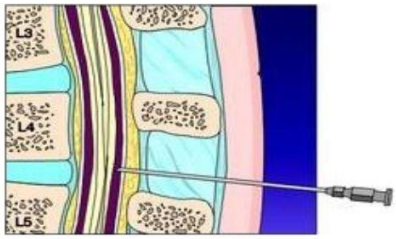
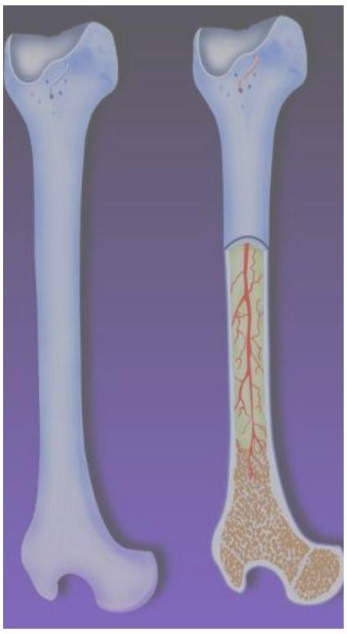
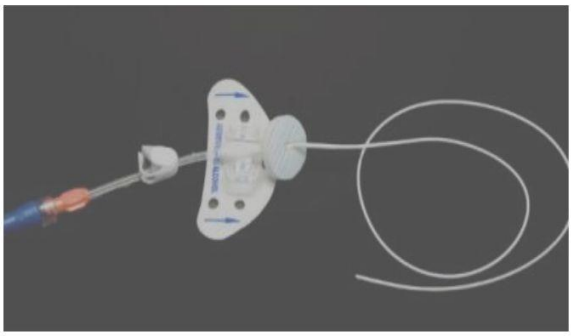
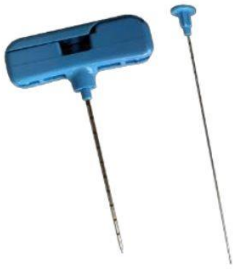
Practical Procedures in Pediatric Oncology









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WHO Regional Office for South-East Asia and St. Jude Children's Research Hospital through the Global Initiative for Childhood Cancer.

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ALL INDIA INSTITUTE OF MEDICAL SCIENCES
शरीरमाद्यं खलु धर्मसाधनम्

SEAR CCN

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About the module

Dr Rachna Seth

Invasive procedures are integral to the provision of treatment necessary for long-term disease-free survival for many children with cancer.

Lumbar puncture (LP), bone marrow aspiration (BMA) and bone marrow biopsy (BMB) are essential for the evaluation and management of many childhood cancers. Chemotherapy forms the backbone of most cancer treatment protocols, is required at different time points and is administered according to treatment protocols. PICC (peripherally inserted central catheters) have gained popularity and are frequently used for sampling and for administration of chemotherapy and antimicrobials.

As part of the WHO Global initiative for Childhood Cancer (GICC), WHO Regional Office for the South-East Asia has initiated a number of activities with the aim of increasing access to care and improving quality of care to children with cancer by prioritizing childhood cancer in policies and by promoting implementation of evidence-based practices.

Among others, one important activity included the establishment of the South-East Asia Regional Childhood Cancer Network (SEAR-CCN) in 2020. The aim of the network is to contribute to improving quality of care and long-term capacity building by harnessing the unique strengths of each individual member institution to support other fellow institution and vice-versa. To participate in this initiative, Pediatric Oncology Division from Department of Pediatrics (AIIMS, New Delhi) is bringing out modules on Practical Procedures in Pediatric Oncology.

The current module is dedicated to cover the training aspects for important procedures (bone marrow examination and lumbar puncture) and care of PICC lines in children with cancer. A core value in pediatric oncology nursing is the provision of atraumatic care. Appropriate analgesia and sedation are essential in the effective management of painful procedures for children with cancer. Pediatric procedural sedation (PPS) refers to techniques and medications used to minimize anxiety and pain associated with unpleasant procedures and will be covered in the module.

The modules are likely to enhance the skills on the most common procedures required in the management of childhood cancer, and more so in relatively low-resource settings. Such trainings are expected to improve the quality standards in procedures, reducing pain and minimizing complications among other things; and in some settings it may enable starting a new service for children with cancer. Additionally, it will empower a centre to perform these investigations in house, thereby decreasing the time to reach to diagnosis and better reporting of reports and accountability.

The training material of the module includes audio visual content on procedures (bone marrow examination, lumbar puncture PICC insertion and pediatric procedural sedation), power point presentations, manual for the training participants, learning objectives and pre- and post-training assessment of trainees.

While the training module will be designed primarily to be delivered hands-on, some of the components such as the audio visuals and power point slides have been developed in a way as to be used independently on the web.

The manual has been carefully developed to cover all aspects of bone marrow examination, lumbar puncture, PICC insertion and procedural sedation in a comprehensive way. It may be a useful reference for trainees, fellows and clinicians practicing pediatric oncology.

I am indeed very grateful for having been given this opportunity and am immensely thankful to all (faculty, residents, nurses) whose contributions have culminated in bringing out this manual. We acknowledge Dr Catherine Lam, Ms Andini Handayani and Dr Roberta Ortiz for their support in the review process of the content of the module. We are extremely grateful to Dr Bishnu Rath Giri for his constant support and guidance throughout the process of making this module. Feedback is welcome and may be mailed at drrachnaseth1967@gmail.com.

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Message

Dr Madhulika Kabra

First of all I would like to thank the WHO for giving this opportunity to the Division of Oncology, Department of Pediatrics, All India Institute of Medical Sciences, New Delhi to contribute for the WHO Global initiative for Childhood Cancer care. Cancer care is improving with better survival even in LMICs and this is a very timely and thoughtful initiative by the WHO.

I wish to congratulate Professor Rachna Seth and her team for this meticulous work. The current module is dedicated to cover the training aspects for important procedures like bone marrow examination, lumbar puncture, PICC lines and procedural sedation which are integral for managing children with cancer and other diseases which will be a rich resource for pediatric practice in general.

The descriptions are crisp, clear and unambiguous beginning from counselling, pre-preparation till post procedure monitoring with check lists in place for ready reference. Common sedation protocol is meticulously written, the most important component of any procedure. Individual procedures are described with minute details including all components. Overall, it was a delight to go through the brilliantly prepared manual.

I congratulate the whole team involved in the WHO Global initiative for Childhood Cancer care and wish them for a successful implementation of the program.

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Contents

Module on Lumbar puncture

LEARNING OBJECTIVES

1. Describe the indications for performing a lumbar puncture in Pediatric oncology.
2. Recognize the clinical scenarios warranting lumbar puncture and list associated contraindications.
3. Demonstrate the procedure for conducting a lumbar puncture safely and effectively.
4. Summarize the characteristics of normal cerebrospinal fluid (CSF) and interpret its analysis.
5. Outline the equipment and steps required for safe administration of intrathecal chemotherapy.
6. Identify potential complications of lumbar puncture and apply essential troubleshooting strategies.
7. Learn to use a checklist prior to the procedure to mitigate risks and improve safety.
8. Explain post-procedure monitoring requirements, including vital sign assessment and neurological evaluation.
9. List criteria for safe discharge following lumbar puncture to ensure patient well-being.
10. Document findings and patient responses accurately for comprehensive medical records.
11. Provide clear instructions for reports collection and follow up.

Introduction

Lumbar puncture is the procedure performed to reach the subarachnoid space, either to sample the cerebral spinal fluid, to aid in the diagnosis of central nervous system involvement of childhood cancers, or to administer medications in the subarachnoid space.

Intrathecal chemotherapy is administered in children with Leukemia, Lymphoma, and in select brain tumors like Medulloblastoma. The antineoplastic drugs used are methotrexate (MTX), cytosine arabinoside (Ara-C) and corticosteroids most commonly. Less commonly instilled medications are thiotepa and topotecan, which were tested in research studies for the management of leukemic meningitis and leptomeningeal metastases of brain tumors such as medulloblastoma, pilocytic astrocytoma and solid tumours such as retinoblastoma, neuroblastoma. Intrathecal instillation of methotrexate (MTX) has reduced the incidence of CNS relapse. (1)

Anatomy of the Blood Brain Barrier

The blood-brain barrier restricts the availability of systemically administered chemotherapeutic agents. The basis for this restriction is the presence of tight junctions connecting the layer of endothelial cells. The cellular structures constituting the blood-brain barrier are depicted in Figure 1 (2) which shows the transverse section through a vessel within the brain parenchyma. Among many methods to overcome the limited CNS penetration of systemically administered drugs is intrathecal instillation of the drug.

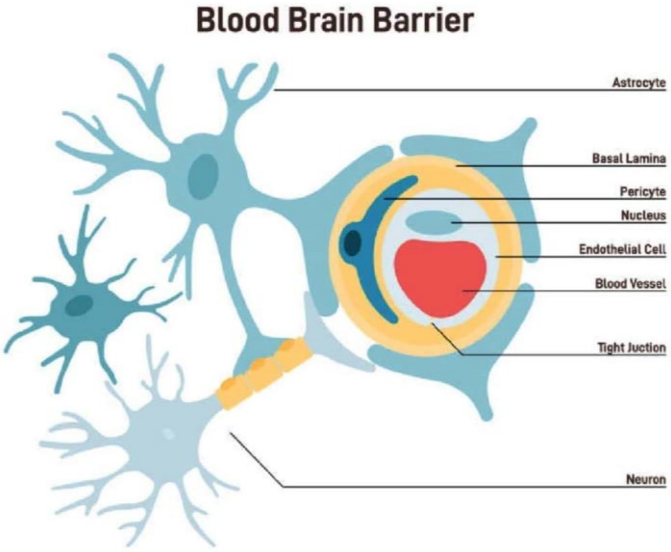

Figure 1. Schematic illustration of the blood-brain barrier (2)

A styletted needle is inserted between the interspinous processes of the lumbar vertebrae and through the supraspinal and intraspinal ligaments, ligamentum flavum, dura mater, and arachnoid mater into the subarachnoid space.

Site of procedure

At the level of the cauda equina, distal to the termination of the spinal cord. In Infants, LP is performed below the L2-L3 interspace to avoid injury to the spinal cord, as the spinal cord ends higher at L1-L2 level, and in older children, it can be performed from L2-L3 interspace to the L5-S1 interspace. (3)

L3-L4 and L4-L5 interspaces can be located by identifying the fourth lumbar vertebra which lies on the line that joins the two posterior-superior iliac crests. A schematic of the spinal anatomy is shown in Figure 2.

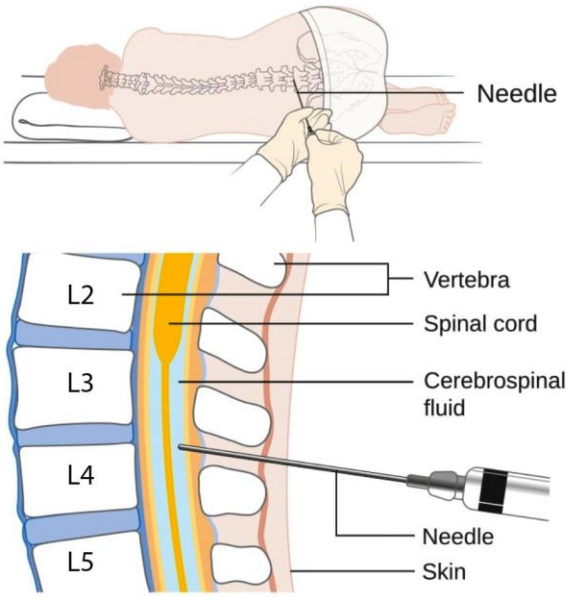

Figure 2. Spinal Anatomy for lumbar puncture

Indications

Diagnostic

1. To determine CNS involvement in leukemia and lymphoma for staging and risk stratification.
2. To determine disseminated disease in medulloblastoma, retinoblastoma, neuroblastoma etc
3. Suspected CNS infection – Bacterial meningitis, Aseptic viral meningitis, fungal like cryptococcal meningitis
4. Suspected subarachnoid haemorrhage.

Therapeutic

1. CNS directed therapy for patients with CSF involvement in acute leukemia and non-hodgkinlymphoma (intrathecal methotrexate, triple intrathecal chemotherapy)
2. For "prophylaxis" intrathecal therapy for preventing meningeal leukemia and lymphoma
3. Children requiring spinal anesthesia

Characteristics of normal CSF[4,5]

Color	**Colourless, clear, like water**
Opening pressure	<20 cm of water
Glucose	Varies with age as given below, 60-70% of blood glucose concentration Infant 0-28 days – 30-61 mg/dL Infant 29-56 days – 30-66 mg/dL Child – 40-80 mg/dL
Protein	Infant 0-28 days – <115 mg/dL Infant 29-56 days – <89 mg/dL Child – 5-40 mg/dL
WBC	Infant 0-28 days – 0-19 cells/µ mL Infant 29 days–56 days – 0-9 cells/µ mL Child – 0-7 cells/µ mL

Definitions of CNS involvement with CSF analysis for acute lymphoblastic leukemia/T -NHL

CNS 1: Absence of blasts in CSF on cytospin

CNS 2

2a: <10 RBCs; <5 WBC and cytospin positive for blasts
2b: ≥ 10 RBCs; <5 WBCs and cytospin positive for blasts
2c: ≥ 10 RBCs; ≥5 WBCs and cytospin positive for blasts

CNS 3

3a: ≥5 WBCs; < 10 RBCs, with blasts in the CSF (with or without clinical signs)
3b: Clinical evidence of CNS disease alone
(facial nerve palsy, brain, eye involvement, hypothalamic syndrome) with no accompanying CSF findings.

If the lumbar puncture is traumatic with >10 RBC/ml of CSF and contains morphologically identifiable blasts, the patient is considered to have CNS involvement. The designation of CNS status will follow the guidelines outlined in the troubleshooting section.

For definition of CNS involvement in Non-hodgkin lymphoma (e.g. anaplastic large cell lymphoma, lymphoblastic lymphoma etc.), reference must be made to specific type of lymphoma protocols

In solid tumors like retinoblastoma, neuroblastoma, rhabdomyosarcoma and Non-hodgkin lymphoma – the CSF is examined for the presence of tumor cells. The presence of tumor cells aids in risk stratification, prognostication and treatment decisions.

Contraindications[6,7]

1. Raised Intracranial Pressure (ICP): due to increased risk for cerebral herniation on performing LP.
2. Respiratory distress: in the lateral recumbent position, hypoxemia is likely to be exacerbated.
3. Hemodynamic Instability
4. Soft tissue infection at the puncture site on the skin
5. Bleeding disorder: LP should not be performed in patients with coagulation defects who are actively bleeding or INR >1.4, severe thrombocytopenia (Platelet counts < 50,000/cumm)
6. Spinal abnormalities: such as spina bifida or severe scoliosis. An alternative approach for obtaining CSF, by performing under fluoroscopic guidance may be necessary.

Pre-Procedure

1. Review the indication for performing the lumbar puncture procedure in the child.
2. Adhere to unit's checklist for doing a lumbar puncture to ensure there are no contraindications to a perform a lumbar puncture safely.
3. Patient and parental counselling – a clear explanation of the indication for the procedure and the details of the procedure is reassuring given the invasive nature of the procedure. The parents must be informed of the potentially severe complications that can occur.
4. Written informed consent is mandatory.
5. Equipment – a tray with all the necessary tools to perform the lumbar puncture and a resuscitation cart with supplies for emergency airway, breathing, and circulation supplies must be available.
    a. Sterile gloves, Face mask and sterile gown
    b. Sterile drapes, sponges and gauze pieces
    c. Topical antiseptic solution – 2% Chlorhexidine/10% Povidone iodine solution and surgical spirit.

d. Sterile CSF collecting tubes
e. Sterile syringes – 5 ml, 1 ml
f. Spinal needles: Preferably use 25G bevelled spinal needles with a stylet. Use atraumatic/pencil point needles if possible (It is advisable to use single-use sterile needles for Lumbar puncture).

The following guidelines for appropriate needle length are based on the child's age

Under 2 years:	1.5 inches (3.75 cm)
Between 2 & 12 years:	2.5 inches (6.25 cm)
Beyond 12 years:	3.5 inches (8.75 cm)

The following guidelines for appropriate needle length are based on the child's height

Height	Needle length
80 cm	3 cm
120 cm	4 cm
150 cm	5 cm
>150 cm	6 cm

g. Local anesthetic agent – Topical lignocaine injection/Lignocaine without adrenaline for infiltration into the skin.
h. Sedation with midazolam and ketamine. Please refer to the sedation module for more information.
i. If raised ICP is suspected, then a fundus examination to rule out papilledema and CNS imaging may be necessary. However, a normal CT brain does not rule out raised intracranial pressure.
j. Clothing for the child – the child must be in loose-fitting hospital clothes.

