Kidz Medical Services

Peripherally Inserted Central Catheter Policy

Purpose:
To provide the clinicians of Kidz Medical Services with guidelines for placement and management of a peripherally inserted central catheter (PICC).

Guideline:

I. Definitions:
   A. Peripherally inserted central catheter (PICC):
      1. A type of central venous access device that is inserted into the peripheral vein and threaded into the central venous circulation.
      2. It is also referred to as a percutaneous central venous catheter (PCVC).
   B. Midline catheters:
      1. Type of catheter that does not enter the central veins. It is inserted in the peripheral vein and threaded to an area of greater blood flow in the proximal portion of the extremity, or inserted into a scalp vein and threaded into the jugular vein.
      2. Appropriate for the infusion of medications with osmolalities <600 mOsm/Kg, a pH ranging from 5-9.
      3. 5 to 7 dwell times with tip placement in an area of nonflexion.
      4. Peripheral catheter 3-8 inches of length from insertion site.
      5. Lower risk for phlebitis than short peripheral catheters.
      6. AAP committee of nutrition recommends that peripheral solutions maintain an osmolarity between 300 and 900 mOsm/L.
   C. Central line-associated blood stream infection (CLABSI):
      1. Term used by the CDC's national healthcare safety network, a CLABSI is a primary blood stream infection in a patient that had a central line within the 48 hour period before the development of the blood stream infection (BSI) and is not blood stream related to an infection at another site.
      2. Since some BSIs are secondary to other sources than the central line that may not be easily recognized, the CLABSI surveillance definition may overestimate the true incidence of CRBSI (Catheter related blood stream infection).
   D. Catheter related blood stream infection (CRBSI):
      1. A clinical definition used when diagnosing and treating patients, requires specific lab tests that identifies the catheter as the source of infection.

II. Indications:
   A. Neonates, premature infants and full term infants:
      1. Requiring surgical intervention.
      2. With neurologic, genetic, or cardiac problems.
      3. Admitted to the neonatal intensive care units who require IV therapy expecting to last more than 6 days with parenteral nutrition, antibiotic or other medication therapy (Recommended by the last CDC guidelines, 2011).
      4. Difficult venous access.
      5. Premature infants with birth weight <1,500 grams
      6. Infants requiring infusion of hyperosmolar fluids or medications >900 mOsm/L, non-physiologic pH (<5 or >9), or irritating properties.
7. Infants whose medical providers or parents prefer the use of a PICC over other vascular access devices.

III. Contraindications:
   A. Lack of suitable peripheral veins or need of vascular access.
   B. Uncontrolled bacteremia or fungemia.
   C. Thrombocytopenia or coagulopathy.
   D. Bone fracture.
   E. Decrease venous return.
   F. Cardiac malformations requiring operative procedures.

IV. Benefits:
   A. Very preterm neonates who receive nutrition via a central catheter have been reported to have significantly higher weight gain, shorter hospital stay, and lower rates of infection compared with infants with multiple peripheral points of venous access.
   B. Prolonged venous access.
   C. Cost effective.
   D. Longer indwelling time before the risk of late-onset sepsis (LOS) increases.

V. Post insertion complications:
   A. Infection:
      1. Incidence:
         a) Infection is one of the most common complications. Rates vary between 0.8% and 12.5%, with an average of 2% to 8%.
         b) National CLABSI project study shows that increased dwell time was not associated with increased risk of CLABSI for PICCS. This study postulated that the significant maturational changes in the immune system that occur in the early neonatal period, particularly premature infants, may lead to decrease risk for infection as the infant ages with the central line in place.
         c) Tunneled catheters such as Broviacs, infection incidence was found to be significantly higher than PICCs.
         d) The incidence of CRBSI in very preterm infants appear unrelated to whether they receive a PICC, UVC, or UVC followed by a PICC as the primary mode of venous access after birth.
         e) In one retrospective population-based matched cohort study, it was identified that there was not a statistically significant difference in the CLABSI rate when a UVC or a PICC was used as the primary vascular access immediately after birth in preterm neonates born at <30 weeks gestation.
         f) UVC’s are frequently the first choice for vascular access in very low birth weight infants (VLBW) because of easy access, however, use of UVCs is associated with an increased rate of late onset sepsis after a median period of 5-7 days.
         g) The risk for LOS associated with PICCs has been reported to increase after an indwelling time of 35 days compared with 7 days with UVC.
         h)   
      2. Etiology
         a) It has been reported that the portal of entry of an infectious organism with either a UVC or PICC is the catheter HUB.
b) After the first 14 days, intraluminal colonization is the most important source of infection. However, it remains to be elucidated why an average of 7 days of indwelling in UVCs or 35 days of indwelling in PICCs is required for an infection to enter the bloodstream.

