

**Royal Belfast Hospital for Sick Children**

**Department of Anaesthesia**

**Starter Pack**

(updated 03.08.21)

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# Royal Belfast Hospital for Sick Children

## Department of Anaesthesia

### Notes for Guidance for Specialist Registrars

- Welcome to the Department of Anaesthesia at the Royal Belfast Hospital for Sick Children. This guide is designed to provide the anaesthetist in training joining the department with administrative and emergency clinical information, but is not comprehensive. If you have questions please ask!

#### Consultant Staff

Dr Bailie	Clinical Director
Dr Carachi	
Dr Cavanagh	Clinical Lead - Scoliosis
Dr Cooke	
Dr Copeland	
Dr Fee	Clinical Supervisor
Dr Fitzpatrick	
Dr Flannigan	PICU
Dr Foster	Clinical Lead – Governance/Audit
Dr Gallagher	Clinical Supervisor
Dr Keaney	
Dr Lipczynski	
Dr Lyons	Sub-Director PICU & Theatres
Dr Marshall	
Dr McCawley	
Dr S McVea	PICU
Dr Quinn	Educational Supervisor / Acute pain lead.
Dr Richardson	PICU / Deputy Head of School for Paediatrics - NIMDTA
Dr Robinson	
Dr Terris	Clinical Lead - Transport

#### Pain Nurses

SN MacDonald/SN Fagan

Theatre Receptionist	<b>PICU Secretary</b>
Kathleen Carey	Anne Brown

#### PICU Receptionists

Stacey McAvoy/Bernadette Irvine

#### Medical Technical Officers

Mark Doyle  
Brendan Kelly  
Paul Flannigan  
Bronagh O'Hagan

**Anaesthetic services are provided to the following sites:-**

Main theatres

Daycare theatre

MRI

CT

Eyes – Theatre 3 in Eyes/ENT Building at RVH

Interventional Radiology (IR) – within X-Ray (Radiology) department, opposite MRI

Musgrave Park Hospital (MPH)

**But your help might be required also in the:**

A/E Department

Wards

**Hospital Wards**

Please check **Appendix 1** for the plan of the RBHSC. Below is the description of the wards and departments:

Emergency Dept	24 hr Emergency Department
Allen Ward	Acute General Paediatrics and Cystic Fibrosis
Barbour Ward	Acute General Surgery, Trauma and Fractures
Belvoir Ward	Paediatric Infectious Diseases
Cherry Tree House	Adolescent Cystic Fibrosis
Clark Clinic	Cardiology
Day care Unit	Day case surgery – mostly dental and oncology investigations
Haematology Unit	Oncology
Knox Ward	Day of surgery admissions / day cases.
Paul Ward	Neurology/Neurosurgery and Plastics
SSU (Short Stay Unit)	Short admissions(?)

All new members of staff should acquaint themselves with all these sites within the first week.



## **Annual Leave**

- Please follow the guidance received at induction for RVH trainees on the procedure for booking leave.

## **Rota**

The monthly published rota identifies where you are each day, and your off duty times. If there is nothing in your theatre, join another theatre list as there are learning opportunities all the time. It has been agreed that the Fellow may ask you to swap out of one list that has been assigned to you during your 3 month attachment subject to suitable notice being given.

## **Paediatric Anaesthesia Shifts**

	MON	TUE	WED	THU	FRI	SAT	SUN	HRS
WEEK 1	N	N	N	N	OFF	OFF	OFF	50
WEEK 2	D	D	D	D	D	OFF	OFF	47.5
WEEK 3	D	D	D	D	D	OFF	OFF	47.5
WEEK 4	L	L	OFF	OFF	N	N	N	62.5
WEEK 5	OFF	OFF	D	D	D	OFF	OFF	28.5
WEEK 6	D	D	D	D	D	OFF	OFF	47.5
WEEK 7	D	D	OFF	OFF	L	WEL	WEL	56.5
WEEK 8	OFF	OFF	L	L	D	OFF	OFF	34.5

## **KEY**

D = 0800-1730h (9.5hrs)

L = 0800-2030h (12.5hrs)

N = 2000-0830h (12.5hrs)

Average Hours over an 8 week period (as above) =  $374.5/8 = 46.8h$

When averaged out over a normal 13 week module, the average hours worked per week  
46.8

The telephone extension for the anaesthetic on-call room is x3649.

## **Daily Routine**

Operating lists start in RBHSC at 0900hrs, however it is necessary to be here at 0800hrs (**including weekends**) in order to prepare theatre, etc, and to ensure a prompt start (see Paediatric Anaesthesia Seminars below). A team brief will be held at 0845h in theatre. Anaesthesia is provided for general surgery, plastics, orthopaedics, ENT and dental procedures. A pre-anaesthetic checklist is included and is a useful aid to ensure that basic checks of anaesthetic equipment are carried out daily.

There is no reason for an anaesthetist to have to leave theatre during a case – even “if only” to go to the anaesthetic room. **The anaesthetised patient should never be left unattended.** There is always a nurse available in theatre to get any other drugs or equipment you may require during a case.

## **Paediatric Anaesthesia Seminars**

Paediatric Anaesthesia Seminars are held on Tuesday and Friday in the PICU Computer Room (Appendix 2) at 0800hrs. The rota for presenting at these meetings will be distributed by the fellow and any swaps required should be discussed with them. The presentation should finish by 0820hrs, and the whole meeting must finish by 0830hrs.

## **Preoperative Visit**

Many children are now admitted to the hospital on the day of surgery and should be seen by the anaesthetist prior to surgery.

