***PAEDIATRIC HAEMATOLOGY/ONCOLOGY SUPPORTIVE CARE HANDBOOK***

**Upendo and Tumaini Ward**

**Muhimbili National Hospital**

**Dar es Salaam**

**Tanzania**

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INTRODUCTION

Welcome to the PAEDIATRIC HAEMATOLOGY/ONCOLOGY Department; we hope you will enjoy working with us. Whatever stage of training you may currently be at or whatever area of Paediatrics or general practice you aspire to, we hope that by the end of your term with us, you will have found the experience beneficial and worthwhile.

The aim of your time with us is to gain experience in the general care of children with malignant disease so that, whether you are a paediatrician or general practitioner, you will be comfortable assuming a certain level of responsibility for these patients. Those of you choosing a career in this subspecialty will be given an opportunity to be more involved, commensurate with your experience.

Most patients are treated according to international guidelines or a locally relevant modification of international guidelines recommended by one of the three following organisations: International Society of PAEDIATRIC HAEMATOLOGY/ONCOLOGY (SIOP), the Children’s Cancer Group (COG) or the International Network of Cancer Treatment and Research (INCTR) protocols. All units, such as ours, are to a greater or lesser extent guided by policies and protocols, which enables a standard of care to be provided, whether the child is a patient in Upendo ward or elsewhere.

In this unit, you will be members of a team, each of whom has a unique level of expertise which complements the other, facilitating a comprehensive level of care to the children and their families. Our nurses, will guide you through the maze of day to day issues in an effort to provide as thorough a standard of care as possible. Please ask the nurses for advice – they have a wealth of experience working on the oncology unit. You will also work in close liaison with our palliative and follow-up care specialist; the patient liaison officer who provide a key role in linking up with other departments and helps transition our children home when this is appropriate. They are key members of the team without whom the operation of a national PAEDIATRIC HAEMATOLOGY/ONCOLOGY service would not be possible. Other members include social workers, teachers, play therapist, pharmacists and nutrition specialists, all of whom contribute greatly to the running of this department.

You will work in close collaboration with other specialties and learn the value and importance of multidisciplinary input. You will be encouraged to participate in weekly tumour board meetings, tutorials and other teaching sessions; you will also have opportunities to present papers at meetings and engage in research, if deemed appropriate.

Finally, we hope you will find this booklet helpful; If you feel there are any gaping omissions, comments to the undersigned are most welcome.

Dr Trish

# The ROUTINE on UPENDO WARD

## General

You will be assigned to either Upendo ward, Tumaini ward, out patients or the procedure room where you will be given opportunities to preform various procedures under supervision.

Daily PAEDIATRIC HAEMATOLOGY/ONCOLOGY rounds occur: twice a day on Upendo ward and once a day on Tumaini ward. We have outpatient clinics at assigned times during the week days.

You are expected to thoroughly examine each child and familiarise yourself with the patient files, observation sheets and medication, including chemotherapy and fluid sheets. Please ensure all medications charted have actually been given and all temperatures (more than 38 degrees) are reported. ALL CHILDREN MUST BE PRESENTED TO ONE OF THE PERMANENT ONCOLOGY SPECIALISTS EVERY DAY. A round book of jobs is filled on each round and all tasks should be completed and checked off in the book each day.

If a child is found to be critical or a new child arrives please find the consultant on call and inform them. Do not wait for a routine round to bring up such urgent matters. NEVER WAIT TIL THE NEXT DAY TO INFORM A CONSULTANT OF A NEW OR CRITICAL PATIENT NO MATTER WHAT TIME THIS EVENT OCCURS.

The evening round occurs between 4-6pm depending on work load and is attended by all the oncall doctors. Any new complications are identified and the round book job list is reviewed to ensure every urgent job and procedure has been completed.

Requests for blood tests the following day should be written during the morning round or before leaving each evening; requests for weekend blood tests should be written up on a Friday evening, if possible.

## Ward Duties:

A rota, compiled by the head of the firm, specifies the allocation of ward duties for each doctor. Please check with the head of the firm when you first arrive to the ward **All doctors who spend more than a week on the ward will be taught how to perform bone marrow aspirates (BMA) & biopies/trephines (BMBx), lumbar punctures (LP) and administration of intrathecal (IT) chemotherapy and will be signed off as competent by a consultant on the ward; only then are they allowed to perform these procedures unsupervised**.

## Discharge Letters:

Children sharing care with a local hospital should have a **“Discharge Letter”** completed with details of their recent counts and chemotherapy. There is a general discharge letter, a Wilms tumour specific and an Acute lymphoblastic leukaemia discharge letter available on the ward. These should be completed for all children going home. There is in addition an Ujasiri transfer form which should be filled out for all children who are discharged to our family hostel – Ujasiri House.

## Prescribing Chemotherapy:

Most chemotherapy is prescribed based on surface area (see UKCCSG chart for estimation of BSA). Patients usually less than 10kg have dose calculated based on weight in kg. Patients with a body mass index (BMI) <2nd or >98th centile should have chemotherapy prescribed as per BSA calculated using BMI chart (Check with a specialist). All chemotherapy prescriptions should be written with the formal guidelines in front of you. NEVER EVER SIMPLY COPY WHAT SOMEONE ELSE HAS WRITTEN. Do not ‘remember’ as you WILL make mistakes. All chemotherapy prescriptions need two doctors signatures (ONE OF WHICH MUST BE A SPECIALIST), a pharmacist and a nurses signature before the pharmacist will reconstitute and the nurse will administer it. **Please make sure at least there is at least one senior doctor has signed and checked every single chemotherapy sheet.**

## Neuro-oncology meeting (NOM)

Tuesday 7.30-8am Neurosurgery office, first floor, MOI (opposite Dr Shabani/Lemeri’s office)

This meeting is attended by the paediatric neurosurgical team, one of the MOI consultant radiologists and the paediatric oncology team. All paediatric neuro-oncology patients are discussed together.

## Retinoblastoma meeting (RbM)

**Wednesday 8am PAEDIATRIC HAEMATOLOGY/ONCOLOGY Conference Room.**

This is attended by the entire paediatric oncology and the paediatric ophthalmologists in charge of Rb – headed by Dr Anna Sanyiwa. All retinoblastoma patients are discussed in detail.

## Tumour Board Meeting (TBM)

**Wednesday 1pm, PAEDIATRIC HAEMATOLOGY/ONCOLOGY Conference Room.**

This meeting is attended by all members of the PAEDIATRIC HAEMATOLOGY/ONCOLOGY team, Paediatric Surgeons, Radiologists and the Radiation Specialists from ORCI. It is hoped that pathologists will someday join. PAEDIATRIC HAEMATOLOGY/ONCOLOGY patients are discussed in detail; clinical histories are presented by PAEDIATRIC HAEMATOLOGY/ONCOLOGY doctors. The radiology department requires all scans to be reviewed at least 24 hours prior to the meeting. The pathology department must receive the list of specimens for review on the Friday prior to each meeting. The following is the format for case presentation:

## New patients – relevant history

Presenting complaint

Clinical findings & investigations at local hospital

Clinical findings on admission to MNH

Relevant past history

Relevant family history

Relevant lab tests

Radiological findings

Relevant surgical procedure including dates

Histopathology

Treatment Plan

Provisional plan for elective surgery.

## follow up patients – relevant history

Chemotherapy Protocol & number of courses to date

Clinical response to date

Date & results of radiological investigations

Dates & results of relevant tumour markers (eg.uCATs, αFP)

Proposed date for elective surgery

Surgical procedure

Histopathology

Proposed date for elective radiotherapy.

## Clinical Audit:

This is almost entirely dependent on the interest and willingness of doctors to become involved. Every effort will be made to facilitate such studies. It is expected that adequate time can be provided to enable clinical audit projects to be performed and papers written.

## Time Off:

One half day off per week should be able to be arranged among doctors, usually after a night on-call. Ideally not more than one doctor should be on annual leave at any one time. Two weeks study leave in each 6 months is usually provided for those studying for masters exams. Again all doctors should not take this time all at the same time. Holidays and study leave should be negotiated as early as possible**. All leave should be approved by the head of the firm.**

# WORK UP FOR NEWLY DIAGNOSED PAEDIATRIC HAEMATOLOGY/ONCOLOGY PATIENTS

## All Patients:

**Vital information to be recorded on all patients:**

1. Patient’s and parent’s and siblings’ history to be recorded at admission.
2. Weight, height and MUAC to be recorded in doctors’ notes at each visit.
3. Size of tumour/lymph nodes; please record whether nodes are palpable, mass is

detectable and if so, please measure dimensions if possible.

1. After each course of chemotherapy all toxicity must be recorded i.e. myelosuppression, nausea, vomiting, alopecia, etc. This toxicity must be graded (*Refer to CTC. scale - see appendix 1*).

**Work up investigations at first presentation to the Children’s PAEDIATRIC HAEMATOLOGY/ONCOLOGY Departmen**t

**All children who attend for the first time need…**

1. Full blood picture
2. Blood grouping +/- cross-matching
3. Coagulation profile
4. LFT, U&E, Calcium, phosphate, Creatinine, LDH, Uric Acid
5. Viral titres: HIV and Hepatitis A, B and C screening

## Individual additional Investigations for specific diagnoses:

### Leukaemia Children

1. Urgent Chest Xray – please do the SAME DAY as admission to ward.
2. Peripheral blood
3. Smear – look for blasts.
   1. *Morphology and Cytochemistry -* 6 PS slides (N.B. spread very thinly)
   2. If blasts present then peripheral blood should be sent for flow cytometry analysis. **If this is diagnostic there is no need for a bone marrow examination.**
   3. At the same time special ‘sticky’ PS slides should be prepared for cytogenetic analysis.
4. Bone marrow aspirate and biopsy **(The following is only necessary if the peripheral blood was non-diagnostic):**
   1. *Morphology and Cytochemistry -* 6 BM slides (N.B. spread very thinly)
   2. *Immunophenotyping/flow cytometry -* 1-2 ml in EDTA (FBP) bottles. This test takes 3-4 hours of laboratory time. The sample must be processed immediately or else transferred from the FBP bottle to the transport bottle and stored in the fridge. Please inform the haematology laboratory **before taking** this sample to alert them so that the sample can be processed in a timely and organised fashion. Please ensure that **this sample is delivered by a doctor to the laboratory** **scientist** performing the procedure as if lost it may be impossible to replace if lost. Once treatment has begun this sample cannot be reliably retaken and it may not be possible to confirm the diagnosis.
   3. At the same time special ‘sticky’ BMA slides should be prepared for cytogenetic analysis.
5. LP cytospin if platelets are more than 25X109/L. If less than 25X109/L hold LP and order platelets. Do LP immediately platelets have been given. If platelets unavailable then hold LP for a maximum of one week and then do LP/IT regardless of platelet count.
6. ECHO

### Retinoblastoma

1. Please fill out form for enucleated/exenterated specimen to go to our lab. Please clearly ask the following questions on the form:
   1. Is the optic nerve involved?
   2. Is the cut end of the optic nerve involved?
   3. Is the anterior chamber involved?
   4. Is there deep choroidal involvement?
2. If clearly intraocular – no other investigations. Proceed to chemotherapy or wait for histopathology result.
3. If possibly or definitely extra-occular (but not obviously metastatic) –
   1. Lumbar puncture cytospin
   2. Bone marrow aspirate/biopsy
   3. If this is normal – MRI/CT brain
   4. If these are all normal proceed to chemotherapy.
4. If definitely metastatic:
   1. No further investigations – please send to palliative care team for counseling.
5. Audiology

### Burkitt’s and other non-hodgkins lymphoma

1. Chest Xray
2. Urgent Ultrasound of abdomen and pelvis
3. Bone marrow aspirate
4. Trucut biopsy if diagnosis not confirmed
5. Lumbar puncture for cytospin.
6. Other investigations depending on site of disease e.g. Xray jaw.

### Wilms Tumour

1. CT abdo/pelvis/thorax
2. If CT not available then order Ultrasound of abdomen and pelvis and CXR
3. 5-10ml of Urine for VMMA – needs to be fresh. 0.5-1ml HCL 6mol/L should be added immediately
4. Serum for Alpha feto protein
5. ECHO

### Neuroblastoma

1. Chest Xray – look for tram-tracking in the ribs, lung mets.
2. Plain film of the abdomen looking for calcification
3. Urgent Ultrasound of abdomen and pelvis +/- CT abdomen
4. 5-10ml of Urine for VMMA – needs to be fresh. 0.5-1ml HCL 6mol/L should be added immediately
5. Serum for Alpha feto protein
6. If stage 3 also needs a bone marrow aspirate/biopsy to rule out stage 4.
7. +/- bone scan

### Hodgkins Lymphoma

1. CT thorax – (if not available - Chest Xray)
2. CT abdomen and pelvis – (If not available – USS abdo/pelvis)
3. Bone marrow biopsy
4. Alpha feto protein in children under 10 years – to outrule ataxia telangiectasia.
5. ECHO

### Rhabdomyosarcoma

1. Chest Xray +/- CT thorax
2. CT abdomen and pelvis – (If not available – USS abdo/pelvis)
3. Bone marrow aspirate/biopsy

### Osteosarcoma

1. Plain film Xray of the affected bone
2. Trucut biopsy if no previous biopsy.
3. Chest Xray - If normal please do CT thorax
4. Bone scan
5. Xray painful bones or hot spots on bone scan.
6. ECHO

### Brain Tumours

1. CT brain +/- MRI brain and spine
2. +/- alpha feto protein and beta hCG.
3. Lumbar puncture for cytospin

### Nasopharyngeal Carcinoma

1. CT brain and nasal sinuses
2. CXR
3. Audiology

### Hepatoblastoma/Hepatocellular carcinoma

1. Alpha feto protein
2. Liver MRI/CT – ask radiology for advice
3. CXR
4. Albumin

# How to access RADIOLOGICAL INVESTIGATIONS:

## Plain Film X-Ray

These can be done 24 hours a day. Urgent scans eg CXR for new patients suspected of leukaemia/lymphoma should **ALWAYS** have a CXR the day of admission (unless it was done elsewhere within the last 7 days).

## USS

The Ultrasound department has very kindly set aside an hour from 8am to 9am to scan our children without prior appointment. All new children should be sent to USS if required within 24 hours of arrival on the ward.

If an urgernt USS or an USS guided biopsy is required please contact the USS department to make appropriate arrangements.

## CT /MRI Scans:

**Please discuss these with senior colleagues before ordering to ensure best use of hospital resources.**

These can be arranged by completing all information on an x-ray form and discussing with our patient liaison officer who will process exemptions as appropriate. Urgent scans can be prioritised and given pre-exemption permission – please ask a specialist to help. Please then discuss with our wonderful colleagues at CT/MRI who will do their best to accommodate our needs. Some patients may require sedation*; if weight <20kg, Chloral hydrate 80mg/kg should be given 30mins to 1hr pre scan with a top up of 40mg/kg if necessary*. If sedation being used, need to fast for 6 hours. If sedation is given a doctor must accompany the child.

# Prophylaxis commencing pre-treatment:

## Pneumocystis prophylaxis

INDICTIONS FOR GIVING PNEUMOCYSTIS PROPHYLAXIS

|  |  |  |
| --- | --- | --- |
| **Diagnosis** | **Protocol** | **Prescribed Septrin** |
| ALL  ALCL  LCH  Hepatoblastoma  Wilms | - UK ALL  -ALCL HR only  -LCH III  -SIOPEL 3  -WT 2002 01  (HR & post lung RT only) | **Commence** Septrin **on Day 1 of treatment.**  For prolonged neutropenia  (>3 weeks) and off treatment check with Consultant prior to stopping Septrin  **Surface Area Dose**  <0.5m2 24mg/kg b.d. Sat & Sun  0.5 – 0.75m2 240mg b.d. Sat & Sun  0.76 – 1.0m2 360mg b.d. Sat & Sun  >1.0m2 480mg b.d. Sat & Sun |

Patients with solid tumours on Septrin whose neutrophil counts have not recovered in time for next course of chemotherapy should discontinue Septrin until count recovers. Septrin should be recommenced at 50% dose.

***Septrin Preparations***

Septrin paediatric suspension 240mg/5ml

Septrin adult tablets 480mg

Septrin forte tablets 960mg

***Duration of Treatment***

Continue Septrin for 3 mths after completion of treatment.

**Alternative PCP Prophylaxis: These are unfortunately currently not available.**

Dapsone 2mg/kg PO daily (max dose 100mg)

Pentamidine 4mg/kg IV over 1 hour every 2-4weeks (<5years)

**Or**

9mg/kg aerosolized over 1 hour (by Respirgard) monthly (<5years)

300mg aerosolized over 1 hour(by Respirgard) monthly (>5years)

**Treatment of Pneumocystis Pneumonia:**

Septrin 120mg/kg/day IV (or PO if IV not available) in 2-4 divided doses for 10 days.

Continue p.o. for further 7-14 days.

OR

If the patient fails to respond to the septrin within 72 hours change to pentamidine isothionate 4mg/kg/d IV over 1 hour and continue for 14 days. The patient must also be given bronchodilator prior to and or during the procedure (to improve the blood flow to the lungs during the infusion.

Salbutamol: 6months-5yrs 2.5mg

5-12 years 5mg

>12 years 5-10mg.

## MOUTH CARE

It is hoped that soon we will introduce a formal dental exam as part of every newly admitted child routine assessment. The importance of maintaining good oral hygiene in the child should be stressed to the parent and a high standard of oral hygiene should be encouraged from the outset.

**Tooth Brushing**

Tooth brushing with a regular toothbrush and a pea-sized amount of fluoride-containing toothpaste (at least 1,000 ppm fluoride) should be continued, where possible, throughout therapy and at least twice a day. Tooth brushing should be supervised by an adult until the child is at least 8 years of age.

**Dental Procedures**

Infection may occur in relation to an extensively decayed tooth/teeth and this may be problematic when the child is neutropenic. **Such decayed teeth should ideally be extracted prior to the commencement of chemotherapy/radiotherapy**. If this is not possible then such teeth should be extracted as soon as is medically appropriate – if feasible when under GA for an oncologic procedure.

Any child having a dental extraction must receive ceftriaxone – a single dose IV at induction and a second dose 24 hours after.

**Management of Mucositis:**

Difflam spray (Benzydamine hydrochloride)

BMX (Benylin, Maalox, Xylocaine) mouthwash

Morphine PO or IV as required.

Anti-fungal prophylaxis with miconazole if no evidence of candidiasis or ketoconazole/fluconazole if candida present.