c) National estimates of CLABSI rates are available through CDC’s NHSN, a surveillance system for health care associated infections, and are available on the CDC’s website [http://www.cdc.gov/nhsn/PDFs/pscManual/4PSC_CLABScurrent.pdf](http://www.cdc.gov/nhsn/PDFs/pscManual/4PSC_CLABScurrent.pdf)

d) Premature Infants with a BWT <1,000 grams are at higher risk of infection.

e) Other risk factors associated with CLABSI may include: PICC insertion by inexperienced staff, multiple catheter entry, and multi lumen catheters.

3. Treatment:

   a) According to NANN’s latest statement on PICC management published in 2015 and after reviewing some literature regarding CRBSI in infants, there are no definite controlled trials available to provide sufficient data to support the appropriate management in infants who acquire a CRBSI. It has been suggested in a variety of sources that for infants with a PICC, who develop bacteremia without an identified source of infection, removing the central line could improve their outcome.

   b) If catheter salvage is attempted, an additional blood culture should be obtained, treat the infection through the catheter, and repeat blood culture after 48 hours of treatment.

   c) If blood culture remains positive, consider removing the catheter.

   d) Insertion of a new catheter can be attempted after 24-48 hours of initiation of antibiotic treatment.

   e) A cohort study done by Tsai, Ming-Horn, et al in neonates with a PICC who developed a BSI between 2001 and 2007 concluded that PICCs should be removed in neonates with BSI, because retention of PICCs for more than 3 days is associated with delayed resolution of clinical sepsis and a higher incidence of recurrence within 1 month.

4. Prevention:

   a) Increase enteral feeds and decrease acuity of illness are contributing factors that may reduce the opportunity of infections.

   b) It is recommended that uninfected PICC lines should not be routinely replaced for fear of infections.

   c) Using standardized protocols for maintaining PICCs is essential.

   d) Using maximum sterile barrier precautions for catheter insertion and sterile technique for dressing changes.

   e) Practicing appropriate hand hygiene before the catheter is inserted and when entering the PICC.

   f) Using povidone iodine or 0.5% chlorhexidine for skin disinfection prior to catheter insertion and with dressing change.

   g) Dressing the insertion site with a sterile, occlusive material. If dressing integrity is lost, change the dressing.

   h) A multidimensional strategy to decrease CRBSI that included weekly dressing changes showed a statistically significant decrease in CRBSI.

   i) Eliminating stopcocks from tubing and instead using capped injection ports that must be vigorously cleaned with alcohol prior to entry.
j) Exercising meticulous care when using the catheter or changing IV tubing.

k) Minimizing entry into the line.

l) A closed medication system (change the medication system every 24 hours) used as a component of a multidimensional strategy to decrease CRBSI was found to significantly decrease the incidence of CRBSI.

m) Optimal catheter site selection, and daily review of line necessity with prompt removal when unnecessary.

n) The 2011 CDC guidelines summarized recommendations for prevention of intravascular related infections. The following are the main points that apply to the pediatric population:

   (1) Educational training of staffing regarding the indications for intravascular catheter use, proper procedures for the insertion and maintenance of the intravascular catheters, and appropriate infection control measures to prevent vascular catheter related infections.

   (2) Periodically assess knowledge of and adherence to guidelines for all personnel involved in the insertion and maintenance of intravascular catheters.

   (3) Designate only trained personnel who demonstrate competence for the insertion and maintenance of peripheral and central intravascular catheters.

   (4) Appropriate nursing staff levels for care of patients with central line catheters should be considered. Observational studies suggest that a higher proportion of pool nurses or an elevated patient to nurse ratio is associated with CRBSI in ICUs where nurses are managing patients with CVCs.

B. Catheter migration:

   1. General:

      a) Migration of PICC may be related to extremity movement and may cause a catheter shift to a more peripheral or central location.

   2. Symptoms of migration of the catheter:

      a) Infant may experience pain or irritability based on the catheter location and infusate.

      b) Erythema or edema of shoulder, neck, or arm.

      c) Change in catheter function (difficulty flushing or withdrawing).

      d) Change in length of external catheter segment.

      e) Symptoms specific to a particular complication (i.e., dysrhythmias due to catheter migration into the heart or pericardial or pleural effusion).