Lumbar-Puncture Procedure

Positioning – An assistant experienced in holding the child in an optimal position must be available. In children, lumbar puncture is performed in the lateral recumbent or sitting position. The lateral recumbent position is most commonly used, as the procedure is carried out under sedation. In older adolescents and young adults, lumbar puncture may be performed without sedation upon request, provided the patient is able to maintain the required position.

- **Lateral recumbent** – The child is placed on their side near the edge of the table, the assistant helps the child draw the knees upward. The neck is gently flexed by placing one arm around the posterior aspect of the neck and the other arm under the child's knees. The hips and shoulders should be

perpendicular to the table to prevent spinal rotation. The gluteal crease will be aligned with the spinous processes.

- **Sitting –** For neonates and cooperative children, sitting position is an alternative to the lateral recumbent position.

Monitoring – It is important to monitor visual respirations as there is a risk of apnea during the procedure. All children undergoing lumbar puncture should undergo continuous cardiorespiratory monitoring and pulse oximetry. Sedation notes must be complete

Steps

1. The interspace (L3-L4 or L4-L5) through which the LP will be performed is identified and marked.
2. Intravenous sedation is administered prior to positioning the child. Please consult the guidelines for procedural sedation for more information.
3. Using a sterile method, the puncture site is cleansed with surgical Spirit followed by Povidone-iodine solution and then surgical spirit again, with circular movements of increasing circumference from centre to periphery. The skin should be allowed to dry completely after each cleansing step. The cleaning solution is poured onto the bowl or handed to the personnel performing the procedure. Do not place the material used for cleaning on the dressing pack, these should be disposed of in the bin.
4. Sterile drapes are placed underneath the patient and a drape with a hole is placed to cover around the puncture site.
5. If providing infiltrative anesthesia, the skin and subcutaneous tissues are anesthetized with 1% lignocaine using a 25-gauge needle to raise a wheal over the interspace, and then deeper subcutaneous tissue is infiltrated. The needle and the syringe used for local anesthesia should be discarded from the dressing set, before proceeding with further steps.
6. Check the spinal needle and ensure that the stylet is firmly in place.
7. In the single-hand approach, utilize the free thumb tip as a guide by placing it on the spinous process either above or below the intended entry site of the desired interspace. In the two-handed approach, hold the needle between the index fingers while securing the hub with the thumbs for stabilization. The bevel should be parallel to the table and face upwards and the spinal needle is positioned in the midline.
8. As the needle is advanced deeper, the stylet is cautiously removed from time to time to look for CSF. A “pop” is perceived as the needle enters the dura and enters the subarachnoid space. The stylet is removed and CSF flow is assessed for in the hub.

CSF Collection

The CSF should be collected in sterile tubes. 8-10 drops per tube as approximately 1 ml of CSF is required for standard studies.

The order of the draw – the first tube is for Gram stain and bacterial culture, second is for glucose and protein and the third is for cell count and differential, the remainder tests can be collected in the subsequent tubes. If clinically indicated CSF samples may be collected for flowcytometry, India Ink preparation, Galactomannan and fungal culture in the setting of suspected fungal infection, antibody panel testing for autoimmune and paraneoplastic etiologies.

We may not need to evaluate CSF for all tests mentioned above. We may only want to evaluate for malignant cells in CSF.

The collected CSF sample must be dispatched to the laboratory and analysed ***within an hour of collection***. It is also advisable to communicate and coordinate with the laboratory to perform the cytospin as soon as possible, if feasible.

Administration of Intrathecal Chemotherapy

Equipment required in addition to those used for lumbar puncture.

Chemotherapeutic agents – Methotrexate- intrathecal preparation, Cytarabine- intrathecal preparation, and Hydrocortisone.

** Note: Intrathecal administration of vincristine is fatal; therefore, it is crucial to avoid storing vincristine in areas where lumbar puncturesis performed or intrathecal medications are being prepared.

Steps

1. Prior to lumbar puncture, it is of utmost importance to make a visual and verbal check that the drug and dosage loaded into the syringe is correct, suitable for intrathecal administration. The chemotherapy protocol must be checked for the number of drugs to be administered- Single IT methotrexate (ITM) or Triple IT with MTX, Cytarabine, and Hydrocortisone (TIT).

2. After verifying the CSF flow in the hub of the spinal needle, connect the syringe containing the chemotherapy drug. Administer the drug slowly, allowing it to dilute with CSF by gently pushing it forward over 2 minutes. The practice of triple IT administration varies regionally, as prefilled syringes with the required medication doses may not be available, necessitating the use of three separate syringes for administration. If administering triple IT, the order of administration is hydrocortisone,

Cytarabine and Methotrexate. The doses can be obtained from the chemotherapy protocol followed in the unit.

Age	Dose
<2 years	8 mg
2-3 years	10 mg
≥ 3 years	12 mg

Note

- Intrathecal chemotherapy should be administered following a clean lumbar puncture.
- If the CSF is blood-stained, chemotherapy should not be administered.
- If the CSF is not free-flowing, chemotherapy should not be administered.

3. Once the procedure is complete remove the needle and apply firm pressure over the site with a sterile swab for 1 minute and then seal the area with a cotton with a drop of tincture iodine and a plaster over the wound.
4. The patient must lie supine for ***at least 1 hour*** following the intrathecal chemotherapy administration.
5. The processing of CSF sample must be within one hour following the procedure and not later as the CSF cell count drops rapidly after one hour of collection.
6. Samples must be maintained at room temperature and transported as soon to laboratory following collection

(Role of Steroid: Hydrocortisone, frequently administered steroid intrathecally, serves not only to enhance cytotoxicity but also to mitigate chemical arachnoiditis).

Complications[8-13]

Post-dural puncture headache and back pain are the most common complications associated with lumbar puncture. Although subacute and chronic complications from intrathecal chemotherapy administration are uncommon, they should be kept in mind.

Acute

1. Post dural puncture headache and backpain– most common complications of LP, occurring at the rate of 5-15% and 11% following a lumbar puncture respectively.

2. Cerebral Herniation if performed in raised ICP setting.
3. Chemical arachnoiditis – Headache, nuchal rigidity, vomiting, fever and CSF pleocytosis, lasting several hours to days.

Subacute

1. Infection – Meningitis, epidural abscess, vertebral osteomyelitis, discitis, intramedullary spinal abscess can occur if the LP is performed through soft tissue infection at the time site of the puncture.
2. Spinal Hematoma – in patients with uncorrected bleeding disorders
3. In 10% of the intralumbar injections, the drug is not delivered into the subarachnoid space, but is injected into the subdural or epidural space
4. Encephalopathy is associated with methotrexate (MTX) – paresis, cranial nerve palsies, ataxia, visual impairment, seizures and coma
5. Ascending radiculopathy with loss of primarily motor function resembling Guillain-barre syndrome – is associated with methotrexate (MTX) and Cytarabine

Chronic

1. Demyelinating encephalopathy – dementia, spastic paralysis, seizures and coma.
2. Epidermoid tumor – a rare complication of LP that occurs years after the procedure is performed, among cases where LP is performed without a stylet.

Troubleshooting

- **Traumatic Puncture** – a CSF sample which is blood-stained and/or CSF RBC count ≥ 10/µL.
    i. It occurs as the needle enters the venous plexus that encircles the spinal when the needle is not in the midline or has been inserted too deep and passed through the posterior wall of the dura into the vertebral venous plexus.
    j. If the blood in the hub clears and a clear fluid flows, the needle is in the subarachnoid space, if there is blood or clot in the hub, the LP needle has to be repositioned at a new site with a new LP needle.
    k. If a traumatic lumbar puncture is suspected and peripheral blood leukocyte counts is not abnormally high or low, then CSF WBC count can be determined by subtracting 1 WBC for every 500-1500 RBC in the CSF.

l. To distinguish between CNS 2 and CNS 3, the Steinherz-Bleyer Algorithm can be used.

$If\ \frac{CSF\ WBC\ /mm^3}{CSF\ WBC\ /mm^3} \geq \frac{Blood\ WBC\ /mm^3}{Blood\ WBC\ /mm^3}$ with blasts then patient qualifies as CNS 3.[15]

- **Resistance felt during advancing the needle**

If a bony resistance is felt, it is likely due to entry over the posterior spinous process or inferior spinous process. The LP needle must be withdrawn to the subcutaneous tissue, ensure that the spine is not rotated and advance the needle along the midline. Resistance caused by the inferior spinous process can be overcome by repositioning the child to provide adequate flexion at the hips, which aids in opening up the interlaminar space and advancing the LP needle cephalad.

- **Poor Flow** – The following are few measures that can be taken to improve the flow of CSF.
  - Rotating the LP needle.
  - Advance the needle slightly further with the stylet in place.
  - Withdraw until the subcutaneous tissue and redirect.
  - If the above measures are unsuccessful, remove the LP needle completely and attempt the puncture at a different site. It is mandatory to use a new needle for every additional attempt.

Criteria for discharge

After performing a lumbar puncture on an outpatient basis, it's crucial to closely monitor the child for any post-procedure complications. If intrathecal instillation of the chemotherapy is performed, the child has to be in supine position for a minimum duration of 1 hour.

The vitals should be recorded periodically every 15 minutes. A neurological examination should be performed after the sedation effects are worn off. Symptoms of headache, pain, nausea should be asked for and treated. Once the child is awake, able to drink fluids, and returns to their pre-procedure state, they can be safely discharged home. However, caregivers should be instructed to bring the child back to the hospital if they experience worsening headache, vomiting, severe back pain with difficulty moving the lower limbs, abnormal limb movements, or changes in behavior. In infants and young children, signs such as irritability, lethargy, and poor feeding should be monitored closely.

Summary

Lumbar puncture is a procedure used to access the subarachnoid space for collecting cerebrospinal fluid (CSF) for diagnostic evaluation or administering medications, including intrathecal chemotherapy in children with certain cancers. The blood-brain barrier limits the entry of systemically administered drugs into the central nervous system, making intrathecal administration necessary.

The procedure involves inserting a styletted needle between the lumbar vertebrae to reach the subarachnoid space. It is indicated for diagnostic purposes in conditions like leukemia, lymphoma, suspected CNS infections, and subarachnoid hemorrhage, as well as for therapeutic interventions such as CNS-directed therapy in high-risk leukemia patients or prophylactic treatment to prevent meningeal involvement in certain cancers.

Pre-procedure preparation includes reviewing indications, ensuring patient and parental understanding and consent, gathering necessary equipment, and positioning the child appropriately. The procedure itself involves identifying the puncture site, administering local anesthesia, and carefully advancing the needle to collect CSF or administer medications. Intrathecal chemotherapy requires additional steps, including verifying drug and dosage, connecting the syringe to the needle, and slowly administering the medication.

Complications of lumbar puncture include post-dural puncture headache, cerebral herniation in cases of raised intracranial pressure, infection, spinal hematoma, and various neurological complications. Troubleshooting may be necessary in cases of traumatic puncture or resistance felt during needle advancement.

After the procedure, close monitoring for post-procedure complications is essential, particularly if intrathecal chemotherapy is administered. The child should be kept in a supine position for at least one hour, vital signs should be monitored periodically, and neurological examination should be performed once sedation wears off. Caregivers should be instructed to seek medical attention if certain symptoms develop.

In summary, lumbar puncture is a valuable diagnostic and therapeutic procedure in pediatric oncology, however it requires careful patient selection, preparation, and execution to minimize risks and maximize benefits.

Checklist for CSF Examination in Day Care and Ward

Name..... Age..... UHID No..... Diagnosis.....

1.	Please check the indication of CSF examination	(Yes/No)
2.	Check vitals (enter details)	
	a. Pulse rate	
	b. Respiratory rate	
	c. Clinical evidence of respiratory distress	
	d. Blood pressure	
	e. SpO_2	
	f. Pallor	
	g. Clinical features of ICP	
	h. Fundus	
3.	Check hemoglobin & Platelet count (enter details and date performed on)	
	a. Hemoglobin	
	b. Platelet count	
	c. Blood sugar	
4.	Explain the procedure to the parent/guardian	(Yes/no)
5.	Take consent	(Yes/No)
6.	Ensure that child is appropriately fasting before procedure (refer to sedation module)	(Yes/No)
7.	Ensure that emergency drugs & resuscitation trolley are available	(Yes/No)
8.	Ensure that the child is in hospital clothes	(Yes/No)
9.	Ensure that the procedure set is available in ward/Day care	(Yes/No)
10.	Ensure that nurse is available to assist with the procedure	(Yes/no)

11. Ensure 2 hours post procedure monitoring of vitals (0,30,60 min and at discharge)

    Pulse rate

    Respiratory rate

    Blood pressure

Before discharge

12. Ensure documentation of a procedure note
13. Ensure that a discharge summary has been given to patient in day care
14. Ensure that discharge carries details of room where reports will be collected
15. Enter details of sedation given to patient

If there is any doubt, discuss with a faculty (Yes/No) till then withhold

Signature

Doctor In charge

Date

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Module on Bone marrow examination

LEARNING OBJECTIVES

1. Understand the indications for bone marrow aspiration and biopsy in Pediatric oncology.
2. Identify the essential equipment and required personnel for the procedures' safety.
3. Learn contraindications for bone marrow aspiration and biopsy in Pediatric oncology.
4. Perform the standard procedure while ensuring proper specimen handling.
5. Prepare high-quality peripheral smears for accurate diagnostic evaluation.
6. Outline the potential complications associated with bone marrow aspiration and biopsy.
7. Understand the necessary monitoring requirements during procedural sedation.
8. Manage potential complications and emergencies that might occur during the procedure.
9. Acquire comprehensive knowledge of post-procedural care and discharge criteria.
10. Communicate effectively with the team about findings and patient's needs post-procedure.
11. Ensure safe discharge of patient.
12. Provide clear instructions for reports collection and follow up.

Introduction

Bone marrow aspiration (BMA) and bone marrow trephine biopsy are important procedures for the diagnosis of hematological malignancies and non-malignant diseases in children.

Bone marrow examination is relatively uncomplicated to perform. The quick nature of the procedure and the ability to perform the procedure on an outpatient basis facilitate an efficient path towards diagnosis and management.

Anatomy and Physiology

At birth, multiple sites support hematopoiesis but as adolescence approaches, this role becomes limited to the axial skeleton. The posterior superior iliac crest is usually the site selected based on patient safety and comfort Figure 1. In individuals with considerable adipose tissue or in cases where there are contraindications, such as a wound covering the posterior iliac crest, the anterior superior iliac crest may be used instead. Occasionally, both these sites may be unsuitable, for instance, due to prior pelvic radiation or severe obesity. In such instances, aspiration from the proximal sternum is an option for patients over 12 years old. Generally, a single aspiration and biopsy site suffice, except in cases like solid tumours where bilateral biopsies can enhance diagnostic accuracy; however, a single biopsy of adequate length (at least 1.5 - 2 cm in adolescent and adults) can often obviate the need for multiple sampling sites. For children adequate biopsy specimen should contain at least 0.5 cm of preserved marrow spaces.

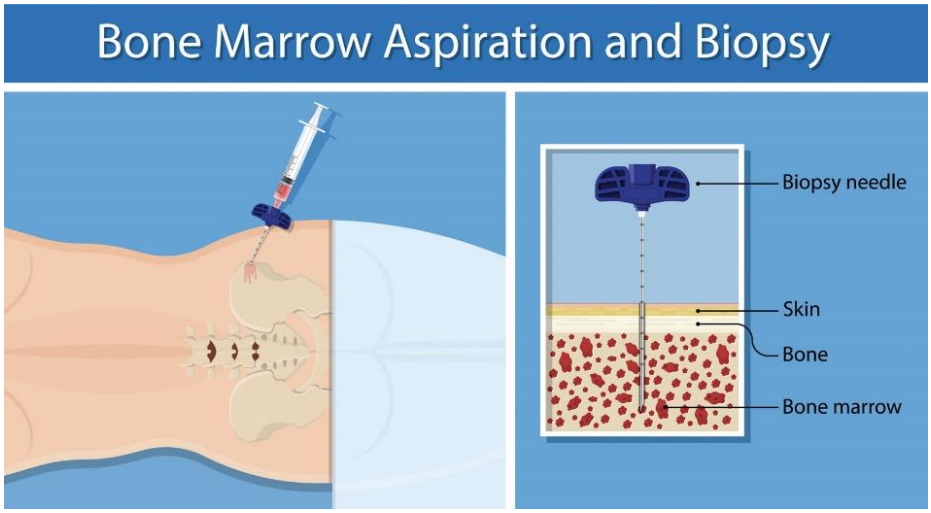


Figure 1. The posterior superior iliac crest is usually the preferred site

Identifying the Site of Bone Marrow Aspiration (Figure 2 A&B)

1. **Posterior Superior Iliac Spine (Figure 3)**

   - The posterior superior iliac spine is a noticeable bony prominence that indicates the posterior end of the iliac crest. It is located at a point where the superior border (iliac crest) meets the posterior border of the ilium. The posterior superior iliac crest can usually be identified by a dimple in the skin located at the lateral edge of Michaelis' rhomboid.