## AML FUNGAL PROPHYLAXIS

**Extended prophylaxis MUST include Aspergillus:**

**Itraconazole** should be given daily to all children diagnosed with AML.

## ANOVULANTS

Girls who are having periods are at greater risk of severe menorrhagia while receiving chemotherapy, particularly when platelet count is <50 x 109/l. It is recommended that anovulants would be prescribed

In general, anovulant is interrupted after chemotherapy course when platelet count recovers to >50 x 109/l; this will allow the patient to have a period prior to the next course of chemotherapy.

# Conscious Sedation Guideline to perform ward based procedures

Preparation is the key to providing safe sedation.

**Necessary items:**

* Oxygen supply
* Anaesthetic bag/bag and mask
* Suction and suction catheter
* Saturation monitor
* Person trained in BLS
* Ketamine
* Midazolam
* Lignocaine
* 2.5ml syringes
* Sterile gloves

**The procedure**

The patient should fast for 6 hours for solids, 4 hours for milk and 2 hours for clear fluids. The oxygen, bag/mask and suction must be tested prior to sedation. A back up oxygen tank should be within close proximity. Using a combination of small doses of sedatives is very effective and safe in providing sedation and preventing the side effects of larger doses of single agents. IV access should be obtained. The patient is best left with their parents for administration of the sedating agents. Distraction techniques can be helpful.

* Ketamine 1-2mg/kg is drawn up and diluted to 1mg/ml with 0.9%w/v Sodium Chloride.
* Midazolam 25-50 microg/kg is drawn up.

These should be administered slowly as they cause stinging at the injection site.

When the patient is sedated they are placed on the procedure bed and the oxygen saturation is then checked.

If after several minutes or any time during the procedure sedation is not adequate and the child is either waking up or still conscious a further dose of ketamine 1mg/kg and midazolam 50microgs/kg can be administered. These additional doses are always titrated to the child’s response and level of consciousness. Do not give more than one additional bolus of these drugs without senior supervision.

The saturation should again be checked.

A local anaesthetic should be used at the procedure site as this provides affective analgesia and reduces the need for further sedation.

# CENTRAL VENOUS CATHETERS

Due to the fact that our patients require regular blood tests and infusions/injections/transfusions we have decided to begin a new service for the children. In almost all newly diagnosed patients a peripherally inserted central venous catheter (PICC lines) will be placed where possible; this is usually inserted within one week of admission as soon as the child is afebrile. It is requested that all staff avoid cannulating or phlebotomising the antecutibal fossae of all potentially PAEDIATRIC HAEMATOLOGY/ONCOLOGY children to improve the chance of successful insertion.

PICC lines are inserted under aseptic conditions. This is of the utmost importance to prevent infection of the lines and the risk of sepsis. Two people are required for the procedure. The procedure room is prepared in advance.

**Necessary items include:**

* Blue cannula
* Tournequet
* 2.5ml syringes
* 10ml syringes
* Sterile gloves
* Methylated spirits
* Heparin/saline solution: (10units/ml) made up as follows: 1ml of heparin 5,000iu/ml in 500mls of normal saline. This can be stored at room temperature for 7 days.
* Sedation – ketamine and midazolam (see guideline)
* Lignocaine
* PICC 3-5 french with guidewire
* Procedure trolley
* Oxygen source
* Anaesthetic set/bag and mask
* Suction and suction catheter
* Saturation monitor
* Dressing

**The procedure:**

* The oxygen supply and bag/mask circuit must be checked prior to sedation.
* The patient should have a yellow cannula inserted away from the antecubital fossa.
* Conscious sedation can be administered through this as per the guideline. When the patient is sedated they are placed on the procedure bed. The patient’s saturations and respiration are now checked.
* The distance from the point of insertion is measured up to the axilla and to the centre of the sternum in each child. The aim is for the tip of the catheter to be located at the SVC/right atrial junction. The PICC line is cut to this length.
* The procedure trolley is sterilised with methylated spirits. The PICC line packet can be placed here and opened up. This should be used as a sterile field. The blue cannula, sterile gauze, 2.5ml and 10ml syringes are placed on this.
* A tourniquet is placed on both arms to locate the optimal vein. Sterile gloves are now worn by the person inserting the PICC.
* The 10ml syringe is filled with heparin/saline solution and the PICC line is flushed with 2-3ml of solution.
* The area around the insertion site is cleaned multiple times using methylated spirits.
* The sterile field should be increased by opening the sterile gauze and placing it on the arm above and below the insertion site.
* Lignocaine is drawn is up (0.5ml) and injected next to the site of PICC insertion. Draw back to ensure the needle is not in the vein.
* The blue cannula is inserted.
* The guide wire is placed up though the cannula 10 – 15cm ensuring not to enter the heart. The monitor can again be listened to assess for any tachyarythmia.
* The cannula is removed over the guide wire holding the guide wire firmly in place. Do not loose the wire as it will be impossible to retrieve without surgery.
* The PICC is now placed over the wire. The wire must be under control at all times and will need to be fed backward until the end protrudes from the PICC line. The end of the wire is held as the PICC is advanced though the skin.
* When fully advanced the wire can now be removed. The PICC is aspirated and again flushed with 3ml of heparin/saline solution. The white cannula bung is placed on the end and the PICC is secured with dressing.
* Once a line has been successfully placed a CXR is required to ensure the line is in the appropriately place.

# PROTOCOL FOR MANAGEMENT OF PICC CATHETER

## General management of PICC lines

Once a PICC line has been inserted successfully and its position has been verified with a CXR this line can remain insitu as long as it is functioning well and the child remains afebrile. The line should be flushed at least once a day when not in use with a heparin saline solution. If in use the line needs to be flushed following each injection/infusion/transfusion to ensure it does not clot and block. At all times an aseptic technique must be used when using the line to ensure the line does not become infected.

## Line Infections:

A documented rise in temperature in a child following flushing of catheter associated with a chill / rigor and constitutional disturbance.

**REMOVE THE LINE**

1. If the child is neutropenic – start the febrile neutropenic (FN) protocol but add in Vancomycin to other first line antibiotics
2. If the child is not neutropenic – observe for signs of fever or evidence of systemic infection
   1. If present – remove the line and start the FN protocol as above.
   2. If absent – simply observe the child. Do not start antibiotics.

## Blocked PICC lines

Unfortunately lines may block. If it is impossible to flush the line then it may be possible to unblock the line using a guide wire. If this is not successful the line will have to be removed. If the line is flushing but it is not possible to withdraw blood it is appropriate to continue to use this line once the position has been verified and confirmed by CXR.

# ONCOLOGICAL EMERGENCIES

## ABC’s

As with any other critically ill child all emergency care management begins with assessment and support of airway, breathing and circulation.

### Airway:

**Be aware that many PAEDIATRIC HAEMATOLOGY/ONCOLOGY children come with airway difficulties. Your first intervention may be to urgently engage with your anaesthetic or surgical (ENT if possible) colleagues, or start some emergency treatment, to stabilise the airway.**

**Assessment:** Look in mouth for oral tumours; Examine cervical area for lymphadenopathy; Look for the position of the child – are they in the tripod position – ie sitting forward and holding the chair/bed sides; Signs of respiratory distress – tachypnoea, stridor, grunting, low oxygen saturations etc.

**Investigations:** CXR DAY ONE of presentation to look for upper airway compression with mediastinal adenopathy.

**Management:**

The initial management of child with airway compromise secondary to a tumour is no different to any other child.

First give oxygen.

The position of the obstruction will dictate further management i.e.:

* Upper Airway Obstruction:

Lesion in the mouth or upper neck: Consider an oral airway, laryngeal mask, endotracheal tube or tracheostomy. See below for detailed instructions.

* Lower Airway Obstruction:

Lesion in the lower neck or upper mediastinum: If none of the above procedures will relieve the obstruction because it is too low down the other interventions possible include:

**Steroids** – Extremely effective for most leukaemia and lymphoma’s; may reduce some inflammatory swellings in other tumours.

**Chemotherapy** – starting emergency chemotherapy may be the best option for some solid tumours with critical airways.

**Radiotherapy** – emergency radiotherapy may be required to rapidly reduce the airway compression if the tumour is deemed to be radiation sensitive.

Sometimes in extreme cases a combination of all these treatment modalities may be needed.

#### Airway interventions for Upper Airway Obstruction:

### Face masks

Ideally, facemasks should be **clear** to allow you to see the child's colour, and the possible presence of vomit.

Some masks conform to the anatomy of the child's face and make providing a good seal relatively easy. These masks also have a relatively low dead space.

Circular soft plastic masks also give an excellent seal and are available across a range of sizes - from those designed to fit small neonates through to masks for large adults. Try to store a wide variety of sizes.

The correct size mask is one, which fits over the mouth and nose but does not press on the eyes.



**A childhood guide to sizes of Laerdel silicone face masks:**

00 and 0/1: Neonate - infant

2: infant - small children

3: small - large children

4: adolescent - adult

### Jaw thrust maneuvers

Jaw thrust is achieved by placing two or three fingers under the angle of the mandible bilaterally, and lifting the jaw upwards, ensuring the maintenance of in-line immobilisation.

Jaw thrust acts to lift the tongue off the back of the pharynx and so clear the airway.

This technique may be easier if the rescuer's elbows are resting on the bed or surface the child is lying on.

### Oropharyngeal (Guedel) Airway

**Indication:** An OPA is indicated if the jaw thrust maneuvers has failed to correct airway obstruction.

An OPA acts by establishing an opening between the tongue and the posterior pharyngeal wall and can make a difficult airway much easier to manage. OPAs may not be tolerated by semi-conscious patients.



**Oropharyngeal Airway Placement**

Measure from the centre of the incisors to the angle of the mandible, when laid on the face concave side up.

Pre-lubricate with either the patient's own saliva or a small amount of lubricating jelly.

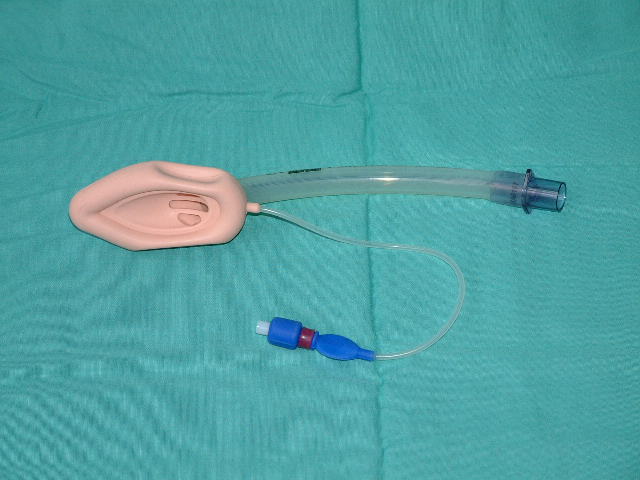
Insertion:

**>8 years:** like an adult: concave side up; pass to the back of the hard palate, then rotate 180o to concave side down

**<8 years:** insert under direct vision, concave side down, using a tongue depressor

If ventilation is still insufficient or not tolerated, the patient may require more advanced airway procedures.

## Laryngeal mask

Indication: If an OAP has failed to relieve an airway obstruction. This is only possible to place in the unconscious child.

Prior to placing the LMA, inflate the cushion on the mask and check for leaks or abnormal bulging. Then deflate the cushion with the cuff gently pressed against a flat surface. It’s crucial that the leading edge of the cuff be smooth and wrinkle free to prevent the tip of the deflated cushion from curling. Curling potentially folds the epiglottis down over the glottis during insertion and can prevent a good seal.

Make sure that the cuff rim curves upward, away from the opening. When the flattened cuff is pressed against the palate during insertion, that curve will naturally push it against the palate and help prevent trapping the epiglottis in the cuff bowl.

## Endotracheal tube intubation

Indications

Failure to obtain an airway by simple airway opening maneuvers (eg: OPA insertion); Airway protection (eg: from blood, broken teeth, vomitus);To provide a secure airway for transport; To control ventilation in the unconscious/head injured patient ;

**Endotracheal tubes**

Uncuffed tubes are preferable in children up to eight years of age, to avoid oedema at the cricoid ring.

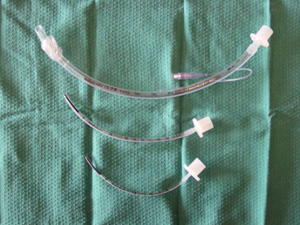
Finding the right-sized tube is important, to avoid large leaks around the tube.

Nasotracheal intubation whilst more secure is contra-indicated in patients with possible base of skull fracture

**Sizing:**

Diameter for Neonate - 3.0 mm; for 0-6 months - 3.5mm; for 6-12 months - 4.0 mm Then use (Age in years / 4) + 4 = size of endotracheal tube (ET) mm. Length of insertion at lips: Visualise the tube passing through vocal cords avoiding endobronchial intubation:

**Endotracheal tubes**

New Born 10cm

1yr 11cm

2yrs 12cm

3yrs 13cm

4yrs 14cm

6yrs 15cm

8yrs 16cm

10yrs 17cm

12yrs 18cm

Formula for length (at lips) of oral tube is Age/2 + 12

**Laryngoscope:** Curved or straight blades can be used although the straight blade laryngoscope is recommended in young children, because it is designed to lift the epiglottis, which is comparatively large and floppy in children, under the tip of the blade, allowing a better view of the vocal cords;

**Preparation for Endotracheal intubation:**

An assistant, who is familiar with intubation equipment, is essential.

Endotracheal tube: Calculate the appropriate size: **Age/4 + 4 mm = internal diameter (ID)**

Have tubes of the appropriate size, plus tubes 0.5 mm ID smaller and 0.5 mm ID larger than that size, available on the child's bed.

Introducer: for ET tubes 4.5 mm ID and smaller, a lightly lubricated stilette inserted almost to the tip of the tube, makes intubation easier.

Oral: Always use oral - never nasal - intubation in a child with a head injury, because of the risk of meningitis, and of entering the cranial cavity if there is an undiagnosed fracture of the skull base.

Laryngoscopes: Have 2 available. Check the light is bright enough.

Suction: -Check it is working. -Use a Yankauer suction catheter. -Place it next to the child's head.

Drugs: Draw up and label [see below] -

Saline flush 10 ml.

IV cannula + 3-way tap on extension tubing: all patent and visible

Have your assistant ready to:

Apply Cricoid pressure -Use direct pressure on the cricoid - thumb & index finger both side, and press directly down.

Start as the first drug is injected.

Don't stop pressure until the ET tube is in place and secure.

Give Drugs:

Hypnotic first, then flush.

Muscle relaxant, then flush.

Hand you Equipment: In the correct order?

Pass the tip over the tongue past the tip of the epiglottis.

Lift the epiglottis to see the vocal cords.

Pass the tip over the tongue into the vallecula (space between tongue and epiglottis).

Lift the handle towards the ceiling at the far end of the room to bring the vocal cords into view.

Don't lever against the teeth.

Don't jam the lip between blade and teeth.

**4. Insert the endotracheal tube.**

Calculate how far. [(Age/2) + 12] cm at the teeth.

Immobilise the tube at the lips.

Auscultate both axillae and epigastrium to confirm the tube position.

Secure with cotton tape around the neck, or Elastoplast on the face.

**5.Insert an orogastric tube on free drainage.**

**Never** use a nasogastric or nasotracheal tube in a child with a head injury (because of risk of meningitis, or of entry of cranial cavity in undiagnosed fracture of the skull base).

**6. Check AP chest Xray:** The ET tube tip should lie at the level of the medial end of the clavicles. If not, re-position the tube and re-tape.

**7. Suction** the ET tube carefully each hour - more often, if needed.

**8. Humidify** the inspired gases using a condenser humidifier (Swedish nose) between the ET tube and the self-inflating bag.

**9. Splint** the child's arms if necessary (child should be sedated)

**Needle Cricothyroidotomy**

If the airway is completely inadequate, consider:

Surgical cricothyroidotomy (> 12 years)

Needle cricothyroidotomy (any age; may be used to gain time during surgical cricothyroidotomy)

Rationale for needle cyricothyroidotomy

Patent airway not possible by other means.

Preferable to surgical airway in children under 12 years of age.

Useful for obstruction in the larynx or above; not if the obstruction is in the trachea or bronchi.

It improves oxygenation slightly, buying 10-15 minutes' time for help to arrive and for a definitive airway to be established.

**Preparation for Needle Cricothyroidotomy**

Continue bag/mask ventilation with O2

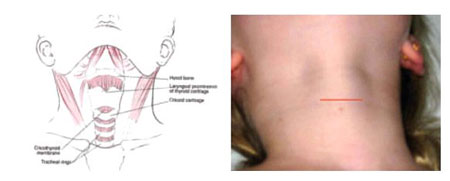
Prepare equipment:

IV cannula: largest available (10 - 16 SWG), with 5 ml syringe;

Oxygen tubing + 3-way tap. (If there is no 3-way tap available, cut a 3mm hole in the side of the O2 tubing and, if necessary, cut the O2 tubing to fit over the hub of the cannula.)

Place a rolled towel under the child's shoulders.

**Surface markings**

Feel your own cricothyroid membrane: this is the horizontal gap between the thyroid cartilage (Adam's apple) above, and the horizontal cricoid cartilage below.

Stand on the child's left and locate the same structures.

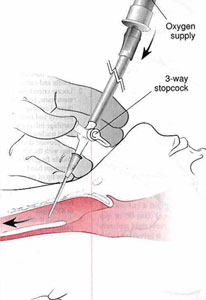
Immobilise the trachea between your left finger and thumb.

Insert the cannula through the cricothyroid membrane, then 45o downwards towards the feet. **STAY IN THE MIDLINE!**

Aspirate continuously as soon as the needle is through the skin.

When you can aspirate air, the needle is in the trachea. Immobilise the syringe (don't pull it back) and slide the cannula down the needle into the trachea.

Tape the cannula in place. Attach the O2 tubing to the cannula. Run O2 at 1 litre/min per year of age.



450 angle. Occlude the side hole of the 3-way tap, or the hole in the O2 tubing, for 1 sec, then release for 4 sec to allow expiration.

**Complications to be aware of:**

Asphyxia, Aspiration, Cellulitis, Oesophageal perforation, Haemorrhage, Haematoma

Posterior tracheal wall perforation

Subcutaneous and/or mediastinal emphysema

Thyroid perforation

Inadequate ventilation leading to hypoxia and death

### Breathing

Respiratory causes and non-respiratory causes of respiratory distress in a newly presenting child with suspected malignancy which include:

## Cardiopulmonary Emergencies:

* Pleural effusions
* Pericardial effusions/Cardiac tamponade
* SVC/SMS
* Respiratory tract infections

### Pleural Effusions

Pleural effusions in PAEDIATRIC HAEMATOLOGY/ONCOLOGY patients are almost always exudates. Treating the underlying condition definitively treats them. However, regardless of whether transudative or exudative, large, refractory pleural effusions causing severe respiratory symptoms can be drained to provide symptomatic relief.

