PERIPHERAL INTRAVENOUS CATHETER (PIVC) COMPLICATIONS AND FAILURE

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ABSTRACT

PIVCs are important devices in modern medicine. Despite their essential widespread use, multiple international and national guidelines, PIVC associated complications rates persist at an unacceptably high rate. Structured, evidence-based literature review to better understand the current clinical environment for preventing and managing PIVC related complications. This report provides a broad summary of the quality of current guidelines and recommendations regarding the insertion, management and removal of PIVCs in paediatric and adult patients. The report highlights a number of similarities between guidelines including adherence to basic infection control measures through maintenance of hand hygiene and aseptic technique; skin decontamination prior to insertion; ongoing assessment for vascular access needed and removal when no longer required.

Key Words: *PIVCs, evidence-based literature review, managing PIVC.*

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INTRODUCTION

The insertion of a peripheral intravenous catheter (PIVC) is one of the most common clinical invasive procedures performed in the clinical setting. Approximately, 70% of hospitalised patients requiring a PIVC at some point during their hospital stay. However, studies estimate that 4% to 28% of PIVCs inserted are not actually needed, placing the patient unnecessarily at risk of infection. Despite frequency in PIVC use, complications are reported to be as high as 70%. They can be prone to blockage and dislodgment, cause inflammation of the vein and infection. Nearly half of all first insertion attempts also fail, causing undue pain and anxiety for patients as a result of multiple failed attempts. To reduce rates of PIVC-related complications, a number of evidence-based strategies have been suggested. Best practice guidelines recommend a range of strategies to reduce risk of complications and increase chances of PIVC success. Despite this, data from nationally and internationally suggest that a significant proportion of patients do not receive care as recommended to optimise use of PIVCs.

Incidence and prevalence rate of PIVC failures and complications:

The rates for PIVC failure were derived from published research. Currently there is no regular surveillance or monitoring PIVC outcomes. Challenges with gaining successful and patent peripheral vascular access start at the moment of insertion. First attempt PIVC insertion failure rates can be up to 35-40% for adults Jacobson AF, Winslow EH. (2005). Malyon L, Ullman AJ, Phillips N, et al. (2014) portrayed between 50–65% for children with a concerning 10% of adults and a quarter of all children experiencing more than four attempts at insertion.

Reasons for PIVC Failure:

The most frequently cited reasons for PIVC failure before the completion of prescribed treatment are dislodgment, occlusion, infiltration and phlebitis Helm RE, Klausner JD, et al. (2015). These may occur in isolation or in combination, indeed existence of one may be precursor to another complication.