   - Michaelis' rhomboid is a diamond-shaped area over the posterior aspect of the pelvis formed by the posterior superior iliac spines, the gluteal muscles, and the groove at the distal end of the vertebral column.

     This area can be located in most patients by palpation with the thumb, even if anatomic landmarks are not visible.

2. **Proximal Tibia (Figure 4)**

   - The tibial tuberosity is identified by palpation

   - Used for children less than 18 months

   - The site of intraosseous cannulation is approximately 1-3 cm below the tuberosity on the medial surface of the tibia

3. **Other sites** include the anterior superior iliac crest which is sometimes used for obese patients and in patients with mediastinal mass who may not tolerate being in a lateral or prone position as airway may get compromised. Sternum is another site that should only be attempted carefully in patients over the age of 12 years by experienced personnel. Bone Marrow biopsy is contraindicated from the sternum due to risk of perforation of sternum and mediastinum.

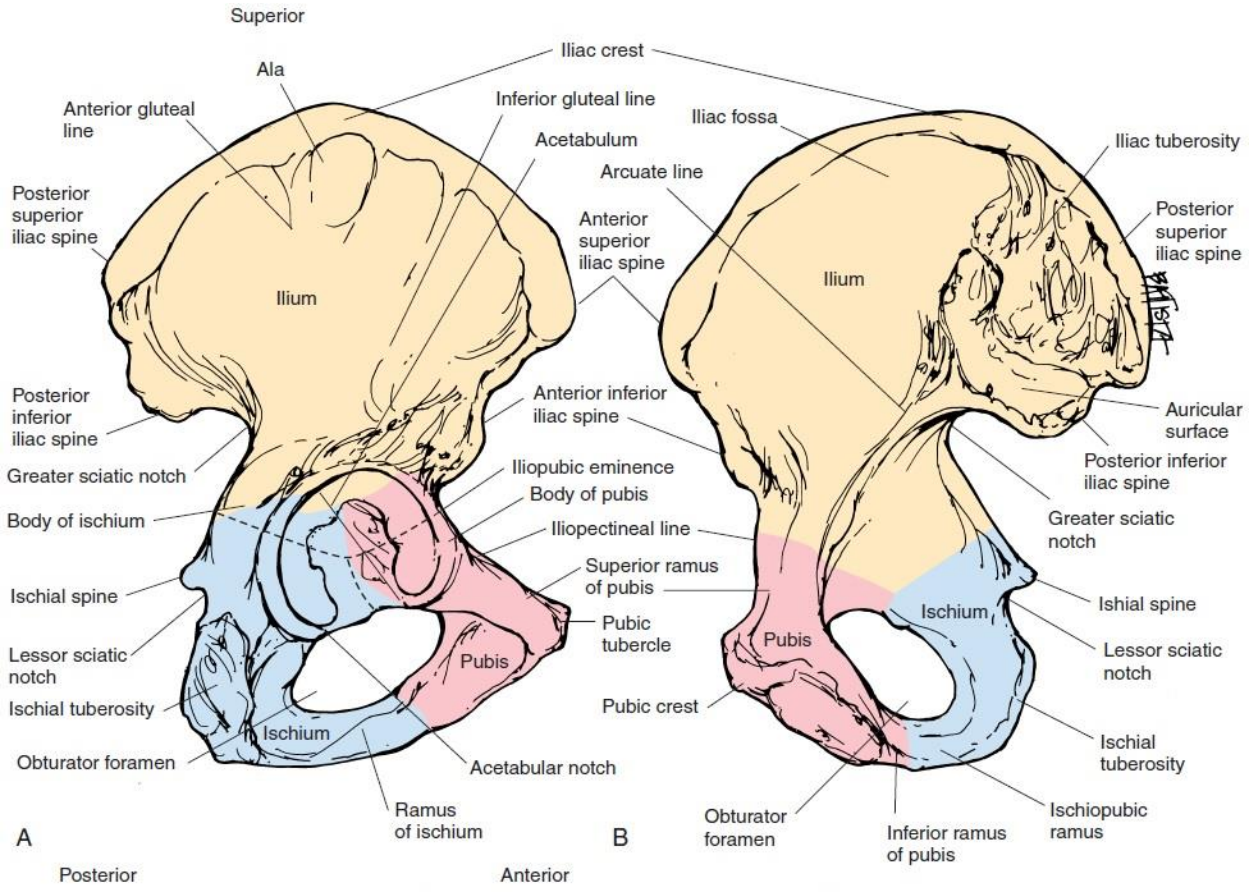


Figure 2. Hip bone: A: Lateral view

Figure 2. Hip bone: B: Medial view

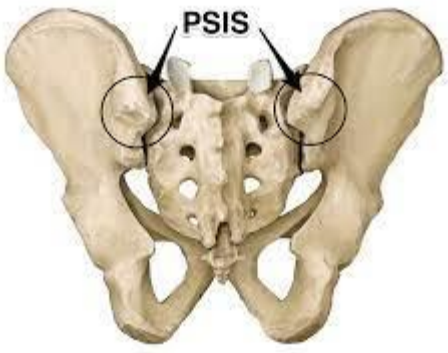


Figure 3. Posterior superior Iliac spine (PSIS)

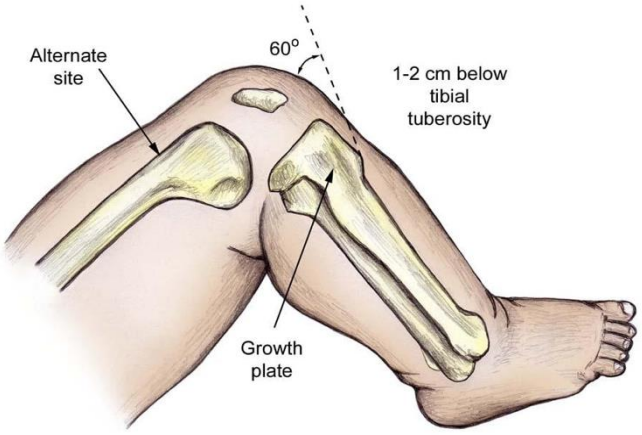


Figure 4. Tibia

Bone marrow aspiration may be indicated to investigate

1. Children with abnormal peripheral blood findings (e.g. atypical cells, pancytopenia, unexplained anemia, leukopenia, or thrombocytopenia.
2. To diagnose malignant hematological disorders, hypoplastic anemia, inherited bone marrow failure syndromes and histiocytic disorders.
3. To obtain microbiological cultures in children with fever of unknown origin.
4. For investigation of hypersplenism, lymphadenopathy, hemophagocytic lymphohistiocytosis (HLH), mediastinal or abdominal masses.
5. Response assessment after chemotherapy and /or hematopoietic stem cell transplant.
6. As a part of metastatic work-up in solid tumors, e.g. sarcoma, neuroblastoma and retinoblastoma.

Common Clinical Indications for Bone Marrow Trephine Biopsy

1. Inadequate or failed marrow aspiration.
2. Suspected bone marrow fibrosis.
3. Investigation and staging of Hodgkin and non- Hodgkin lymphoma, and small blue round cell tumors of childhood (neuroblastoma, rhabdomyosarcoma and Ewing sarcoma).
4. Diagnosis of aplastic anemia, hemophagocytic lymphohistiocytosis (HLH) and myelodysplastic syndromes.

Contraindications

1. In patients with hemorrhagic disorders such as congenital coagulation factor deficiencies (e.g. hemophilia), disseminated intravascular coagulation, or those concurrently using anticoagulants, careful consideration should be given before performing a bone marrow aspiration (BMA) or bone marrow trephine biopsy (BMTB). Prior to the procedure, factor replacement therapy or cessation of anticoagulant treatment should be considered, and the patient must be closely monitored for 24 hours post-procedure.
2. While severe thrombocytopenia is not a strict contraindication to BMA, it is essential to apply prolonged pressure at the site to prevent bleeding. In obese patients with severe thrombocytopenia requiring a bone marrow biopsy, it is advisable to administer a platelet transfusion to raise the platelet count.
3. Individuals with skin infections or recent radiation therapy at the sampling site should avoid undergoing bone marrow aspiration or biopsy until the infection has resolved or the skin has healed from radiation therapy.
4. Bone disorders such as osteomyelitis or osteogenesis imperfecta should be taken into consideration before performing bone marrow aspiration or biopsy. These conditions may affect the integrity of the bone structure and increase the risk of complications during the procedure.
5. Hemodynamic instability.

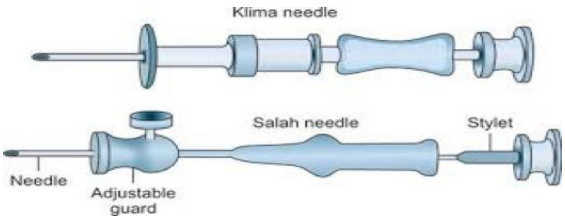
Equipment

Ensure that an adequate number of syringes (some heparinized as indicated for the specimens to be collected) are prepared, and transport tubes containing EDTA (necessary for flowcytometry and molecular studies) are available.

i. Sterile tray skin prep (chlorhexidine or povidone iodine).
ii. Requisitions.
iii. Consent forms.
iv. Procedure notes.
v. Labels specimen bags or containers mask.
vi. Gown.
vii. Sterile gloves.
viii. Sterile towels or drapes.
ix. Two 18-gauge drawing needles and one 25-gauge injecting needle (It is advisable to use single-use sterile needles for bone marrow aspiration/biopsy).
x. Local anesthetic.

xi. Many 5 or 10 mL syringes (to draw samples).

xii. Age appropriate bone marrow aspiration needle(s) the bone marrow aspiration needle should be stout and made of stainless steel. About 7-8 cm should be the length and a well fitted stylet should be provided with an adjustable guard to prevent over penetration. The most commonly used needle is Salah /Klima. The bore size is 0.2mm.



xiii. Slides.

xiv. Slide tray.

xv. EDTA tubes.

xvi. Heparinized tubes.

xvii. Age appropriate bone marrow biopsy needle(s) if BMTB is performed on the posterior iliac crest, a Jamshidi needle is often preferred for biopsy. Pediatric trephine needle size is usually 9 cm long.

xviii. Formalin (10%) specimen jar.

xix. The bone marrow examination needle can be reused after autoclave where possible.

Preparation

- Before initiating the bone marrow aspiration, preparatory measures include a comprehensive patient assessment, obtaining informed consent, and ensuring awareness of the patient's identity, indications, contraindications, and allergies.
- Considering the discomfort associated with bone marrow aspiration, conscious sedation is advised. The infiltration of local anesthetics such as lidocaine into the periosteum is recommended to alleviate post-procedural pain.
- Adequate preparation of equipment is imperative.
- Bone marrow aspiration (BMA) needles are generally available in 14, 16 or 18 gauge. BMB or Jamshidi needles are generally available in adult (11-gauge, 4-inch), pediatric (13-gauge, 3.5-inch), or infant (13-gauge, 2-inch) sizes. The most commonly used pediatric sizes for BMA and BMB are 16/18 gauge and 13 gauge respectively.

Patient Assessment

1. Confirm patient identity.
2. Consider the application of a topical anesthetic cream to the marrow sampling site 30 to 60 minutes before the procedure.
3. Review the primary diagnosis and treatment protocol to assess the necessity of the study and any specific requirements, such as flow cytometry, cytogenetic, or molecular studies.
4. Obtain written consent from the guardian or the child, if the child is deemed competent.

5. Evaluate the need for sedation, considering options like conscious sedation (intravenous ketamine + midazolam is the most commonly used combination in our set up).
6. Children with a mediastinal mass and those experiencing severe respiratory distress should undergo an anesthesia assessment before the procedure. Sedation is contraindicated in superior mediastinal syndrome.
7. Choose an appropriate site and assess the skin at the bone marrow site for signs of infection.
8. Check the medical records for any history of allergy to local anesthetics, iodine solutions, or anesthetic medications.
9. Ensure all necessary personnel are present, such as a laboratory technician, if cytogenetic studies are required.

Technique

The posterior superior iliac crest is the preferred site for bone marrow extraction in children due to its rich cellular content, lack of proximity to vital organs and non-weight-bearing nature. In very obese patients, the anterior iliac crest is preferable. For children under 18 months old, the anteromedial aspect of the tibia is favoured, although this site may not yield sufficient samples in inexperienced hands and carries a risk of bone fracture.

When conducting trephine biopsies in children, the posterior superior iliac crest is typically utilized, although a technique involving the tibia has been described for small neonates. It is crucial that both bone marrow aspiration (BMA) and bone marrow trephine biopsy (BMTB) procedures are carried out exclusively by experienced healthcare professionals who have received comprehensive training in the respective techniques.

Procedure Steps

Bone marrow aspirate

- During the procedure, identifying the optimal site is crucial. Sterile precautions are strictly adhered to, with the operator wearing gloves, gown, and mask, and the puncture site being meticulously cleansed and draped.
- Local anesthetic is administered, followed by puncturing the skin. Puncture the skin with the BMA needle and advance to the periosteum, then enter the bone marrow space with a twisting motion until the needle is firmly anchored in the bone. The contact with the marrow cavity is noted by a sudden reduction in pressure. The depth of the penetration should not exceed initial 1.0cm

- Remove the stylet and attach a syringe to the needle hub. It is recommended that the aspirate should be drawn with a 10ml or 20-ml plastic syringe, to provide adequate negative pressure, attached to the aspiration needle. To preserve morphology, the syringe should not contain anticoagulant.
- If an aspirate is not obtained, replace the stylet and advance or reposition the needle.
- This first pull contains the marrow particles or spicules that should be used for preparing initial smears.
- A heparinized, larger syringe may be used to obtain additional marrow for cytogenetic analysis, flow cytometry, and other studies.
- Ask the technician to make smears (6 slides) from the aspirate immediately and verify that it contains particles.
- After proper samples have been obtained, the stylet can be reinserted, the needle can be removed and the site is sealed.
- The vitals should be noted and the patient must be transferred to recovery area.
- After the transfer of the patient to a recovery area, monitor the patient and procedure site carefully till the child comes out of sedation.
- At discharge, instruct the patient or the family not to use ibuprofen or acetyl salicylic acid for pain at the procedure site (because these drugs can cause platelet dysfunction). Paracetamol is the analgesic of choice. The dressing over the procedure site should be removed around 12 hours after the procedure as it may cause skin infection if it is left on for too long.
- High-quality marrow aspirate smears are crucial for proper interpretation. Smears should be prepared immediately in the procedure room by a trained resident doctor to prevent contamination with peripheral blood and coagulation, or placed within a dedicated tube containing ethylenediamine tetra-acetic acid (EDTA) anticoagulant (purple top tube) for smear preparation upon returning to the hematopathology laboratory.
- The marrow aspirate is typically placed in an EDTA (purple top tube) tube for molecular diagnostics and cell morphologic assessment, and in a heparinized tube (sodium heparin)(green top tube) for cytogenetic (chromosome) analysis Figure 5.

Figure 5. EDTA and Heparin vial

- The aspirate is placed in EDTA (preferred) or acid- citrate dextrose tubes for flow cytometry evaluation.
- In cases of dry tap, biopsy imprint ("touch") preparations should be prepared from the bone marrow biopsy core.
- The imprint slides may be stained using the Wright-Giemsa technique for morphologic evaluation or used for cytochemical analysis or immunoperoxidase staining.
- In cases of dry tap or suspected infection, core biopsy material should be collected.

Making a Good Quality Smear

Push Slide Technique: This technique is similar to that used to make cytology or hematology slides. Marrow is collected and a drop is placed toward the end of one slide. It is then spread in an even film using a second glass slide (held at an angle) as a spreader. The spreader slide is slid forward the length of the slide to produce a smear Figure 6.

This method is demonstrated in the video.