   3. Treatment:

      a) Obtain radiographic verification of the catheter tip location.

      b) Patient repositioning maneuvers have been shown to successfully correct malpositioned PICC catheters in some instances.

      c) Determine whether it is safe to leave the catheter in its current position; doing so may not be acceptable, especially if the patient is symptomatic.

         (1) Some assert that most malpositioned catheters correct spontaneously within 24 hours.

      d) Consider removing the catheter or performing a catheter exchange if the tip is outside the appropriate location in the vena cava.
4. Prevention:
   a) Migration may not be preventable due to dynamic forces within the body.
   b) Strategies that could help to minimize the risk of migration include:
      (1) Maintaining the security of the catheter with intact dressing.
      (2) Verifying the catheter tip location upon insertion, repositioning, and on
          ongoing basis.
      (3) Verifying the position of the extremity or head on radiograph. This can
          alter the catheter tip position.

C. Catheter dislodgement:
   1. General:
      a) Termed as an inadvertent partial or complete removal of the catheter from the
         body.
   2. Etiology:
      a) Loss of secure dressing
      b) Catheters are retracted during a dressing change.
      c) Excessive bleeding or drainage at the insertion site prevents catheter
         securement.
      d) Extension set and tubing are not secured to the infant.
      e) Tension placed on catheter and dressing particularly when excess catheter
         remains external.
   3. Treatment:
      a) Obtain radiographic verification of the catheter tip location to determine
         safety of leaving catheter indwelling.
      b) Remove catheter or perform a catheter exchange if new tip location is
         unsatisfactory.
   4. Prevention:
      a) Maintain the security of the catheter with an intact dressing.
      b) Consider using specially designed catheter securement devices.
      c) Avoid using ointment under the dressing.
      d) When performing a dressing change, remove the old dressing by pulling
         toward and not away from the insertion site.
      e) Secure extension tubing to the infant.

D. Dysrhythmias:
   1. Etiology:
      a) Atrial and ventricular dysrhythmias can occur if the catheter enters either
         chamber of the heart.
   2. Treatment:
      a) Monitor the heart rhythm during insertion, and slightly withdraw the catheter
         if dysrhythmias occur.
      b) If dysrhythmias occur without an identified etiology, verify the catheter tip
         placement by radiograph or another imaging technique.
   3. Prevention
      a) Measure the patient to determine the correct length of the catheter to be
         inserted.
b) Verify and maintain the catheter tip location in the vena cava and outside the heart.
c) Maintain a secure dressing to prevent catheter migration.

E. Myocardial perforation, effusion or tamponade

1. General:
   a) The incidence rate of pericardial effusion or tamponade is 1.8/1,000 lines, with a mortality rate of 0.7/1,000.
   b) This complication was found to be associated with centers with limited PICC experience.
   c) Furthermore, it was also found, that positioning the tip of the PICC outside of the cardiac silhouette does not eliminate the risk of cardiac tamponade.
   d) Pericardial effusion and tamponade should be considered in any infant who has a PICC and experiences cardiac arrest, has an enlarging cardiac silhouette on radiographic studies, or develops sudden cardiovascular decompensation.

2. Etiology:
   a) Pericardial effusion is suggested as the most dangerous complication as a result of PICC catheter malposition or extravasation.
   b) Based on retrospective data, effusion may occur at any time during catheter dwell.
   c) Pericardial effusion, tamponade, and death can result if the symptoms are not readily identified and the pericardial effusion drained.

3. Signs and symptoms:
   a) Tachycardia or bradycardia.
   b) Narrow pulse pressure.
   c) Hypotension.
   d) Muffled heart tones.
   e) Dysrhythmias.
   f) Weak peripheral pulses.
   g) Respiratory distress.
   h) Poor color or extreme pallor.
   i) Poor response to resuscitation.
   j) Resistance to external cardiac compressions.
   k) Sudden cardiovascular or respiratory compromise.
   l) Pulseless electrical activity.