- Dislodgement of the PIVC out of the vein, partial or complete, occurs when there is poor securement of the catheter to the skin, or with patient or operator (staff) interference Campbell C, Bowden T. (2011) Dislodgement or accidental removal reportedly accounts for between 6% and 20% of catheter failures. This may be a contributing factor to localised irritation and inflammation (phlebitis) through micro motion (pistoning) of the device in the vein, further heightening the risk of failure.
- A poorly secured catheter often causes the patient discomfort and result in catheter failure, delaying intravenous (IV) therapy and requiring insertion of a new IV device.
- Occlusion, either partial or complete blockage, results in the inability to infuse or inject fluids or medications through the lumen of the PIVC. Occlusion can be mechanical (e.g. kinking), thrombotic or medication related in origin. Occlusion can also occur from irritation or trauma to the cannulated vein wall, leading to a release of thromboplastic substances and platelets Hawthorn a, Bulmer AC, et al. (2019) This process promotes the clotting of blood and can result in narrowing or complete occlusion of the cannulated vein. Occlusion of the catheter lumen can be a precursor to infiltration as the IV fluid or medications leak into the surrounding tissue.
- Infiltration is the defined as the leakage of a non-vesicant solution into surrounding tissues. This may be related to dislodgment of the device from the vein or occlusion of the lumen.
- Signs and symptoms of infiltration can include oedema, stretched or blanched skin, localised cool skin, or visible leakage of IV fluids around the site. This may or may not be accompanied with discomfort or pain. Although injury due to infiltration is often considered minor and usually resolves without any intervention, there is a risk of significant morbidity related to localised compression or even tissue damage.
- Extravasation is traditionally distinct from infiltration as it specifically refers to the leakage of vesicant fluids or drugs (including contrast media or cytotoxic agents). The incidence of infiltration and extravasation is hard to determine because of limited reporting; however, extravasation injury from cancer chemotherapy is reported to be 11% in children and 22% in adults. One study found that, of all the complications associated with peripheral cannulas, 34% occurred as a result of infiltration Dougherty L. (008). Given the root cause (vesicant substance) and related tissue damage, the presenting signs and symptoms of extravasation are similar to infiltration, but accompanied with more visible tissue damage and pain. In recognition of the risk associated with their treatment Imaging and Cancer Care specialities usually have specific policies and procedure for dealing with extravasation to minimise damage.
- Phlebitis is defined as localised irritation or inflammation of the vein wall has been the focus Of much discussion and research in relation to PIVC complications25, 26. It can have either a mechanical, chemical, or bacterial origin, and it can occur in isolation or in combination with any of the other known PIVC complications. Generally, phlebitis is characterised by a combination of tenderness/pain, erythema, oedema, purulent discharge, or a palpable cord, and results in failure and removal of the device. However,

even one sign, (e.g. erythema) can be an indication of underlying phlebitis.

- PIVC associated infections are a relative rare but serious complication and occur when Micro-organisms track along the insertion site and into the cannulated vein, irritating thevessel wall, contaminating the catheter and then the bloodstream. These microbes may be from the patient's skin, contaminated disinfectant or healthcare workers' hands. The most common signs and symptoms of a local PVC-related infection are pain, erythema, pus, and palpable venous cord, whereas the more serious catheter related blood stream infection presents with fever, chills, headache, tachycardia, and nausea/vomiting. Infection rates associated with PIVCs are much lower than those reported for central venous catheters (CVC). Whatever the root cause of failure of the PIVC it has significant implications for the patient's treatment, hospital experience and healthcare budget.

Risk factors for PIVC complications:

To reduce the incidence of catheter failure and avoid preventable IV replacements, a clear understanding of why catheters fail is required. Previous research has identified that catheter gauge, insertion site, and inserter skill, have an impact on PIV failure. Limitations of existing research are small study sizes, retrospective design, or secondary analysis of an existing data set; all potentially introducing sampling or reporting bias. However, a large prospective study with rigorous analysis was recently published study identified that one in three PIVCs failed before the completion of prescribed therapy.

Phlebitis was the main complication observed at a rate of 17%, followed by occlusion and/or infiltration (14%) and dislodgement (10%). Factors that were associated with PIVC failure included the PIVC gauge, insertion site, poor securement, type of IV medication administered and number of IV accesses generally. The PIVC gauge has been previously been identified as a risk factor for catheter failure: in particular, small gauge catheters (≤ 22 gauge) and large gauge catheters (≥ 18 gauge). Further, risk may not be because related to gauge alone. The level of intravascular purchase (degree to which catheter sits in the vein) associated with a shorter length may also influence PIVC performance. PIVCs inserted in the hand, anterior cubital fossa or over a joint have also been associated with an increased risk of catheter failure. The placement of a PIVC over an articulated joint increases the risk micro movement which in turn increases the risk of local irritation and dislodgment of the PIVC within the vein. Patients have reported significant discomfort and pain associated with this also. However ad hoc use of non-sterile tape and joint immobilisation products (e.g. elasticised tubular bandage) may contaminate site or reduce visibility and assessment.

In summary, PIVCs are important devices in modern medicine. Despite their essential widespread use, multiple international and national guidelines, PIVC associated complications rates persist at an unacceptably high rate. Structured, evidence-based literature review to better understand the current clinical environment for preventing and managing PIVC related complications.