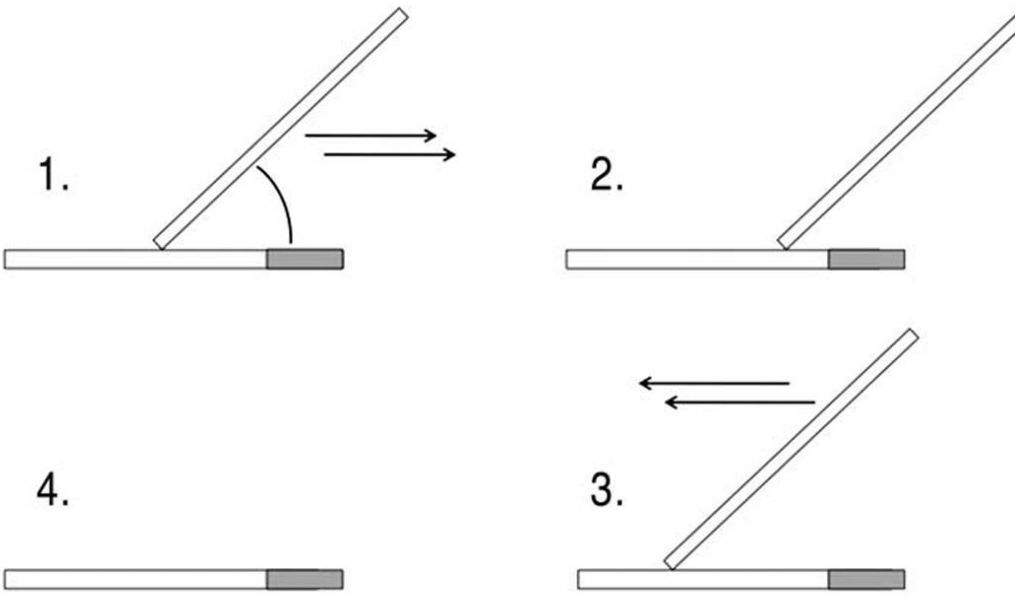


Figure 6. Push Slide Technique

- **Squash or Pull Prep Technique:** Bone marrow is collected and spread by the push technique. A drop is placed toward the end of the slide. Marrow is spread by placing a second microscope slide over the sample perpendicular to the slide with the sample and pulling the two slides apart. The weight of the top slide should be the only pressure exerted on the sample Figure 7.

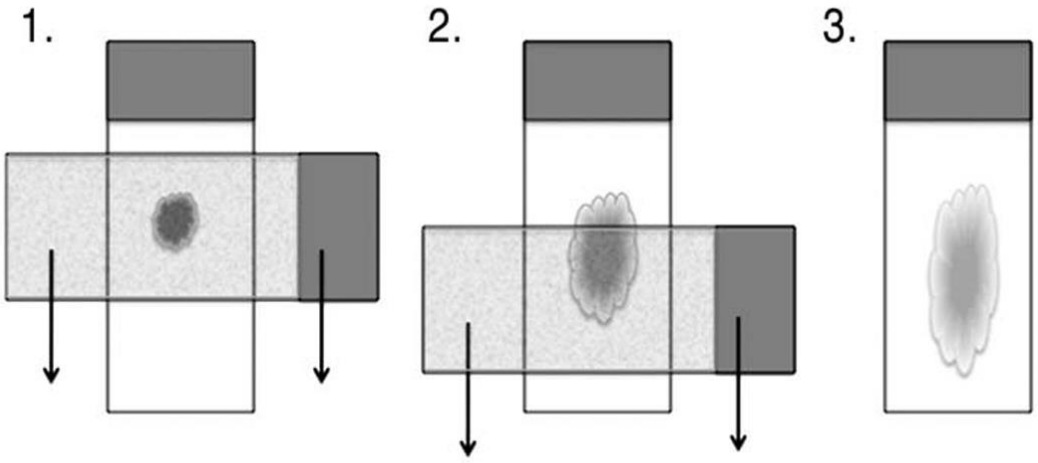


Figure 7. Pull Prep Technique

- **Slant technique:** Place drops of the spicule-laden marrow on slides which are tilted at 60^0. The blood runs down the slide, leaving behind the spicule(s). The excess blood is then wiped or blotted away quickly and the spicule(s) is smeared by placing another clean slide across the specimen slide parallel to it. The slides are then gently pulled away in opposite directions as the spicule is spreading under the gentle pressure of the upper slide.

Bone Marrow Trephine Biopsy

- A marrow biopsy and aspiration can be carried out through the same skin site (An alternate site for biopsy may be considered when both aspiration and biopsy are performed for a patient at same time. In such situations it is important to change the needle position slightly to a different area of bone after aspiration is obtained to avoid aspiration artifact that has been created where the marrow has been aspirated out of the core.).
- Position and prepare the patient as discussed earlier.
- Hold the needle with the proximal end in the palm and the index finger against the shaft near the tip.
- With the stylet locked in place, introduce the needle through the skin pointing toward the anterior iliac spine.
- Using gentle pressure, advance the needle with a slight twisting motion until it feels anchored to the bone; remove the stylet, then using alternating clockwise and counter-clockwise motion, advance the needle slowly for 2 mm to 10 mm into the bone; the depth of the insertion depending on the size of the patient.
- Rotate the needle with three twists to the right and then to the left without advancing; repeat once again, then withdraw the needle using a rotary motion.
- Using a sterile gauze pad, apply manual pressure to the site until the bleeding stops.
- Remove the bone specimen from the biopsy needle by introducing a probe through the distal end (this prevents specimen crushing).
- An adequate biopsy in children should contain at least 0.5 cm of well-preserved bone marrow.
- Drop the specimen in formalin and label it.
- If uncertain whether marrow particles have been obtained with the aspirate, before placing it in formalin, roll the biopsy specimen along a slide to obtain touch imprints.
- Minimum recommended core biopsy lengths for improved diagnostic yield: 2 cm (International Council for Standardization in Hematology) and 1.5 cm (World Health Organization)

Complications of Bone Marrow Procedure

I. Bone marrow aspiration (BMA) and bone marrow trephine biopsy (BMTB) are generally safe procedures with low morbidity risk.
II. Literature review indicates an incidence of adverse events related to bone marrow examination at 0.08%.
III. The most common adverse events include hemorrhage, infection, and persistent pain at the marrow site.
IV. Hemorrhage predominantly occurs in the buttocks, thighs, and retroperitoneum.
V. Increased risk of bleeding is observed in patients undergoing both BMA and BMTB, as well as those diagnosed with myeloproliferative disorders or osteoporosis.
Patients with severe thrombocytopenia, platelet dysfunction, coagulopathy, von Willebrand's disease, renal impairment, obesity, or on anticoagulant therapy are at higher risk.
VI. Breakage of the marrow needle is a rare occurrence.
VII. Prophylactic platelet transfusion before BMA in thrombocytopenic patients is discouraged to minimize alloimmunization risk.
VIII. Rare complications include gluteal compartment syndrome, arteriovenous fistulizations, pseudoaneurysm formation, internal iliac artery injury, sciatica with neurological deficit, osteomyelitis, sacroiliac septic arthritis, and septicemia.

Post-procedure, documentation is essential, along with the provision of adequate analgesia. Patients are instructed to remove the bandage the following day, with no specific bed rest required. A discharge summary must be provided to patients.

Clear instructions on timeline and how to access the reports should be given to the family.

Summary (and time out)

Bone marrow aspiration and biopsy remain essential for diagnosing hematological disorders and malignancies.

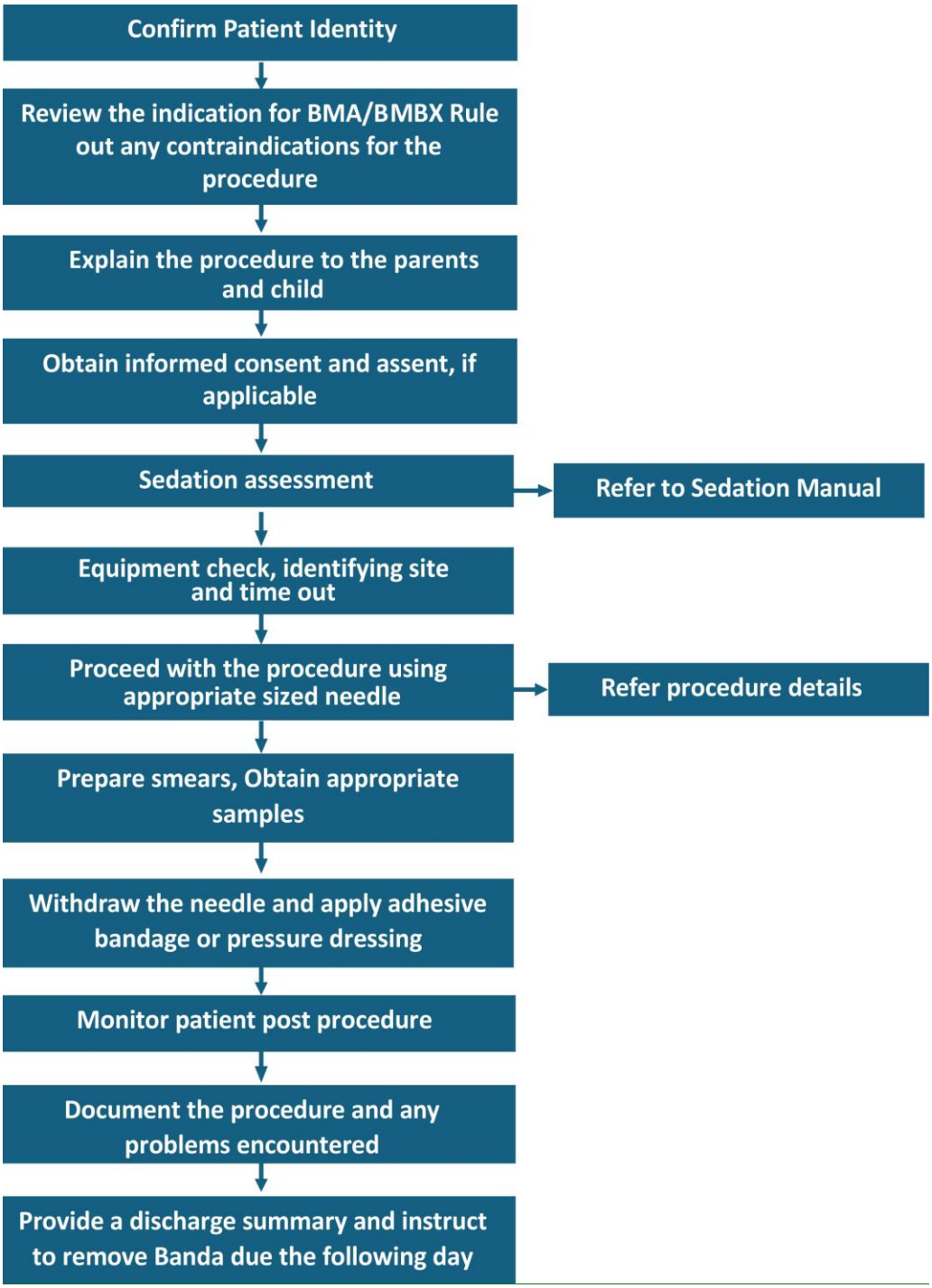


Figure. An algorithm for the bone marrow procedure in children

Checklist for Bone marrow Examination in Day Care and Ward

Name..... Age..... UHID No..... Diagnosis.....

1. Please check the indication of bone marrow examination (Yes/No)

2. Please check if only bone marrow aspirate/only bone marrow biopsy/both are required (yes/no)

3. Check vitals (enter details)
   a. Pulse rate
   b. Respiratory rate
   c. Clinical evidence of respiratory distress, feeding difficulty, change of voice (any feature of superior mediastinal/vena cava syndrome). When in doubt do chest X-ray including lateral view/CT chest to look for mediastinal compression and assessment of anesthesia risk
   d. Blood pressure
   e. SpO_2
   f. Pallor
   g. History of bleeding diathesis
   h. Local site of bone marrow examination for any infection/discharge

4. Check hemoglobin & Platelet count (enter details and date performed on)
   a. Hemoglobin
   b. Platelet count
   c. Blood sugar

5. Explain the procedure to parent/caregiver (Yes/no)

6. Take consent (Yes/No)

7. Ensure that child is appropriately fasting before procedure (refer to sedation module) (Yes/No)

8. Ensure that emergency drugs & resuscitation trolley are available (Yes/No)

9. Ensure that the child is in hospital clothes (Yes/No)

10. Ensure that the procedure set is available in ward/Day care (Yes/No)

11. Ensure that nurse is available to assist with the procedure (Yes/no)

12. Ensure time out before the procedure and team debriefing

13. Ensure 2 hours post procedure monitoring of vitals (0,30,60 min and at discharge)

    Pulse rate
    Respiratory rate
    Blood pressure

Before discharge

14. Ensure documentation of a procedure note

15. Ensure that a discharge summary has been given to patient in day care and carries details of procedure site care and dressing removal instructions

16. Ensure that discharge carries details of room where reports will be collected

17. Enter details of sedation given to patient

If there is any doubt, discuss with a faculty (Yes/No) till then withhold

Signature

Doctor In charge
Date

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Peripherally Inserted Central Catheter (PICC) in Pediatric Oncology

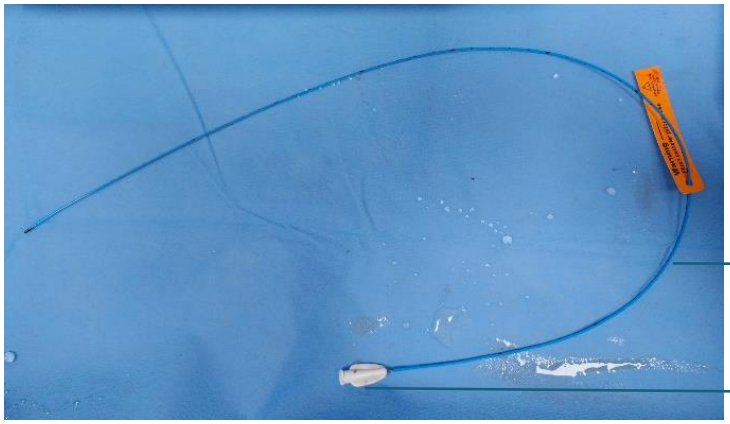
LEARNING OBJECTIVES

1. Understand the indications and contraindications for PICC line insertion.
2. Identify optimal veins for PICC line placement and assess patient suitability.
3. Learn proper preparation technique for PICC line insertion.
4. Adhere to sterile practices during insertion and use of PICC line.
5. Execute the step-by-step procedure for accurate PICC line insertion.
6. Implement effective maintenance strategies for PICC lines to ensure longevity.
7. Recognize potential complications associated with PICC insertion and management strategies.
8. Know troubleshooting methods for common issues encountered during PICC maintenance.
9. Evaluate the indications for PICC line removal and the protocol for antibiotic locking.
10. Apply appropriate practices for the safe and effective use of PICC lines in patient care.
11. Document and communicate findings and care related to PICC line usage effectively.

Introduction

Venous access is an integral element in the care of sick infants and children for the delivery of medicines and nutrition. Intravenous access represents a unique challenge in children due to small veins and poor visualization making cannulation difficult. Repeated venipunctures are often the source of significant stress in children and caregivers requiring IV infusion over a prolonged span.

Peripherally inserted central catheters (PICC) are a valuable alternative to traditional venous devices and are emerging as a safe option for intermediate to long-term central venous access in children. They can be used in both in-hospital and outpatient settings and new types of PICC are being developed that may facilitate even broader indications and longer dwell times. Parts of single lumen PICC are depicted in Figure 1A and 1B)



Parts of PICC

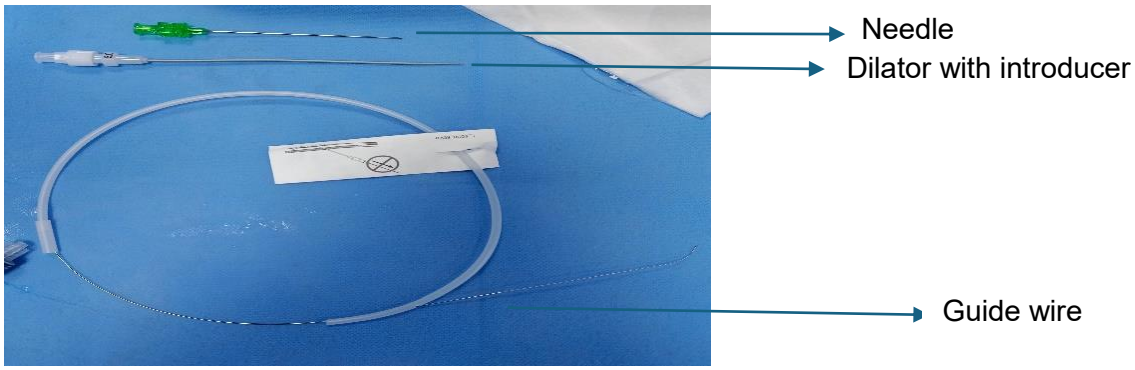


Figure 1A & 1B

Indications

PICC is indicated when intermediate to long-term IV access is needed for medications, fluid therapy, blood sampling, or parenteral nutrition.