The preoperative visit is an important feature of the anaesthetic service. It is a chance for the child to become familiar with theatre personnel and “theatre garb”. It is important to explain to the child (when appropriate) in simple terms what will happen with regards to their anaesthetic and gives an opportunity to allay both parental and child anxieties about the procedure. If you use the term “going to sleep” to the child, make sure they understand they will wake up at the end. Failure to do so can cause major distress. In particular one should emphasise that adequate post-operative analgesia will be provided since this is one of their greatest worries. It is our practice to inform parents and children of postoperative IV fluids and the various options for analgesia, including **suppositories**. It is also an opportunity to identify children with particular problems (behavioural, etc) and to plan further anaesthetic care.

Details of relevant medical and anaesthetic history, and laboratory results should be entered in the anaesthetic chart. In particular one should record any relevant family history of anaesthetic problems.

Occasionally patients scheduled for major surgery in the afternoon are admitted the morning of surgery and one should ensure that bloods, etc and grouping and cross-matching of blood is carried out as appropriate.

The decision to cancel a case should be made in conjunction with a consultant. The child with a “runny nose” or cold presents frequently for surgery and the decision to postpone surgery is made by a consultant on the basis of urgency of surgery, associated symptoms, etc.

The question of parents accompanying children to the theatre is left to the anaesthetist in charge. If parents are to come to theatre, they need some counselling since they are also

anxious. It has to be made clear that they must leave the theatre when their child has lost consciousness. Usually a nurse is assigned in the anaesthetic room to look after the parents. Guidelines for parental presence are included (see page 14).

NB This has been superseded currently by the COVID guidance, which means that the default is for parents NOT to attend theatre, but there is room for manoeuvre if it would be felt that there are exceptional circumstances.

### **Day Care Unit / Knox Ward**

Many children have their operations carried out as day cases and are admitted to the Day Care Unit / Knox Ward. As there are no housemen in this ward, it is the duty of the anaesthetists and surgeons to evaluate these children preoperatively. The nurses will admit the patients and complete a pre-operative past medical history questionnaire, but as the anaesthetist, you should obtain any further relevant information and conduct a relevant clinical examination. All observations should be written on the first page of the anaesthetic record. It is usual for day cases, following painful procedures, to be discharged home **with three days supply of analgesics, which should be prescribed on a regular and not a prn basis**. Do not forget to prescribe anti-emetics as well.

### **Premedication**

All children coming to theatre for anaesthesia and surgery should have been adequately prepared psychologically. Much of this will come from the parents and will be reinforced by the nurses and play therapists in hospital. Most children do not require a sedative premed. However, there are several groups of children where this may be indicated, including:

- the younger child without the ability to reason (pre-school),
  - children undergoing repeat anaesthetics,
  - and those with learning disabilities.
- 
- In these instances, midazolam ( $0.3\text{mg kg}^{-1}$  to a max of 8-10mg, **buccal**, or  $0.5\text{mg kg}^{-1}$  to a max of 20mg **orally**) given 20-30 minutes preoperatively, may be used.
  - Dexmedetomidine is our second choice premed – see protocol.
  - Ketamine and clonidine are alternative drugs.

### **Induction of Anaesthesia**

It is the anaesthetist's duty to ensure that the appropriate equipment is present and ready for each case. Anaesthetic equipment (**Appendix 3, 10 & 13**) should be **checked fully** in the anaesthetic room and theatre in the morning, and circuits etc checked before each case.

Induction of anaesthesia can be carried out in the theatre.

It is essential in paediatric anaesthesia to ensure that all drugs, equipment, etc required for anaesthesia, are ready before the patient comes into the room. The child may be kept in the playroom until you are ready. Delays in the theatre only increase anxiety for the child and seeing drugs being drawn up, etc do nothing to allay their fears. Therefore all drugs should be drawn up and labelled and kept out of view until their induction. It is also a good idea to have a separate supply of suxamethonium and atropine drawn up and easily available in the event of an emergency.

The choice of intravenous induction or inhalational induction is left to the anaesthetist concerned. Inserting a cannula hurts and can be unnecessarily traumatic for the child. "Ametop" gel is routinely applied pre-op by nursing staff for elective cases, and may provide adequate analgesia for cannulation. Gas induction frequently allows a much easier subsequent cannulation, if the patient's condition allows. Please ask for help rather than attempting multiple cannulations in a distressed child. Occasionally it may be appropriate to insert a central line or ask for a surgical line. Intra-osseous needles are available in theatres / recovery, and A&E, for emergency access.

Anaesthetic assistance is provided by an anaesthetic nurses. However, each anaesthetist is responsible for ensuring that all the necessary equipment (laryngoscopes, tubes, etc) is personally checked. A useful "aide-memoire" has been suggested by Gregory (STATICS) and we have modified this to **STATICs – M**

- S** (Scope) Laryngoscope of appropriate size and in working order
- T** (Tube) The choice of size of endotracheal tube is based on the chart supplied. However, this is only a guide and tubes one size bigger and one size smaller should be available. In the case of small infants, a small black line should correspond to the level of the cords, to avoid accidental bronchial intubation.
- A** Airway, Guedel
- T** (Tape) Please ensure that the appropriate tape is ready to secure the tube
- I** Introducer
- C** Connector
- S** Suction
- M** Mask

### Ventilators

The Maquet Flow-i anaesthetic machine is in main theatres and daycare. There is a different ventilator in A&E – the Hamilton. You should familiarise yourself on the induction day when you first come to the hospital.