Complicated parapneumonic effusions and empyemas should be drained to prevent development of fibrosing pleuritis. Malignant effusions may require pleurodesis to prevent recurrence if the child is deemed palliative.

**Symptoms:** Dyspnoea, Cough, Chest Pain

**Signs:** Tachypnoea; Tachycardia; low saturations; decreased air entry; stony dull percussion note; orthopnoea; haemoptysis.

**Diagnosis:** Chest Xray – PA and Lateral, +/\_ pleural tap for: microscopy, microbiology, TB staining and culture and biochemistry and histology exam with cytospin. The pleurodesis (tap) should not be attempted in an effusion less than 1cmthickness in a lateral decubitus film or in a child with coagulopathy or platelet count less than 25.

Normal pleural fluid has the following characteristics:

* Clear ultra-filtrate of plasma that originates from the parietal pleura
* A pH of 7.60-7.64
* Protein content of less than 2% (1-2 g/dL)
* Fewer than 1000 white blood cells (WBCs) per cubic millimeter
* Glucose content similar to that of plasma

Lactate dehydrogenase (LDH) less than 50% of plasma

**Treatment:** Small pleural effusions will resolve with appropriate treatment of the underlying condition. Large symptomatic effusions require chest tube thoracostomy.

**Intercostal Catheter (guide sizes only):**

* Use smaller size for draining air
* Larger size for draining blood/fluid

Newborn  8-12 FG

Infant    12-16 FG

Child 16-24 FG

Adolescent  20-32 FG

The chest tube must be inserted into an underwater drainage system. The drained fluid should be observed for colour and volume. If the tube stops training DO NOT assume the chest is now dry. The tube may be blocked and the child’s condition may rapidly deteriorate if the drain is not unblocked or replaced. ALWAYS perform a check CXR prior to removing a chest tube.

If a pleural effusion does not resolve with standard treatment (drainage, systemic chemotherapy, antibiotics, (low fat diet for chylothorax) etc pleurodesis may be required.

**Chylothorax**

Operative intervention for chylothorax should be considered when: (a) Average daily loss has exceeded 1500 ml/year of age in children for a five-day period, (b) Chyle flow has not diminished over 14 days, (c) Nutritional depletion, fluid and electrolyte loss, hypolipemia, lymphocytopenia and immunodeficiency appear imminent, and (d) Accumulation of chyle is continuous and more than 5 ml/Kg per day despite chest tube drainage, after all conservative measures.

**Pleurodesis:**

Various agents, including talc, doxycycline, bleomycin sulfate (Blenoxane), and zinc sulfate, can be employed to sclerose the pleural space and effectively prevent recurrence of the malignant pleural effusion.

Talc is the most effective sclerosing commercially available agent and can be administered as slurry through chest tubes or pleural catheters. Talc particles tend to occlude the small drainage holes in small pleural catheters. Therefore, pleural catheters should be at least 10-12F if intended for talc pleurodesis.

Doxycycline and bleomycin are also effective in most patients and can be administered more easily through small-bore catheters, although they are somewhat less effective and substantially more expensive than talc.

**The procedure:**

After complete drainage of the pleural fluid, the slurry (4 – 6 g of talc in a solution of 100 ml saline with or without lidocaine for an adult patient – reduce proportionally for children) is instilled. Adverse reactions include microemboli and granulomatous tissue reactions. Doxorubicin at a dose of 20 mg/kg/dose, diluted in normal saline to a final syringe concentration of 2-8 mg/ml is an alternative. Bleomycin (60 units) has been used as an alternative sclerosing agent.

Chose one and inject through the chest tube. The patient should be rotated hourly. The dose remains in the pleural space for approximately 6 hours before being drained under suction.

All sclerosing agents can produce fever, chest pain, and nausea. Talc rarely causes more serious adverse effects, such as empyema and acute lung injury. The latter appears to be related to the particle size and the amount of talc injected for pleurodesis.

### Pericardial effusions/Cardiac tamponade

This occurs when the left ventricle fails to maintain output because of compression. It may be caused by a mediastinal mass, pericardial effusion, leukemic infiltrate, inflammation or infection, or fibrosis due to radiation.

**Symptoms:** Cough, Chest pain, Dyspnea, Abdominal pain

**Signs:** Tachycardia, Cyanosis, Hypotension, Pulsus paradoxus  
greater than 10 mm.

**Treatment :**

Transfer to PICU if possible

Echocardiog/Cardiology Consult to consider Pericardiocentesis

### Superior Vena Cava Syndrome (SVCS) and superior mediastinal syndrome (SMS):

SVC: compression, obstruction or thrombosis of the superior vena cava due to rapidly growing mass with no time to develop compensatory collateral circulation.

SMS: SVC signs and symptoms + tracheal compression

They may be considered together.

**Intrinsic causes:** Vascular thrombosis

**Extrinsic causes:** Malignant mediastinal tumors: Hodgkin lymphoma, Non-Hodgkin lymphoma, Teratoma or other Germ Cell Tumor, Thymoma.

**Symptoms:** Dyspnea, Cough, Dysphagia, Orthopnea, Hoarseness, Anxiety, Confusion, Lethargy, Headache, Distorted vision, Central Venous Stasis

**Signs:** Edema, Plethora, Cyanosis of face, neck and upper extremities, facial suffusion, Cervical and thoracic venous distention, conjunctival suffusion and edema, wheezing, stridor.

**Note:** Sometimes no signs or symptoms until stressed

**Management:**

* Allow patient to rest in the position where they are most comfortable & minimize agitation. This is commonly sitting upright in the tripod position or sitting leaning forward.
* Minimize/avoid sedation.
* Make the diagnosis in the least invasive manner remembering that this may not be possible or may be delayed for a day or two until the child is more stable
  + Thoracentesis if pleural effusion
  + Bone marrow aspirate if suspect leukemia/lymphoma
  + Biopsy of peripheral node
* Avoid intubation/ventilator if possible: can be very difficult to secure airway and ventilate facial suffusion
* Monitor closely
* Corticosteroids – dexamethasone 10mg/m2 in 2 divided doses for 3 days
* Empiric tx as a life-saving measure may be needed.
* Anticoagulation for symptomatic venous thrombosis (Heparin or LMWH)

### Respiratory Tract Infections

In any febrile child who has tachypnoea, abnormal chest signs, or low saturations please consider viral, bacterial, fungal as well as PJP, TB, and (particularly if there is doubt about vaccination status of the child) pertussis.

## TUMOUR LYSIS SYNDROME

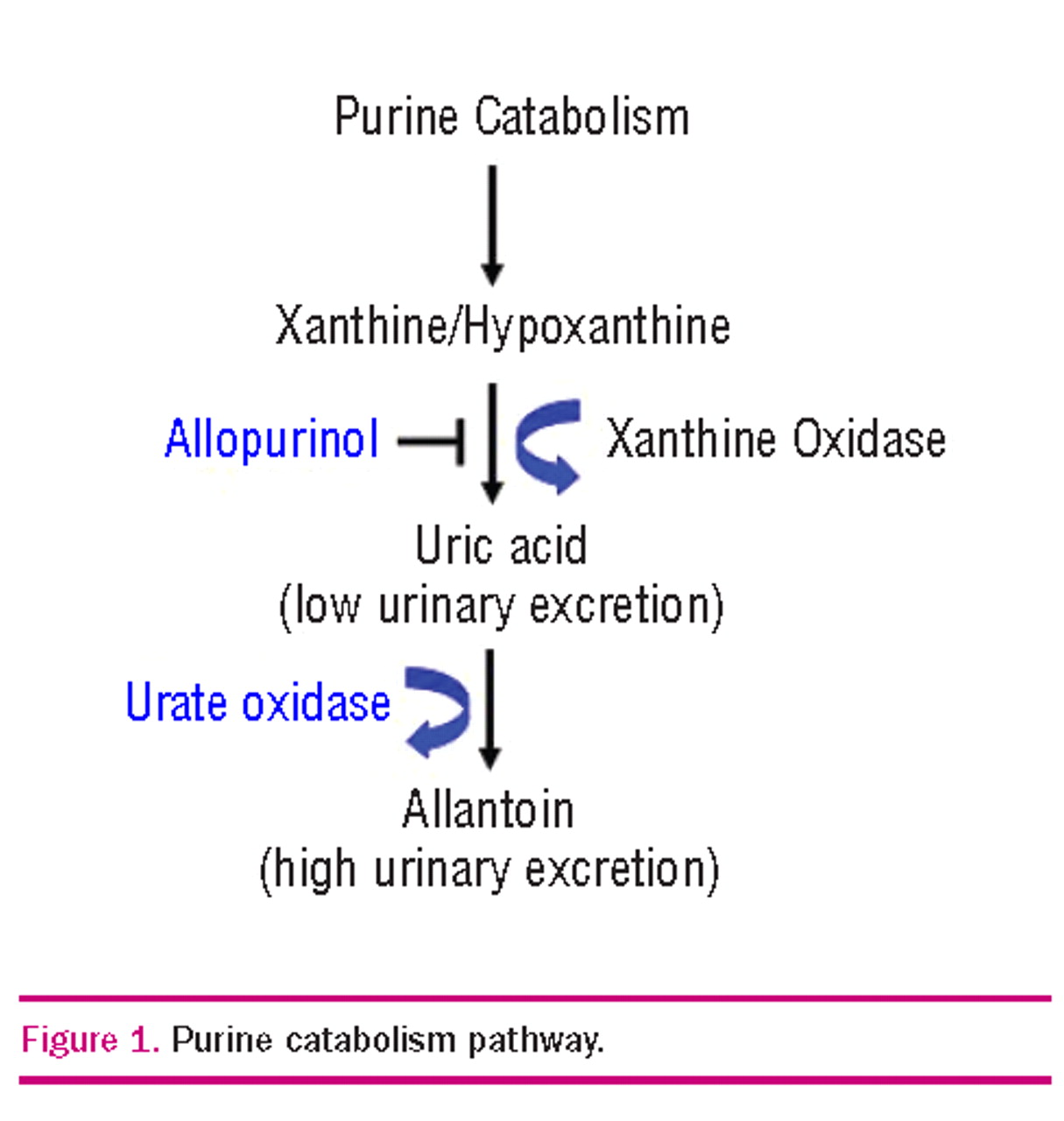
### Introduction

This is a constellation of biochemical abnormalities resulting from massive tumour cell lysis which may be apparent at diagnosis or during the first few days of induction chemotherapy. Conditions most likely to cause this include:

a) Burkitts Lymphoma and other NHL’s

b) Acute leukaemia with WCC > 50 x 109/l

d) Large tumour burden e.g. Stage IV NBL



### Principal Biochemical Abnormalities found in Tumour Lysis Syndrome:

1. Hyperuricaemia

2. Hyperphosphataemia

3. Hypocalcaemia

4. Hyperkalemia

Acute renal failure may result from precipitation of urate in renal tubules.

### Initial Management:

1. Measure **weight**
2. **Fluids:** Commence hydration on admission with DNS at 3L/m2/24hrs

Strict adherence to fluid balance. Aim for a urine output of 3mls/kg/hour. Ask parents to collect all the urine and review this at least daily if not more often initially.

1. **BP** 4 hourly or more frequently according to severity of clinical condition.
2. **Blood Investigations**
3. U + E - if possible, 12 hourly but at least every day until stable
4. Urate - if evidence of massive cell lysis or reduced urine output, monitor 6 hourly, otherwise once daily
5. Creatinine - as for urate
6. Inorganic Phosphate
7. FBP - daily
8. **CXR**
9. **Renal ultrasound** when a child has an abdominal mass to rule out renal infiltration or obstructive uropathy. Children with the latter are at increased risk of renal failure and may require dialysis at an early stage.
10. If possible **ECG** monitoring if hyperkalemic or on calcium infusion if possible.
11. **Allopurinol:** 1month-15 years 10-20mg/kg daily. Maximum 400mg daily

15-18years – 10-20mg/kg daily with a maximum of 900mg.

Preferably with food. Doses over 300mg are given in divided doses.

Start from first admission and to continue for 5 days (or longer if child has confirmed Tumour Lysis Syndrome).

1. **Urate oxidase** – Although this drug is currently unavailable on the ward it is important to include it here. It is extremely effective and is given at a dose of :

0.2mg/kg daily diluted in 50ml of NaCL 0.9%w/v administered over 30 minutes (for up to 5 days).

For children less than 5yrs with uric acid levels > 400micromol/L

For children more than 5yrs with uric acid levels > 600micromols/L

This should never be mixed with chemotherapy. Uric acid levels should be checked daily.

### Management of Complications:

1. ***Fluid Balance:*** If diuresis is not adequate and there is no evidence of obstructive uropathy, frusemide 1-2mg/kg can be given as a stat dose, or up to every 6 hours under strict consultant supervision and repeated as indicated.

2. ***Hypocalcaemia:*** Clinical signs include: neuromuscular irritability including

**(<1.8 mmol/L)**tetany as manifested by Chvostek's sign (twitching on tapping of facial muscle) or Trousseau's sign (occlude brachial artery with BP cuff and hand spasms into painful ‘main d’accoucheur), bronchospasm, electrocardiographic changes, and seizures.

Ca gluconate 10% (2.2mmol/10ml) 1-2mmol/kg/day i.e.

as separate infusion diluted in 100-200 ml 0.9% w/v NaCI. If symptomatic, 0.1 mmol/kg Ca gluconate 10% (0.4ml/kg) diluted in 10-20 ml 0.9% w/v NaCI can be given slowly over 10 mins with ECG monitoring if possible. Calcium

replacement may need to be continued at a

lower dose while lysis is continuing.

**NB: Stop infusion if bradycardia develops.**

**Site of cannula should be left exposed so that area can be inspected at regular intervals (extravasation causes severe tissue necrosis)**

3. ***Hyperkalemia*:** See next section below.

**(>5.5 mmol/L)**

## HYPERKALAEMIA

Hyperkalaemia is defined as serum potassium greater than 5.5 mEq/L (mmol/L). Severe hyperkalaemia (potassium > 7mmol/L) is a medical emergency and requires urgent treatment.

**Causes:**

* Excessive potassium intake (eg. potassium supplements, potassium sparing diuretics)
* Transcellular movement of intracellular potassium into the extracellular space (e.g. tumour lysis, massive transfusion, metabolic acidosis)
* Decreased renal excretion of potassium (e.g. impaired effective arterial perfusion, renal dysfunction)
* Pseudohyperkalaemia (haemolysed blood sample)

**Severe hyperkalaemia**

* Patients with a potassium level > 7mmol/L or
* Patients with rapidly rising potassium level e.g. tumour lysis syndrome or
* Patients with significant ECG changes (widening of the QRS complex or loss of P waves, not simply tented T waves) associated with raised potassium levels

### Management of severe hyperkalaemia:

1. Consider cause of hyperkalaemia. Review medication list and check previous blood results.
2. Repeat an urgent renal profile (including potassium, sodium, chloride, urea and creatinine); inform the lab that this is urgent and ensure the sample is taken to the lab immediately. Do not delay treatment if the clinical picture is in keeping with the blood result.
3. Perform an ECG if possible but do not delay treatment. Place on a cardiac monitor and pulse oximeter if possible.
4. Cardiac membrane stabilization.

Calcium should be infused **SLOWLY over 5 minutes** intravenously to patients with:

* 1. Serum potassium >7mmol/L OR
  2. Significant ECG changes
  3. Severe arrhythmias thought to be caused by hyperkalaemia

There are two forms of calcium. Please check carefully which is available in your centre and calculate accordingly. Note the large difference in maximum volumes. (If both are available use calcium gluconate):

1. IV Calcium Gluconate 10%w/v, 0.5 -1ml/kg (equivalent to 0.11-0.22mmol/kg). The **maximum single dose** is 4.4mmol or **20ml.**

**OR**

1. IV Calcium Chloride 10%w/v, 0.2ml/kg (equivalent to 0.14mmol/kg) The **maximum single dose** is 1.4mmol or **2ml.**

1. Therapy to shift extracellular potassium into cells is needed in conjunction with cardiac membrane stabilization
   1. **Inhaled salbutamol (can be repeated after 20 minutes)**
      1. Neonates 0.4mg in 2ml of saline
      2. Infants and children > 25kg 2.5mg in 2ml of saline
      3. Children 25-50kg 5mg in 2ml of saline
      4. Children >50kg 10mg in 2-4mL of saline
   2. **Intravenous insulin and glucose.**

Fast acting insulin (e.g actrapid) is mixed with dextrose 1g/kg and given concurrently IV over 30 minutes as follows:

* + 1. Insulin (actrapid) 0.1iu/kg
    2. Dextrose: 5mL/kg dextrose 20%w/v or 20ml/kg of 5%w/v dextrose depending on what concentration is available.

This must be double checked with two doctors prior to administration. Serum glucose should be measured prior to and one hour after commencement of infusion.

1. Therapy to remove potassium from the body
   1. Frusemide 1mg/kg IV can be given if renal function and volume status are normal in severe hyperkalaemia or for non-urgent levels of hyperkalaemia (5.5-6.5mmol/L)
   2. If enteral cation exchange resins e.g. sodium polystyrene sulfonate or dialysis are considered, senior input is advised
2. Repeat potassium 2 hours after commencement of therapy
3. **Criteria for Dialysis (In case this service develops in your centre):**

Remember: most times acute renal failure secondary to tumour lysis syndrome can be reversed with intensive fluid balance management. Catheterise any child where the fluid balance and urine output is critical.

1. Severe oliguria (unresponsive to frusemide) or anuria
2. Serum K+ persistently > 6.5 mmol/l
3. This is usually accompanied by:
4. S. urate > 1000 mmol/l
5. S. Creatinine > 500 mmol/l
6. Urea > 50 mmol/l
7. S. PO4 > 4 mmol/l

Decision regarding haemofiltration will be made in consultation with Nephrology Team.

**REFERENCE**

<http://www.uptodate.com/contents/management-of-hyperkalemia-in-children?source=search_result&search=hyperkalemia&selectedTitle=4%7E150>

## FEVER AND NEUTROPENIA AND SEPSIS

### Definitions

**Febrile**

Temperature ≥ 38.3° on one occasion

or

Temperature ≥ 38.0° and ≤ 38.2° on at least two occasions, taken at least one hour apart

Note: In order to be practical, the above temperature recordings can be obtained from any site, e.g. oral, axilla, external auditory canal, etc.