- Delivery of chemotherapy that can be administered through the peripheral vein with a duration of more than 3 months.
- Sampling in a hospitalized patient, provided that the expected duration of IV access is more than 15 days.
- Delivery of peripherally compatible infusions having a duration of more than 6 days.
- Delivery of non-peripherally compatible infusates (e.g. irritants or vesicants) regardless of the proposed duration of use.
- Intermittent infusions or infrequent sampling in patients with poor/difficult peripheral venous access provided the proposed duration of use is more than 6 days.

Contraindications

- Preexisting skin infections, burns, or radiation damage near insertion site as these increase the risk of catheter colonization or bacteremia.
- Allergy to PICC components
- Vascular surgeries in the catheter path
- Small, damaged, or thrombosed vessels caused by previous catheter insertions or repeated attempts.
- Central thrombosis/stenosis.
- Peripheral edema can result in difficult access (Relative contraindication and this can be circumvented by use of USG guided insertion)

PICC placement

Preprocedural evaluation

PICCs can be placed by a variety of trained personnel including anesthesiologists, interventional radiologists, pediatricians, or nurses. Insertion can be performed bedside, operating theater, or in a specialized angiography suite.

Before initiation of the procedure comprehensive patient assessment should be performed. This includes the history of underlying disease, hematologic and metabolic parameters, requisites for sedation like adequate nil per oral status, and examination of vitals along with systemic examination. Informed consent from parent/guardian should be taken after explaining the procedure to the patient and attendant. If the patient is to receive sedatives or analgesics, verify correct patient using two identifiers and perform a time-out to verify correct patient, correct site and correct procedure. The veins of the anterior cubital fossa (preferred site for PICC insertion) can be identified visually or by palpation. Basilic vein cephalic vein and brachial veins can be visualised by using high resolution ultrasound for guided placement of PICC. It is advisable and safer to perform ultrasound guided PICC insertions in children.

Sedation

Most children need to be sedated to reduce patient discomfort, optimize the positioning of the insertion arm, and keep it in place. Most sedation protocols include spontaneous breathing with supplemental oxygen via the nasal route or laryngeal mask airway.

For older children (>10-12 years), it may be possible to perform PICC insertion using local anesthesia like an eutectic mixture of local anesthetic cream applied over a suitable vein and or infiltration with lignocaine.

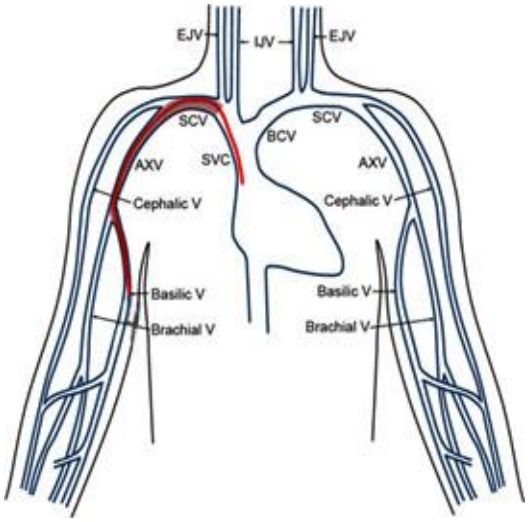
(Eutectic means the two anesthetics, which are normally solids at room temperatures, become an oily preparation when mixed in certain proportions. EMLA, a eutectic mixture of local anesthetics, is made of lidocaine 2.5% and prilocaine 2.5%. EMLA is commonly used for surface anesthesia in children.)

Please refer to the sedation module.

Vein selection

The most commonly used veins in the upper limb are the basilic, brachial vein and the cephalic vein (the basilic vein is preferred due to the shorter and direct course to the central vein) Figure 2. Visualization by ultrasound is generally easy 2- 4cm above the anterior cubital fossa where insertion of an indwelling catheter may cause less discomfort to the patient during flexion of the elbow.

The basilic and brachial veins usually have a suitable size that makes the puncture easier and lowers the risk of postprocedural complications. The cephalic vein sometimes ends in small collaterals in the upper arm and the angle of insertion into the axillary vein may be acute, making it prone to malpositions and pose difficulty in insertion of catheter. In the lower limb, a long saphenous vein and popliteal vein may be chosen if the upper limb veins are obliterated. Other sites that can be used in rare circumstances are the axillary and external jugular veins.



Anatomy of upper limb veins
AXV- Axillary vein, SCV- Subclavian vein, BCV-Brachiocephalic vein, IJV-Internal jugular vein, SVC-Superior vena cava, EJV-External jugular vein

Figure 2. The red line depicts the PICC in the basilic vein

Choice of catheter

PICCs are made of silicone or polyurethane, the latter being preferred because of its greater flexibility when customizing the material to specific requirements. Polyurethane provides the PICC with greater wall strength, allowing the production of small-sized high-flow catheters with greater inner lumina. PICC sizes are chosen according to vein dimension and age of the child (Table 1). The ideal catheter should be single lumen, low-diameter, high-volume, and polyurethane catheter. Larger PICCs may increase the risk of venous occlusion and thrombosis while smaller catheters can cause mechanical problems with luminal occlusion.

Table 1. : Age

Age	< 1year	1-6 years	6-10 years	>10 years
Catheter size (French)	2-3	3-4	4	4-5

Insertion procedure (Figure 3)

- Before initiating the insertion procedure, central line insertion practice adherence checklist should be filled and vital signs should be obtained.
- After performing hand hygiene and donning, patient positioning and vein selection are done.
- Place the patient in a supine position with the selected arm turned up and extended 60-90 degrees from the body.
- A tourniquet should be applied and ultrasound-guided vein selection is done.
- Catheter length to be inserted (mark the point immediately above the bifurcation of the median cubital and forearm basilic vein), is measured using a tape from the point of insertion, along the selected vein tract to the right side of the sternal notch (angle of Louis)
- Scrub the arm with povidone iodine or chlorhexidine and allow the area to dry for 30-60 seconds.
- Perform ultrasound-guided venipuncture using the safety needle and check for the gush of blood through the needle after puncture of the vein.
- Guidewire will be inserted through the safety needle and advanced slowly. If resistance is encountered while advancing the guidewire, forceful advancement should not be done. Recheck the intraluminal position of the needle on the ultrasound machine and reinsert the guidewire.
- Remove the safety needle carefully while holding the guidewire.
- Remove tourniquet
- Local anesthetic application is preferred before inserting the dilator as this is a painful procedure.
- Insert the introducer-dilator assembly over the guidewire and a small skin nick can be applied if required.
- Remove the guidewire alongwith the dilator slowly and place the cap over the introducer.
- Remove the dilator with a cap and insert the catheter through the introducer.
- Advance the catheter with small increments up to the measured length which was calculated previously.
- The introducer will be removed by breaking the T- handle and peeling the sheath apart. Clean the insertion area and fix the catheter along with locking of catheter hub.

- While using the Groshong PICC, the catheter should be cut at least 5cm proximal to the skin entry point and the external connector unit is fixed with the proximal end (most PICC devices don't need to be cut, this should be based on specific device being used).
- Aspirate using a 5ml syringe and check for free backflow and flush the catheter with normal saline or heparinized saline.
- At the insertion site transparent dressing is done and it should be labelled.
- Post-procedure, count and ensure all sharps and syringes are discarded as per biomedical waste management guidelines.
- Vital signs should be examined after the procedure.
- To confirm the position of PICC (ideal location of catheter tip-cavo atrial junction), order a chest X-ray, and if required repositioning should be done.
- Document the procedure in patient's record

    1. Informed consent
    2. Time -out procedure
    3. Length of catheter inserted, length of catheter inside the patient and length of catheter outside insertion site
    4. Approximate blood loss and difficulties in insertion
    5. Insertion site (right or left) and location (vein-specific)
    6. Brand, lot number, and the size of catheter
    7. Number of insertion attempts
    8. Disinfection with chlorhexidine or other antiseptic
    9. Ultrasound guidance used
    10. Medications administered (anaesthetic and sedatives)
    11. Confirmation of tip location in the vena cava
    12. Presence of blood return and ability to flush catheter
    13. Unexpected outcomes and related interventions
    14. Education about PICC maintenance

Insertion procedure: a stepwise approach

Comprehensive patient assessment, complete procedure checklist and obtain informed consent

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Patient positioning, ultrasound-guided vein selection, and measurement of catheter length to be inserted

↓

Cleaning of insertion site followed by ultrasound-guided venepuncture

↓

Guidewire is to be inserted through the needle hub and advanced slowly

↓

Remove the needle and insert the introducer over the guidewire

↓

Remove the guidewire and insert a catheter through the introducer till the measured length

↓

The backward flow will be ensured and remove the introducer by breaking the T handle

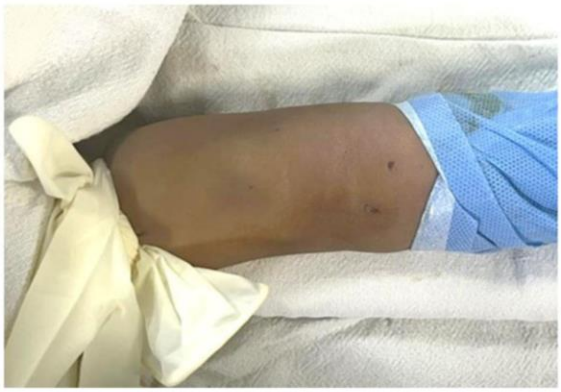
↓

Fix the catheter and transparent dressing should be done

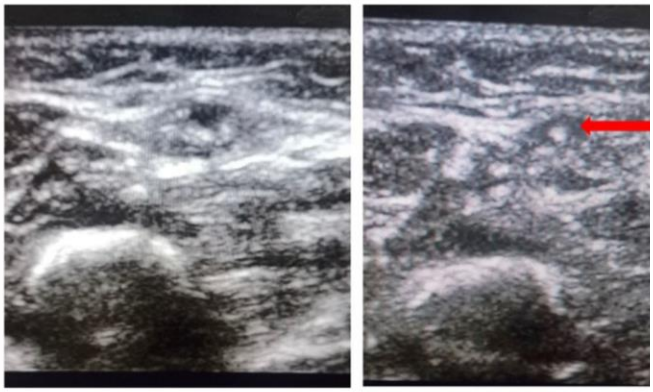
↓

Monitor vitals post-procedure

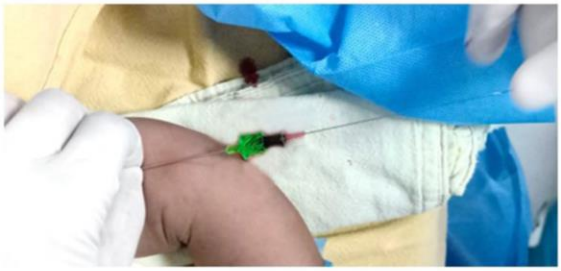
Order a chest X-ray to confirm the position of PICC and if required repositioning should be done.



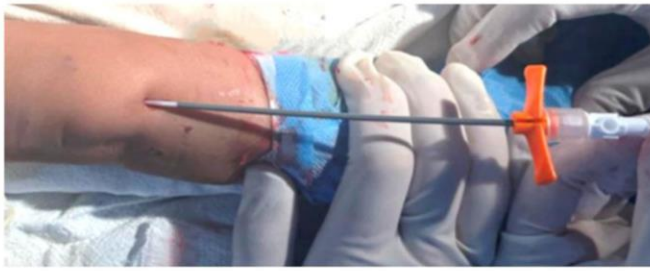
Cleaning of insertion site



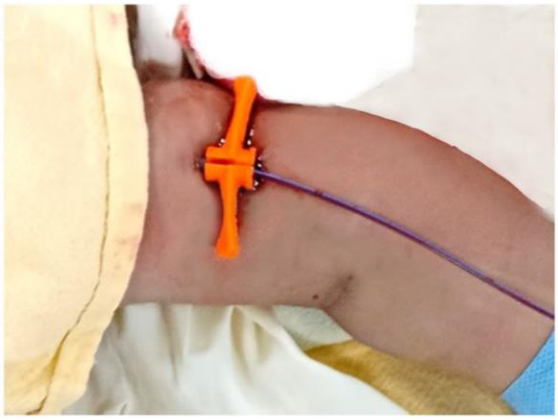
Venepuncture under ultrasound (arrow showing needle tip in basilic vein)



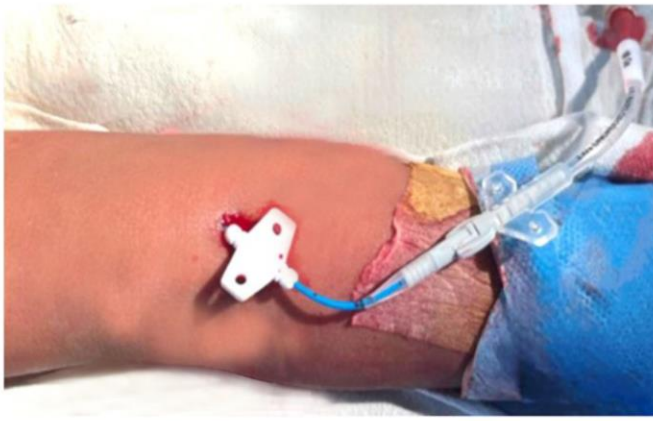
Guidewire is to be inserted through the needle hub



Remove the needle and insert the peel-away sheath-dilator combination over the guidewire



Remove the guidewire and insert PICC through the introducer till the measured length



Fixing of the catheter

Figure 3. Steps of PICC insertion

Catheter tip placement (Figure 4)

PICC insertion should aim to place the tip of the PICC in the cavo-atrial junction. Tip location in the right ventricle should be avoided because of the risk of tachyarrhythmias. The carina can be used as a simple landmark for appropriate positioning. The position of the arm during insertion and subsequent chest radiographs influences tip location. During control of tip position, the arm should be positioned in a natural position by the side with flexion of the elbow.

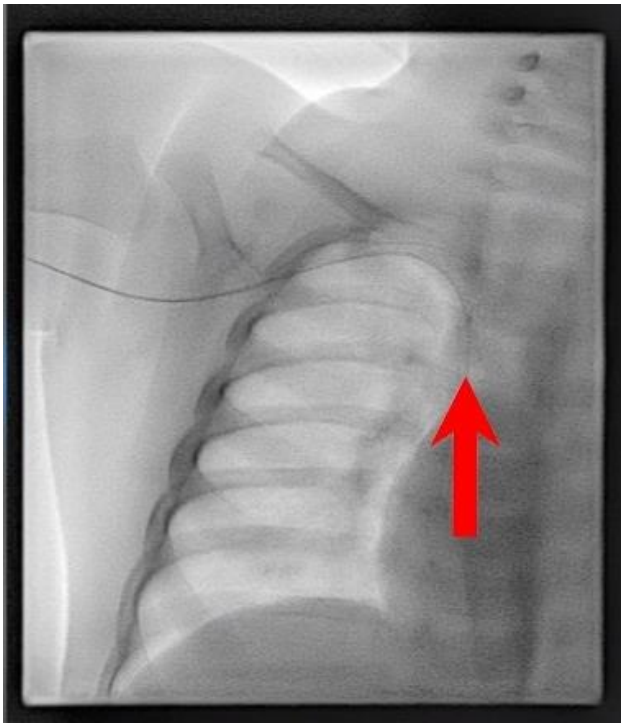


Figure 4. Image depicting the position of tip of PICC

PICC maintenance and appropriate practices

- Careful post-operative management is required to maintain PICC patency and prevent complications. Aseptic technique and proper hygiene should be observed during handling and dressing.
- If the catheter site is bleeding or oozing gauze dressing is preferred over the transparent dressing. The dressing should be replaced whenever it becomes damp or loosened.
- The PICC needs to be flushed once weekly with 10ml 0.9% saline to maintain patency when not in use or after any infusion.
- Evaluate the access site for complications such as catheter migration (observe the external catheter length), mechanical damage or leaking, and other complications during flushing or locking and during dressing change.

- Integrity of catheter, lumen, and needleless connectors for signs of mechanical damage or leaking
- Check for adequate circulation to affected extremity distal to the catheter access site
- Assess for the need to continue PICC line regularly to eliminate the risk of infection or other complications

Appropriate PICC practices include the following

- After non-fluoroscopically guided PICC insertion, verify PICC tip position via chest radiography
- Adjust PICCs that terminate in the upper or middle one-third of the superior vena cava. It should be positioned at the distal part of the SVC or the upper right atrium.
- Use single-lumen PICC of the smallest gauge over multi-lumen PICC wherever possible
- Use normal saline rather than heparin to flush PICCs after infusion or sampling
- Provide more than 3 months of systemic anticoagulation for the treatment of PICC-related DVT in the absence of any contraindications to therapy
- Provide a line-free interval to ensure clearance of bacteremia when managing PICC-related bloodstream infections

Removal of catheter

PICC lines can be kept in situ for a duration of 6-8 months if no other catheter related complications are encountered and appropriate care can be provided.

