUSIVE BREACH

Case Number:

COR 2351/05(6) QLD

Case Précis Author:

Dr Nicola Cunningham

B.Med, MForensMed, FFCFM (RCPA),
FACEM

CLINICAL SUMMARY

Mrs F was admitted to hospital for removal of a caecal polyp by a laparoscopic right hemicolectomy. The surgery was uneventful, however, two days later she developed abdominal distension, thought to be due to an ileus or small bowel obstruction. This was treated with the insertion of a nasogastric tube which led to some improvement in her symptoms despite ongoing radiological evidence of an obstruction. After almost 10 days of fasting, a decision was made by a physician to commence her on total parenteral nutrition (TPN) to manage her deteriorating nutritional levels. A double lumen peripherally inserted central catheter (PICC line) was inserted into her right arm under an image intensifier by a radiologist. Mrs F developed atrial fibrillation (AF) that evening and was found to be hypokalaemic on review. She was closely monitored over the next two days and a covering physician increased her TPN from 20ml/hr to 60ml/hr because of large nasogastric losses.

There was evidence of a perforation of the right ventricular wall by the PICC line.

Two days later she deteriorated rapidly and despite intensive care treatment, died soon after.

PATHOLOGY

A post mortem examination was performed which found that the small intestine and part of the large bowel were markedly distended with gas but the anastomosis looked intact. There were no findings to explain the ileus or obstruction that had been apparent clinically. Examination of the heart revealed approximately 300mls of white milky fluid in the pericardium. There was evidence of a perforation of the right ventricular wall by the PICC line. The pathologist gave the cause of death as cardiac tamponade as a consequence of a ruptured heart, as a consequence of total parenteral nutrition.

INVESTIGATION

An inquest was held over three days and focussed on two main issues: how and when the right ventricular perforation occurred, and whether the diagnosis of cardiac tamponade should have been made prior to Mrs F's death.

The coroner heard that the episode of AF could indicate that the PICC was impinging on a heart structure. Mrs F had a number of other conditions however, (bowel obstruction, hypokalaemia), that also predisposed her to developing arrhythmias. It was accepted that Mrs F's rapid deterioration had been appropriately managed by the treating team. The diagnosis of a perforated ventricle would not have been an easy one to make.

The coroner accepted that the risks are rare but known in the medical literature, and as such, was unable to make any recommendations as to how to avoid similar deaths in the future.

A number of radiologists and intensivists were called as experts. All agreed that the quality of the image taken at the time of insertion was poor, but that the tip of the PICC was probably in the vicinity of the right atrium. One mechanism put forward for the perforation was that the guide wire had been reversed and the stiffer end inserted with the tip of the PICC. It was acknowledged though, that a perforation occurring at the time of the insertion should have resulted in earlier symptoms. The experts also debated the possibility of a redundancy in the catheter as it had been inserted its full length (50cm). Again however, there were opposing views as to whether this was likely and what a reasonable insertion length should be for a person of Mrs F's height and weight. Adding further uncertainty was the discussion surrounding the notions that a complete tear of the ventricle should have resulted in a large amount of blood in the pericardium, and that saline solution from the second lumen was not being infused into the pericardium. Mortuary attendants had removed the PICC line prior to the autopsy so its final resting position could only be postulated, not confirmed.

CORONER'S FINDINGS

The coroner stated, *"although no doubt unsatisfactory for the family, with the differing opinions and wide variations as to possible scenarios, it is not possible for me to make a positive finding as to the mechanics of how the TPN fluid made its way into the pericardium other than that there must have been a perforation at some stage"*.

The coroner accepted that the risks are rare but known in the medical literature, and as such, was unable to make any recommendations as to how to avoid similar deaths in the future.

EDITOR'S COMMENTS

It is important to note that all vascular catheters, drainage tubes and medical devices that are in-situ at the time of death should not be removed by hospital or mortuary staff, in anticipation of a post-mortem examination by a pathologist. This will enable confirmation of the integrity, contents and placement of such items in the body, which may be pertinent to the cause of death.

RESOURCES

Central Line Insertion and Maintenance Guideline. Australian and New Zealand Intensive Care Society [Internet]. Melbourne; 2012. ANZICS Safety and Quality Committee. Available from www.anzics.com.au.

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KEYWORDS

PICC, hypokalaemia, TPN, ventricular perforation, cardiac tamponade, bowel obstruction

CASE #3 NOT WHERE YOU THINK YOU ARE

Case Number:

2011/387679 NSW

Case Précis Author:

Ms Libby Newman MPH, BN,

Dip HSci (Pre-Hospital Care)

CLINICAL SUMMARY

Mr G was a 63 year old man who lived in regional NSW. In June 2011 he was admitted to the local base hospital ('A') for an emergency right hemicolectomy due to necrotic bowel. Mr G's medical history included chronic obstructive pulmonary disease, alcohol addiction, bipolar affective disorder, poor kidney function and liver cirrhosis.