4. Identification and treatment:
   a) Rapid identification and treatment are critical for survival.
   b) If myocardial perforation, effusion, or tamponade are suspected or occur the following management strategies should be used:
   c) Stop the infusion of fluid.
   d) Immediately obtain a chest X-ray, or an echocardiogram and locate the catheter within or near the heart.
   e) An echocardiogram is the preferred method because it facilitates viewing the effusion, but it may not be readily available.
   f) Attempt to aspirate blood from the catheter while awaiting the imaging study.
      (1) If the aspirate appears consistent with the infusate, continue to aspirate until as much fluid as possible is removed.
      (2) If the fluid cannot be retrieved by direct aspiration from the catheter, pericardiocentesis may be necessary.
(3) The infant’s condition may require life-saving intervention before the radiologic procedure can be accomplished.

g) Withdraw the catheter to the appropriate position in the vena cava; removal of the PICC is not required.

h) Follow up with an X-ray or ultrasound because effusion can reoccur.

5. Prevention:
   a) Maintain the catheter tip in the appropriate location in the vena cava.
   b) Dress the catheter securely to prevent possible migration and trim the catheter to the length required for the infant to facilitate assessment.
   c) Nursing assessment should include verification that the correct length of catheter is outside the body.
   d) Obtain an X-ray at periodic intervals to detect migration. Follow up PICC placement once a week, after a dressing change, whenever the integrity of dressing is compromised, or when in doubt of tip location.
   e) Ensure that the extremity containing the PICC or head is in the same position with each X-ray.
   f) Maintain the catheter tip 1 cm outside the cardiac reflection in a premature infant and 2 cm in a term infant, suggested but not proven.

F. Pleural effusion or hydrothorax:
   1. Etiology:
      a) Pleural effusion has been reported when catheter tips reside in the right atrium, inferior or superior vena cava, brachiocephalic and subclavian veins, and a small branch of the pulmonary artery.
      b) This complication occurs infrequently, is typically unilateral, and has been reported to occur due to a variety of factors.
      c) Perforation can occur during or after catheter insertion
      d) Catheter tip against a vessel wall or malpositioned or migrated into a small vessel and not into the vena cava.
      e) Erosion of the vessel due to contact with the catheter.
      f) Superior vena cava thrombosis leading to chylothorax.
      g) Mechanical and chemical irritation can erode the vessel.

   2. Signs and symptoms:
      a) Vary with the size of the effusion, rate of fluid accumulation, size of the infant, and degree of venous damage.
      b) Respiratory distress with decreased breath sounds over the affected lung soft-tissue swelling.
      c) Absence of blood return from the catheter (this may also be due to other causes).

   3. Identification and management:
      a) Obtain imaging studies—radiologic imaging studies confirm the diagnosis of pleural effusion and hydrothorax.
      b) Stop the infusion of fluid through the catheter.
      c) Thoracentesis to remove effusion fluid may be required.
      d) Some pleural effusion and hydrothorax resolve themselves spontaneously without catheter removal.
      e) Monitor for re-accumulation with radiologic imaging studies.

   4. Prevention:
a) Maintain the catheter tip in the appropriate position within the superior or inferior vena cava.

G. Phrenic Nerve Injury:
1. Etiology:
   a) This infrequently reported complication has been seen with catheter tips that reside in the subclavian vein or internal jugular.
   b) The specific mechanism of action is speculative, but the reported cases include:
      (1) Extravasated fluid from the catheter tip residing in the subclavian vein causes irritation of the underlying phrenic nerve.
      (2) Thrombosis and the resulting engorgement of the subclavian vein, which compresses the phrenic nerve.
2. Signs and Symptoms:
   a) Respiratory distress.
   b) Persistent elevation of the diaphragm on X-ray.
3. Management:
   a) Diagnosis radiologic imaging (e.g., X-ray, ultrasound, fluoroscopy) can be used to diagnose phrenic nerve injury and diaphragmatic paralysis.
4. Prevention:
   a) To prevent phrenic nerve injury and diaphragmatic paralysis, the catheter tip should be in the superior or inferior vena cava.