Unexplained leucocytosis, fever or suspicion of Catheter related blood stream infection (CLABSI)

The IDSA 2011 defines CLABSI as Bacteremia or fungemia in with at least 1 positive blood culture and with clinical manifestations of infections and no apparent source of BSI except the catheter and one of the following

i) A positive semi qualitative or semiquantitative culture
ii) Same organism isolated from the catheter and peripheral blood
iii) Simultaneous quantitative blood culture>5:1 ratio
iv) Differential time period positivity > 2 hours

Removal is recommended if

- Infected with organism like Staphylococcus aureus, Pseudomonas aeruginosa,multi resistant organism, fungi or disseminated infections
- Bacteremia or clinical features of bloodstream or local insertion site infection do not resolve in 72 hours appropriate antimicrobial therapy

- Clinical Instability (eg. septic shock, not improving after antibiotic therapy i.e. source control and has to be done early in management of infections.)
- Presence of tunnel site infections
- Three or more repairs to the catheter because of leakage or breakage
- The patient no longer has a clinical indication for a PICC or the original indication for use has been met

Role of antibiotic lock

Prophylactic antimicrobial lock is recommended for long term catheter with history of multiple CRBSI despite optimal adherence to aseptic techniques

Complications

1. Mechanical problems

Mechanical problems can cause interruption of treatment and need for removal. Occlusion of the inner lumen is not uncommon and may be due to thrombotic or non-thrombotic in origin (caused by precipitation of incompatible drugs and infusions inside the catheter). Fibrin sheath formation on the outside part of the catheter may form a pseudovalve, impairing aspiration from the catheter. Thrombotic occlusions and fibrin sheaths often respond to careful flushing with saline or to the instillation of a fibrinolytic agent. A potentially serious complication in the form of catheter fracture with embolization of catheter fragments is rarely observed.

2. Infections

PICC-associated infections are potentially life-threatening and the overall rate ranges from 0.2 to 6.4/1000 catheter days. Exit site infection is usually defined as local erythema, tenderness, or induration around the catheter exit site or purulent secretion from the catheter site. The pathogens most commonly identified in PICC-related infections are gram-positive cocci (coagulase-negative staphylococci, staphylococcus aureus) while infections with gram-negative (Klebsiella pneumonia) or fungi (candida species) are also common. Treatment of CRBSI requires appropriate systemic antibiotics and may necessitate removal of the catheter. PICC should be removed in cases of clinical instability (i.e, septic shock) not improving after antibiotic therapy (this is source control and occasionally has to happen early in management of infection).Empirical antibiotic therapy includes the inclusion of gram-positive coverage with drugs like vancomycin for a duration of 7-14 days for uncomplicated Staphylococcus

aureus, 7-14 days for gram-negative bacilli or enterococcus, 14 days for candida species and 6-8 weeks for osteomyelitis. Evidence of antibiotic lock is sparse regarding PICC as compared to other IV devices.

3. Venous thrombosis

In children, more than 90% of deep venous thrombosis is attributed to long-term indwelling central venous devices. Risk factors include underlying malignancy, congenital thrombophilia and a history of catheter occlusion and catheter-related infection. PICC-related thrombosis may lead to infection, post-thrombotic syndrome, or pulmonary embolism.

4. Arrythmias

Arrythmias, particularly atrial arrythmias, are a complication of PICC placement. Treatment is patient stabilisation and pulling back line (if deep) or removing PICC.

Troubleshooting

a. Unable to flush the PICC

Possible causes

- A blood clot within the catheter lumen
- Mechanical obstruction
- Drug or mineral precipitate
- Lipid residue

The following actions are to be taken

- Ensure that the arm is straight
- Observe external kinks- dressing may need to be renewed to aid close observation
- Attempt to flush without exerting force

b. Unable to obtain blood sample from the PICC

Possible causes

- Fibrin sheath formation
- Mechanical obstruction
- The catheter tip resting close to the vein wall

The following actions are to be taken

- Ensure that the arm is straight
- Observe external kinks- dressing may need to be renewed to aid close observation
- Flush the PICC with saline using a push-pause technique

- If no blood returns – attempt to flush with saline using a push-pull method, ending with a flush
- Change the position of the patient and encourage deep breaths

c. Leaking of fluid at the exit site or along the PICC

Possible tear in the PICC which may necessitate removal after confirmation

d. The patient experiencing any of the following symptoms

- Redness, swelling, exudate, or pain at the exit site
- Pyrexia or rigor post PICC flush

Possible causes

Catheter related blood stream infections CRBSI

The following actions are to be taken

- Microbiological testing includes peripheral blood and samples from PICC for culture and sensitivity and intravenous antibiotic administration.
- Most of the time the catheter needs to be removed.

Summary

PICCs have a vital role in improving care quality among pediatric oncology patients through the delivery of medications and nutrition. PICC placement can be performed with ultrasound guidance and the position should be confirmed. The risk of serious complications in the long term is comparatively low but the maintenance of the catheter should be meticulously done to avoid them.

Checklist for PICC line insertion in Day Care and Ward

Name..... Age..... UHID No..... Diagnosis.....

1. Please check the indication of PICC line insertion (Yes/No)
2. Check vitals (enter details)
   a. Pulse rate
   b. Respiratory rate
   c. Clinical evidence of respiratory distress
   d. Blood pressure
   e. SpO_2
   f. Pallor
   g. Clinical features of ICP
   h. Fundus
3. Check hemoglobin & Platelet count (enter details and date performed on)
   i. Hemoglobin
   j. Platelet count
   k. Blood sugar
4. Explain the procedure to parent/caregiver (Yes/no)
5. Examine local site for evidence of infection, deformity, congenital anomalies, vascular anomalies
6. Take history of radiation exposure to the site of PICC line insertion
7. Take consent ensure patient preparation, patient verification and time out (Yes/No)
8. Ensure that child is appropriately fasting before procedure (refer to sedation module) (Yes/No)
9. Ensure that emergency drugs & resuscitation trolley are available (Yes/No)
10. Ensure that the child is in hospital clothes (should have preferably taken bath on day of procedure) (Yes/No)
11. Ensure that the procedure set is available in ward/day care (Yes/No)

12. Ensure that nurse is available to assist with the procedure (Yes/no)
13. Ensure 2 hours post procedure monitoring of vitals (0,30, 60 min and at discharge)
    i. Pulse rate
    ii. Respiratory rate
    iii. Blood pressure
    iv. Ensure patient is out of the sedation effects
14. Ensure that a discharge summary has been given to patient mentioning the site of access and catheter type.
15. Enter details of sedation given to patient.
16. Ensure follow up plan for maintenance of PICC line has been explained to family

If there is any doubt, discuss with a faculty (Yes/No) till then withhold

Signature

Doctor In charge

Date

References

1. Westergaard et al., Peripherally inserted central catheters in infants and children - indications, techniques, complications and clinical recommendations. Acta Anaesthesiol Scand. 2013 Mar;57(3):278-87.

2. Guidelines for the maintenance of a peripherally inserted central catheter- South Wales Intravenous Access Advisory Group April 2014

3. Clinical Practice Guidelines for the diagnosis and management of intravascular catheter related infection:2009 Update by Infectious Diseases Society of America

Pediatric Procedural Sedation Module

LEARNING OBJECTIVES

1. Understand the need for and benefits of utilizing procedural sedation in Pediatric patients.
2. Clarify the goals of sedation and analgesia to optimize patient outcomes during procedures.
3. Gain knowledge of available sedative drugs, their mechanisms of action, and duration effects.
4. Identify contraindications for using procedural sedation and assess patient eligibility.
5. Familiarize with the complete process of procedural sedation, including pre-procedure evaluation.
6. Organize the procedure room setup according to best practice principles for safety and efficiency including use of check list and concept of 'time out'.
7. Apply the Pediatric Sedation State Scale to monitor and assess patient sedation levels effectively.
8. Recognize potential adverse effects of sedation and detail management protocols for complications.
9. Understand the importance of thorough documentation related to sedation practices and patient monitoring.
10. Communicate effectively with healthcare team members regarding the sedation plan and patient status.

Introduction

Procedural sedation is an important component of pediatric care during invasive procedures such as lumbar puncture, PICC line insertion, and bone marrow examination. It ensures patient comfort, procedural success, and safety. These guidelines aim to provide a framework for safe and effective procedural sedation in pediatric patients.

Indications

1. Painful or uncomfortable procedures. For example: lumbar puncture, PICC line insertion, and bone marrow aspiration.
2. Procedures causing significant anxiety or distress in pediatric patients, where sedation can improve cooperation and comfort. For example: radiological imaging
3. Procedures where sedation can improve the safety and efficacy of the procedure. For example: complex wound management, foreign body removal, lumbar puncture (diagnostic or therapeutic)

Contraindications

1. Allergy or hypersensitivity to sedative agents.
2. Respiratory compromise or significant respiratory distress.
3. Acute or recent upper/lower respiratory infections, which are common in children and can increase the risk of adverse events during sedation.
4. Anticipated difficult airway in pediatric cases, where children may obstruct their airway during sedation.
5. Hemodynamic instability or shock.
6. Unstable medical conditions, including uncontrolled seizures, uncontrolled diabetes, severe dehydration, heart failure etc.
7. Symptomatic mediastinal mass, particularly in children with lymphomas.
8. Recent intake of solid food (<8hrs) or clear liquids (<2hrs).
9. Inadequate staffing or equipment for safe sedation administration and monitoring.
10. Lack of appropriate informed consent or understanding of the risks and benefits of sedation.

1. **Pre-procedural Evaluation**
   History and examination (airway & systemic)
   Informed and written consent
   Effective communication
   Pre-procedural instructions (fasting status)

Fasting status

Clear liquid- 2hrs
Breast milk- 4hrs
Formula milk- 6hrs
Solids -8hrs

2. **Procedural room setup**
   Check equipments
   (resuscitation, suction, drugs, airway)
   Positioning
   Authorised personnel

Risk stratification*

Low risk (ASA1)
Moderate risk (ASA2)
High risk (ASA3&4)

3. **Monitoring and Sedation**
   Oxygen saturation, Blood pressure,
   Sedation depth (Pediatric sedation State scale)
   Choice of sedative agent

Sedative agents

1. Midazolam
2. Fentanyl
3. Propofol
4. Ketamine

4. **Procedure**
   Hemodynamic monitoring to continue
   Assessment of depth of sedation
   Bolus and maintenance dose of sedative agents as needed
   Applying a local anesthetic cream to areas of needle puncture (depending on local resource availability and institutional practices, to minimize discomfort during procedures).

Antagonists

1. Flumazenil
2. Naloxone

5. **Post procedure care and Discharge**
   Continuous monitoring in recovery area until the patient meets post sedation discharge criteria

Pre-procedural Evaluation

1. Medical History

- Allergies: Inquire about any known allergies and document them in the patient's chart.
- Current Medications: Obtain details of the child's current medications, including prescription and over-the-counter medications, as well as any herbal supplements.
- Past Medical History: Review the child's past medical history, including any underlying medical conditions, previous surgeries, and anesthesia experiences.
- Developmental History: Consider the child's developmental stage and cognitive abilities, as this may influence their understanding and cooperation during the procedure.

Risk stratification* (The American Society of Anesthesiologists (ASA) physical status classification system)

ASA PS classification	Definition	Pediatric examples, including but not limited to:
ASA 1	A normal healthy patient	Healthy (no acute or chronic disease), normal BMI percentile for age
ASA 2	A patient with mild systemic disease	Asymptomatic congenital cardiac disease, well controlled dysrhythmias, asthma without exacerbation, well controlled epilepsy, non insulin dependent diabetes mellitus, abnormal BMI percentile for age, mil/moderate OSA, oncologic state in remission, autism with mild limitations
ASA 3	A patient with severe systemic disease	Uncorrected stable congenital cardiac abnormality, asthma with exacerbation, poorly controlled epilepsy, insulin dependent diabetes mellitus, morbid obesity, malnutrition, severe OSA, oncologic state, renal failure, muscular dystrophy, cystic fibrosis, history of organ transplantation, brain/spinal cord malformation, symptomatic hydrocephalus, premature infant PCA< 60weeks, autism with severe limitations, metabolic disease, difficult airway, long term parenteral nutrition, full term infant < 6 weeks of age.
ASA4	A patient with severe systemic disease that is a constant threat to life	Symptomatic congenital cardiac abnormality, congestive heart failure, active sequelae of prematurity, acute hypoxic-ischemic encephalopathy, shock, sepsis, disseminated intravascular coagulation, automatic implantable cardioverter–defibrillator, ventilator dependence, endocrinopathy, severe trauma, severe respiratory distress, advanced oncologic state.

2. Physical Examination

- Airway Assessment: Evaluate the child's airway for any anatomical abnormalities (cleft palate, micrognathia, glossoptosis, mandibular hypoplasia, high arched palate) which are suggestive of syndromes such as Pierre Robin sequence, Treacher Collins syndrome, Goldenhar syndrome, Down syndrome. Also look for predictors of difficult intubation if any (Limited head extension, reduced mandibular space, increased tongue thickness and reduced mouth opening.
- Respiratory Assessment: Assess the child's respiratory status, including lung sounds and work of breathing, with a focus on evaluating tachypnea/labored breathing while upright sitting, during exertion, or lying supine and in the Trendelenburg position to identify effects of a mediastinal mass, which occurs in children with lymphomas.
- Cardiovascular Assessment: Assess the child's cardiovascular status that includes heart rate, rhythm, and presence of murmurs or other abnormalities.
- Neurological Assessment: Perform a brief neurological examination to assess baseline neurological function.

3. Fasting Status:

Type of food	Duration of fasting
Clear liquids	2hrs
Breast milk	4hrs
Formula milk	6hrs
Solid foods	8 hrs

4. Informed and written consent

Discuss the procedure, risks, benefits, and alternatives with the child's parent or legal guardian.

Obtain informed and written consent for the sedation procedure and the specific procedure being performed.

5. Pre-procedural Instructions

- Provide instructions to the parent or legal guardian regarding fasting guidelines, medication administration (if applicable), and arrival time for the procedure.
- Bearing in mind resource constraints, consider obtaining pre-procedure anesthesia-relevant laboratory tests, a chest X-ray (e.g., for leukemia/lymphoma or respiratory symptoms), and an echocardiogram (e.g., for anthracycline exposure) whenever possible to identify risks.

- Address any concerns or questions the parent or legal guardian may have regarding the procedure or sedation.

6. Pre-procedural Medications

Routine pre procedural medications are not indicated

7. Documentation

- Document the pre-procedural evaluation findings, including medical history, physical examination, fasting status, and informed consent, in the patient's medical record.
- Ensure that all necessary pre-procedural assessments and preparations have been completed before proceeding with the procedure.

The goals of pediatric sedation are

(i) Maintain patient safety
(ii) Minimize discomfort
(iii) Maximize amnesia
(iv) Control behaviour and/or movement for the safe completion of the procedure
(v) Safe discharge

How to choose the right sedative agent?

Have a tailored approach for every patient is important. One must consider following points to decide the most suitable sedative agent for the type of patient in a given set of clinical scenario.

1. **Intent:** The choice of sedative agent for pediatric procedural sedation depends on the intent of the sedation, which could be minimal sedation (anxiolysis), moderate sedation (conscious sedation), or deep sedation.

2. **Who is administering anesthesia:** The choice may vary based on whether the sedation is administered by an anesthesiologist, pediatrician, or other healthcare provider with appropriate training.

3. **Depth of anesthesia:** For minimal sedation, agents like oral midazolam or fentanyl may be sufficient, while moderate sedation may require agents like propofol or ketamine. Deep sedation may necessitate agents like propofol or a combination of ketamine and a benzodiazepine.

4. **Required duration:** The duration of the procedure impacts the selection of sedation method, potentially necessitating bolus doses for shorter procedures and continuous infusion via an infusion pump for longer procedures

5. **Side effects:** Consideration should be given to potential side effects of the chosen agent, such as respiratory depression, hemodynamic instability, emergence reactions, and allergic reactions, especially in children with comorbidities or special needs.