**Neutropenia**

Defined as per the absolute neutrophil count (ANC) which is the sum of the neutrophils and band forms. An ANC < 1 x 109/L is the critical value below which all patients should be treated along the following guidelines.

**Sepsis**

Patient with a known or suspected infection + 2 or more of the following:

1. Fever or hypothermia
2. Unexplained tachycardia or tachypnea

**Septic Shock**

Septic shock is a systemic response to pathogenic microorganisms and endotoxins in the blood. It’s usually caused by G-negative organisms which arise from endogenous flora. It leads to decreased perfusion, cellular hypoxia and often, death. There are two types of shock:

1. Compensated shock:
   1. Tachycardia,
   2. poor perfusion
   3. Normal blood pressure
2. Decompensated shock:
   1. Weak central pulses
   2. Oliguria
   3. Hypotension

Children at highest risk include those with prolonged severe neutropenia (<0.1X109/L), breaks in the skin/mucous membranes; invasive devices insitue; malnutrition

### Treatment of septic shock:

1. Volume resuscitation (Most Important) 20ml/kg 0.9% w/v NaCI boluses over 5-20 minutes (up to 60ml/kg in first hour)
2. Vasopressors
3. Broad-spectrum antibiotics
4. Constant monitoring for signs of response to treatment

### Febrile Neutropenia guidelines

These guidelines apply only to the management of patients with:

* Fever and neutropenia as a result of a known or suspected malignancy or the use of chemotherapy
* Fever and neutropenia as a result of a bone marrow failure syndrome.
* Fever (or evidence of infection) who are receiving chemotherapy or who have completed cancer therapy within 6 months even though they are not neutropenic.

The need for initiating empiric antibiotic therapy in such cases is assessed by the severity of the presenting signs and symptoms, the results of initial investigations and the presence/absence of a PICC lines. PICC cultures must be drawn as part of this assessment. It is important to note that some patients, although with infrequent occurrence, may present with hypothermia and therefore under such circumstances the patient’s clinical condition is of paramount importance in determining management including the initiation of these guidelines.

### Acute/Initial Management

1. Thorough assessment, including a comprehensive examination, of the patient is required.
2. Obtain FBP and differential, and determine ANC.
3. Malaria screen
4. Obtain aerobic and anaerobic blood cultures from any PICC lines AND a peripheral site prior to giving antibiotics.
5. Antibiotic administration must not be unduly delayed in order to obtain cultures. It is important that antibiotics are administered within 1 hour of reaching the hospital. It is very important to obtain appropriate and timely cultures as the results are used to optimize treatment of the patient.
6. Initiate antibiotic treatment, as detailed below in table 1, if:

* Patient is febrile and ANC < 1 x 109/L, or
* ANC ≥ 1x 109/L and ANC expected to fall below 1 x 109/L within the next 24 to 48 hours, it is advisable to initiate antibiotic treatment.
* Patient is febrile and the neutrophil count is unavailable in the acute stage but the patient recently received chemotherapy and therefore is at risk of neutropenia.

If you are unsure about the management of any febrile Haematology/PAEDIATRIC HAEMATOLOGY/ONCOLOGY patient, regardless of the patient’s ANC, do not hesitate to contact an appropriate member of the Haematology/PAEDIATRIC HAEMATOLOGY/ONCOLOGY medical team.

1. Please discuss with the consultant Haematologist/Oncologist prior to making decision regarding discontinuation of current chemotherapy or if considering holding cotrimoxazole prophylaxis.
2. Vital signs hourly until stable and then 4 hourly and/or as indicated.
3. The following additional investigations, apart from the above mentioned blood cultures, are required in all patients:

* Urine analysis
* Urine culture
* Biochemistry, specifically renal function (creatinine, electrolytes)

Following assessment of the patient consider the following and order if clinically indicated:

* CXR
* Swab of any infected site (specific attention to the central venous line site)
* Throat swab
* Stool analysis

1. Always consider the patient’s past history of **previously cultured multidrug resistant organisms (VRE, MRSA, ESBL, CRE etc.)**, current and recent antibiotic use and clinical status (e.g. septic shock) when selecting antibiotics. Standard initial antibiotics for the stable patient as given below may not be appropriate in a patient who has a history of serious infection due to an antibiotic-resistant organism*.* If in doubt contact the **Paediatric** **Haematology/PAEDIATRIC HAEMATOLOGY/ONCOLOGY consultant** and discuss further.
2. PICC line infection may present as fever related to recent access to the line, infection at the line exit site or as infection along the subcutaneous course of the line. If this is the case, systemic antibiotics directed at this site of infection (usually vancomycin) should be considered **IN ADDITION** to the broad spectrum empiric antibiotic regimen below.
3. Give Paracetamol. It is the preferred antipyretic agent. (Ibuprofen and other non-steroidal anti-inflammatory agents are not generally recommended as first-line antipyretic agents for neutropenic patients due to their effect on platelets. Please inform the haematology/PAEDIATRIC HAEMATOLOGY/ONCOLOGY consultant prior to giving NSAIDs).
4. Aerobic Blood cultures must be taken every 48 hours while patient remains febrile, and/or prior to the addition of a new antibiotic. If the initial blood culture is positive a repeat blood culture should be obtained to ensure clearance of bacteremia.

**Table 1:** Guidelines for initial (first-line) and subsequent (second-line – deteriorating patients) empiric antibiotic selection.

|  |  |  |
| --- | --- | --- |
| Patient Condition | Antibiotics & Doses | Comments |
| PATIENTS *with* *no significant beta-lactam reactions:* | **Piperacillin-tazobactam (Tazocin)** 90 mg/kg/dose IV 6 hourly  (max single dose: 4.5g) | Adjust Tazocin doses for renal impairment.  Tazocin usually provides adequate coverage for G positive organisms includingviridans streptococci. However, if additional coverage against resistant G positive organisms (e.g. coagulase negative staph, MRSA) is desired, the addition of **Vancomycin** is recommended. Consider discontinuation of Vancomycin once culture and susceptibility results are available. |
| DETERIORATING PATIENTS on first line treatment with *no history of anaphylaxis to Beta Lactams (i.e. if history of rash only, can still use Meropenem)* | **Meropenem** 20 mg/kg/dose IV 8 hourly  AND  **Amikacin** 7mg/kg/dose OD (OR **Ciprofloxacin** 10 mg/kg/dose IV 12 hourly OR **Gentamicin** 7mg/kg once daily in 50-100ml 0.9% w/v NaCI by infusion over at least 30minutes)  AND  **Vancomycin**  12mg/kg/dose 8 hourly | Meropenem: Max single dose: 1g  Ciprofloxacin: dose reduce if creatinine clearance <20ml/min/1.73m2, use half normal dose. Max single dose: 400mg  **Maximum dose of GENTAMICIN is 400mg daily.** |
| PATIENTS with history of definite anaphylaxis to Beta Lactams | **Ciprofloxacin** 10 mg/kg/dose IV 12 hourly  **AND**  **Metronidazole** 7.5mg/kg/dose IV 8 hourly  **AND**  **Amikacin** dose as above  **AND**  **Vancomycin** dose as above | Adjust ciprofloxacin doses for renal impairment. Max single dose: 400mg  Metronidazole max single dose: 500mg. |
| PATIENTS deteriorating despite the above treatment where you suspect or confirm resistant gram negative bacteria. | **CEFOSO (cefoperizone and sulbactam 1g+1g)**  Doses are expressed in terms of cefoperazone.  20-40 mg/kg/day, given in equally divided doses every 6-12 hours.  For serious infections: Up to 160 mg/kg/day, given in 2-4 equally divided doses may be used.  Max dose of sulbactam: 80 mg/kg/day | May cause pseudomembranous colitis.  Renal impairment: Dose adjustments may be needed.  Reconstitution: sterile water for injection/normal saline/ 5% dextrose in water, and then diluted to 20 ml using the same diluent followed by admin over 15-60 minutes. |

\*In an effort to avoid or minimize aminoglycoside-induced hearing loss, patients with known, significant, pre-existing **hearing loss** (sensorineural hearing loss ≥ 30dBHL at one or more frequencies between 250Hz-4000Hz) or **renal impairment** (i.e. GFR ≤ 60mL/min/1.73m2, serum creatinine 1.5 times upper limit of normal for age, or **Hepatoblastoma protocol-directed chemotherapy** and no significant beta lactam allergy should receive single agent Ceftazidime only (with the addition of oral Metronidazole if anaerobic infection suspected) rather than gentamicin. Similar patients **with** significant beta lactam allergy may receive one dose of aminoglycoside.

### Continued Management

Continue with antibiotic management as outlined above, relative to the patient’s culture report, temperature, ANC and clinical condition.

**Further modifications include:**

**a) Culture Negative Patients**

1. **Patient had a single spike of fever (i.e.child’s temperature returns to normal within 4 hours of the initial fever)…..**

If a child is well, shows no evidence of a focus, AND has had a single episode of fever which rapidly returns to normal AND cultures are negative at 48 hours antibiotics may be discontinued.

1. **Patient had more than a single spike of fever**

If a child is well, shows no evidence of a focus, cultures are negative at 48 hours but has more than a single spike of fever antibiotics must be continued for a minimum of **7 afebrile days.**

1. **Culture Negative Patients still febrile on…**

DAY 3

If patient remains febrile and neutropenic on day 3, continue first line antibiotics and if:

1. Oral herpes or severe mucositis, commence IV Aciclovir.
2. Obvious fungal infection – suspect candida – add fluconazole IV; suspect other fungal infection – add Amphoteracin B IV.
3. Diarrhoea and vomiting – culture stool and commence ciprofloxacin andmetronidazole
4. Signs of skin infection – add vancomycin
5. No clinical focus but deteriorating rapidly or extremely unwell – see below DETERIORATING STATUS
6. No clinical focus but slowly deteriorating – consider adding vancomycin

DAY 5 – 7

If patient remains febrile, neutropenic, consider performing a fungal work-up, prior to commencing empiric appropriate antifungal treatment.

Fungal work-up:

CXR

CT chest

Abdominal U/S (or CT abdo)

CT sinuses (if patient is > 7 yrs of age)

DAY 7+

If patient having responded to initial regimen becomes febrile again or has had persistent fever and fungal work-up not yet done, perform above fungal work-up and commence on empiric appropriate antifungal treatment.

DAY 10-14+

If persistently neutropenic patient becomes febrile again after discontinuation of a 10 – 14 day course of antibiotics, reculture and restart broad-spectrum antibiotics as per day 1 of F&N guidelines. If fever persists for a further 48hrs or more, add in empiric appropriate antifungal treatment.

**b) Culture Positive Patients**

If patient becomes afebrile and is clinically well, re-culture and await identification of organism and sensitivity data before modifying treatment. If patient remains neutropenic continue with broad-spectrum IV antibiotics for at least 7-10 days.

Antibiotics specifically directed toward the identified organism should ordinarily be **added to** the broad spectrum therapy if the initial antibiotics do not provide adequate coverage.

I.E. **Broad spectrum coverage must not be replaced by organism-specific antibiotic(s) alone in the neutropenic patient.**

**c) DETERIORATING STATUS**

Patients who become haemodynamically unstable or appear to be progressively deteriorating should be brought to the immediate attention of the consultant Haematologist/Oncologist and the Infectious Disease service if present in your hospital.

If child has signs of septic shock:

I.e. Tachypnoea, tachycardia (or bradycardia and apnoea), cold clammy peripheries, thread pulse, prolonged Capillary Refill Time (CRT) and especially if BP is dropping:

* + - 1. Give NaCL 0.9w/v 20ml/kg fluid bolus stat
      2. Assess for response
      3. If still unstable give second bolus of NaCl0.9%w/v 20ml/kg
      4. Escalate antibiotic coverage as outlined below
      5. Take repeat FBP, Urea, Creatinine, Electrolytes, Blood culture.
      6. If any evidence of bleeding
         1. Order blood (calculate as outlined in section 9)
         2. Order minimum 3 units of platelets if thrombocytopenic
         3. Order 20ml/kg FFP, Vit K (+/- tranexamic acid if no haematuria)
         4. If abdominal site of bleeding call surgeons to review
      7. If still unstable following 40ml/kg bolus of NaCl 0.9%w/v
         1. Call anaesthetics/ICU colleagues as child will need to be ventilated
         2. Meanwhile start CPAP ventilation with 15L Oxygen if child is breathing. If child is apnoeic start BMV or insert a laryngeal mask for BMV.
         3. Pass an NGT and a Urinary catheter and keep on free drainage and record colour and volume of urine and gastric contents.
         4. Keep child Nil per oral
         5. Monitor vital signs every 15 minutes. If continuing to be unstable and shut down peripherally may cautiously give further fluid boluses but please observe for pulmonary oedema.
         6. Start Adrenaline infusion as follows:
* To calculate adrenaline volume: 0.3xbody weight= correct ml of 1:1000 adrenaline. Add this volume to 100mls of NaCl 0.9%w/v.
* 1ml/hr of this solution = 0.05mcg/kg/minute.
* Give 1-2ml/hr (no higher than 2ml/hr)

See **Table One** above for the empiric antibiotic guideline changes recommended for patients deteriorating on first-line treatment. If the patient has received 5 to 7 days of empiric antibiotic therapy, consider the addition of empiric antifungal coverage too.

### Duration of Antibiotic Treatment

**Table 3:** Duration of Antibiotic Therapy

|  |  |
| --- | --- |
| PATIENT PARAMETERS | PLAN |
| Afebrile > 48hrs; ANC ≥ 1 x 109/L, cultures negative.  Febrile on only one occasion, any ANC, culture negative, well child. | DISCONTINUE antibiotics or treat as a immunocompetent child would require |
| Afebrile >7 days, ANC < 0.5 x 109/L, no evidence of hematological recovery, no documented focal infection, IV antibiotic duration ≥ 7-10 days | DISCONTINUE antibiotics. |
| Afebrile > 48 hrs, ANC ≥ 0.5 x 109/L, cultures positive or documented focus of infection | CONSIDER discontinuing broad spectrum coverage after 7 days, CONTINUE specific therapy, and tailor duration to diagnosis, e.g.   * Skin/soft tissue infection: 7 – 14 days * Uncomplicated bacteremia:   + G –ve: 10 – 14 days   + G +ve: 7 – 10 days   + S. Aureus (no endocarditis): min 14 days * Bacterial pneumonia: 10 – 21 days * HSV/VZV: 7 – 10 days |

## Abdominal emergencies

The Acute Abdomen

**Symptoms:** Pain (location, quality & timing), blood in stool or emesis, bilous vomiting, constipation absence of flatus

**Signs:** Tenderness and guarding, abdominal distention, absent bowel sounds, abdominal mass.

**Note:** Classic Physical Exam findings may not be present in a neutropenic patient or in those on steroids.

**Differential diagnosis:**

1. Esophagitis: Most common GI problem in PAEDIATRIC HAEMATOLOGY/ONCOLOGY patients
2. Gastric hemorrhage: Patients on steroids
3. Typhlitis: Neutropenic enterocolitis of terminal ileum and cecum particularly when neutropenia is prolonged
4. Peri-rectal abscess: Seen with prolonged neutropenia
5. Hemorrhagic pancreatitis: Patients on L- asparaginase therapy
6. Constipation/Ileus: secondary to chemotherapy especially vincristine or patients recovering from abdominal surgery.
7. Appendicitis: Don’t forget about it!

**Management of the acute abdomen:**

* NPO, and NG on free drainage or low pressure suction
* Abdominal plain film abdomen (PFA): erect and left lateral.
* Broad spectrum antibiotics, possibly antifungal treatment
* Supportive care: IVF, pressors, blood products, oxygen
* Indications for Surgery
  + Persistent GI bleeding
  + Free air
  + Evidence of abscess

## Neurological emergencies

These occur in more than 10% of paediatric PAEDIATRIC HAEMATOLOGY/ONCOLOGY patients. This include:

* Seizures
* Altered mental status (AMS)
* Cerebrovascular accidents (CVA)
* Spinal cord compression
* Increased intracranial pressure (ICP)

### Seizures:

**Causes:**

Febrile – bacterial or viral, abscess or meningitis

Afebrile – Hypocalcaemia or other electrolyte disturbance, hypoglycaemia, SOL, drug interaction, SIADH, stroke, haemorrhage, epilepsy, hypertensive emergency, toxins (including chemotherapy, blocked shunt.

#### Management of Status Epilepticus:

**Note regarding diazepam:** In the below algorithm Diazepam may be used instead of (but not in combination with) other benzodiazepines as follows:

**Per rectum**

2-6 years: 0.5 mg/kg; may repeat in 4-12 hours PRN

6-12 years: 0.3 mg/kg; may repeat in 4-12 hours PRN

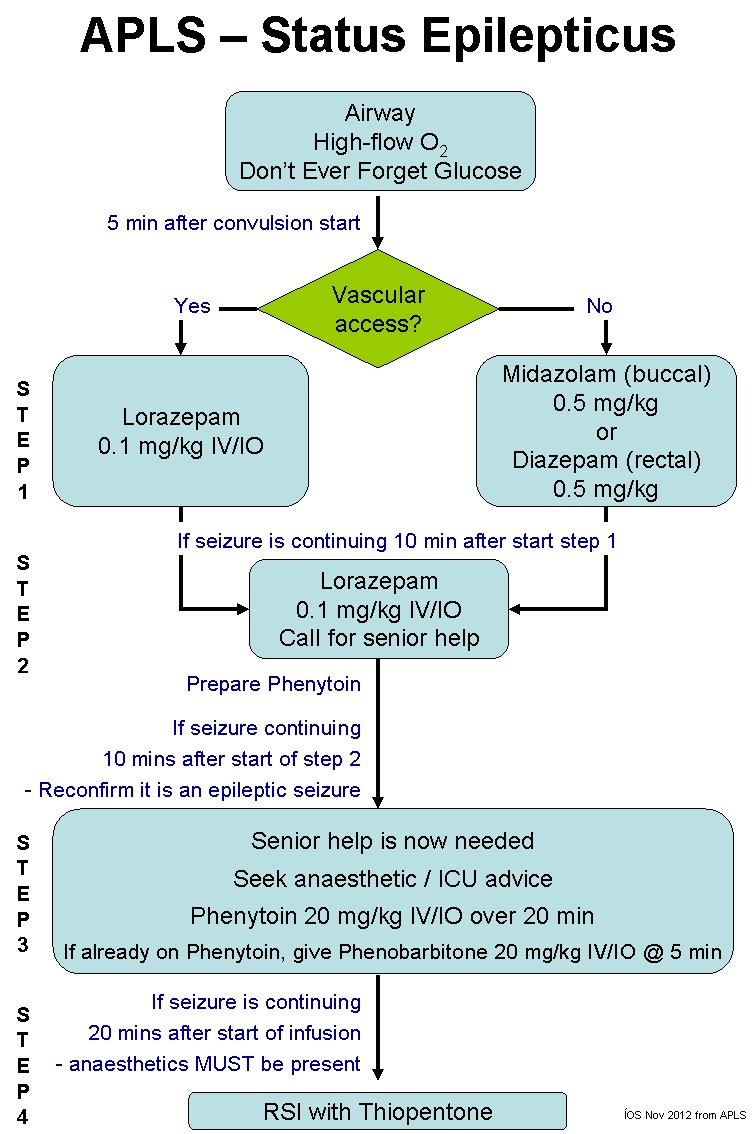
>12 years: 0.2 mg/kg; may repeat in 4-12 hours PRN

**IV**

6 months-5 years: 0.2-0.5 mg IV initially, repeat every 2-5 minutes; do not exceed 5 mg; may repeat 2-4 hours later PRN

>5 years: 1 mg IV given slowly every 2-5 min; not to exceed 10 mg total dose; may repeat in 2-4 hours if necessary

Note: Potentially toxic dose in patients < than 6 years: greater than 0.5mg/kg



### Altered mental status

General causes: Infection, dehydration, anaemia, metabolic syndromes.