**Appendix 3** gives details for a full pre-use check of the Maquet Flow-i anaesthetic machine. You will be expected to know how to perform the pre-use check and this will be confirmed by you being signed off after successful check.

## Drugs

- Midazolam is particularly useful for the very anxious child and is one of the few reliable premedicants in the preschool child. Normally we use the buccal route, at a dose of  $0.3\text{mg kg}^{-1}$  (max 8-10mg). If using oral dosing, it should be  $0.5\text{mg kg}^{-1}$  (max 20mg). The IV preparation can be used but is bitter and should be mixed with a small amount of Ribena or other sweet drink.
- Propofol is commonly used for intravenous induction in children ( $3-4\text{mg kg}^{-1}$ ). One ml of 2% lignocaine should be added to 10-20ml of propofol ( $1\text{mg.ml}^{-1}$ ) to reduce pain on injection. TCI pumps for TIVA should be readily available. There are various different options available for TCI including:
  - Separate Propofol and Remifentanil infusions (Remi concentration of  $20\text{mcg ml}^{-1}$  is easiest to handle for most children)
  - Mixed Propofol and Remifentanil – 3,5, or  $10\text{mcg ml}^{-1}$
  - Mixed Propofol and Alfentanil ( $20\text{mcg ml}^{-1}$ )
- Thiopentone  
Dosage:

Neonates	$3-4\text{mg kg}^{-1}$
Older infants	$6-7\text{mg kg}^{-1}$
Children	$5-6\text{mg kg}^{-1}$

Caution in **hypovolaemic** patients and in patients with **limited cardiac reserve**
- Ketamine is a very useful drug for emergency situations and provides analgesia with maintenance of the airway. Dosage:  $2\text{mg kg}^{-1}$  IV;  $10\text{mg kg}^{-1}$  IM.
- Atropine is available in two concentrations  $0.6\text{mg ml}^{-1}$  and  $0.2\text{mg ml}^{-1}$ . The dose of atropine is  $0.01-0.02\text{mg kg}^{-1}$  IV.
- Suxamethonium is available as  $50\text{mg ml}^{-1}$ .
- Atracurium and Rocuronium are the most commonly used non-depolarising relaxants.
- Sevoflurane is now the standard agent for gas induction. In view of the costs concerned, please remember to keep flows low after induction ( $<2\text{l/min}$ ) or to switch to another agent (e.g., isoflurane). Sevoflurane alone is associated with emergence delirium in children. Isoflurane is not recommended for induction.
- Commonly Used Antibiotics
  - Cefuroxime  $50\text{mg kg}^{-1}$
  - Co-Amoxiclav  $30\text{mg kg}^{-1}$
  - Metronidazole  $7.5\text{mg kg}^{-1}$
  - Gentamicin  $3-7\text{mg kg}^{-1}$

## Monitoring

The minimum monitoring necessary during induction of anaesthesia is the pulse oximeter. The decision to apply the other monitors – BP cuff and ECG electrodes is based on clinical assessment and demeanour of the child.

In the case of an anxious, fretful child, it is better to induce anaesthesia, then ask the assistant to apply other monitors, as consciousness is lost.

BASIC (for all patients)	ECG, BP Cuff, Temp
OTHER monitors available	ETCO <sub>2</sub> , SpO <sub>2</sub> , Nerve stimulator, Direct Arterial Pressure, CVP, NIRS
OTHER Equipment	Heating blanket, Blood warmer, Warm Air Blower

### **Analgesia**

There is a multi-disciplinary approach in the form of the Paediatric Acute Pain Team at the RBHSC. There are two Pain Control Nurses. They can be contacted during normal working hours **on bleep 2450** and will assist in preoperative instructions, setting up infusions/PCA and postop care. You are encouraged to participate in the morning Pain Round at 0830hrs.

When appropriate, local and regional anaesthesia is administered to supplement general anaesthesia – wound infiltration, caudal or brachial plexus blocks most commonly. An intravenous line should be established before performing the block.

Caudal Levobupivacaine 0.2% plain (0.5-1.0mg kg<sup>-1</sup>) is recommended for ambulatory cases for procedures below the umbilicus, e.g. inguinal surgery or circumcision. Clonidine 1mcg kg<sup>-1</sup> is used as an adjuvant for caudals in over 1 year olds / over 10kg.

All analgesic management strategies should include the use of non-steroidal agents (Diclofenac 1mg kg<sup>-1</sup> PO/PR 8hrly or Ibuprofen 7.5-10mg kg<sup>-1</sup> 6hrly TDS PO) (if not contraindicated) and Paracetamol up to 75mg kg<sup>-1</sup> in 24hrs, PO & PR and up to 60mg kg<sup>-1</sup> in 24hrs IV (at 15mg kg<sup>-1</sup>). Please note the age appropriate dosages of Paracetamol – especially for those under 10kg – where reduced doses must be used.

### **Intravenous Morphine**

NCA morphine is commonly used for the treatment of moderate to severe postoperative pain in infants and younger children or in older children who are unable to use PCA. Doses should be reduced in neonates and infants less than six months of age. Morphine infusions are sometimes used in younger children in the PICU. Morphine is infused via a separate cannula or by using a non-return valve on the main IV line. PCA morphine is used for able school-age children in Barbour Ward and Knox Ward. If it is proposed to use intravenous morphine analgesia, the Recovery Ward staff should set up the pump in advance. This is performed by the duty anaesthetist out of hours.