Mr G's pre-morbid condition placed him at risk of suffering from respiratory difficulties and alcohol withdrawal and he was admitted to the High Dependency Unit post-operatively. On post-operative day one Mr G showed signs of alcohol withdrawal and was administered benzodiazepines as per hospital policy. This treatment was continued regularly over the next 24 hours. His surgeon reviewed him late on post-operative day two as a response to nursing concerns regarding respiratory compromise. The surgeon noted, "...Keep in mind he smokes 60 cigarettes a day and will surely be a carbon dioxide retainer so be careful how much oxygen we give..." The surgeon added if Mr G's respiratory rate increased to more than 30 breaths/min or his saturations dropped to less than 85% he should commence positive airway support via a BiPAP mask (Bilevel Positive Airway Pressure).

Mr G developed another complication – hypernatraemia. Mr G's intravenous therapy with saline was ceased and 5% dextrose solution was commenced.

Mr G's condition deteriorated and he was commenced on BiPAP therapy but shortly after became unresponsive. A MET call was made and he was intubated and ventilated. It was thought Mr G's deterioration was due to either carbon dioxide narcosis or high sodium levels. Dr T became involved in Mr G's care. Dr T was a full time visiting medical officer who performed anaesthetic duties at the hospital. Dr T discussed Mr G's circumstances with the surgeon and a decision was made to transfer Mr G to a larger, tertiary base hospital ('B') where he could receive intensive care unit support. Dr T decided to insert a central venous catheter (CVC) to provide additional means of venous access.

Dr T inserted the CVC and requested a chest x-ray to check its position and Mr G was then transferred to hospital B. After arrival at hospital B another chest x-ray was carried out to check the positions of both the endotracheal tube and the CVC. Infusions and medications were commenced via the CVC.

In the afternoon on Mr G's second day in the ICU his nurse assessed his central venous pressure via the CVC using a transducer. The nurse noted the results suggested the CVC was positioned in an artery. A blood sample was taken and it proved to be arterial. All infusions were stopped and an incident form completed. The medications Mr G had received via the CVC included: propofol, insulin, glucose, vitamin K and pantoprazole.

The next day a CT scan of Mr G's brain demonstrated right sided brain infarction – this was attributed to the fluids and medications being delivered directly to the brain via the carotid artery. Clinical staff determined this was a catastrophic and irreversible brain injury. After consultations with Mr G's family he was palliated and died in early July 2011.

PATHOLOGY

Mr G's cause of death was listed as brain injury caused by inadvertent misplacement of the central line into the carotid artery.

INVESTIGATION

The inquest primarily investigated the circumstances of the misplaced central venous catheter.

Dr T gave evidence and stated he had been inserting CVCs for over 25 years regularly placing ~6-8 CVCs each month and using anatomical landmarks to guide placement. Dr T stated he traditionally interpreted the absence of pulsatile blood and the colour of the blood as indicators of correct catheter placement. He added that he "undertook all checks that could reasonably be done and expected to be done at the time and there was nothing during the procedure that suggested that the line was in an unsatisfactory position." Dr T did not perform any other test – stating there was no need as the blood was dark and non-pulsatile.

Evidence was given that blood colour and the absence of pulsatile blood are unreliable markers to confirm venous placement, particularly in the setting of hypotension.

Dr T was aware of transducing and testing blood gases to check position but did not consider it necessary as he was confident he had put the line in the correct place. An ultrasound machine had been available at Hospital A to assist anaesthetists placing lines since 2010. Dr T had not attended the training course for its use at the time of Mr G's admission (but had since completed the relevant training).

CORONER'S FINDINGS

Checking measures were not mandated at Hospital A at the time of Mr G's admission. A state-wide policy directive was brought in that same year requiring clinicians to complete written confirmation of CVC placement and site confirmation. The coroner recommended the local health district introduce a policy mandating that practitioners confirm venous placement of central lines consistent with the State policy directive and incorporating advice given to the hospital by a quality review committee regarding line confirmation checks.

AUTHOR'S COMMENTS

Arterial puncture is a recognised complication of CVC insertion. The misplacement of a central venous catheter can have devastating consequences. A 'traditional' method of checking blood colour and whether the flow is pulsatile has been shown to be unreliable. The use of ultrasound to guide catheter placement is beneficial although not failsafe. Pressure transducing and blood gas analysis may be considered cumbersome but these checks, along with the use of ultrasound guidance in the first instance offer multiple levels of independent confirmation which increase reliability of the findings.

RESOURCES

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Nayeemuddin M, Pherwani AD, Asquith JR. Imaging and management of complications of central venous catheters. *Clin Radiol* 2013; 68: 529-544.

KEYWORDS

CVC, arterial puncture, site confirmation, ultrasound guidance, central venous access

EXPERT COMMENTARY

CENTRAL VENOUS ACCESS

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Platform

Central venous access (into the superior or inferior vena cava) is a common intervention for the critical care specialties of Anaesthesia, Emergency Medicine and Intensive Care Medicine. Patients who receive central lines usually have complex medical problems, are about to undergo complex procedures, or both. Central venous access is often required for one, or more, of the following indications: haemodynamic monitoring, higher risk intravenous drug therapy, parenteral nutrition, renal replacement therapy, rapid volume resuscitation, and blood sampling.