PAEDIATRIC HAEMATOLOGY/ONCOLOGY causes: Chemotherapy neurotoxicy including Ifosphamide, vincristine; post cranial radiotherapy.

**Note: Ifosphamide neurotoxicity is treated with methylene blue**

### Spinal cord compression

Occurs in 3-5% of children with cancer Sarcomas account for about half the cases of spinal cord involvement in kids. Other causes include neuroblastoma, germ cell tumors, lymphoma, leukemia and metastasis of CNS tumors. While not usually life threatening this is a medical emergency as irreversible neurological damage is likely with delays to treatment.

**Symptoms and signs include**: Back pain with localized tenderness (80% of patients); Loss of strength and sensory deficits; Incontinence, urinary retention and other abnormalities of bowel/bladder are late findings.

**Children with cancer + back pain = spinal cord involvement until proven otherwise.**

**Management**

* Spinal radiographs (useful if vertebral mets are present but will miss 50% of epidural disease)
* MRI +/- contrast
* Cerebrospinal fluid analysis (important when evaluating subarachnoid disease)
* Immediate initiation of treatment is crucial!!
  + Dexamethasone (decrease local edema)
  + Chemotherapy,
  + Radiation
  + Surgical decompression

## Leukostasis and hyperleukocytosis

This is defined as WCC> 100,000/mm3 and is seen at presentation in

9-13% of children with ALL and in 5-22% of children with AML. This massive white cell load leads to hyperviscosity.

Clinical features –

* CNS: Blurred vision, confusion, somnolence, delirium stupor, coma, papilloedema – Risk of stroke both haemorrhagic and ischaemic
* Pulmonary: tachypnea, dyspnea, hypoxia.
* GU: Oliguria, anuria, priapism,
* Vascular: DIC, retinal haemorrhage, MI, renal vein thrombosis.

**Treatment:**

* Oxygen therapy;
* Fluids 3L/m2;
* Blood product support but carefully maintain Hb level between 5-6g/dl;
* Start chemotherapy urgently.
* Transfuse platelets to > 20,000 to prevent CNS hemorrhage (Platelets don’t contribute as much to blood viscosity).

# BLOOD AND PLATELET TRANSFUSIONS

## RED CELL CONCENTRATE TRANSFUSION

Blood transfusions are frequently required because of myelosuppression associated with cytotoxic chemotherapy. **The following recommendations are guidelines and should only be used in conjunction with clinical assessment of the individual patient.**

**Indications for RCC Transfusion**

The decision to order a RCC transfusion should be taken based on the following factors:

1. The patients age and how well they can tolerate a low Hb,
2. Haemoglobin level
3. Number of days post chemotherapy and anticipated bone marrow

recovery.

With the above listed factors in mind, it is acceptable to allow patients have a Hb level of 8g/dl before RCC transfusion is required.

**Formula for Calculating Amount of RCC Required :**

3 x weight in kilo x desired increase in g of Hb = number of millilitre needed.

eg. A 20 kg child with a Haemoglobin of 5 gs/dl. The desired rise is to 10 gs/dl, therefore

3 x 20 x 5 = 300mls.

**Aim to increase haemoglobin to 10g/dl**

Administration Recommendations for RCC

**A standard blood infusion set with an in-line filter must be used to infuse all RCC transfusions**.

The recommended transfusion time per unit is 2 to 4 hours, with a maximum time of 5 hours from the time the blood was removed from the fridge to the completion of the transfusion.

An infusion pump, verified as suitable by the manufacturer for RCC transfusion, should be used if available to deliver RCC transfusions at a controlled rate.

Blood warming to a temperature greater than room temperature is unnecessary unless instructed to do so for a specific reason.

Baseline temperature, pulse, blood pressure and respiratory rate should be performed prior to commencing the transfusion. Temperature and pulse should be measured 15 minutes after the start of each unit of blood. Hourly temperature and pulse are then sufficient unless the patient becomes unwell. It is preferable that a transfusion is not given if the child is febrile, however this is not always possible. Post transfusion observations should also be recorded. (Please observe local policy if different from the above)

The PICC line should be flushed with 10ml of heparinised saline prior to and following the transfusion, using sterile technique.

## Whole blood transfusions:

There are only two indications for giving whole blood:

1. When PRC are not available and the child urgently requires blood
2. When the child is bleeding, has thrombocytopenia and there are no platelet transfusions available

In all other situations PRC should be given preferentially.

**Formula for Calculating Amount of whole blood Required**

6 x weight in kilo x desired increase in g of Hb = number of millilitre needed.

eg. A 20 kg child with a Haemoglobin of 5g/dl. The desired rise is to 10 g/dl, therefore: 6 x 20 x 5 = 600mls.

Aim to increase haemoglobin to 10g/dl

## PLATELET TRANSFUSION

**Indications for Platelet Transfusion**

The following recommendations are guidelines and should only be used in conjunction with clinical assessment of the individual patient.

***Prophylactic (no active bleeding****)*

Transfuse to maintain a platelet count of greater than 10 x 109/L

A higher threshold (20 – 50 x 109/l) may be indicated if associated risk factors for bleeding are present, i.e.

• Sepsis

• Fever (>380C)

• Abnormal clotting times (PT/APTT/TT)

• Platelet functional defect (i.e. uraemia, NSAIDs)

• Neonates

Procedures:

Platelets should be 25 x 109/l prior to procedures including:

* insertion of NG tube
* LP/IT injections
* Chest physiotherapy.
* Bone marrow biopsy

**If platelets are ordered to allow the safe completion of a procedure please remember that the procedure MUST immediately follow the transfusion of platelets. It is not appropriate to infuse platelets the night before a procedure is planned. If platelets are delivered to the ward hours before a procedure is planned – either change the plans and perform the procedure immediately OR return the platelets to the laboratory until you are ready to perform the procedure.**

A higher threshold (50 –100 x l09/l) is needed to cover invasive procedures/surgery.

Please note: bone marrow aspirations may be safely performed at any platelet count.

The decision to order a platelet transfusion should be made based on the above listed guidelines and taking into consideration the number of days the patient is post chemotherapy and anticipated bone marrow recovery.

***Therapeutic (active bleeding)***

For thrombocytopenic patients with active bleeding, platelet transfusions should be given to a level sufficient to control bleeding. There may be diminished benefit from further platelet transfusions once the platelet count exceeds 100 x l09/l.

Administration recommendations for platelets

An infusion pump should not be used for platelet transfusions.

**NOTE**

All transfusion request forms should be completed by 12 noon on the day of the request and include the following information:

Patient first name and surname

Date of birth

Hospital Number

Consultant name

Signature of doctor making the request

Component required

Reason for the transfusion

Date and time required

Previous transfusion history/transfusion reactions

## Management of Minor Transfusion Reactions

Some children may develop a minor reaction to blood or platelets e.g. mild allergic or urticarial reaction. A doctor should review all transfusion reactions to determine the appropriate treatment. If a minor reaction occurs intravenous Chlorpheniramine (Piriton) and Hydrocortisone should be prescribed and given promptly.

Recommended Dose:

Piriton < 2 years old = 2 mg IV

> 2 years old = 4 mg IV

Hydrocortisone < 4 years old = 25 mg IV

> 4 years old = 50 mg IV

# HAEMORRHAGIC CYSTITIS

Haemorrhagic cystitis may occur following Ifosfamide or Cyclophosphamide infusions. This is due to a metabolite called Acrolein irritating the bladder mucosa. Untreated, it results in bladder fibrosis and an increased risk of transitional cell carcinoma many years later. All urine specimens of kids on these agents should be ward tested for blood.

MESNA binds Acrolein, thereby reducing the risk of urothelial toxicity. The dose is 100 – 120% of the dose of Ifos/Cyclo and is given either as a bolus on a 4 – 6 hourly basis or continuously as per relevant protocol. If there is evidence of haematuria on ward testing, an extra dose of MESNA should be given (25% of the total daily dose). Hydration and MESNA should be continued for 12 hours after haematuria has ceased, if necessary, over and above prescribed fluids. In certain situations, oral MESNA may be prescribed on discharge (check with Consultant).

# GUIDELINES FOR THE MANAGEMENT OF PAIN

## Introduction

Analgesics comprise three classes

* Nonopioid - paracetamol and NSAIDs
* Opioid - weak and strong
* Co-analgesics - corticosteroids, antidepressants,

anticonvulsants, muscles relaxants

The principles governing their use are encapsulated in the WHO method of relief of Cancer Pain:

1. “By the Mouth” i.e. oral route preferably

2. “By the Clock” i.e. persistent pain requires regular, not PRN, analgesia

3. “By the Ladder”

4. “Individualised Treatment”

5. “Use Co-analgesic Drugs”

6. “Attention to Detail”

The WHO describes three steps in analgesic prescribing – the “Analgesic Ladder”

Strong opioid

+nonopioid

+co-analgesics

**Step 3**

Weak opioid

+ nonopioid

+ co-analgesics

**Step 2**

Nonopioid

+/- co-analgesics\_\_\_\_

**Step 1**

**Principles of Ladder**

Ladder serves as guide. Start patient on step 1, 2 or 3 depending on severity of pain. If pain persists or increases, move up to the next step of the ladder. Where pain persists always consider use of coanalgesia where appropriate. Remember psychosocial issues which may be contributing.

## ANALGESICS FOR MILD AND MODERATE PAIN:

## Non Opioids (Step 1):

**Paracetamol and Non Steroidal Anti-Inflammatory Drugs (NSAIDs)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Drug | Single dose for child >1month | Freq. | Forms available | Comment |
| Paracetamol  (Calpol/Panadol) | 10–15mg/kg PO  or  20mg/kg PR  or  3–12mth: 60mg – 120mg PO  1– 5yrs: 120mg – 250mg PO  6–12yrs: 250mg – 500mg PO  12–Adult: 500mg – 1g PO | 4– 6hrly | Tablets 500mg  Liquid 120mg/5ml  250mg/5ml  Please do not give suppositories to PAEDIATRIC HAEMATOLOGY/ONCOLOGY patients. | Maximum:  60mg/kg/day  or  4g/day whichever is lower |
| Ibuprofen  (Brufen/Nurofen) | 5mg/kg PO  or  1– 2yrs: 50mg  3– 7yrs: 100mg  8–12yrs: 200mg  >12yrs: 200 – 600mg | 6– 8hrly | Tablets:  200mg, 400mg  600mg,800mg retard  Liquid 100mg in 5ml  Granules 600mg sachet | Maximum:  2.4g daily or 20-30mg/kg which ever is lower. |
| Diclofenac  (Voltarol/Difene) | 300microgs – 1mg/kg PO/PR | 8hrly | Tablets  25mg, 50mg  Please do not use suppositories in PAEDIATRIC HAEMATOLOGY/ONCOLOGY patients. | Not recommended for children less than 6 months.  Maximum dose: 3mg/kg/day or 150mg which ever is lower |

**Note re neutropenic patients: If a child is neutropenic, any antipyretic agent (ie paracetamol, NSAIDs) should only be used with extreme caution because it may mask a fever. Always take temperature prior to giving analgesia. If temperature is <37.5, use paracetamol/NSAIDs. If temperature <37.5ºC use Codeine Phosphate; if temperature >37.5ºC contact Upendo Ward. Please avoid suppositories in neutropenic children and children with platelet counts below 20X109/L.**

**Notes Re NSAIDs**

* ASPIRIN is contra-indicated in children.
* These drugs have analgesic, anti-pyretic and anti-inflammatory properties. They are therefore often effective in musculo-skeletal pain, e.g. that associated with bone metastases or soft tissue inflammation. There is a large number of these agents and patient response to different NSAIDs can show marked variation.
* Regular dosing is required for the full anti-inflammatory effect, but the maximum effect is usually seen within two weeks.
* If a patient fails to respond to one type of NSAID, it is often well worth trying another.
* **Care in patients with thrombocytopenia; avoid if platelets <20X109/L**
* Damage to the gastro-intestinal mucosa is the most frequent unwanted effect. The frequency is higher with ‘older’ drugs, such as indomethacin, but is seen even with the ‘newer’ drugs, such as naproxen. Always give with or after food or milk. In those patients with a history of peptic ulceration, they should be used in conjuction with Cimetidine or Omeprazole.
* All NSAIDs should be used with caution in patients with heart failure, renal or liver failure. Avoid in asthma or hypersensitivity to aspirin or other NASIDs. Important interactions occur with diuretics, anti-hypertensives and warfarin.

## Weak Opioids (Step 2)

**(Not always available on the ward).**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Drug** | **Single dose for child**  **> 1 month** | Frequency | **Forms available** | **Comment** |
| **Codeine Phosphate** | 0– 12mth: 0.5mg/kg/dose  >12mth:0.5–1mg/kg/dose  >12yrs: 30–60mg/dose | 4– 6hrly | Codeine Linctus 15mg/5ml  Codeine phosphate tabs  (Codant) 30mgs | Maximum dose:  240mg daily or 60mg per dose. |
| **Dihydrocodeine**  (DF 118 Tablets / Paracodin Liquid) | 1– 4yrs: 0.5mg/kg  4–12yrs: 0.5mg – 1mg/kg  > 12yrs: 30mg | 4– 6hrly | Tablets 30mg  Liquid: 12mg/5ml | Not for children <1 year.  90% effective at 30mg dose – no need to increase dose above this. Do not prescribe with other opiates. |

There is a ceiling effect with weak opioids i.e. a max dose is reached beyond which further dose escalation doesn’t improve analgesia.

**Notes: Constipation should be anticipated and laxatives prescribed**. Injections of both dihydrocodeine and codeine are available but should be avoided in paediatrics.

## CO ANALGESICS

A co-analgesic is a drug which may or may not have intrinsic analgesic activity, but which may when used with conventional analgesics contribute significantly to pain relief.

### Bone Pain:

1. **Nonsteroidal Anti-inflammatory Drugs (NSAIDs):**

NSAIDs are of particular benefit for pain associated with inflammation e.g. soft tissue infiltration and bone metastases. Because inflammation leads to central sensitization and increased pain, NSAIDs will sometimes play a crucial role in relieving cancer-related neuropathic pain. See above for details.

1. **Corticosteroids:**

Steroids have specific benefits for pain management because of their anti-inflammatory effect and ability to produce euphoria, improve appetite and weight gain. They often result in an increased sense of well being. They also have anti-inflammatory effects on certain tumors. Dexamethasone has advantages over prednisolone because of its weaker mineralocorticoid effect with a lesser tendency to cause oedema and weight gain. However, side effects can be severe in children and they should only be used when benefits outweigh the disadvantages.

### Neuropathic Pain

Pain in an area of altered sensation, usually due to nerve compression or destruction.

Patient describes burning, shooting, stabbing pain.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Drug** | **Single dose for child >1 month** | **Frequency** | **Form** | **Comment** |
| **Gabapentin** | D1-4: 10mg/kg OD  D5-8:10mg/kg 12hrly  Then 10mg/kg 8hrly  To discontinue please reduce over 3 days. | Daily for 4 days then twice daily & titrate | 100mg, 300mg, 400mg caps.  Capsule contents may be mixed with water. | Titrate as required.  Maximum dose 300mg for the first dose. After the first 4 days this can be titrated up as required |
| **Amitriptyline** | 2-12yrs: 0.5-1mg/kg  >12yrs: 30–150mg | Nocte | Tablets:10, 25, 50mg  Elixir 10mg/5ml | Antidepressant of choice. Analgesic effects seen after 2 – 3 days. May need to increase laxatives as it can exacerbate constipation. Start on lower dose and increase as tolerated if necessary. |
| **Carbamazepine** | 2.5mg/kg (Max 200mg)  5mg/kg (Max 600mg) | 12hrly  8–12hrly | Tablets: 100mg, 200mg, 400mg  SR Tablets: 200mg, 400mg  Elixir: 100mg/5ml | Starting dose. Increase by 2.5mg – 5mg/kg/day at weekly intervals if required.  Maintenance dose. |

## MORPHINE: ANALGESICS FOR SEVERE PAIN:

Oral morphine is the drug of choice in the majority of children with severe pain. Children can tolerate very large doses of morphine if titrated appropriately.

# Morphine Dose Titration:

* There is no such thing as a standard dose of morphine; no upper limit.
* To obtain control initially:

The dose has to be adjusted for each child until their pain is controlled.

Prescribe an appropriate dose, according to weight (usually give a range).

Start low and work up

Use an immediate release morphine preparation (oral morphine suspension) for dose titration.

**Give it regularly every 4 hours.**

At the same time prescribe the same dose for ‘breakthrough’ pain to be repeated as often as necessary between regular doses.

Review after 24 – 48 hours and adjust regular dose according to breakthrough requirements.

A common dose increment is between 25 – 30% of the previous dose. (minimum increase 20%, maximum increase 50%).

Starting dose: 1 – 12 months 0.1mg/kg 4 hourly

1 – 12 years 0.2 – 0.5mg/kg 4 hourly

* May be necessary to round off whichever morphine sulphate preparation used to the closest practical dose.

|  |
| --- |
| To calculate total amount of morphine given in a 24 hr period:  5mg oral morphine suspension given 4hrly for 24hrs:  = 5 x 6 = 30mg  5mg breakthrough dose needed twice in 24hrs:  5 x 2 = 10mg  **30mg + 10mg = 40mg = total morphine in that 24hrs**  (If it is available it may be possible to:  Convert to 12hrly sustained release preparation (MST):  40mg ÷ 2 = 20mg twelve hourly dose as sustained release PLUS  Now calculate breakthrough dose = 1/6th of total daily dose:  40mg ÷ 6 = 5mg PRN given as instant release morphine. |

### Morphine Side Effects:

These are to be expected and so do not usually necessitate a dose change.