H. Catheter fracture or embolism:
1. Etiology:
   a) This multifactorial complication has several proposed etiologies, with fracture being identified on the internal or external portion of the PICC.
   b) Shearing of the catheter can occur during insertion if the catheter is withdrawn while the insertion needle is in place or if the infant moves significantly during the insertion and damages the catheter.
   c) Catheter fracture from high pressure created using small volume syringes for infusion or flushing against resistance.
   d) Removal of the catheter using force.
   e) Disconnection of the catheter from the original or a repaired hub.
   f) Break in external segment of the catheter secondary to securement failure or force is also a cause.
2. Signs and Symptoms:
   a) Varies depending upon the location of the fracture and the presence of embolus.
   b) Some infants remain asymptomatic with the fracture or catheter embolus being identified radiographically or clinically based on the assessment of the length of the external catheter segment.
   c) Respiratory distress, hypoxia, and hypotension.
   d) Fluid leaking from the insertion site.
   e) Inflammation or swelling along the catheter pathway.
   f) Difficulty flushing or withdrawing blood.
   g) Cardiac dysrhythmias.
3. Treatment:
a) If the catheter snaps during withdrawal apply digital pressure over the vein or apply a tourniquet to the involved extremity to prevent further migration into the central circulation.
   (1) The tourniquet should not be tight enough to occlude arterial flow.
b) Keep the patient immobile.
c) Obtain radiographic verification of the location of the catheter fragment.
d) Catheters kept in the peripheral circulation can be removed by venotomy.
e) Catheters embolizing to the central circulation may require removal by interventional radiology, cardiology, or surgical procedures.

4. Prevention:
   a) Assess the need for analgesia or sedation for the insertion procedure
   b) If catheter repositioning is needed at the time of insertion, do not retract the PICC through the introducer needle to prevent catheter shearing.
c) Maintain the catheter securely under the dressing, while preventing tension to the catheter. Ensure connecting tubing (i.e., T-connector) is also connected to patient.
d) Monitor catheter repair sites diligently. Consider exchanging the catheter for a new PICC rather than repairing.
e) Avoid forceful infusion through the catheter using syringes.
f) Don’t flush if resistance is encountered.
g) Only healthcare professionals with demonstrated clinical competency should remove PICCs.
h) Remove the catheter gently, while holding the catheter at the point of insertion rather than the hub, and do not use force.

I. Thrombosis:
   1. General:
      a) The incidence of thrombosis varies due to the lack of a standardized method of diagnosis, but is higher in smaller children. Some report venous thrombosis rates with PICCs range from 4% to 29% and are associated more commonly with lines placed in lower extremities.
   2. Etiology:
      a) Endothelial damage due to vascular trauma, inflammation of the vessel wall, alteration in coagulation, and stasis of blood flow.
      b) Low flow or turbulent flow rates.
      c) Intrinsic patient coagulopathy, and high osmolar infusates may contribute and propagate a thrombus.
      d) Catheter tips residing outside the vena cava can lead to an increased risk of thrombosis.
   3. Signs and symptoms:
      a) Most are silent. Mechanical occlusion, drug or mineral precipitation, and fungal-related occlusion should be excluded first.
      b) Prominent superficial or collateral vessels.
      c) Edema or discoloration of the extremity in which the catheter is located.
         (1) For infants who have lower extremity PICCs, clinical findings of unexplained hypertension or leg swelling may warrant a search for a line-associated thrombus.
         (2) For a PICC placed from the head or upper extremity, neck or facial edema may be clues to catheter thrombosis.
d) Unexplained fever.
e) Unexplained thrombocytopenia.
f) Chylothorax, which may be the only sign of a superior vena cava thrombosis.

H) Unexplained cardiorespiratory decompensation, particularly with hypoxia, is suggestive of pulmonary embolus or pericardial effusion.

4. Prevention:
   a) The catheter tip should be located appropriately.
   b) The catheter size should be appropriate for the size of the vessel to be cannulated.
      (1) An appropriately sized catheter facilitates blood flow around the catheter and allows adequate dilution of the infusate, preventing irritation of the venous wall.
   c) Powder-free gloves should be used for catheter insertion to decrease the risk of tissue reactions.
   d) Secure the catheter to prevent vessel damage, stimulation of the coagulation cascade, and thrombosis secondary to migration.

J. Vena Cava Thrombosis:
   1. General:
      a) Most superior and inferior vena cava thrombosis are subclinical.
   2. Etiology:
      a) This condition can be diagnosed using ultrasound or a venogram. Many of the etiologies are inclusive of those outlined under “Thrombosis.”
   3. Signs and Symptoms:
      a) Edema of the upper extremity, neck, and head (superior vena cava thrombus).
      b) Edema of the lower body and limbs (inferior vena cava thrombus).
      c) Dilation of veins on the skin (collateral circulation).
      d) Respiratory distress.
      e) Cardiac murmur.
      f) Central nervous system disturbances (superior vena cava thrombus).
      g) Full fontanel (superior vena cava thrombus).
   4. Treatment:
      a) Treatment of superior vena cava thrombosis varies depending on its severity.
      b) A variety of treatment options have been proposed though there is no consensus about which is the preferred method.
      c) Treatment options may include:
         (1) Infusion of a thrombolytic agent via the PICC or an alternative vascular access device.
         (2) Anticoagulation therapy.
         (3) Surgical removal of the thrombus.
         (4) Catheter removal with supportive care.