While arterial injury can occur with any approach, complications associated with carotid artery perforation are the most frequently reported often due to the severity of complications.

Other disciplines, notably haematology, oncology, and infectious diseases utilise peripherally inserted central catheters (PICC lines) for long term venous access. As with all interventions, the approach to central venous access needs to be individualised to the patient's requirements including the insertion site, type of catheter (e.g. central line vs pulmonary artery catheter), the size of the catheter (length and diameter), the number of catheters, and the number of lumens and features of the catheters.

The three most commonly used access veins for critical care lines are the internal jugular, subclavian, and femoral veins, while cubital fossa veins are the most common for PICC lines. PICC lines are usually inserted with radiological assistance. Traditionally, anatomical landmarks were used to guide central venous catheter insertion.

Nowadays, where available, ultrasound devices provide guidance for insertion points and guide-wire placement. One use of ultrasound (before inserting any needles) is to identify the site and size of the target vessel, the relationship to arteries and other structures, the depth from the skin, and any rare variants such as small or absent veins. A second use is real-time ultrasound guidance for needle insertion. A third use is to check that guide wires or catheters are in the vein.

There are a range of methods to detect arterial cannulation apart from bright blood pulsing out of the needle, including: ultrasound visualisation of wires and catheters, simple or electronic manometry, measuring the oxygen partial pressure in aspirated blood, transoesophageal echo, and chest x-ray.

An emerging training problem, is that critical care trainees, particularly anaesthesia trainees, increasingly do not cannulate veins for central venous access without real time ultrasound guidance. This creates too much reliance on ultrasound. Training and ongoing practice should include some proficiency with anatomical landmark-based venous access to maintain skills for urgent situations where ultrasound is unavailable. A practical way to learn and maintain proficiency with landmark identification is to mark a proposed cannulation site and then confirm the accuracy of that landmark estimate during the initial ultrasound survey.

Following insertion, the tip of the catheter should ideally be positioned in the lower superior vena cava and confirmed with chest x-ray or echography. Recording depth based on catheter markings can help detect migration of the catheter, particularly with long PICC lines, both into (risks of arrhythmias and cardiac injury), and out of (risks of extravasated infusions and loss of IV access) the patient.

Fixing and dressing central lines is an area of ongoing debate and limited evidence. In adults this is usually achieved via a combination of suturing and large adhesive dressings.

Complications of central venous access include: infection, thrombosis, emboli (clot, catheter or gas), arrhythmias, cardiac and vascular injury, inadvertent infusion toxicity (intra-arterial or extravascular), pneumothorax, and retained guide wires. Complication severity can range from minor to fatal. Many of these risks can be reduced, but not eliminated, by using ultrasound guidance for insertion, and radiological and physiological testing to confirm intravenous placement.

While arterial injury can occur with any approach, complications associated with carotid artery perforation are the most frequently reported often due to the severity of complications. Injury to the carotid wall has been associated with cerebral stroke as well as local haemorrhage, which in turn has been associated with further complications including airway compromise. Factors associated with severity of arterial injury include: insertion site, size of the needle or catheter, and the patient's coagulation status.

Unrecognised carotid artery placement of central lines has led to neurological injury and death secondary to high concentrations of drugs (such as propofol) infused directly into the cerebral circulation.

Teams placing central venous catheters need skills in minimising risks and managing potential complications.

There are a range of methods to detect arterial cannulation apart from bright blood pulsing out of the needle, including: ultrasound visualisation of wires and catheters, simple or electronic manometry, measuring the oxygen partial pressure in aspirated blood, transoesophageal echo, and chest x-ray. Importantly, arterial perforation can occur after traversing a vein, so that initial signs of venous entry do not rule out subsequent arterial perforation. Further, when two catheters are inserted into a vein, the venous siting of one does not exclude arterial siting of the other. Even in emergency situations clinicians should confirm venous placement of central lines as soon as possible.

EXPERT COMMENTARY (CONTINUED)

CENTRAL VENOUS ACCESS

When inadvertent arterial cannulation is suspected, the treatment depends on the size of the catheter. Larger catheters such as pulmonary artery catheter sheaths and vascaths (>6F) should be left in place and urgent surgical, or interventional radiology, repair sought. For smaller cannulas a “pull and press” approach may be reasonable in patients with normal coagulation but does not eliminate the risk of stroke or haemorrhage. Continuing with extensive elective surgery after arterial injury with larger needles requires careful team consideration, especially if there is a need for planned anticoagulation.

Teams placing central venous catheters need skills in minimising risks and managing potential complications. The key phases are skin preparation, insertion technique, catheter securing, and confirmation of placement of the catheter. Careful attention to these steps and early recognition of complications is critical to the safe performance of this important procedure.

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FEEDBACK

The editorial team is keen to receive feedback about this communication especially in relation to changes in clinical practice. Please email your comments, questions and suggestions to: clinical.communicue@vifm.org