Nausea and vomiting may occur in some patients. It usually wears off after 24 – 48 hours. Warn patient/parents and reassure. Treat with anti-emetic such as metoclopramide.

Pruritis may occur. It is treated with antihistamines and usually subsides within 3 – 4 days. Antihistamine cream applied topically may be prescribed for a troublesome nasal itch. May benefit from switch to alternative strong opioid if itch persists.

Anticipate that the child may become drowsy when morphine is started.

This is transient and will be reversed within 2 – 3 days.

**Always prescribe laxatives (a combination of a softener and a stimulant) when starting a patient on opioids. Remember to titrate laxative dose as morphine dose is titrated.**

### Alternatives to Oral Route:

The oral route is the route of choice and should be used whenever possible. Occasionally an alternative route may be required – intravenous or subcutaneous.

1. Intravenous / Subcutaneous morphine if available:

Conversion from oral to I.V/S.C route: Divide oral dose by 2 to obtain equianalgesic dose.

Initial Morphine Loading Dose I.V: 0.05 – 0.1mg/kg

(50 – 100 microg/kg) over 10 minutes.

Infusion Rates:

0 – 3 months: Average initial rate 10microg/kg/hr

Range 5 – 15 microg/kg/hr

3 – 6 months: Average initial rate 15 microg/kg/hr

Range 5 – 20 microg/kg/hr

6 months – 18 years: Average initial rate 25 microg/kg/hr Range 10 – 40 microg/kg/hr

A guide must titrate amount to severity of pain.

### Recommendation for preparation of infusion of morphine:

Patient must be pain free by bolus morphine before commencing infusion.

Weight (kg) = mg morphine (e.g. 10kg child draw up 10mg of morphine)

Mix in 5% dextrose to a total volume of 50ml

This gives a concentration such that an infusion rate of 1ml/hr = 20microg/kg/hr. Max concentration 50mg/50ml.

Use syringe pump for delivery

1. Transdermal: Fentanyl patches are sometimes available.

### MORPHINE OVERDOSE

Naloxone, an opioid antagonist, is the antidote to morphine. It is used for the reversal of life-threatening opioid-induced respiratory depression. It should NOT be used for drowsiness and/or delirium which is not life threatening because of the danger of totally reversing the opioid analgesia and precipitating severe/agonizing pain.

Dose: 10 microg/kg (Max 800microg) IV as an initial

dose. If no response give further 100microg/kg (Max 2mg) IV as a single dose. Repeat doses as necessary to maintain opioid reversal.

Finally………..

## If pain is not responding to increased analgesia then check:

1. Is dose appropriate (check weight)
2. Is route appropriate (eg vomiting child may not be absorbing)
3. Have you maximised co-analgesics?
4. Is pain opioid sensitive? (some pain eg neuropathic pain does not always respond fully to opioids)
5. Would anaesthetic procedure eg nerve block be helpful
6. Would palliative radiotherapy help? eg bone pain.
7. Remember psychosocial issues (eg. fear, anxiety or low mood may contribute to pain experience).

# ANTIFUNGAL AGENTS

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Antifungal agent** | **Effective against candida?** | **Effective against aspergillus?** | **Effective against Cryptococcus (most as part of combination treatment)?** | **Effective against mucor?** | **Route** | **Additional comments** |
| Fluconazole | YES | NO | YES | NO | PO or IV | Excellent levels in CSF and urine. |
| Itraconazole | YES | YES | YES | NO | PO only | No vincristine on the same day |
| Ketoconazole | YES | NO | YES | NO | PO only | No vincristine on the same day. |
| Amphoteracin B | YES | YES | YES | YES | IV only | Caution in renal impairment. Must give potassium or K+ sparing agent concommitantly |
| Flucytosine | YES | NO | YES | NO | PO | Rarely given as single agent |
| Voriconazole | YES | YES | YES | NO | PO | No vincristine on the same day. |

**Oral Candida treatment and prophylaxis:**

**Fluconazole** 6mg/kg/day PO for mucositis; this should be continued for the duration of neutropenia.

**NB.** If patient is receiving **vincristine**, it is recommended that all azoles ie fluconazole, itraconazole etc. be **discontinued for 48 hrs** before & after vincristine.

# PRESCRIPTION OF ANTI-MICROBIAL AGENTS

**Drug Doses for different conditions/ages**

|  |  |
| --- | --- |
| **Aciclovir:** | **Herpes Simplex Treatment**:  Oral dosing:  >1mth – 2yrs: 200mg 4hrly PO during waking  i.e. 5 times/day  >2yrs: 400mg 4hrly PO during waking  i.e. 5 times/day  IV dosing:  <3mo: 10-20mg/kg 8hrly IV infusion  3mo – 12yrs: 500mg/m2 8hrly IV infusion  Usual adult dose: 10mg/kg 8 hrly IV infusion  **Herpes Simplex Prophylaxis:**  1mth – 2yrs: 200mg 6hrly PO  2yrs – 5yrs: 400mg 6hrly PO  **Varicella Zoster Treatment**:  If severe, commence with IV aciclovir  <3mth: 10-20mg/kg 8hrly IV infusion over 1 hour  3mth-12yrs: 500mg/m2 8hrly IV infusion over 1 hour  >12yrs: 10mg/kg 8hrly IV infusion over 1 hour  When lesions are drying, switch to oral – see doses above  (may consider Valaciclovir at that stage, see below) |
| **Amikacin**  **Amphoteracin B:** | 7mg/kg/dose OD  Day 1: 0.25mg/kg in 50mls of D5% infuse over 4hours  Day 2: 0.5mg/kg in 100mls of D5% infuse over 4hours  Day 3: 0.75mg/kg in 150mls of D5% infuse over 4hours  Day 4 and all subsequent days: 1mg/kg in 200mls of D5% infuse over 4hours  **NOTE:** Potassium supplementation or potassium sparing diuretics must be given concomitantly with amphotericin B as this drug causes renal wasting of potassium which can be life threatening. |
| **Artemether** | 5-15 kg: 1 tab stat, then 1 tab after 8 hrs, then 1 tab BD X 2/7  15-25 kg: 2 tabs stat, then 2 tabs after 8 hrs, then 2 tabs BD X 2/7  25-35 kg: 3 tabs stat, then 3 tabs after 8 hrs, then 3 tabs BD X2/7  >35 kg: 4 tabs stat, then 4 tabs after 8 hrs, then 4 tabs BD X2/7 |
| **Artisunate** | ***Oral administration***Over 6 months: 5 mg/kg PO Day 1. Then 2.5 mg/kg D2 & 3. Given with stat dose of mefloquine (15 mg/kg) D2.  ***Parenteral administration***  Reconstitute with 5%w/v sodium bicarbonate and diluted in an equal volume of D5%w/v or 0.9% w/v NaCI. Given IV bolus. A loading dose of 2 mg/kg then 1 mg/kg after 4 hours and 24 hours. Then 1 mg/kg OD until can tolerate PO artesunate or for a maximum of 7 days. |
| **Cefixime (Suprax)PO:** | 6mth to 1yr 75mg once daily  1yr to 5 yr 100mg once daily  5yr to 10yr 200mg once daily  10yr to 12yr 300mg once daily  >12yr 400mg once daily |
| **Cefoso**  **Ceftazidime:** | 20-40 mg/kg/day, given in equally divided doses every 6-12 hours.  For serious infections: Up to 160 mg/kg/day, given in 2-4 equally divided doses may be used.  Max dose of sulbactam: 80 mg/kg/day  50mg/kg/dose given q 8 h, **(max. daily dose 6g)** |
| **Ciprofloxacin:**  **Cotrimoxazole:**  **Fluconazole:** | 10 mg/kg/dose IV 12 hourly  **Prophylaxis:**  <0.5m2 24mg/kg b.d. Sat & Sun  0.5 – 0.75m2 240mg b.d. Sat & Sun  0.76 – 1.0m2 360mg b.d. Sat & Sun  >1.0m2 480mg b.d. Sat & Sun  **Treatment dose:**  Septrin 120mg/kg/day IV(or PO if IV not available) in 2-4 divided doses for 10 days. Continue p.o. for further 7-14 days.  6mg/kg/day **(max. daily dose 400mg)** |
| **Flucytosine:**  **Gentamicin:** | 150mg/kg/day divided into 4 doses.  7mg/kg/day (>1mth – 18 yrs) single daily dose as 30min infusion (max: 400mg/dose)  Check levels 18-24hrs after 1st dose, trough (<1mg/l) & every 3rd to 4th day thereafter.  **Amino glycosides should not be prescribed for patients with Hepatoblastoma because of ototoxicity associated with Cisplatin. Use with caution in children with Wilms tumour as only one kidney functioning.** |
| **Itraconazole**  **Ketoconazole** | 2.5mg/kg/dose BD – oral dose for prophylaxis in AML; use 6mg/kg/day as treatment dose.  >15Kg 3mg/kg/D  15-30kg 100mg OD  >30kg 200mg OD  If response inadequate you may double the original dose. |
| **Meropenem:** | 20mg/kg/dose every 8 hours (meningitis use 40mg/kg/dose) **(max. daily dose 6g)** |
| **Metronidazole:** | 7.5mg/kg IV/PO 8 hourly |
| **Piperacillin/Tazobactam:** | 90mg/kg/dose 6 hourly **(Max. single dose 4.5g)** |
| **Quinine** | 20mg/kg first dose 4hrly infusion; then 10mg/kg/dose 8 hourly, infused in D5%w/v over 4 hours. |
| **Vancomycin**  **Voriconazole:** | 12-15mg/kg/dose 8 hourly (infuse in 100ml D5%w/v over 1 hour) to a maximum of 2g/day. If you cannot check levels please use the 12mg/kg dose for renal safety.  For Aspergillus:  Intravenous treatment:  2-11yrs: 9mg/kg 12hrly (maximum per dose 350mg).  12yrs plus: 6mg/kg 12hrly for 2 doses then 4mg/kg 12hrly. |
|  | Oral Treatment:  <40kg body weight: 100mg 12hrly  >40kg body weight: 200mg 12hrly. |
|  |  |
|  |  |

# NUTRITION

Nutrition support of the child with cancer is an integral part of the overall treatment regime. The intensity of chemotherapy and the increase in duration of treatment have resulted in children presenting with more challenging nutritional problems.

**Newly Diagnosed Patients.**

All new patients should be assessed for their nutritional status. If considered malnourished steps will be taken to offer supplementation.

Initial **weight and height** should be recorded and plotted on the appropriate centile charts**.** The growth charts currently used in this hospital are provided by Dr Muze and the paediatric endocrinology department.

Weight should be recorded on every admission (and once a week for inpatients). This should be from the same scales, in similar clothing, at the same time of the day. Height measurements should be performed monthly. All results should be documented clearly in the medical notes.

**Nutritional intervention**

1. Nutritional assessment and advice

Generally a high protein high calorie diet is recommended for the majority of haem/onc patients. Patients will be reviewed frequently and further recommendations made as required.

2. Oral nutritional supplements (ONS)

There are several whole food plant based fresh ONS available (or planned) on the ward. These are available for all the children but most particularly for those children who struggle with normal food. They are in liquid form and are nut milk and fruit and veg based. Compliance should be encouraged and recorded.

**3. Enteral feeding**

Enteral feeding is generally via a nasogastric tube however some children may have a Percutaneous gastrostomy tube. The most suitable feed will be prescribed for the child, depending on 1) age, 2) weight, 3) requirements and 4) condition of gut/ability to absorb.

Rate of delivery of feed depends on the child’s requirements and tolerance. The parents must be carefully taught how to access the NGT and also given clear guidelines as to the total volume of supplement expected at each feed. This should be reviewed with the carer every day. The whole food plant based high calorie fresh drinks are appropriate to used as NG feeds.

Any child on NGT feeding should be weighed **DAILY.**

# ANTIEMETIC GUIDELINES

## DEFINITIONS:

* **Nausea:** A subjective, unobservable phenomenon of an unpleasant sensation often associated with a feeling that vomiting is imminent. It may be accompanied by unpleasant sensations experienced in the back of the throat and/or by autonomic nervous system activity such as pupil dilation, sweating and salivation
* **Vomiting:** The forceful expulsion of the contents of the stomach through the oral or nasal cavity.
* **Retching:** Is an attempt to vomit without bringing anything up. It may be described as ‘dry heaves’ ‘gagging’ or attempting to vomit without results.

Chemotherapy and radiotherapy may cause nausea and vomiting. Chemotherapy-induced nausea and vomiting (CINV) is classified into 3 types depending on the time of occurrence relative to the time of administration of chemotherapy.

The 3 phases of CINV are:

1. acute
2. delayed
3. anticipatory.

**Acute**

The acute phase begins with the first dose of chemotherapy, continues during

each consecutive day that chemotherapy is given and for 24 hours following the

last dose of chemotherapy.

**Delayed:**

The delayed phase begins 24 hours after the last dose of chemotherapy or radiotherapy

and may persist for up to 7 days.

**Anticipatory:**

Anticipatory nausea and vomiting is any nausea or vomiting which occurs within 24

hours prior to the first dose of chemotherapy in a cycle. It is believed to be a behavioral response linked to poor emetic control during previous chemotherapy treatments.

## CINV DURING THE ACUTE PHASE

The selection of appropriate antiemetics is determined on the intrinsic emetogenicity of

the therapy to be given. Identify the most emetogenic agent in the combination (see Table 1). Use its rank as a baseline.

Selecting the antiemetic regimen

Once the emetogenicity of the chemotherapy to be given has been ranked, the initial

antiemetic regimen for a chemotherapy-naïve patient should be selected accordingly from Table 2. Antiemetics are given around the clock (not PRN) until 24hrs following the completion of chemotherapy.

Dosages of oral ondansetron are outlined in Table 3.

**Note: All oral anti-emetics are more effective than in their IV form and PO should always be prescribed where tolerated.**

## CINV IN THE DELAYED PHASE

The following patients are at higher risk of developing CINV in the delayed phase:

• Patients who experience nausea or vomiting during the acute phase,

• Patients who are known to have experienced nausea or vomiting during the delayed

phase of past cycles and/or

• Patients who receive carboplatin, cisplatin, or cyclophosphamide.

Treatment/prevention:

Vomiting or nausea that occurs during the delayed phase should be treated /prevented

with

* Oral dexamethasone 4 mg/m2/dose 12 hourly (maximum 8 mg/dose)
* Ondansetron may be considered although most adult studies have demonstrated that 5-HT3 receptor antagonists such as ondansetron are ineffective in preventing CINV in the delayed phase.
* Some patients may also benefit from the addition of metoclopramide.

Dexamethasone may be contraindicated; review each patient’s protocol to verify. This

relative contraindication may be reevaluated, particularly during the delayed phase,

based on each patient’s response

Antiemetics should be given on a "round-the-clock" basis until the patient is symptom free for 24 hours and should be reinstituted should symptoms reappear.

If nausea and vomiting increase in severity or are persistent despite appropriate antiemetic administration, other possible causes of vomiting are evaluated and every effort should be made to ensure that dehydration, constipation, pain or metabolic causes are not present.

## ANTICIPATORY CINV

See Table 4 for recommended management.

## RATIONALE FOR SPECIFIC ANTIEMETIC USAGE

1. Recommended guidelines for management of high risk CINV now includes ondansetron and dexamethasone.1

2. Aprepitant is a moderate inhibitor of CYP3A4 thereby affecting the metabolism of corticosteroids.1,3 As a result the dose of dexamethasone has been empirically reduced by 50% when prescribed together with aprepitant.3 Unfortunately this drug is only very intermittently available on the ward.

3. Dexamethasone dosage for management of CINV has not been standardized. However extrapolating data from a comprehensive literature search, recommendations for dosages of antiemetics in the paediatric patients has been published.4

4. The duration of dexamethasone usage in paediatrics has not been established. However current guidelines recommend dexamethasone be prescribed for the duration of chemotherapy administration and for 24 hours thereafter. Clinical trials prove dexamethasone to be the most effective agent for delayed CINV, this has the potential of a relatively high cumulative dose of dexamethasone being used in paediatrics. As a result these guidelines recommend limiting such use to a maximum of 6 days.

5. Current data suggests the efficacy of single daily dose or divided daily doses of ondansetron to be equally efficacious.

**REFERENCES**

1: American Society of Clinical PAEDIATRIC HAEMATOLOGY/ONCOLOGY, Kris MG, Hesketh PJ, Somerfield MR, Feyer P, Clark-Snow R, Koeller JM, Morrow GR, Chinnery LW, Chesney MJ, Gralla RJ, Grunberg SM. American Society of Clinical PAEDIATRIC HAEMATOLOGY/ONCOLOGY guideline for antiemetics in PAEDIATRIC HAEMATOLOGY/ONCOLOGY: update 2006. J Clin Oncol. 2006 Jun 20;24(18):2932-47. Epub 2006 May 22. Erratum in: J Clin Oncol. 2006 Nov 20;24(33):5341-2.

2: Smith AR, Repka TL, Weigel BJ. Aprepitant for the control of chemotherapy induced nausea and vomiting in adolescents. Pediatr Blood Cancer. 2005 Nov;45(6):857-60.

3: Gore L, Chawla S, Petrilli A, Hemenway M, Schissel D, Chua V, Carides AD, Taylor A, Devandry S, Valentine J, Evans JK, Oxenius B; Adolescent Aprepitant in Cancer Study Group. Aprepitant in adolescent patients for prevention of chemotherapy-induced nausea and vomiting: a randomized, double-blind, placebo-controlled study of efficacy and tolerability. Pediatr Blood Cancer. 2009 Feb;52(2):242-7.

4: Antonarakis ES, Evans JL, Heard GF, Noonan LM, Pizer BL, Hain RD. Prophylaxis of acute chemotherapy-induced nausea and vomiting in children with cancer: what is the evidence? Pediatr Blood Cancer. 2004 Nov;43(6):651-8.