K. Mechanical or chemical phlebitis:
   1. General:
      a) The incidence, clinical symptomatology, treatment, and outcomes are not well defined in neonates.
   2. Etiology:
      a) Mechanical phlebitis is an inflammatory reaction of the vein associated with placement and the ongoing dwell of a catheter within the vein.
      b) Risk factors for mechanical phlebitis include the following:
(1) Rapid or traumatic insertion, which can damage the intima of the vein.
(2) Use of a large-gauge catheter in relation to the size of the vein catheter tip outside of the vena cava.
(3) Cephalic vein insertion.
(4) Saphenous vein insertion.
(5) Inadequately secured catheter.
(6) Manipulation of the PICC during insertion.
(7) Inexperienced clinicians placing the catheter have been anecdotally associated with a more rapid insertion, which may foster contact with the vein intima.

3. Signs and Symptoms:
   a) The constellation of symptoms vary and may include pain at the insertion site or along the track of the vein, edema, erythema, palpable venous cord, and purulent drainage.
   b) Mechanical phlebitis is most commonly reported during the first 72 hours to 1 week.
   c) Symptoms of phlebitis have also been referred to in the neonatal literature as erythematous tracking or cording.

4. Treatment:
   a) The need for and type of treatment for phlebitis remains unclear. Some consider this a benign condition with spontaneous resolution.
   b) Treatment options include:
      (1) Elevating the involved extremity and administer a gentle range-of-motion exercise if the infant has little spontaneous activity.
      (2) With early identification and treatment, phlebitis usually resolves itself within 24–72 hours.
      (3) If there is no improvement or if the phlebitis advances after 24 hours of therapy (as indicated by a red streak, palpable cord, or purulent drainage), discontinuing the catheter should be considered.

5. Prevention:
   a) Maintain the catheter tip within the vena cava.
   b) Frequently monitor (observation and palpation) the vein of catheter insertion to allow for early identification and treatment.
   c) Slowly and gently insert the catheter.
   d) Use the smallest catheter capable of delivering the required therapies
   e) Secure the catheter to prevent movement
   f) Avoid touching the catheter with gloves containing powder.

L. Chemical phlebitis:
   1. Etiology:
      a) Chemical phlebitis is most commonly associated with PIVs and midline catheters, but can be associated with an improperly positioned or malfunctioning PICC.
      b) Risk factors:
         (1) Indwelling portion of the catheter is damaged and contains holes. (The damage may occur during insertion, flushing against resistance, or infusing with pressure that exceeds the burst strength of the catheter.
         (2) The properties of the infusate may lack adequate hemodilution, which leads to venous damage.
A fibrin sheath forms around the tip and propagates along the length of the catheter. Catheter tip in a location with adequate hemodilution leading to chemically induced vessel irritation and erosion.

2. Treatment:
   a) Chemical phlebitis due to tip location (non-vena cava) warrants catheter removal.
   b) If chemical phlebitis is caused by a fibrin sheath, the catheter should be removed or the fibrin sheath can be treated using a thrombolytic agent (Review the risks and benefits of this treatment before proceeding).

M. Occlusion:
1. Etiology:
   a) Thrombotic occlusions represent the most common etiology.
   b) Nonthrombotic or mechanical occlusions caused by incorrectly set pump occlusion alarm, closed clamps on tubing, kinks or bends in catheter tubing and infant’s extremity position.

2. Risk factors:
   a) Failure to adequately flush before and after medication administration or incompatible solutions.
   b) Calcium-phosphate imbalance of total parenteral nutrition (TPN).
   c) Lipid residual.
   d) Fungus infection.

3. Signs and symptoms for all types of catheter occlusion:
   a) Sounding of pump occlusion alarms.
   b) Visible clots, particulate matter, or lipid clumps in the catheter.
   c) Change in ability to aspirate or flush the catheter.
   d) Pain during infusion and fluid exiting the catheter insertion site.