### **Epidural Analgesia**

This type of analgesia is often used in children undergoing major surgical procedures. The option for an epidural should always be discussed with a consultant. The infusion used in children more than six months is levobupivacaine 0.125% and fentanyl 2mcg ml<sup>-1</sup>, pre-prepared by pharmacy. An infusion rate of more than 0.5mg kg<sup>-1</sup> hr<sup>-1</sup> (0.4ml kg<sup>-1</sup> hr<sup>-1</sup>) should not be exceeded. In infants less than six months, a levobupivacaine 0.125% solution only should be used and an infusion rate of 0.25mg kg<sup>-1</sup> hr<sup>-1</sup> (0.2ml kg<sup>-1</sup> hr<sup>-1</sup>) should not be exceeded. Also a catheter placed via the caudal route may be considered in

neonates. Postoperatively children with epidurals are discharged from Theatre Recovery directly to a ward. This always needs to be discussed and agreed with the ward staff.

## **Anti-emetics**

Ondansetron 0.1-0.15mg kg<sup>-1</sup> IV 8hrly should be given and prescribed for all patients who have been prescribed opioids either IV or epidurally.

## **Recovery Room**

All patients spend some time in the recovery room. Nursing staff may discharge patients from recovery now, if they meet the criteria for discharge, otherwise the anaesthetist must sign out children from recovery.

## **Postoperative Visit**

Whenever possible, it is recommended that you see your patients in the ward or check with ward sister or staff nurse personally that all is well. It is particularly important to regain the child's confidence, especially after a "traumatic" induction. Remember you or a colleague may meet that child again. In addition, it gives on the opportunity to evaluate the adequacy of postop analgesia and identify any minor problems that may have arisen.

## **Pre-operative Feeding Guidelines**

For **all** emergencies, such as reduction of fracture, the general rule is no safe fasting period; **assume a full stomach**.

For elective surgery in children:

- Clear fluids up to 1 hour preoperatively (max 3ml kg<sup>-1</sup> in last hour)
- Breast milk may be given up to 4 hours preoperatively
- Solids, other milk drinks, and fizzy drinks should only be given up to 6 hours

## **Anaesthetic Record**

This is a vital part of your anaesthetic management and will be assessed. The anaesthetic sheet is a legal document describing anaesthetic care and should be carefully filled in. It is recommended that a record of blood pressure and heart rate be made as soon as possible. This only takes a second, but is very valuable, especially in the event of something untoward happening. We conduct an audit of anaesthetic record sheet keeping during your rotation.

In addition, the drug kardex, fluid chart, and any additional charts for analgesia should also be completed when appropriate.

## **Emergencies and Call**

Frequently cases are added to elective lists – unfortunately ward and surgical staff can forget to tell anaesthetist about them! This is sometimes frustrating, but it is the nature of our work and one has to accept that it will happen!

Consultant cover is provided on a 24 hour basis. It is vital that Consultant opinion should be sought before embarking on potentially difficult cases:

- All neonatal surgery, major trauma, airway surgery (i.e. bronchoscopy, tracheostomy)
- Children less than three years of age and all ASA 3 or 4 children
- When you feel any doubt about the anaesthetic management of a particular patient

**For example, a chubby six month old baby needing inguinal herniotomy can be very challenging on your own! No-one should feel pressurised to do a case on their own and it makes everything easier if there are two pairs of hands available.**

**You are encouraged to become involved in PICU emergency admissions, etc when on-call.**

In the event of an untoward incident, Paediatric Medical Staff are very willing to help in theatre. A crash or emergency team is available. Call **6666**. Paediatric Medical Staff will also help in an emergency if there are any problems with IV access (doctor always available in the PICU).

## **Miscellaneous**

Medical students attached to anaesthesia are not permitted to induce anaesthesia in any of the patients.

Books may be borrowed from the office, but please leave them back and don't take them home.

## **ANAESTHETIC MANAGEMENT OF EX-PRETERM INFANTS**

General anaesthesia in ex-preterm infants (less than 60 weeks Post-Conceptual Age), is associated with life-threatening apnoeas. Avoidance of general anaesthesia by utilising regional anaesthesia (spinal or caudal) may reduce this complication.

### **Standard**

All ex-preterm infants (less than 60 weeks P-CA) undergoing inguinal herniotomy at the RBHSC, should receive a regional anaesthetic. **Supervision by consultant.**

Contra-indications:-

- Back sepsis
- Open spina bifida
- ? Neurological disease

### **Spinal Technique**

1 Preop assessment	a) Fasting Orders b) Parental Discussion c) Underlying problems, BPD, etc
2 Positioning & Asepsis	Lateral or upright may be used Sterile gloves, trolley and syringes, etc
3 Dosing	Heavy Levobupivacaine 0.5% 0.1ml/kg body weight (+0.1ml)
4 Precautions	Return to lateral position until binding complete Experienced surgeon to commence urgently Minimise number of attempts Leg and arm restraints

### **Caudal Technique**

1 & 2	As above
3 Dosing	Plain Levobupivacaine 0.25% 1ml kg <sup>-1</sup> body weight
4 Precautions	Return to lateral position until binding complete Experienced consultant Commence when motor block (10-15mins)

### **Combined Technique**

1, 2 & 3	As above
4	Perform Spinal first for rapid onset and permits analgesia of caudal region.

### Other Points

1. Secure IV access required
2. This technique is not justified for term infants or day cases
3. Respiratory monitoring required postop (24hrs) (Apnoea alarm ± SaO<sub>2</sub>)
4. If failure, etc of regional, then give caffeine 10mg kg<sup>-1</sup> with GA.