TABLE 1: ACUTE EMETOGENIC POTENTIAL OF SINGLE ANTINEOPLASTIC AGENTS

|  |  |  |
| --- | --- | --- |
| **AGENT** | **EMETOGENICITY** | **RANK** |
| (dose = cumulative dose/cycle | (anticipated rate of emesis if no antiemetic given) |  |
| cisplatin ≥50 mg/m2\* | VERY HIGH | 4 |
| cyclophosphamide >1500 mg/m2\* | > 90% |  |
| Combination cyclophosphamide >750 to 1500 mg/m2  AND anthracycline (any dose) |  |  |
| dacarbazine |  |  |
| carboplatin\* | HIGH | 3 |
| cisplatin <50 mg/m2\* | 60 - 90% |  |
| cyclophosphamide >750 to 1500 mg/m2\* |  |  |
| cytarabine >1000 mg/m2 |  |  |
| dactinomycin |  |  |
| daunorubicin >60 mg/m2 |  |  |
| doxorubicin >60 mg/m2 |  |  |
| methotrexate >1000 mg/m2 |  |  |
| procarbazine |  |  |
| topotecan |  |  |
| cyclophosphamide ≤750 mg/m2\* | MODERATE | 2 |
| cyclophosphamide: oral | 30 - 60% |  |
| cytarabine > 100 to 1000 mg/m2 |  |  |
| daunorubicn ≤60 mg/m2 |  |  |
| doxorubicin ≤60 mg/m2 |  |  |
| etoposide ≥60 mg/m2 |  |  |
| etoposide: oral |  |  |
| intrathecal chemotherapy |  |  |
| ifosfamide |  |  |
| imatinib |  |  |
| methotrexate 250-1000 mg/m2 |  |  |
| temozolamide |  |  |
| radiation to upper abdomen |  |  |

|  |  |  |
| --- | --- | --- |
| etoposide <60 mg/m2 | LOW | 1 |
| fluorouracil | 10 - 30% |  |
| methotrexate 51-249 mg/m2 |  |  |
| radiation to lower thorax/pelvis/craniospinal |  |  |
| asparaginase | MINIMAL | 0 |
| bleomycin | < 10% |  |
| chlorambucil |  |  |
| cytarabine <100 mg/m2 |  |  |
| hydroxyurea |  |  |
| mercaptopurine |  |  |
| methotrexate ≤50 mg/m2 |  |  |
| methotrexate: oral |  |  |
| rituximab |  |  |
| thioguanine (oral) |  |  |
| vinblastine |  |  |
| vincristine |  |  |
| radiation to head/neck/extremities/cranium |  |  |
| \* associated with delayed nausea/vomiting | | |

TABLE 2: INITIAL ANTIEMETIC SELECTION BASED ON EMETOGENICITY OF ANTINEOPLASTIC REGIMEN

|  |  |
| --- | --- |
| **EMETOGENIC RANK** | **RECOMMENDED ANTIEMETIC AGENTS DURING ACUTE PHASE** |
| VERY HIGH Rank ≥ 4 |  |
|  | Ondansetron PO (see Table 3 for dose) or IV 5 mg/m2 (max 8mg) pre-chemo and then 8 hourly |
|  | AND |
|  | dexamethasone\* **6** mg/m² (max **12** mg/dose) pre-chemo PO/IV over at least 10 minutes and 12hourly thereafter, for duration of chemotherapy administration and 48 hours thereafter if risk of delayed nausea/vomiting (aim for maximum period ≤ 6 total days administration) |
|  |  |
|  | Children ≥ 12 yrs |
|  | If Aprepitant is available it may be added into the above regimen as 125mg PO one hour pre chemotherapy on Day 1, followed by 80mg PO in the morning Day 2 and 3 only. If this is given then reduce the dexamethasone dose by 50% |
| HIGH | Ondansetron PO (see Table 3 for dose) or IV 5 mg/m2 (max 8mg) pre-chemo and 8 hourly |
| Rank 3 | AND |
|  | dexamethasone\* 4 mg/m² (max 8 mg/dose) pre-chemo PO/IV over at least 10 minutes and 12 hourly thereafter for duration of chemotherapy administration and 48 hours thereafter if risk of delayed nausea/vomiting (aim for maximum period ≤ 6 total days administration) |
| MODERATE | ondansetron PO (see Table 3 for dose) or IV 5 mg/m2 (max 8mg) pre-chemo and 8 hourly |
| Rank 2 |  |
| LOW | ondansetron PO (see Table 3 for dose) or IV 3 mg/m2 (max 8mg) pre-chemo and 8 hourly |
| Rank 1 |  |
| MINIMAL | None |
| Rank 0 |  |

\* Use of dexamethasone may be contraindicated if the protocol prohibits its use as an antiemetic or in patients receiving treatment for brain tumours.

TABLE 3: ORAL ONDANSETRON DOSE

|  |  |
| --- | --- |
| **Weight** | **Oral Ondansetron dose** |
|  | |
| < 5 kg | 1 mg |
| 6 - 15 kg | 2 mg |
| 16 - 35 kg | 4 mg |
| > 35 kg | 8 mg |

TABLE 4: MANAGEMENT OF BREAKTHROUGH AND ANTICIPATORY NAUSEA/VOMINTING

|  |  |
| --- | --- |
| **ANTIEMETIC FAILURE** | **RECOMMENDED MANAGEMENT** |
| Breakthrough nausea/vomiting | Consider increasing ondansetron dose to 5 mg/m² (max 8 mg) IV 8 hourly |
|  | AND |
|  | Consider addition of dexamethasone or increase dexamethasone dose to 6 mg/m²/dose (max 12 mg/dose) 12 hourly if applicable |
|  | AND |
|  | Select antiemetics for next cycle of chemo as emetogenicity level + 1 ranking |
|  |  |
|  | If patient fails despite the above interventions, consider additional antiemetics (see Table 5) |
| Anticipatory nausea/vomiting | Lorazepam (5-10 yrs: 0.5 mg/dose; >10 yrs: 1 mg/dose) PO the night before chemo and/or the morning of chemo |
|  | AND |
|  | Select antiemetics as emetogenicity level + 1 ranking |

TABLE 5: ADDITIONAL CHOICES FOR PATIENTS WHO HAVE FAILED RECOMMENDED PROPHYLAXIS DURING ACUTE PHASE

|  |  |
| --- | --- |
| **DRUG** | **DOSE** |
| Metoclopramide | 0-10kg: 100microgs/kg to max of 1mg PO/IV 12 hourly |
|  | 10-14kg: 1mg PO/IV 2-3 times daily |
|  | 15-19kg: 2mg PO/IV 2-3 times daily |
|  | 20-29kg: 2.5mg PO/IV 3 times daily |
|  | 30-60kg: 5mg PO/IV 3 times daily  >60kg: 10mg PO/IV 3 times daily |
| Promethazine | 0.25-0.5mg/kg to maximum of 25mg 4-6hourly PO/slow IV (over at least 5 minutes |
| Cyclizine (Valoid) | By mouth or by IV injection over 3-5mins |
|  | 1month -6yrs: 0.5-1mg/kg 8 hourly |
|  | 6-12yrs: 25mg 8 hourly |
|  | 12-18yrs: 50mg 8 hourly |
|  |  |
|  | By continuous IV or subcutaneous infusion |
|  | 1month-2yrs: 3mg/kg over 24hours |
|  | 2-5yrs: 50mg over 24hours |
|  | 6-12yrs: 75mg over 24hours |
|  | 12-18yrs: 150mg over 24hours |

# Constipation

Certain cytotoxic agents are associated with constipation, most notably vincristine. Ondansetron and the other 5HT3 anti-emetics can also cause constipation. Opioid analgesics are always associated with constipation and laxatives should routinely be prescribed with opioids. It is important to ensure that a regular bowel pattern is maintained.

**MANAGEMENT OF CONSTIPATION**

Well balanced diet (including high fibre content), fluid intake and physical activity should be encouraged concurrently with laxative administration. Consider the underlying cause of constipation and treat where appropriate e.g. dehydration, obstruction. Anticipate the problem and prescribe prophylactically in all patients on opioids and drugs causing constipation. Titrate the dose up as necessary, rather than adding in a new laxative. Do not mix drugs of the same group e.g. two stimulant laxatives

## PROPHYLAXIS AND/OR REGULAR USE

The following drugs are used regularly for the prophylaxis of drug-induced constipation and may also be used for the treatment of chronic constipation.

**Lactulose (Duphalac)** is an osmotic laxative, which absorbs water into the gut and adds bulk to the stool, thereby increasing peristalsis. It may be used in patients from one month of age. The dose is titrated against response but it can be difficult to titrate dose, as response can be inconsistent. It takes 48hours to exert its effect. It may be associated with nappy rash. Good dental hygiene should be emphasised as it contains high concentrations of sugar. It may be diluted with water or other drinks. Flatulence may occur but this usually disappears within a few days. Encourage increased fluid intake.

Dose (oral): < 1yr 2.5ml twice daily

1 – 4yr 5ml twice daily

5 – 12yr 10ml twice daily

> 12yr 15ml twice daily

These are initial starting doses – adjust dose to suit patient.

**Liquid Paraffin** is a faecal softener. It is very unpalatable and should be stored in the fridge to help improve the taste. It can be mixed with yogurt or jam to disguise the taste. It should not be given to children under the age of one or to children with a poor gag reflex because of the risk of aspiration which may result in lipoid pneumonia . It should be given at night when food intake has been completed (to avoid any interference with vitamin absorption) but not just prior to lying down. The dose is titrated against response.

Dose (oral): >1yr 10-20ml single dose at night. This may be increased to 40ml if required.

**Senna** (Senokot) is also a stimulant laxative. It is available in tablet and liquid form. It acts in 8-12 hours and so is given at night

Dose: 2-6yrs 2.5-5ml at night

6-12yrs 5-10ml at night

1-2 tablets at night

> 12yrs 10-20ml at night

2-4 tablets at night

**Movicol**/**PEG powder** is an osmotic laxative 1 – 3 sachets/scoops can be given daily.

## SEVERE CONSTIPATION

If a child has become impacted, treatment with a stimulant laxative is required. This is for short-term use only.

**Bisacodyl (Dulcolax)** is a stimulant laxative. It is the drug of choice for disimpaction. It may cause abdominal cramps. Avoid prolonged use (may result in the development of atonic colon and hyperkalaemia). Bisacodyl is available in tablet and suppository form. The tablets should not be crushed and thus are not suitable for young children who can not swallow them whole. The oral tablet is given at night (effect seen after 10-12hours). The rectal suppository is given in the morning (effect seen after 20 – 60 minutes)

Dose (oral or rectal): <10yrs 5mg for three days.

>10yrs 10mg for three days

**Movicol/PEG powder**

One Movicol Paediatric sachet /scoop = 6.9g

Chronic Constipation:

2-6yrs: 1 sachet/scoop Movicol Paediatric daily PO to start. Adjust dose to produce regular soft stools (max. 4 sachets/scoops daily)

7-11yrs: 1 sachet/scoop Movicol Paediatric daily PO to start. Adjust dose to produce regular soft stools (max. 4 sachets/scoop daily)

>12yrs: 1-3 sachets /scoops Movicol daily PO in divided doses 1-2weeks. Maintenance 1-2 sachets/scoops Movicol daily PO

Faecal impaction:

1-6yrs: 2 sachets/scoops Movicol Paediatric PO on the first day, then 4 sachets/scoops daily for 2 days, then 6 sachets/scoops daily for 2 days, then 8 sachets/scoops daily for 2 days (treat until impaction resolves or for a max. of 7 days)

2-12yrs: 4 sachets/scoops Movicol Paediatric PO on the first day, then increase in steps of 2 sachets/scoops daily to max 12 sachets/scoops daily. Total daily dose to be taken over a 12-hour period.

**Suppositories/Enemas**

These should always be discussed with the PAEDIATRIC HAEMATOLOGY/ONCOLOGY/haematology consultant prior to implementation. In the neutropenic or thrombocytopenic child they are dangerous as they may lead to anal fissures, tears or abscesses or bleeding and haematoma’s.

**The routine use of enemas in children is not recommended as children find these both frightening and painful**. **Do not use enema if**

a) Platelets < 50 x 109 /l

b) ANC < 0.5 x 109 /l

c) Anal fissure

**Micro-enema (Microlax/Micolette)** contains sodium citrate, an osmotic laxative. The enema is administered rectally as a single dose for rectal impaction if combination of bisacodyl and liquid paraffin/lactulose is not effective. Slight cramp may occur. When used in children less than three years of age, insert only half the nozzle length (but expel total contents).

Dose (rectal): 1 mth -18yrs 1 enema as single dose

# COLONY STIMULATING FACTORS

G-CSF is used in the following situations:

1. to accelerate neutrophil recovery following intensive chemotherapy for children with solid tumours (dose 5microgram/kg/day). Please discuss with Consultant.
2. To accelerate neutrophil recovery in selected leukaemia patients in the presence of serious infection

It is given subcutaneously (rounded as much as possible to nearest 50microgram)

**Growth factors should be discontinued when WCC reaches 5x109/l. Children on G-CSF should have FBC repeated on D14 after chemotherapy; if WCC has not reached 5 x 109/l, repeat FBC 3 to 4 days later.**

# ELECTROLYTE REPLACEMENT

## Potassium:

Patients most at risk of hypokalaemia are those receiving nephrotoxic chemotherapy or Amphoteracin B.

IV KCI is routinely added to maintenance IVF at a dose of 10mmol/500mls (5ml of KCL available on ward). If serum potassium is <3.5mmol/l, this may be increased to 15 - 20mmol/500ml.

Tumour lysis may result in release of intracellular potassium into the circulation; **such patients should not receive K routinely in their IVF.**

Oral potassium is given if tolerated; Slow K is available on the ward. Please note Slow K should never be crushed as its coating protects the upper GIT from an alkaline burn. Serum potassium below 3mmol/L usually requires IV correction.

Hypokalaemia and hypomagnesium may occur concurrently and careful monitoring of both is advised.

## Magnesium:

Patients most at risk of hypomagnesemia are those receiving ifosfamide.

IV MgSO4 50%w/v solution is added to IV fluids at 0.3ml/kg/day (0.6mmol/kg/day) if Serum Mg++ is < 0.7mmol/l; this may be infused over 6-24 hours. The maximum daily dose is 20mmol/day.

Oral Magnesium: magnesium citrate tablets (6.2mmol) or Mg verla sachets (5mmol) or most antacid tablets available on the ward are magnesium based. Given BD

NB Excessive correction by oral route may cause diarrhoea.

## Calcium:

Patients most at risk are those children at risk of tumour lysis syndrome.

Serum calcium should be correlated with serum albumin. If serum albumin is low, calculate true serum calcium as follows:

**Ca(total)-(albumin x 0.01625)+0.65 = corrected calcium.**

Calcium infusions may cause cardiac arrhythmias and if an extravasation occurs are vesicant. Therefore they should only be prescribed when ionised serum Ca is low.

Reference ranges for **ionised** calcium:

* 0-1 month 1-1.5mmol/L
* 1-11 months 0.95-1.5mmol/L
* 1-19 years 1.22-1.37mmol/L.

(Pediatric Reference Ranges, Soldin SJ et al, AACC Press, 1995).

**Dose:**

Calcium gluconate 10%w/v as separate infusion diluted in 100-200ml of 0.9%w/v NaCl.

* 1mth – 2yrs 1mmol/kg daily. Usual max. 8.8 mmol over 24hrs.
* 2yrs – 18yrs 8.8 mmol over 24hrs.
* If symptomatic, 0.1mmol/kg Calcium gluconate 10%w/v diluted in 10-20ml saline can be given slowly over 10 mins with ECG monitoring.**N.B. Stop infusion if bradycardia develops.**

## Phosphate:

Serum phosphate is usually only monitored in the following patients:

1. newly diagnosed patients with leukaemia/lymphoma
2. patients receiving ifosfamide

If serum phosphate is <0.8mmol/L, replacement therapy is indicated:

**Oral Dose:**

* 1mth-5yrs: 2-3mmol/kg, max 48mmol daily in 2-4 divided doses
* 5-18yrs: 2-3mmol/kg, max 97mmol daily in 2-4 divided doses.

# Extravasation Injuries:

## Definitions:

EXTRAVASATION: leakage of fluid outside of the vasculature into the perivascular and subcutaneous spaces; aka infiltration.

Vesicants: Substances that, upon leakage into subcutaneous tissue, have the potential to cause severe tissue damage and even necrosis.

List antineoplastic drugs that are vesicants:

* actinomycin-D
* daunorubicin
* doxorubicin
* idarubicin
* mechlorethamine
* mitomycin-C
* paclitaxel
* streptozocin
* vinblastine
* vincristine
* vinorelbine

Only the commonest chemotherapy agents will be discussed here.

OTHER VENOUS REACTIONS:

Pain: Some chemotherapeutic agents can cause pain or burning on administration, even though they may remain in the vasculature:

* carmustine (BCNU)
* dacarbazine (DTIC)

Pain or burning can be minimized by infusing these drugs slowly, as dilute solutions (eg. 100-250ml over 30-60 minutes, as opposed to IV push injections)

Discolouration:

5-FLUOROURACIL frequently causes darkening of the veins. This is referred to as "serpentine veins". It may be embarrassing for patients, although it is merely a discoloration. That is, the vein(s) can still be utilized for administration of chemotherapy, etc. This venous discoloration is particularly prominent in black patients.

DOXORUBICIN (as well as DAUNORUBICIN) can cause redness and itching along the distribution of the vein through which it has been administered. This is known as a "flare". Usually the flare is self-limited. It disappears in several minutes without treatment. The cause is not known, although it has been suggested that the incidence is less when the diluent for doxorubicin is normal saline instead of water for injection. Rarely, the flare has been associated with systemic allergic symptoms. Management involves making sure a systemic allergic reaction is not present, and making sure the reaction does not represent an extravasation.

## Factors influencing the severity of EXTRAVASATION:

Vessel Characteristics:

* Fragile, low flow, or small diameter vessels, or previously irradiated sites may all have relatively decreased vascularity. Thus, extravasated fluid is more likely to remain concentrated in a given area.
* Use of vessels close to tendons or muscles can lead to greater functional loss in the event of extravasation of a vesicant agent.
* Administration of drug distal to the site of a recent venipuncture can lead to leakage of the drug as it passes the venipuncture site.

Patient characteristics:

* Age
* Presence of lymph node dissection impeding drainage of the site.

Drug Characteristics:

* Type of drug (discussed above and below). The onset of injury is earlier with vinca alkaloids. Tissue damage from anthracyclines is progressive over weeks to months.
* Concentration:
  + The ulceration size following extravasation of vesicant agents is related to the concentration and the total amount of drug that has extravasated.

**Note that pain is not always present at the time of extravasation.**

## MANAGEMENT OF EXTRAVASATION

### Prevention

Primary prevention (see above):

* Choice of vessel
* 5-10ml bolus of non-vesicant flush
* Drug concentration
* Slow IV push injections with regular aspirates during this bolus may be preferred when possible. Infusions may be more likely to be left unattended, allowing for leakage of a greater amount of fluid before the extravasation is detected.