4. Identification and management:
   a) The cause of catheter occlusion should be sought by reviewing the etiologies of each type of occlusion and the patient’s history with the catheter and recent infusates.
   b) The catheter should be inspected under the dressing for kinks and bends and secured to prevent bends or movement.
   c) An X-ray may determine whether the catheter is malpositioned or bent internally.
   d) The hub and the external portion of the catheter should be checked for leaks and assessed for malposition and migration.
   e) Contrast injections through the catheter, venogram, or ultrasound can be used to detect thrombotic occlusions.
   f) The etiology determines the course of treatment.
   g) Repositioning may be required if the catheter is lodged against a vessel wall.
   h) The infant can be moved from side to side or from prone or supine.
   i) If the catheter is in an extremity, the arm or leg can be repositioned.
   j) Abducting or extending the arm can alleviate a catheter bend.
   k) The catheter can be removed and a new one inserted if needed. In general, this is necessary for fungal occlusion.
   l) Remove the blockage by instilling a “clearing agent.” Some of these agents return the precipitate into solution by creating a favorable pH balance. Most reports of success have been anecdotal. Tissue plasminogen activator (tPA) has
been used in neonates and is the approved thrombolytic agent used for catheter clearance in children and adults.
m) A protocol should be in place and staff trained in the procedure. The risks and benefits of the procedure must be examined to determine whether the catheter is essential for care. The volume of the clearing agent instilled should approximate the catheter volume (or be slightly more in the case of thrombolytic) to minimize entry into the bloodstream.
n) Catheter-clearing agents such as tPA can be instilled into the catheter using one of these techniques:
   (1) Gentle push: Use for catheters with partial occlusion.
   (2) Using a three-way stopcock create a vacuum in the catheter:
      (a) Attach the stopcock to the hub of the catheter.
      (b) Using a 10-ml syringe, aspirate until enough resistance is felt to indicate the presence of a vacuum within the catheter.
      (c) Attach a 10-ml syringe containing the clearing agent.
      (d) Open the stopcock to the syringe containing the clearing agent, and the agent will be gently drawn into the catheter.
      (e) Close the stopcock to the patient to allow the clearing agent to dwell within the catheter for the prescribed time.
      (f) Verify the catheter patency by assessing for blood return.
   (3) If patency is achieved, aspirate the clearing agent and blood from the catheter, flush the catheter well with saline, and begin infusion of prescribed fluids.
o) In cases of thrombotic occlusion, thrombolytic agents (e.g., tPA) have to be instilled into the catheter according to the manufacturer’s recommendations.
p) Assessment after clearing
   (1) Possible complications related to the clearing agent and the procedure include the following:
      (a) Catheter damage
      (b) Leakage
      (c) Thrombolytic-induced bleeding

5. Prevention:
   a) Heparinization of infusion fluid reduces the risk of thrombosis. Add heparin 0.5-1 units/ml to reduce the risk of occlusion and thrombosis.
   b) Consider the minimum infusion rate orders based on NICU outcome data reporting rate of thrombotic catheter occlusion.
   c) The flushing method:
      (1) Use pulsatile movements (i.e., short bursts) when flushing.
   d) Ensure compatibility of medications and co-infusing solutions.
   e) Flush before and after giving medications or changing solutions to prevent drug incompatibility and precipitate formation.
   f) Promptly respond to occlusion alarms on the infusion pump.
   g) Ensure TPN components are balanced.

N. Drainage:
   1. General:
      a) Drainage at the insertion site may be a normal serous fluid or a leak in the catheter due to catheter damage or a fibrin sheath surrounding the catheter.
   2. Prevention:
a) Use techniques to minimize catheter damage;
   (1) Do not apply clamps or sharp objects to the catheter or hub.
   (2) Use the appropriate syringe size a 5 or 10-ml syringe, per the
       manufacturer’s recommendation and pressure when infusing.
   (3) Do not flush when resistance is encountered.
   (4) Do not pull the catheter back through the needle introducer.
   (5) Cautiously remove break-away needles.
   (6) Secure the catheter and extension tubing to the patient to prevent
       stretching and breakage.

3. Management:
   a) If a leak occurs because of a catheter fracture, prevent embolization of the
      catheter (refer to “Catheter embolism”).
   b) Determine if the catheter can be repaired or exchanged for a new catheter, or
      if removal is necessary.