## **PARENTAL PRESENCE**

**Final decision is by the anaesthetist doing the case.**

### **Rights**

“Parents have the right to accompany their child as far as the operating theatre”!!

#### When a Parent may NOT be INVITED into the theatre

1. When a child does not want a parent to be present
2. When a parent may not wish to be present
3. For an emergency procedure, or when insufficient staff are present to provide a duty of care for the child and parent
4. For infants less than nine months of age (parents anxious +++;induction difficult)
5. When a parent is judged not to be capable/suitable

Please note that you may prevent problems by personally explaining to a parent why you do not wish them to be present. This is always accepted in even the most extreme cases if the child's welfare is seen to be paramount.

#### When ONE PARENT ONLY may BE INVITED into the theatre

1. When a child (>1 year) wants a parent to be present
2. When a capable parent expresses a wish to be present
3. For an elective procedure or when sufficient staff are present to provide a duty of care for the child and parent.

## ESTIMATION OF BLOOD VOLUME (EBV) IN CHILDREN

AGE	Blood Vol ml kg <sup>-1</sup>
Preterm	90-100
New born	80-85
6/52 to 2years	75
2years to puberty	72

## NORMAL FLUID REQUIREMENTS

Body wt	Per Day (ml kg <sup>-1</sup> )	Per hour (ml kg <sup>-1</sup> )
1 <sup>st</sup> 10kg	100	4
2 <sup>nd</sup> 10kg	50	2
Subsequent kg	20	1

## NORMAL ELECTROLYTE REQUIREMENTS

Body wt	Na	K	Energy	Protein
1 <sup>st</sup> 10kg	3	2	110	3
2 <sup>nd</sup> 10kg	1.5	1	75	1.5
Other kg	0.75	0.45	30	0.75

## PERIOPERATIVE FLUID MANAGEMENT

Consider following aspects:

- **Dehydration** present before preoperative fasting
- **Fluid deficit** incurred during preoperative fasting
- **Maintenance fluid** during surgery
- **Estimated ECF loss** resulting from surgical trauma
- **Alterations in body temperature**

### Short surgical procedures <1hr – fluid bolus

- Giving 20ml kg<sup>-1</sup> peri-operatively reduces the incidence of:
  - thirst
  - drowsiness
  - dizziness

(Anesthesia and Analgesia 1995; **80**: 682-6)

### Surgical procedures >1hr

- IV infusion peri-operatively and postop
- use Hartmann's/normal saline
- monitor CVS indices and urine output
- check blood glucose levels (dextrose 4-6mg kg<sup>-1</sup> min<sup>-1</sup>, as required)

**Formula:**

- |   |                       |
|---|-----------------------|
| - 4ml kg <sup>-1</sup> hr <sup>-1</sup> | 1 <sup>st</sup> 10kgs |
| - 2ml kg <sup>-1</sup> hr <sup>-1</sup> | Next 10kgs            |
| - 1ml kg <sup>-1</sup> hr <sup>-1</sup> | Rest of body weight   |

- **Adjust hourly rate if:**
  - ↑ insensible fluid loss ( $\uparrow$  temp)
  - Extrarenal losses present (GIT losses)
- Compensate for **preoperative fasting**
- **Total volume = number of hours (fasting + surgery) x hourly maintenance fluids**  
i.e., 10kg child, fasting 4hrs, 4hr surgery: fluid =  $(4 \times 10 \times 4) + (4 \times 10 \times 4) = 320\text{ml or } 8\text{ml kg}^{-1} \text{ hr}^{-1}$
- Surgical procedures causing significant tissue trauma and/or blood loss, give **additional fluids** to replace ECF or 3<sup>rd</sup> space losses.
- Use a **balanced salt solution** i.e. Ringer's lactate
  - in preterm and neonates, 10% dextrose is also given to prevent hypoglycaemia
- **Monitor cardiac indices and urine output**

**Blood Product Replacement**

- **See massive transfusion policy**
- Transfuse if blood loss > 15% EBV
- Ca. gluconate 10% 0.1ml kg<sup>-1</sup>. if massive transfusion and unresponsive hypotension
- FFP 10-20ml kg<sup>-1</sup>
- Platelet count <100,000, 1 unit per 5kg body weight

## **SUGGESTED READING**

- Manual of Paediatric Anaesthesia Stewart D.J.
- Pediatric Anesthesia Gregory G.A.
- Anesthetic Management of Difficult and Routine Paediatric Patients Berry F.A.
- Anesthesia and Uncommon Pediatric Diseases Katz J, Stewart D.J.
- A Practice of Anesthesia for Infants and Children Cote C.J.
- Paediatric Anaesthesia Sumner E, Hatch D.J.
- Handbook of Neonatal Anaesthesia Hughes D.G, Mather S.J,  
Wolf A.R
- Your guide to Paediatric Anaesthesia Sims C, Johnson C
- iPhone apps available locally produced include PICU calculator and Paediatric  
Emergencies by ITDCS (Flannigan C, Terris M, Flannigan S)

## **PAEDIATRIC ANAESTHESIA COMPETENCIES**

### **Intermediate Trainees (ST3/4) – from the RCoA CCT in Anaesthetics Annex C**

#### **Learning outcomes:**

- Build on the knowledge and skills gained during Basic Level training
- Develop in-depth knowledge and understanding of the anaesthetic needs of children and neonates
- Understand the potential hazards associated with paediatric anaesthesia and have obtained practical skills in the management of such events