Sedation Agents for painful and non-painful procedures

Sedation Agent	Indication	Dosage	Onset of action	Considerations
Midazolam	Anxiolysis and sedation	Initial dose of 0.05-0.1 mg/kg IV or 0.3-0.5 mg/kg PO/IM Maximum dose: 0.6mg/kg IV	Onset of action within 1-5 minutes IV	Paradoxical reactions (patient becomes more agitated rather than sedated)
Propofol	Deeper sedation	Initial dose of 1-2 mg/kg IV Maximum dose: 2-3.5mg /kg	Onset of action within 30-60 seconds Maintenance infusion at 25-75 mcg/kg/min	Respiratory depression and hypotension, and awareness of potential allergic reactions and neurotoxicity are crucial.
Fentanyl	Analgesia	Initial dose of 1-2 mcg/kg IV Maximum dose: 2-3 mcg/kg	Onset of action within 1-2 minutes IV Repeat doses may be given every 5-10 minutes upto maximum of 3mg/kg	Fentanyl is rarely associated with chest wall rigidity.
Ketamine	Sedation and analgesia	Initial dose of 1-2 mg/kg IV or 4-5 mg/kg IM Maximum dose: 4-6 mg/kg IV	Onset of action within 1-2 minutes IV Maintenance infusion at 5-30 mcg/kg/min	Agitation with emergence, diplopia, nausea, and/or vomiting. Intracranial bleed in high dosages has been described with ketamine.
Dexme-detomidine	Sedation and anxiolysis	Loading dose of 1 mcg/kg IV over 10 minutes Maximum dose : 2-3 mcg/kg	Onset of action within 5-10 minutes Followed by maintenance infusion at 0.2-1 mcg/kg/hr	Used with caution in patients with bradycardia or heart block
Triclofos	Sedation	Initial dose of 50-100mg/kg PO, titrated to effect	Onset of action within 30-60mins	Respiratory depression and overdose risk

We recommend to follow the institutional protocol for choice and combination of drugs.

Note

- Follow your institutional protocol for the choice and combination of sedative agent.
- Avoid targeting a maximum dosage for sedation drugs, tailor doses to individual patient needs.
- Local anesthesia can reduce the need for systemic analgesics and sedatives
- Always consider the patient's age, weight, medical history, and procedure duration when selecting and dosing sedation agents.
- When using oral as route of administration of sedative agents, it is advisable to wait for sufficient period of time before giving repeat dosage. The route for repeat dosage should be preferably intravenous.
- Continuous monitoring of vital signs and sedation depth is essential during sedation.
- Have reversal agents (e.g., flumazenil for midazolam, naloxone for fentanyl) readily available in case of over sedation or adverse events, and ensure resuscitation equipment is available to rescue a patient with respiratory compromise.

Monitoring

- Continuous monitoring of vital signs (heart rate, respiratory rate, oxygen saturation and blood pressure).
- Clinical assessment of sedation depth using validated scales (e.g. Ramsay sedation scale, Observer's assessment of alertness/Sedation scale/ Pediatric sedation state scale).

Pediatric sedation state scale

State	Behavior
5	Patient is moving (purposefully or non-purposefully) in a manner that impedes the proceduralist and requires forceful immobilization. May cry or shout
4	Moving during the procedure (awake or sedated) that requires gentle immobilization for positioning. May verbalize discomfort or stress
3	Expression of pain or anxiety on face (may verbalize discomfort), but not moving or impeding completion of the procedure
2	Quiet (asleep or awake), not moving during procedure, and no frown indicating pain or anxiety. No verbalization of any complaint
1	Deeply asleep with normal vital signs, but requiring airway intervention and/or assistance (e.g. central or obstructive apnea, etc.)
0	Sedation associated with abnormal physiologic parameters that require acute intervention (i.e., oxygen saturation <90%, blood pressure is 30% lower than baseline, bradycardia receiving therapy)

Procedural Room Setup

1) Equipment Preparation

Ensure all necessary equipment is readily available, including :

a. Bag-valve equipment and appropriately sized masks along with an oral airway device, in addition to airway management equipment (e.g., laryngoscope, endotracheal tubes).
b. Resuscitation medications and equipment (e.g. adrenaline, atropine, mephentermine, defibrillator).
c. Intravenous access supplies (e.g. catheters, extension tubing, saline flushes).
d. Monitoring equipment (e.g. pulse oximeter, blood pressure cuff, ECG monitor).
e. Procedural supplies (e.g. sterile drapes, gloves, dressings).
f. Check equipment for proper functioning and expiry of medicines.
g. Ensure that emergency equipment, including airway management and resuscitation equipment, is readily accessible and functional.
h. Assign roles and responsibilities for managing emergencies, including airway management, drug administration, and CPR.

2) Room Preparation

a. Ensure the procedural room is clean, well-lit, and at a comfortable temperature.
b. Arrange the room layout to allow easy access to the patient and equipment.
c. Ensure there is adequate space for the procedural team to move around comfortably.

3) Positioning

a. Position the patient appropriately for the procedure, ensuring comfort and accessibility for the proceduralist.
b. Consider using positioning aids, such as pillows or positioning devices, to maintain a stable and comfortable position for the child.

4) Monitoring Setup

a. Place monitoring equipment in a position that allows continuous monitoring of vital signs throughout the procedure.
b. Ensure that monitors are visible to the procedural team and positioned to allow easy access for monitoring and documentation.

5) Sedation Setup

a. Prepare sedation medications according to institutional guidelines and the patient's weight and age.
b. Ensure that all medications are labelled appropriately and prepared in a safe manner.

6) Communication and Team Briefing (Time out)

a. Conduct a team briefing before the procedure to review the patient's medical history, procedural plan, and roles and responsibilities of team members.
b. Ensure clear communication channels are established between team members throughout the procedure.

7) Post-procedure Care Setup

a. Prepare a post-procedure area for monitoring the patient's recovery, including a comfortable and safe environment.
b. Ensure that appropriate post-procedure medications and monitoring equipment are readily available.

8) Documentation

a. Have documentation materials ready for recording procedural details, medications administered, vital signs and any complications or interventions.

Post-procedure Care

- Continued monitoring in a recovery area until the patient meets discharge criteria.
- Assessment of vital signs and neurological status.
- Post-procedure instructions and follow-up plan provided to parent or legal guardian.

Post Sedation Discharge Criteria

Discharge Criteria	Score
Level of consciousness	
- Awake and oriented	2
- Arousable with minimal stimulation	1
- Responsive only to tactile stimulation	0
Physical activity	
- Able to move all extremities on command	2
- Some weakness in movement of extremities	1
- Unable to voluntarily move extremities	0
Hemodynamic stability	
- Blood pressure ± 15% of baseline MAP* value	2
- Blood pressure ± 15%–30% of baseline MAP value	1
- Blood pressure ± 30% below baseline MAP value	0
Respiration	
- Able to breathe deeply	2
- Tachypnea with good cough	1
- Tachypnea with weak cough	0

Oxygen saturation	
- Maintains value > 90% on room air	2
- Requires supplemental oxygen (nasal prongs)	1
- Saturation < 90% with supplemental oxygen	0
Pain	
- None or tolerable	2
- Moderate to severe pain controlled with intravenous analgesics	1
- Persistent severe pain	0
Nausea and vomiting	
- Tolerable nausea without vomiting	2
- Temporary vomiting	1
- Persistent severe nausea and vomiting	0
Total score	**14**

*MAP: mean arterial pressure.

The maximum possible score is 14. A score of 12 (with no score less than 1 in any category) is considered sufficient for discharge from the operating room.

Documentation

- Detailed documentation of pre-procedure evaluation, sedation medications, vital signs, sedation depth, and post-procedure care.
- Adverse events or complications (for example failed sedation, aspiration, laryngospasm, cardiac arrest, permanent neurological injury) should be documented and reported as per institutional policy.

Levels of Sedation

1. Minimal Sedation (Anxiolysis): Non-anaesthesiologist physicians may administer minimal sedation, typically using medications such as benzodiazepines or opioids, under specific guidelines and protocols.
2. Moderate Sedation/Conscious Sedation**: Non-anaesthesiologists may also provide moderate sedation, but the medications and dosages are usually more limited compared to what anaesthesiologists can use.

3. Deep Sedation: Deep sedation, which approaches general anesthesia, is generally reserved for administration by anaesthesiologists due to the higher risk and need for advanced airway management and monitoring.

   ** A clinician with advanced cardiac life support (ACLS) skill should be present in the procedure room

Authorized Providers

	Non-Anaesthesiologists	Anaesthesiologist
Minimal Sedation	Midazolam, Fentanyl	Midazolam, Fentanyl, Dexmedetomidine
Moderate Sedation	Fentanyl, Ketamine, Propofol	Fentanyl, Propofol, Ketamine, Dexmedetomidine
Deep Sedation	Not typically authorised	Fentanyl, Propofol, Ketamine

Practical challenges associated with sedation (especially moderate and deep sedation) done in remote areas like ward/day care room.

1. Limited monitoring equipment in wards or day care rooms can hinder continuous assessment of vital signs during sedation.
2. Emergency response may be delayed in these settings, impacting the timely management of complications.
3. Staff may lack specialized training in sedation, potentially leading to errors in medication administration or monitoring.
4. Distractions and interruptions in busy ward environments can affect the safety and efficacy of sedation.
5. Identifying suitable candidates for sedation and ensuring proper preparation is more challenging in ward settings, increasing the risk of complications.

Conclusion

Procedural sedation in pediatric patients requires careful planning, appropriate patient selection, and vigilant monitoring. Adherence to these guidelines can help ensure safe and effective sedation practices during lumbar puncture, PICC line insertion, and bone marrow examination in pediatric patients.

Checklist for Procedural Sedation in Day Care and Ward

Name.....Age.....UHID No.....Diagnosis.....

Task	Completed [Yes/No]
Pre-procedural Evaluation	
- Medical history	
- Physical examination	
- Fasting status	
- Informed consent	
- Pre-procedural instructions	
- Pre-procedural medications	
- Documentation	
- Communication	
Sedation Agents	
- Midazolam	
- Propofol	
- Fentanyl	
- Ketamine	
- Dexmedetomidine	
- Local Anaesthesia	
Monitoring	
- Vital signs (Pulse rate, Respiratory rate, SpO_2& Blood pressure)	
- Sedation depth assessment	
Procedural Room Setup	
- Equipment preparation	
- Room preparation	
- Positioning	
- Monitoring setup	
- Emergency equipment	
- Emergency drugs (Adrenaline, Atropine)	
- Sedation setup	
- Communication and team briefing	

- Post-procedure care setup	
- Documentation	
- Clean-up and disposal	
Post-procedure Care	
- Continued monitoring	
- Assessment	
- Post-procedure instructions	
Documentation	
- Detailed documentation	
- Reporting adverse events	

Signature

Doctor In charge

Date

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Schedule of Training in Practical Procedures of Pediatric Oncology

1. Lumbar Puncture
2. Bone Marrow Examination
3. PICC line Insertion
4. Procedural Sedation

Duration: Two and half days

Day 1

8.45 am to 9.00 am	Reporting and registration
9.00 am to 9.15 am	Welcome, and Introduction of participants
9.15 am to 9.30 am	Briefing about module – Course director and faculty
9.30 am to 10.00 am	Pretest
10.00 am to 1.00 pm	Observing Procedure
	Bone Marrow with Sedation – 2
	Lumbar Puncture with Sedation – 2
1.00 pm to 2.00 pm	**Lunch break**
2.00 pm to 3.20 pm	**PowerPoint Presentation**
2.00 pm to 2.20 pm	Lumbar Puncture
2.20 pm to 2.40pm	Bone Marrow
2.40 pm to 3.00 pm	PICC line
3.00 pm to 3.20 pm	Sedation
3.20 pm to 4.30 pm	Doubt clearing, Interaction with faculty and residents
Reading manual – mandatory for all course participants	

Day 2

9.00 am to 10.00 am	Discussion and Doubt clearing on manual
10.00 am to 1.00 pm	Assisted and hands on Bone Marrow (2)
	Lumbar Puncture (2)
1.00 pm to 2.00 pm	**Lunch break**
2.00 pm to 4.00 pm	Observation of PICC line insertion
4.00 pm to 5.00 pm	Interaction on observed procedures

Day 3

9.00 am to 11.00 am	**Feedback by Faculty to Participants**
9.00 am to 9.30 am	Lumbar Puncture module
9.30 am to 10.00 am	Bone Marrow Examination
10.00 am to 10.30 am	PICC line Insertion
10.30 am to 11.00 am	Sedation Module
11.00 am to 11.30 am	Post Test
11.30 am to 12.30 pm	Discussion – Pretest and Post test
12.30 pm to 1.00 pm	**Lunch and Close**

Practical Procedures in Pediatric Oncology

PRE TEST

Procedural Sedation

Pre-Test Questions:

1. What is the purpose of procedural sedation in pediatric patients?
   - A. To induce deep anaesthesia ☐
   - B. To minimize discomfort and anxiety ☐
   - C. To achieve complete immobility ☐
   - D. To induce temporary paralysis ☐

2. Which of the following is a contraindication for pediatric procedural sedation?
   - A. Stable medical condition ☐
   - B. Recent intake of solid food (<8 hours) ☐
   - C. Hypersensitivity to sedative agents ☐
   - D. Ability to cooperate with the procedure without sedation ☐

3. Which of the following is NOT a component of the pre-procedural evaluation for pediatric sedation?
   - A. Medical history ☐
   - B. Physical examination ☐
   - C. Review of current medications ☐
   - D. Determining the cost of the procedure ☐

4. What is an important consideration when selecting sedation agents for pediatric patients?

   A. Availability of the agent in the hospital pharmacy ☐
   B. Cost-effectiveness of the agent ☐
   C. The child's age, weight, and medical history ☐
   D. The proceduralist's preference for a specific agent ☐

5. How should sedation depth be monitored during a procedure in a pediatric patient?

   A. Visual observation only ☐
   B. Using a sedation scale (e. g., Ramsay Sedation Scale) ☐
   C. Monitoring only vital signs ☐
   D. Not necessary to monitor sedation depth ☐

6. Which of the following medical conditions would contraindicate procedural sedation in children?

   A. Mild asthma ☐
   B. Recent severe upper respiratory tract infection with active wheezing or respiratory distress ☐
   C. Controlled epilepsy ☐
   D. Well-controlled diabetes mellitus ☐

7. Which medication, if currently prescribed, would require special consideration or adjustment during procedural sedation?

A. Acetaminophen ☐

B. Albuterol inhaler ☐

C. Ibuprofen ☐

D. Montelukast ☐

8. Which of the following allergies poses the greatest risk during procedural sedation?

A. Allergic to penicillin ☐

B. Allergic to peanuts ☐

C. Allergic to latex ☐

D. Allergic to pollen ☐

9. Which vital sign is most crucial to monitor during procedural sedation in children?

A. Temperature ☐

B. Blood pressure ☐

C. Heart rate ☐

D. Respiratory rate ☐

10. Which factor is not typically assessed regarding previous sedation experiences in children?

A. Duration of sedation ☐

B. Types of medications used ☐

C. Child's emotional state immediately before sedation ☐

D. Any adverse reactions ☐

PICC Line

Pretest Questions

1. Which one of the following is the preferred site for PICC insertion

   A. Basilic vein ☐

   B. Axillary vein ☐

   C. Subclavian vein ☐

   D. Cephalic vein ☐

2. Characteristics of an ideal catheter are

   A. Double lumen, large-diameter, low-volume, and polyurethane catheter ☐

   B. Double lumen, low-diameter, high-volume, and polyurethane catheter ☐

   C. Single-lumen, low-diameter, high-volume, and polyurethane catheter ☐

   D. Single-lumen, large-diameter, low-volume, and polyurethane catheter ☐

3. Ideal catheter size for 1- 6year old child is

   A. 2- 3 F ☐

   B. 3-4 F ☐

   C. 4F ☐

   D. 4-5F ☐

4. The catheter length to be inserted will be measured using a tape from the point of insertion, along the selected vein tract to

   A. The right side of the sternal notch (angle of Louis) ☐
   B. The left side of the sternal notch (angle of Louis) ☐
   C. Two centimeters below left side of the sternal notch (angle of Louis) ☐
   D. Two centimeters below right side of the sternal notch (angle of Louis) ☐

5. Tip location in the right ventricle should be avoided because of the risk

   A. Thrombosis ☐
   B. Malposition ☐
   C. Infection ☐
   D. Tachyarrhythmias ☐

6. Smaller lumen PICCs are avoided because of the increased risk of

   A. Malposition ☐
   B. Infection ☐
   C. Leakage ☐
   D. Mechanical problems with luminal occlusion. ☐

7. Which is the simple landmark for appropriate positioning

   A. Fifth intercostal space ☐
   B. Third intercostal space ☐
   C. Right bronchus ☐
   D. Carina ☐

8. How to verify tip position after non - non-fluoroscopically guided PICC insertion?

   A. Via ultrasound ☐
   B. Via palpation ☐
   C. Via auscultation ☐
   D. Via chest radiography ☐

9. All are indications for the removal of the central line except

   A. Infected with organisms like Staphylococcus aureus, Pseudomonas aeruginosa, multi-resistant organisms, fungi, or metastatic infections ☐
   B. Bacteremia or clinical features of the bloodstream or local infection do not resolve in 24 hours appropriate antimicrobial therapy ☐
   C. Bacteremia or clinical features of the bloodstream or local infection do not resolve in 72 hours appropriate antimicrobial therapy ☐
   D. Presence of tunnel site infections ☐

10. Which is the preferred material for PICC

   A. Nylon ☐
   B. Silicone ☐
   C. Polyurethane ☐
   D. Polyethylene ☐

Lumbar Puncture & Intrathecal Chemotherapy Administration

Pre-test Questions:

1. The site for performing lumbar puncture in infants is below the _____ interspace as the termination of the spinal cord ends higher up at _____ level.