O. Extremity edema:
1. General:
   a) Throughout the catheter dwell, mild to gross edema surrounding the insertion
      site or in the extremity may be identified.
2. Etiology:
   a)restrictive dressing.
   b) Bend in the extremity.
   c) Dependent positioning.
   d) Decreased movement.
   e) Thrombus.
   f) Catheter that is too large for the size of the vein so that it restricts adequate
      venous return.
   g) Extravasation of infusate.
3. Treatment:
   a) The treatment is based on the cause.
   b) Redress and straighten the extremity (possibly using a limb board for a short
      period of time).
   c) Elevate the extremity.
   d) Measure the circumference of the proximal portion of the extremity and
      compare to the opposing extremity until the edema improves.
   e) Obtain a venogram or ultrasound if thrombus is suspected.
   f) If the edema is mild and stable without compromising the health of the
      extremity, the catheter may be left in place if it is monitored vigilantly.
   g) If the edema is progressive or if the extremity is compromised, consider
      removing the catheter.

P. Neurologic complications:
1. General:
   a) Catheters placed through the scalp or arm veins have rarely been linked to
      complications.
   b) The most commonly reported neurologic symptoms stem from catheters
      placed via veins in the lower extremities.
      (1) PICCs inserted via a leg or femoral vein pose a risk of entering the
          ascending lumbar veins rather than the inferior vena cava.
(2) The ascending lumbar veins drain the vertebral venous plexus into the common iliac vein.
(3) Infusion through a catheter in this location can result in venous stasis and pressure and fluid transmitted to the spinal cord, thereby leading to a variety of neurologic complications.
(4) Migration of the central venous catheter or redistribution of the infusate into the ascending lumbar vein is thought to occur in infants who are experiencing an increase in intra-abdominal pressure (i.e., abdominal distention, necrotizing enterocolitis, repaired congenital diaphragmatic hernia).

2. Identification:
   a) Radiographic findings:
      (1) Left-sided insertion that fails to cross the midline to enter the inferior vena cava and appears to overlay the spine.
      (2) A bend or hump in the catheter at the L4-5 level on AP view, particularly on left-sided insertions and when the catheter is threaded to or beyond the level of L3.
      (3) Marked posterior deviation of the catheter at L4-5 on a lateral view.
      (4) A 360° curl or loop in the catheter in the inguinal region prior to advancement up the ascending lumbar vein.
      (5) Posterior deviation of the catheter through the spinous process in the lateral radiograph.

3. Prevention:
   a) Maintain a high index of suspicion throughout treatment.
      (1) Experienced personnel should meticulously assess the radiograph for the catheter location.
      (2) Observe the length of the catheter from the leg to the tip for subtle clues of malposition.
   b) If malposition is suspected, obtain a radiograph from the lateral perspective.
      (1) The catheter presenting anterior to the spinal column is typically in the inferior vena cava, while the catheter deviating posteriorly may be in the ascending lumbar vein. (see above identification)

VI. Family Education and Consent for Procedure:
A. Family members should be educated about the reason for the procedure and how the procedure is performed.
B. A consent MUST be obtained prior to a PICC line insertion.
C. Document education about benefits and possible complications once discussed.

VII. Assessment and evaluation:
A. Some facilities have a team of RNs that insert PICCs.
   ALL PICC LINE INSERTIONS MUST BE APPROVED BY THE PHYSICIAN OR ALLIED HEALTH PROFESSIONAL ON DUTY.
B. Some facilities grant privileges for AHP to insert PICCs under indirect or direct supervision so it is important to know the policy at each facility you attend.
C. Assess the insertion site, if a suitable vein cannot be identified, the infant may be a candidate for another vascular device.
D. Check blood cultures obtained from the neonate to ensure that they are negative prior to inserting a PICC line and assess for thrombocytopenia prior to insertion.
E. Comply with Universal Protocol.
F. Consider using non-pharmacological measures, pain medication or sedation prior to procedure. Some hospitals have developed protocols for pain management prior to PICC line insertion. Follow institution guidelines.
G. Ensure that the neonate has proper monitoring during procedure.
H. Ensure availability of personnel for assistance.
I. Ensure availability of imaging to confirm line placement after ending procedure.
J. Use catheter checklist, standardized supply kit, and standardized protocol for insertion.
K. Position infant for comfortable access, include proper head placement.

VIII. Procedure-Insertion (Refer to Kidz Medical Service PICC line Procedure).
IX. Care and Maintenance (Refer to Kidz Medical Service PICC line Procedure).
X. Placement (Refer to Kidz Medical Service PICC line Procedure).

References


Stanz M. Adjusting pH and osmolarity levels to fit standards and practices. *J Vasc Access Device* 2002;7:12-17. (Ph of solution)