#### **Core clinical learning outcome:**

- Deliver safe perioperative anaesthetic care to ASA 1 and 2 children aged 5 years and over for minor elective and emergency surgery (e.g. inguinal hernia repair, orchidopexy, circumcision, superficial plastic surgery, grommets, manipulation of fractures, appendicectomy) with distant supervision

#### **Competencies – Knowledge**

<b>Competence</b>	<b>Description</b>
<b>General</b>	
PA_IK_01	Recalls/explains the relevance of the knowledge of applied basic sciences to all age groups including neonates
PA_IK_02	Recalls/explains the implications of paediatric medical and surgical problems including major congenital abnormalities (eg tracheoesophageal fistula, diaphragmatic hernia), congenital heart disease and syndromes eg Down's for anaesthesia
PA_IK_03	Recalls/explains the adverse effects of starvation and hypoglycaemia in neonates and children
PA_IK_04	Recalls the specific factors in preoperative assessment and preparation of neonates for surgery
PA_IK_05	Describes special anaesthetic techniques for neonates
PA_IK_06	Explains the difficulty of thermoregulation in the newborn and the measure required to prevent hypothermia
PA_IK_07	Explains the law as relates to children in respect of Consent, Restraint and Research and the concept of 'Gillick competence'
PA_IK_08	Describes the anaesthetic management of neonates and infants for minor operations, major elective and emergency surgery
PA_IK_09	Calculates the analgesic requirements of neonates and infants
PA_IK_10	Describes the specific anaesthetic and monitoring equipment required for neonates
PA_IK_11	Lists common anesthetic problems in the neonatal period and explains their perioperative anaesthetic management (e.g. inguinal hernia, intestinal obstruction, pyloric stenosis)
PA_IK_12	Describes the special problems of the premature and ex-premature neonate

PA_IK_13	Explains the importance of a comprehensive knowledge of Child Protection and how to be responsible for taking appropriate action when non-accidental injury is suspected
	<b>Immediate Care</b>
PA_IK_14	Recalls/explains how to recognise the critically ill child with e.g. sepsis, trauma, convulsions, diabetic emergencies and describes their timely management
PA_IK_15	Explains the principles of stabilisation and safe transport of critically ill children and babies

## Competencies - Skills

<b>Competence</b>	<b>Description</b>
<b>Children and Infants</b>	
PA_IS_01	Demonstrates the ability to resuscitate all ages, both basic and advanced (BLS and ALS)
PA_IS_02	Demonstrates correct preoperative assessment in all ages down to 1 year
PA_IS_03	Demonstrates the ability to use the correct technique for induction, maintenance and monitoring for elective and emergency anaesthesia
PA_IS_04	Demonstrates correct selection, management and monitoring of children requiring diagnostic and therapeutic procedures carried out under sedation
PA_IS_05	Demonstrates ability to maintain perioperative physiology (e.g. glucose, fluids and temperature) in children down to 5 years of age
PA_IS_06	Demonstrates strategies for, and the practical management of, anaesthetic emergencies in children (e.g. loss of airway, laryngospasm, failed venous access, anaphylaxis including latex allergy)
PA_IS_07	Demonstrates correct postoperative pain management, including the use of regional and local anaesthetic techniques, simple analgesics, NSAIDs and opioids
PA_IS_08	Demonstrates the ability to communicate clearly with children & young people, parents and carers, including those with cognitive, communication or behavioural problems.

## Higher Training (ST5-7) – RCoA CCT in Anaesthesia Annex D

### Learning outcomes:

- Capture the maturation process by building on the knowledge, understanding and skills gained during intermediate training
- Become more independent in managing paediatric anaesthesia as demonstrated by requiring less consultant guidance and supervision
- Be competent at managing complications that arise in paediatric anaesthesia without immediate consultant support

### Core clinical learning outcomes:

- Be able to resuscitate and stabilise a sick baby or child prior to transfer to a specialist centre
- Provide perioperative anaesthetic care for common surgical conditions, both elective and emergency, for children aged 3 years and older with distant supervision

## Competencies – Knowledge

<b>Competence</b>	<b>Description</b>
PA_HK_01	Undertakes a critical discussion about the problems and risks inherent in anaesthesia for former premature babies and children with significant co-morbidity
PA_HK_02	Undertakes a critical discussion about the commoner problems of paediatric intensive care, including ventilatory and circulatory support, upper airway problems and trauma.

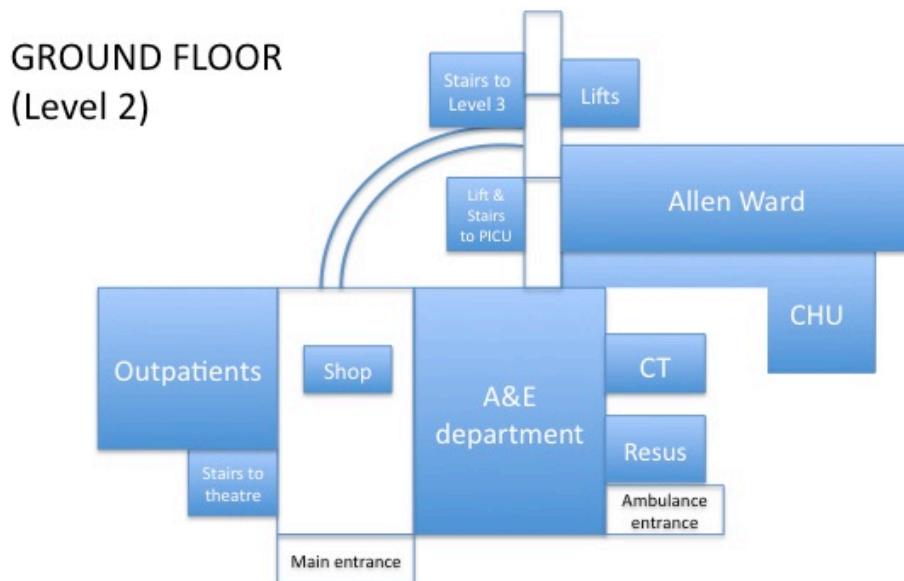
PA_HK_03	Provides a clear explanation of the current local and national guidelines for provision of paediatric services.
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Competencies – Skills in relation to children aged 3 years and older (unless specified):