### Treatment

The goal of treatment is to prevent severe tissue damage and preserve function.

* Aspirate back fluid, to avoid extravasation of any more fluid remaining in the needle/catheter.
* Remove the needle/cannula.
* Aspirate any visible bleb if possible.
* Administer antidote.
  + Sodium bicarbonate followed by HYALURONIDASE:
    - Recommended for:
      * VINCRISTINE, VINBLASTINE
    - Breaks down hyaluronic acid in connective/soft tissue, allowing for dispersion of the extravasated drug.
    - How to administer: Instill 10mls of sodium bicarbonate followed by 150U (1ml) via multiple injections in and around the extravasation area using a 25g needle. As this can be very painful may give local anaesthetic prior to this treatment.
  + DIMETHYLSULFOXIDE (DMSO) 50%w/v solution.
    - Recommended for:
      * DOXORUBICIN, DAUNORUBICIN and ACTINOMYCIN D.
    - May work by virtue of its free radical scavenging property.
    - How to administer: apply 1.5ml topically (ie. "paint" on the skin) QID x 14 days. Leave uncovered.
  + Cold packs for:
    - DOXORUBICIN, DAUNORUBICIN ACTINOMYCIN D VINCRISTINE, VINBLASTINE.
    - Apply for 20 minutes alternating on and off for first 2 hours and QID x 3/7.
* Follow up. Continued pain or major ulceration after 1-2 weeks is an indication for surgery/skin grafting.

# Xeroderma Pigmentosa (Children of the dark)

## Introduction:

Children with Xeroderma Pigmentosa (XP) are a very special vulnerable group of children who are treated on Upendo ward. XP is an autosomal recessive genetic disorder of DNA repair in which the ability to repair damage caused by UV light is deficient.

## Presenting signs:

These children are born with normal looking skin. With chronic sun exposure they first develop freckling, followed later by the development of pre-malignant papules (or solar keratosis) and dry rough skin. Eventually Basal cell carcinoma’s, squamous cell carcinomas and melanomas develop primarily on the most exposed areas of their bodies – face (including cornea), head, neck and extremities. As a result, in our setting, children rarely live beyond their 10th birthday. We are trying to change this terrible reality.

## Management

(Please provide each child with all of the below advice and items):

### Sun exposure advice:

* 1. **If these children are not exposed to sunlight at all their skin will look normal and remain intact.** Parents may not understand that simply keeping them indoors away from the light will protect their children.
  2. Advise families that these children should **never ever** be outside between 11am-3pm
  3. At other times they should only go outside fully covered (see protective clothing below).

### Sun protection clothing:

1. Should be worn at all times. Please make sure each child has each of these items at each outpatient appointment. If a child appears to outpatients inadequately covered please admit this child as the parents require further counselling.
   * 1. Sun hat with neck flap
     2. Sunglasses
     3. Sun protection suits or long sleeved tops and long skirts or trousers

### Prophylactic medications

1. Total sun block. This should be applied twice a day if water resistant (or more often if not).
2. Accutane 0.1 – 0.3mg/kg/day PO regularly. LFT’s should be checked at least every 6 months.

### Treatment of pre-malignant lesions

1. 5FU cream OD topically sparingly to papules/rough skin, carefully avoiding normal skin.
2. Alternatives include: Imiqimod cream or Picato.

### Surgical management:

1. Surgical excision if ulcers present or lesions very large or not improving with medical management. Only if lesions are still resectable and no lymph node involvement.
2. Refer to plastic surgeons/paediatric surgeons for skin lesions and ophthalmologists for corneal lesions.
3. Refer to ophthalmologists from diagnosis every 6 months for review of cornea.

### Palliation:

1. Radiotherapy to unresectable lesions
2. Pain management
3. Shared care with local centres

## Genetic counseling.

1. Risk for other siblings is 1 in 4 chance in most families. But it is simpler to explain to families that every subsequent child has a risk of XP and they should watch carefully for the early signs – i.e. freckling.
2. Advise families to bring the children to the service when freckling noted to begin all preventive measures as soon as possible.

# VARICELLA / MEASLES POLICY

Significant exposure in non-immune child is defined as:

1) CONTINUOUS HOUSEHOLD CONTACT

2) PLAYMATE CONTACT (GENERALLY > 15 mins PLAY INDOORS from 2 days

before appearance of rash (varicella) and from 5 days prior to and 4 days after

appearance of rash (measles)

3) If the contact is with shingles then the child has to actually touch the shingles to count as an exposure.

4) HOSPITAL CONTACT (IN SAME 2-4 BED ROOM)

## Varicella Exposure:

1. ZOSTER IMMUNE GLOBULIN (VARITEC) 1ML 25 IU/KG BY SHORT IV INFUSION (obtainable from the Pharmacy), WITHIN 72 HRS OF EXPOSURE TO VARICELLA. Protection lasts 4 weeks approx. (Caution this dose is for IV infusion only (IM Preparation stated in Medicines for Children and is not available in this country).
2. If above is not possible, Aciclovir (Zovirax) 80mg/kg/day PO in 4-5

divided doses (max. 4000mg) should be prescribed from D7 to D21.

Varicella Infection:

See Prescription of Antimicrobial Agents

## Zoster Exposure:

Zoster is not transmitted by droplet infection; patients are only susceptible if there has been direct contact with lesions. In this case Aciclovir is prescribed as per Varicella exposure.

## Measles Exposure:

There is no specific treatment currently available in MNH. Strict Isolation is required for a week following exposure and all supportive measures should be implemented if the child becomes symptomatic or unwell.

# IMMUNISATION POLICY

## On treatment and within six months of completion of treatment:

Vaccination with non live vaccines may be undertaken during chemotherapy, in keeping with Childhood Immunisation Schedule, provided child’s general condition is stable (free from infection and no organ toxicity and is expected to stay so for 3 weeks post immunisation). Re-immunisation IS recommended following 6 months completion of therapy.

**All live vaccines (MMR, BCG) must be avoided during and for 6 months following chemotherapy.**

## Immunisation six months after completion of treatment:

An additional booster of diphtheria, tetanus, acellular pertussis, IPV, Hib, is recommended.

MMR may be administered at this time.

Subsequent boosters (eg. preschool) will not be then indicated if scheduled to be given within one year of this additional dose.

If patient has had BCG, check tuberculin test and if negative, revaccinate. If patient has not been vaccinated, immunise according to local policy.

# SOCIAL Programme

The PAEDIATRIC HAEMATOLOGY/ONCOLOGY Department has an active social programme to support the children and their families through this very stressful time. Every family is counselled by our team of experts who initially meets them soon after their arrival on the ward.

Our supportive and social care team is a key part of the multi-disciplinary team whose role is to:

1. Counsel individuals, families and groups.
2. Undertake crisis intervention work with families.
3. Provide literature on the child’s condition
4. Discuss coping strategies
5. Advise about services, benefits and resources and link people to such resources
6. Work jointly with all staff in providing family support during palliative care.
7. Provide a bereavement service.
8. Provide professional support to Tumaini la Maisha – our parent’s support group.
9. Introduce the families and children to all the activities that are available when the child is feeling well enough to participate including school, play, yoga, outings, movie nights, music therapy (intermittent) and birthday parties.

# SHARING CARE

All patients will require some involvement from their GP, PHN, and / or local Paediatric Unit at some stage during their chemotherapy or radiotherapy treatment. Each child must have a designated doctor at their local facility who has been contacted and has agreed to help us share the care of this child. Communication with this doctor must be made in the local hospital prior to initial discharge from Upendo Ward. This is especially important for children with leukaemia who require weekly blood tests, modifications to chemotherapy and monthly injections of chemotherapy locally administered.

The aim of shared care is to empower local services to provide safe care for children while they are at home between courses of treatment. Local hospitals are required to provide all supportive care an immunocompromised child might need. This includes phlebotomy, administration of blood transfusion and management of febrile neutropenia. **Admission for febrile neutropenia locally is always treated initially as a medical emergency. Local hospitals follow the MNH Upendo policies written in the Supportive Care Guidelines.**

**For every discharge, a discharge letter must be written by the** **discharging doctor, given to the family for their local hospital.** This letter outlines the recent treatment the child has received, what medications the child is currently on, and any other relevant information. **Prescriptions should be written and given to the** **family the day before discharge**.

**Administration of Chemotherapy Locally**

Many local hospitals administer a limited amount of chemotherapy. These include intravenous pushes of Vincristine, Vinblastine, Cytarabine and intra-muscular injections of Asparaginase. If a local hospital is asked to give chemotherapy, it must be written on a prescription letter by one of the doctors, before discharge.

# LIST OF PROTOCOLS & TREATMENT GUIDELINES FOR MALIGNANT HAEMATOLOGY/PAEDIATRIC HAEMATOLOGY/ONCOLOGY PATIENTS

## Bone

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| Euro Ewing 99  Version 2.0 Dated: August 2005 | Ewing’s Sarcoma |
| EURAMOS 1  Protocol Version 2.1 Dated: 21Apr2009  appendix A v2.0 Final 31Dec2008  appendix B v2.0 Final 31Dec2008 | Osteosarcoma |

## Germ Cell tumours

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| UKCCSG TUMOURS IN CHILDREN AND ADOLESCENTS (GC III) (GC 2005 04) | Extra-cranial germ cell tumours |

## Histiocytosis

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| Langerhan Cell Histiocytosis Treatment Guidelines Dated: 10.10.08. | Langerhans Cell Histiocytosis |
| HLH 1994  Dated: Jan 1995 | Haemophagic Lymphocytic Histiocytosis |

## Hodgkins

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| European guidelines ABVD alone | Hodgkin’s Lymphoma |

## Leukaemia

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| MNH ALL protocol modified from the UKALL 2003  Version 7.0 | Patients > 1yr with Leukaemia |
| ALL R3 (Burkitt’s) MNH BL protocol modified from the  INCTR BL protocol | BL leukaemia |

## Liver

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| SIOPEL 6 (LT 2007 03)  Version 2.0 Dated: April 2008 | Non-cirrhotic hepatoblastoma |

## Neuroblastoma

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| Unresectable Neuroblastoma  (NB 2000 09)  See letter dated February 2007 | >1yr with Unresectable Localised NBL |

## Non Hodgkin’s Lymphoma

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| 1. As above from BL  Large cell NHL – July 2003  2. As above in ALL for lymphoblastic lymphoma.  3. ALCL protocol | Management of Burkitt/Burkitt like & B Large cell NHL  Lymphoblastic lymphoma in children over 1yr  ALCL |

## Rhabdomyosarcoma (Soft Tissue Sarcoma)

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| MNH RMS protocol based on the EpSSG 2005 STS 2006 04  Version 1.2 Dated: Sep2008 | Non Metastatic RMS |
| EpSSG NRSTS 2005 (STS 2006 03) V2.0 Dated: June 2005 | Localised Non RMS Soft Tissue Sarcomas |

## Renal

|  |  |
| --- | --- |
| **Protocol Name** | **Treatment for** |
| MNH Wilms protocol based on a combination of SIOP Africa and (WT 2002 01)  Version 4 Dated: 04/12/2009 | Wilms tumour |

# COMMON TOXICITY CRITERIA GRADING SCALE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | **Grade 0** | **Grade 1** | **Grade 2** | **Grade 3** | **Grade 4** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **General condition** | normal activity | mild impairment | age-related activities strongly decreased | bedridden,  in need of care | intensive care,  very sick |

## Haematological toxicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Haemoglobin (g/l)** | normal for age | > 100 | 80 – 100 | 65 – 79 | < 65 |
| **WBC (x 109/l)** | ≥ 4.0 | 3.0 – 3.9 | 2.0 – 2.9 | 1.0 – 1.9 | < 1.0 |
| **Granulocytes (x 109/l)** | > 2.0 | 1.5 – 1.9 | 1.0 – 1.4 | 0.5 – 0.9 | < 0.5 |
| **Platelets (x 109/l)** | > 100 | 75 – 100 | 50 – 74.9 | 25 – 49.9 | < 25 |

## Infections

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Infection** | | none | mild | moderate, pathogen not identified;  i.v. antibiotics | severe, pathogen identified;  i.v. antibiotics | life threatening  with hypotension |
| **Fever (°C)** | none | | 37.1 – 38 | 38.1 – 40 | > 40 for < 24 h. | > 40 for ≥ 24 h. |

## Gut toxicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stomatitis** | none | painless ulcer, erythema | painful erythema  or ulceration,  can still eat | painful erythema  or ulceration,  cannot eat | TPN required,  due to stomatitis |
| **Vomiting** (no. of episodes in 24h**)** | 0 | 1 | 2 - 5 | 6 - 10 | > 10 or TPN necessary |
| **Diarrhoea** (stools/day**)** | none | 2 - 3 | 4 - 6 or nightly stool  or light cramps | 7 - 9 or incontinence or severe cramps | ≥ 10 or bloody diarrhoea or  TPN required |

## Skin toxicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Changes in the skin** | none | erythema | dry desquamation, vasculitis, pruritus | moist desquamation, ulceration | exfoliative dermatitis, necrosis |

## Renal toxicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Creatinine** | normal for age | < 1.5 x N | 1.5 - 3.0 x N | 3.1 - 6.0 x N | > 6 x N |
| **Proteinuria (g/l)** | none | < 3 | 3 - 10 | > 10 | nephrot. Syndrome |
| **Haematuria** | none | microscoPICC | macroscoPICC,  no clots | macroscoPICC, clots | transfusion required |
| **Glomerular Filtration Rate**  **GFR)** ml/mn/1.73m² | ≥ 90 | 60 - 89 | 40 - 59 | 20 - 39 | ≤ 19 |
| **Tubular phosphate reabsorption** | ≥1.0 | - | 0.99 – 0.80 | ≤0.80 | deterioration |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | **Grade 0** | **Grade 1** | **Grade 2** | **Grade 3** | **Grade 4** |

## Liver toxicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Bilirubin** | normal for age | - | < 1.5 x N. | 1.5. - 3 x N. | > 3 x N. |
| **SGOT / SGPT** | normal for age | ≤ 2.5 x N | 2.6 - 5.0 x N. | 5.1 - 20.0 x N. | > 20 x N. |

## Cardiac toxicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Cardiac function** | normal | asymptomat.,  EF ↓ of <20% of baseline | asymptomat.,  EF ↓ of >20% of baseline | mild congestive heart failure, therapeutically compensated | severe/ refractory congestive heart failure |
| **ECHO: LV-SF** | normal | >28 %, temp.  ↓ ≤10% from baseline | >28%, temp.  ↓ >10% from baseline | temp. <28%or  ↓ >20% from  baseline | persistent <28%, or req. cardiac medication |

## Neurological toxicity

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Central neurotoxicity**  **Seizure(s)** | None  None | mild somnolence,  or agitation, drowsiness  None | somnolence  < 50% of the time, moderate disorientation  seizure(s) self-limited and consciousness is preserved | somnolence  > 50% of the time, severe disorientation, hallucinations  seizure(s) in which consciousness is altered | Coma  Seizures of any type which are prolonged, repetitive, or difficult to control (e.g. status epilepticus, intractable epilepsy) |
| **Peripheral neurotoxicity** | none | paresthesia, mild subjective weakness | severe paresthesia and/or mild weakness | unbearable paresthesia, deficits in motor function | Paralysis |

# Estimated GFR based on serum creatinine (The Schwartz formula)

The close relationship between creatinine clearance and GFR on the one hand, and creatinine production and muscle mass on the other, along with the difficulties of collecting urine, have led to the concept of estimating GFR from serum creatinine and some parameter of body habitus, as detailed by Schwartz et al.:

**eGFR 1⁄4 kL=Scr**

**eGFR** = estimated GFR in milliliters per minute per 1.73 square meters,

**L** = height in cm,

**Scr** is serum creatinine in mgs/dl.

**k** is a constant, (milligram creatinine/100 min × cm × 1.73 m2) i.e.

|  |  |  |
| --- | --- | --- |
| **Age** | **k value (Male)** | **k value (female)** |
| From term infant to 1yr | 0.45 | 0.45 |
| From 1yr to 16 yr | 0.7 | 0.55 |

This formula is also based on the relationship that Ccr is reciprocally proportional to the serum creatinine. Such a formula generally provides a good estimate of GFR (r~0.9) when compared with creatinine and inulin clearance data. Interestingly, at high values of GFR, the variation between inulin clearance and GFR estimated by the Schwartz formula was about 20%, but it was much smaller at lower levels of GFR.

# What Are Normal Ranges of Vital Signs for Various Ages?

The following charts summarize the range of age-based normal vital signs.

| Normal Heart Rate by Age (Beats/Minute) | | |
| --- | --- | --- |
| **Age** | **Awake Rate** | **Sleeping Rate** |
| Neonate (<28 d) | 100-205 | 90-160 |
| Infant (1 mo-1 y) | 100-190 | 90-160 |
| Toddler (1-2 y) | 98-140 | 80-120 |
| Preschool (3-5 y) | 80-120 | 65-100 |
| School-age (6-11 y) | 75-118 | 58-90 |
| Adolescent (12-15 y) | 60-100 | 50-90 |

| Normal Respiratory Rate by Age (Breaths/Minute) | |
| --- | --- |
| **Age** | **Normal Respiratory Rate** |
| Infants (<1 y) | 30-53 |
| Toddler (1-2 y) | 22-37 |
| Preschool (3-5 y) | 20-28 |
| School-age (6-11 y) | 18-25 |
| Adolescent (12-15 y) | 12-20 |

| Normal Blood Pressure by Age | | |
| --- | --- | --- |
| **Age** | **Systolic Blood Pressure** | **Diastolic Blood Pressure** |
| Birth (12 h) | 60-76 | 31-45 |
| Neonate (96 h) | 67-84 | 35-53 |
| Infant (1-12 mo) | 72-104 | 37-56 |
| Toddler (1-2 y) | 86-106 | 42-63 |
| Preschooler (3-5 y) | 89-112 | 46-72 |
| School-age (6-9 y) | 97-115 | 57-76 |
| Preadolescent (10-11 y) | 102-120 | 61-80 |
| Adolescent (12-15 y) | 110-131 | 64-83 |

Tables and data have been adapted from the Pediatric Advanced Life Support Manual.

American Heart Association, 2012

REFERENCES:  
  
Chameides, Leon, Ricardo A. Samson, Stephen M. Schexnayder, and Mary Fran Hazinski, eds. *Pediatric Advanced Life Support Provider Manual: Professional Edition*. United States of America: American Heart Association, 2011.  
  
Kliegman, R.M., et al. *Nelson Textbook of Pediatrics, 20th Edition*. Philadelphia, PA: Elsevier, 2015.

# Surface area calculations