This report provides a broad summary of the quality of current guidelines and recommendations regarding the insertion, management and removal of PIVCs in paediatric and adult patients. The report highlights a number of similarities between guidelines including adherence to basic infection control measures through maintenance of hand hygiene and aseptic technique; skin decontamination prior to insertion; ongoing assessment for vascular access needed and removal when no longer required

Prevention of complications

Much of the content of the guidelines are similar especially in regards to standard and transmission based precautions, hand hygiene and aseptic technique. Other commonalities include:

- Assessment (at basic level) of need and type of IV device, and catheter site selection.
- Skin decontamination with 2% Chlorohexidine in 70% alcohol solution unless contraindicated)
- Limiting of insertion attempts to two (2) per practitioner
- Use of a transparent, semi permeable dressing to cover IV insertion site and secure catheter
- Decontamination of any ports or hubs prior to access -Type and technique of port or hub decontamination. There were varied recommendations for decontamination solution (70% alcohol versus 2% Chlorhexidine in alcohol), decontamination timing (times of 5, 15 and 30 second cited), as well as technique (active scrubbing versus passive cap).
- Frequency and technique for IV flushing. Varied frequencies cited for flushing of PIVCs not in continuous use (e.g. Q24h, Q8h, Q6h and PRN).
- Frequency of IV administration set changes. Disagreement between key guidelines on frequency of IV administration set changes (for solutions not containing blood or lipid)
- Use of O.9% sodium chloride flushes pre and post drug administration.
- Removal and replacement of IV device if (a) no longer device no longer working (i.e. occluded) or (b) patient shows signs of local or systemic infection (i.e. local redness, pain or swelling or fever and

malaise.

- Removal of device when no longer required
- The CDC (2011) recommend removal of PIVCs no more frequently than 72-96 hours and regard clinically indicated as unresolved (except in children). All local (Australian) guidelines recommend PIVC replacement at 72 hours.

A number of recommendations are made in relation to the findings from this review. These include:

I. Development of a national clinical care standard aimed at reducing PIVC related complications and failure.
II. Education and training of nursing and medical staff that focus on contemporary and evidence based PIVC insertion and maintenance care.
III. Evidence based assessment of patient's need for vascular access and device type.
IV. Early referral to vascular access specialist and use of ultrasound to minimise insertion trauma in patents identified as having difficult vascular access.
V. Routine use of analgesic agents or strategies to minimise PIVC insertion associated pain.
VI. Evidence based clinical assessment of PIVC site and function
VII. Ongoing monitoring and reporting of PIVC use and outcomes to facilitate benchmarking and drive quality improvement
VIII. Inclusion of patients' views in all future research in to the optimal PIVC insertion and maintenance practices and products.

In summary, PIVCs are important devices in modern medicine. Despite their essential widespread use, multiple international and national guidelines, PIVC associated complications rates persist at an unacceptably high rate. Structured, evidence-based literature review to better understand the current clinical environment for preventing and managing PIVC related complications. This report provides a broad summary of the quality of current guidelines and recommendations regarding the insertion, management and removal of PIVCs in paediatric and adult patients. The report highlights a number of similarities between guidelines including adherence to basic infection control measures through maintenance of hand hygiene and aseptic technique; skin decontamination prior to insertion; ongoing assessment for vascular access needed and removal when no longer required.

CONCLUSION

This structured evidence-based literature review was undertaken to better understand the current clinical environment for peripheral intravenous catheter insertion and care, and to identify issues or gaps that may be addressed by clinical experts at a clinical roundtable. The review includes an analysis of international, national and state guidelines as well as a review of randomised clinical trials. There was a high degree of variation in guideline quality and recommendations. This may be contributing to inconsistency in practice and the unacceptable rates of PIVC failure reported in studies.

The development of a national clinical care standard should assist in bringing clinicians and health services together to agree upon the way forward to improve outcomes for all patients who rely on safe and patent vascular access for the delivery of vital medical treatment.

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