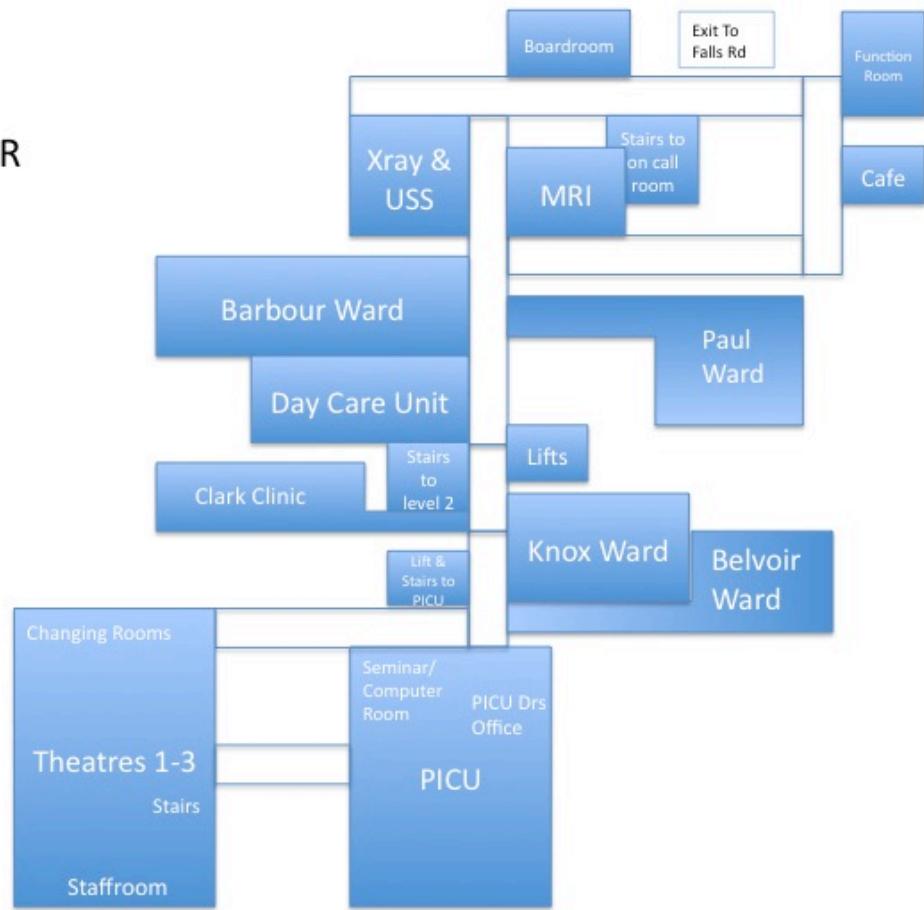
<b>Competence</b>	<b>Description</b>
PA_HS_01	Demonstrates the ability to provide safe perioperative anaesthetic care (including both inhalational and intravenous induction techniques) for children over the age of 3 years with distant supervision
PA_HS_02	Demonstrates the ability to provide safe peri-operative anaesthetic care for children less than 3 years of age under direct supervision
PA_HS_03	Demonstrates ability to manage children with difficult venous access
PA_HS_04	Demonstrates the ability to manage the airway in children and babies of all ages safely and effectively
PA_HS_05	Demonstrates the correct management of fluids, electrolytes, glucose and temperature peri-operatively
PA_HS_06	Demonstrates the ability to manage acute pain in children safely and effectively, including the use of local and regional anaesthetic techniques, the use of opioids (including infusions and PCA/NCA where these are used), adjuvant NSAIDs and simple analgesics
PA_HS_07	Demonstrates the ability to provide safe and effective caudal epidural and peripheral nerve blockade without direct supervision
PA_HS_08	Demonstrates the ability to provide safe and effective anaesthetic management of the young child (less than 5 years of age) with a full stomach
PA_HS_09	Demonstrates the ability to provide safe and effective anaesthesia for children over the age of 3 years for diagnostic radiological procedures
PA_HS_10	Demonstrates effective management of anaesthetic emergencies in children e.g.: acute airway obstruction, croup and acute epiglottitis, inhaled foreign body, loss of airway, laryngospasm, malignant hyperthermia, anaphylaxis (including latex allergy)
PA_HS_11	Demonstrates ability to provide safe transport of critically ill children and babies
PA_HS_12	Demonstrates appropriate engagement in compassionate, authoritative discussion with patients, and/or carers and gives a balanced judgement of the estimated risk and likely complications of anaesthesia
PA_HS_13	Demonstrates ability to take responsibility and appropriate action when non-accidental injury is suspected

## APPENDIX 1

Plan of RBHSC - Schematic diagram only Dr P Fee - October 2019



## FIRST FLOOR (Level 3)



## APPENDIX 2

### PAEDIATRIC SEMINARS IN ANAESTHESIA ATTENDANCE RECORD

August 2021 – October 2021

The following seminars have been organised for August 2021 – October 2021 and will be held on Tuesday & Friday mornings from 8.00am until 8.30am. Attendance is compulsory (unless you are on leave or off-duty) and please sign the attendance register book.