   A. L3-L4 interspace, L2-L3 ☐

   B. L4-L5 interspace , L2-L3 ☐

   C. L2-L3 interspace, L1-L2 ☐

   D. At the level of the conus medullaris, L4 ☐

2. Which of the following are commonly administered intrathecally for the treatment of childhood cancers?

   A. Methotrexate (MTX) ☐

   B. Cytosine arabinoside (Ara-C) ☐

   C. Corticosteroids ☐

   D. All of the above ☐

3. What structures are penetrated during a lumbar puncture procedure?

   A. Ligamentum flavum ☐

   B. Intraspinal ligaments ☐

   C. Arachnoid mater ☐

   D. All of the above ☐

4. The line joining the two posterior superior iliac spine goes through ----- vertebr A. which aids in identifying the correct position for a lumbar puncture.

   A. 4th lumbar vertebra ☐
   B. 5th lumbar vertebra ☐
   C. 3rd lumbar vertebra ☐
   D. Upper Sacral vertebra ☐

5. What is the recommended practice if a bony resistance is felt during needle insertion?

   A. Continue advancing the needle ☐
   B. Rotate the needle ☐
   C. Withdraw the needle to the subcutaneous tissue and redirect ☐
   D. Use a larger needle ☐

6. What is the cut-off of RBCs in a CSF sample that defines a traumatic lumbar puncture?

   A. ≥ 10/μL ☐
   B. >50/μL ☐
   C. >20/μL ☐
   D. any RBC in CSF analysis ☐

7. What rare complication of lumbar puncture may occur years after the procedure if performed without a stylet?

   A. Vertebral osteomyelitis ☐
   B. Epidural abscess ☐
   C. Epidermoid tumor
   D. Intramedullary spinal abscess ☐

8. In what percentage of intralumbar injections is the drug not delivered into the subarachnoid space?

   A. 5% ☐
   B. 10% ☐
   C. 15% ☐
   D. 20% ☐

9. Which complication is most commonly associated with lumbar puncture?

   A. Cerebral herniation ☐
   B. Post-dural puncture headache ☐
   C. Spinal hematoma ☐
   D. Hypotension ☐

10. What is a complication of performing lumbar puncture in the setting of raised intracranial pressure?

   A. Raised ICP results in poor flow of CSF ☐
   B. the child will require higher doses of sedation ☐
   C. increased chance of a traumatic lumbar puncture ☐
   D. Cerebral Herniation ☐

Bone Marrow Aspiration & Biopsy

Pre test questions:

1. Which of the following is not true regarding hematopoiesis?

   A. Liver is the primary site of hematopoiesis during early gestation ☐

   B. Bone marrow hematopoiesis begins during 3rd and 4th month of gestation ☐

   C. Bone marrow becomes the primary site of hematopoiesis by 6th month of gestation ☐

   D. Bone marrow and liver continue to be the sites of hematopoiesis after birth ☐

2. Which site is preferred for bone marrow aspiration in a child?

   A. Sternum, PSIS ☐

   B. Posterior superior iliac spine ☐

   C. Tibial tuberosity, PSIS ☐

   D. PSIS, Sternum ☐

3. Which of the following site is not preferred for bone marrow aspiration?

   A. ASIS ☐

   B. PSIS ☐

   C. Sternum ☐

   D. Proximal Radius ☐

4. Which of the following is not an indication of Bone marrow examination?

   A. Suspected Acute Leukemia ☐
   B. Extraocular retinoblastoma ☐
   C. Metastatic Neuroblastoma ☐
   D. Metastatic Wilm's tumor ☐

5. Which of the following is not a contradiction for performing bone marrow aspiration?

   A. Hemodyamic instability ☐
   B. Thrombocytopenia ☐
   C. Active infection at bone marrow site ☐
   D. Severe DIC ☐

6. You are currently posted in Oncology division of your unit, and see that 2 patients are planned for bone marrow examination tomorrow. One of the patients is a 5-year-old boy undergoing marrow examination for Pyrexia of unknown origin (PUO) and the other is a5 month old infant undergoing the same procedure for suspected acute leukemia. Which combination of bone marrow needles would you prefer for these two patients, respectively?

   A. 16G and 14G respectively ☐
   B. 14G and 16G respectively ☐
   C. 18G and 14G respectively ☐
   D. 11G and 14 G respectively ☐

7. Which of the following is not a technique of making a marrow smear?

   A. Push slide technique ☐
   B. Squash technique ☐
   C. Slant technique ☐
   D. Swirl technique ☐

8. Which of the following is a complication of Bone marrow aspiration?

   A. Local site pain
   B. Osteomyelitis
   C. Haemorrhage
   D. Fat embolism

   1. 1.1 and 2 only ☐
   2. 2 and 3 only ☐
   3. 1,2,4 only ☐
   4. 1,2,3,4 ☐

9. What is the adequate size of a bone marrow biopsy specimen as per ICSH and WHO respectively?

   A. 2 cm and 1.5 cm ☐
   B. 2.5 cm and 2 cm ☐
   C. 1.5 cm and 2 cm ☐
   D. 2 cm and 2.5 cm ☐

10. Which of the following is not true regarding bone marrow aspiration?

A. First pull sample is checked for presence of particles and sent for flow cytometry ☐

B. Thrombocytopenia is not an absolute contraindication for bone marrow ☐

C. In case of dry tap, core biopsy should be collected ☐

B. Bone marrow aspiration sample is stored and transferred in Formalin solution ☐

Practical Procedures in Pediatric Oncology

POST TEST

Procedural Sedation

Post-Test Questions:

1. What is the purpose of post-procedural care in pediatric sedation?
   - A. To administer additional sedatives ☐
   - B. To assess recovery and readiness for discharge ☐
   - C. To perform another procedure ☐
   - D. To document the procedure ☐

2. What are some potential adverse events or complications associated with pediatric procedural sedation?
   - A. Upper airway obstruction (with or without laryngeal spasm) ☐
   - B. Increased cooperation and comfort ☐
   - C. Decreased anxiety ☐
   - D. Improved procedural success ☐

3. Why is effective communication important during pediatric procedural sedation?
   - A. To increase the cost of the procedure ☐
   - B. To ensure a coordinated approach to the procedure ☐
   - C. To reduce the need for sedation ☐
   - D. To decrease the safety of the procedure ☐

4. How should the procedural sedation process and outcomes be documented for a pediatric patient?

   A. By the proceduralist only ☐

   B. By the sedation nurse only ☐

   C. By the entire procedural team ☐

   D. Documentation is not necessary ☐

5. What is an important factor to consider when monitoring sedation depth during a pediatric procedure?

   A. Visual observation ☐

   B. Monitoring only vital signs ☐

   C. Using a sedation scale ☐

   D. Not monitoring sedation depth ☐

6. Which of the following is NOT a recommended component of the pre-sedation assessment according to ASA guidelines?

   A. Current medications and allergies ☐

   B. Past medical history ☐

   C. Family medical history ☐

   D. Physical examination including airway assessment ☐

7. What is the recommended minimum duration of observation in the recovery area after pediatric procedural sedation as per ASA guidelines?

   A. 15 minutes ☐

   B. 30 minutes ☐

   C. 60 minutes ☐

   D. 90 minutes ☐

8. According to ASA guidelines, which of the following factors is most important to consider when assessing a child's medical history before procedural sedation?

   A. Family medical history ☐
   B. Previous sedation experiences ☐
   C. Social history ☐
   D. Dietary habits ☐

9. Which of the following airway assessment findings in children would prompt consideration for an anesthesiologist's help as recommended by ASA guidelines?

   A. Mallampati class I ☐
   B. Normal thyromental distance ☐
   C. Receding mandible ☐
   D. Adequate mouth opening ☐

10. According to ASA guidelines, which of the following medications should be administered with caution due to the risk of paradoxical reactions, especially in children with developmental delay?

   A. Ketamine ☐
   B. Propofol ☐
   C. Midazolam ☐
   D. Fentanyl ☐

PICC line

Post Test Questions:

1. The ideal catheter size for < 1-year-old child is

   A. 2- 3 F ☐

   B. 3-4 F ☐

   C. 4F ☐

   D. 4-5F ☐

2. Which one of the following is the preferred site for PICC insertion in lower limb

   A. Long saphenous vein ☐

   B. Femoral vein ☐

   C. Fibular vein ☐

   D. Anterior tibial vein ☐

3. Contraindications for PICC insertion are

   A. Infections, burns, or radiation damage – increase the risk of catheter colonization or bacteremia ☐

   B. Small, damaged, or thrombosed vessels caused by previous catheter insertions or repeated attempts ☐

   C. Central thrombosis/stenosis ☐

   D. All of the above ☐

4. Larger lumen PICCs are avoided because of the increased risk of

   A. Malposition ☐

   B. Infection ☐

   C. Leakage ☐

   D. Venous occlusion and thrombosis ☐

5. Which is the ideal position for PICC tip?

   A. Proximal part of the IVC or the lower right atrium ☐

   B. Distal part of the IVC or the lower right atrium ☐

   C. Distal part of the IVC or the lower right atrium ☐

   D. Proximal part of the IVC or the lower right atrium ☐

6. If resistance is encountered while advancing the guidewire, the next step to be done

   A. Forcefully advance the guidewire ☐

   B. Its normally encountered, continue the procedure without interruption ☐

   C. Slowly advance the guidewire ☐

   D. forceful advancement is deferred, recheck the intraluminal position of the needle on the ultrasound machine and reinsert the guidewire ☐

7. Possible causes for unable to obtain blood samples from PICC are

   A. Fibrin sheath formation ☐

   B. Mechanical obstruction ☐

   C. The catheter tip resting close to the vein wall ☐

   D. All of the above ☐

8. Sequence to be followed while insertion of PICC are

   A. Guidewire insertion -> insert the introducer -> ultrasound-guided venipuncture -> insert the introducer-> Insert a catheter-> Patient assessment ☐

   B. Patient assessment-> Guidewire insertion -> ultrasound-guided venipuncture -> Insert the introducer-> Insert a catheter ☐

   C. Patient assessment-> insert the introducer -> ultrasound-guided venipuncture -> Insert a catheter-> Guidewire insertion ☐

   D. Patient assessment-> ultrasound-guided venipuncture -> Guidewire insertion -> Insert the introducer-> Insert a catheter ☐

9. Indications for removal of PICC are all except

   A. Unexplained leukocytosis, fever, or suspicion of CLABSI ☐

   B. Three or more repairs to the catheter because of leakage or breakage ☐

   C. The patient no longer has a clinical indication for a PICC or the original indication for use has been met ☐

   D. Position of PICC in the right ventricle assessed by post-procedure x-ray ☐

10. Risk factors for venous thrombosis associated with PICC include

   A. Congenital thrombophilia ☐

   B. History of catheter occlusion ☐

   C. Catheter-related infection ☐

   D. All of the above ☐

Lumbar Puncture & Intrathecal Chemotherapy Administration

Post-test Questions

1. In which scenario would intrathecal chemotherapy administration be contraindicated?

   A. Blood-stained cerebrospinal fluid ☐

   B. Presence of tumor cells in the CSF ☐

   C. Past history of febrile seizures ☐

   D. Facial nerve palsy, risk stratified as CNS 3 at diagnosis ☐

2. How is CNS2 and CNS3 stage distinguished?

   A. Steinherz-Bleyer Algorithm ☐

   B. CSF flowcytometry studies ☐

   C. Repeat lumbar puncture for CSF cytospin study ☐

   D. Presence of clinical findings – facial palsy, focal motor deficits ☐

3. Which of the following chemotherapeutic agent if delivered intrathecally is associated with fatal neurotoxicity, ascending radiculoneuropathy and death?

   A. Vincristine ☐

   B. Prednisolone ☐

   C. Cytarabine ☐

   D. Methotrexate ☐

4. Bony resistance caused by the inferior spinous process can be overcome by ….

   A. Repositioning the child to provide adequate flexion at the hips ☐
   B. Ensure the spine is not rotated ☐
   C. Gluteal crease is in alignment with the spinal column ☐
   D. All of the above ☐

5. The recommended order of draw of tubes for CSF samples is…

   A. Glucose and Protein>Cell counts>Gram stain and culture ☐
   B. Cell counts>Glucose and Protein>Gram stain and culture ☐
   C. Gram stain and Culture>Cell counts>Glucose and Protein ☐
   D. Gram stain and culture>glucose and protein>cell count ☐

6. Soft tissue infection at the site of lumbar puncture is a contraindication to performing the procedure. The complication of performing the LP is associated with:

   A. Meningitis and epidural abscess, ☐
   B. Vertebral osteomyelitis and discitis, ☐
   C. Intramedullary spinal abscess, ☐
   D. All of the above ☐

7. A safe lower limit of platelet counts to perform LP is …../cumm

   A. 50,000 ☐
   B. 1 lakh ☐
   C. 30,000 ☐
   D. 10,000 ☐

8. The CSF samples collected for testing should be analysed within a time duration of ……for most accurate results and interpretation.

   A. 1 hour ☐
   B. 2 hour ☐
   C. 4 hours ☐
   D. 8 hours ☐

9. The minimum duration of time for which the patient should lie supine post intrathecal chemotherapy administration is …….

   A. 2 hours ☐
   B. 1 hour ☐
   C. 30 minutes ☐
   D. 4 hours ☐

10. A "pop" or sensation of give way is felt during advancing the LP needle is due to piercing of ……

   A. Arachnoid Mater ☐
   B. Dura Mater ☐
   C. Ligamentum Flavum ☐
   D. Interspinous Ligament ☐

Bone Marrow Aspiration & Biopsy

Pre and Post test questions

1. Which of the following is an indication of doing a bone marrow examination?
   - A. Suspicion of storage disorder ☐
   - B. Suspicion of acute leukemia ☐
   - C. For obtaining cultures as a part of PUO ☐
   - D. All of the above ☐

2. Which of the following is an indication for obtaining a bone marrow biopsy ?
   - A. Suspected Bone marrow ☐
   - B. Failure of bone marrow aspiration ☐
   - C. Suspected bone marrow failure syndrome ☐
   - D. All of the above ☐

3. Which of the following is a site of obtaining a bone marrow aspirate in infants?
   - A. PSIS ☐
   - B. ASIS ☐
   - C. Proximal tibia ☐
   - D. All of the above ☐

4. Arrange the following in order of doing a bone marrow procedure

   a. Use appropriate size needle for puncturing skin advance to periosteum and enter the bone marrow space till the needle is anchored firmly

   b. Confirm indication of BMA

   c. Attach syringe to the hub, pull to obtain an aspirate

   d. Confirm patient identity

   e. Check for particles, and take first sample for flow cytometry

   f. Obtain the relevant samples

   g. Sedation/ local anaesthesia

   h. Prepare smear

   i. Remove BMA needle and put dressing over BMA site

   A. a, b, c, d, e, f, g, h, i ☐

   B. c, a, b, i, h, e, f, g, d ☐

   C. d, b, g, a, c, e, h, f, i ☐

   D. i, c, b, g, a, d, e, f, h ☐

5. Which of the following is not a common complication of Bone Marrow procedure?

   A. Haemorrhage ☐

   B. Infection ☐

   C. Persistent pain ☐

   D. Seizure ☐

6. Which of the following needle(s) can be used for a bone marrow procedure?

   A. Jamshidi Neddle ☐

   B. Klima needle ☐

   C. Salah's needle ☐

   D. All of the above ☐

7. Which of the following is not required while performing a bone marrow procedure?

   A. Consent ☐

   B. Sterile gloves, gown ☐

   C. Local anaesthetic ☐

   D. Artery forceps ☐

8. What is the preferred size of Jamshidi needle for Bone marrow biopsy in pediatric age group?

   A. 13G, 9cm ☐

   B. 11G, 10cm ☐

   C. 11G, 15cm ☐

   D. 8G, 10cm ☐

9. Identify the needle:

A. Salah Needle ☐

B. Klima Needle ☐

C. Jamshidi Needle ☐

D. Swent Needle ☐

10. What samples are collected in vial labelled A and B respectively?

A. Flow cytometry and Cytogenetics ☐

B. Cytogenetics and Flow Cytometry ☐

C. Biochemistry and Flow cytometry ☐

D. Cytogenetics and Biochemistry ☐

10. Which of the following are techniques for preparing a good slide smear?

A. Push slide technique

B. Pull Prep Technique

C. Slant technique

D. Overlap technique

1. c ☐
2. a,b,c ☐
3. a,c ☐
4. a,b,c,d ☐

NOTES :

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