Co-ordinator	Venue
Dr Gallagher/Dr Fee	Teaching Room 2

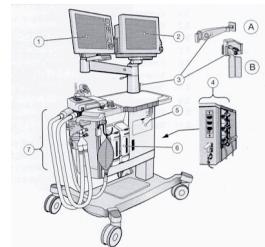
Date	Topic	Presenter
Tuesday 10th August	Paediatric Airway - Anticipated difficult airway and management options	Dr Tim Moore
Friday 13th August	Collapsed new-born	Dr Blayne McCann
Tuesday 17th August	Initial resus of the critically ill child	Dr Arijj Booley
Friday 20th August	Fasting guidelines	Dr Danielle Gallagher
Tuesday 24th August	Management of bronchiolitis, management of seizures in ED	Dr Ruth McCrystal
Friday 27th August	Communication with children and parents and the use of premedication	Dr Garwei Ho
Tuesday 31st August	Paediatric transfusion triggers and massive blood transfusion	Dr Neil Cody
Friday 3rd September	Neurodevelopmental outcomes after anaesthesia	Dr Danielle Gallagher
Tuesday 7th September	Pain management including common RA techniques and their complications	Dr Tim Moore
Friday 10th September	Perioperative management of the child with neuromuscular disease	Dr Arijj Booley
Tuesday 14th September	Monitoring in paediatrics: NIRS and Sedline	Dr Stephen Cullen

Friday 17 <sup>th</sup> September	Mediastinal mass and tumour lysis syndrome	Dr Blayne McCann
Tuesday 21st September	Pyloromyotomy	Dr Stephen Cullen
Friday 24 <sup>th</sup> September	Inhaled FB	Dr Neil Cody
Tuesday 28th September	Trisomy 21	Dr Garwei Ho
Friday 1 <sup>st</sup> October	Burns	Dr Ruth McCrystal
Tuesday 5th October	Fluid and electrolyte management in paediatrics: fluids used in theatre (inc. Plasma-Lyte)	Dr Tim Moore
Friday 8 <sup>th</sup> October	Child for emergency neurosurgery	Dr Dr Blayne McCann
Tuesday 12 <sup>th</sup> October	VTE in paediatrics	Dr Arijj Booley
Friday 15 <sup>th</sup> October	Child with cerebral palsy	Dr Danielle Gallagher
Tuesday 19 <sup>th</sup> October	TIVA	Dr Ruth McCrystal
Friday 22 <sup>nd</sup> October	Scoliosis	Dr Garwei Ho
Tuesday 26 <sup>th</sup> October	Eye surgery	Dr Neil Cody
Friday 29 <sup>th</sup> October	Emergence Delirium	Dr Stephen Cullen
Tuesday 2 <sup>nd</sup> November	Post tonsillectomy bleed	Dr Tim Moore

## Maquet FLOW-i C30 Anaesthetic Machine

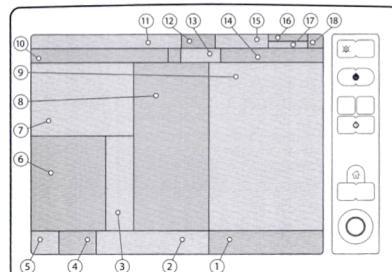
### System Parts:

1. Control panel
2. Patient monitor
3. Additional arm 'A' (option) and/or Gas backup holder 'B' (option)
4. External connections
5. Emergency ventilation system
6. Vaporizer unit
7. Breathing system



### Areas of the screen

1. Ventilation direct access settings
2. Gas direct access settings
3. Fresh gas mix rotameter
4. Fresh gas mix setting
5. APL valve value
6. Gas measurement area
7. Ventilation measurement area
8. Loop area
9. Waveform area
10. System message area
11. Alarm message area
12. Audio pause
13. Vaporizer setting
14. Ventilation mode setting
15. Timer
16. Time and date



17. System power status

18. Patient category

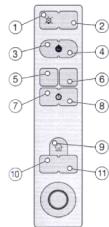
## Navigating the Screen

There are two ways of navigating the screen and setting values:

1. Using the touch screen
  - a. Press the required touch pad; it will become active, indicated by a blue highlight.
  - b. Turn the rotary knob to the required value.
  - c. Press the touch pad to confirm the new setting.
2. Using the rotary knob
  - a. Turn the rotary knob to move between the touch pads on the screen. The selected touch pad is indicated by a blue frame.
  - b. On required touch pad, press the rotary knob to activate the touch pad. This will highlight the touch pad in blue.
  - c. Turn the rotary knob to the required value.
  - d. Press the rotary knob to confirm the new setting.

## Membrane buttons

1. Audio pause



2. Audio profile

3. Start case

4. End case

5. Save screen

6. Trends

7. Start/Stop timer

8. Reset timer

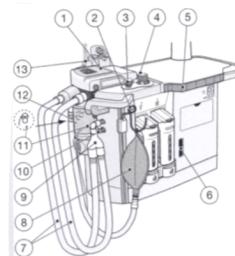
9. Home

10. Screen layout

11. Menu

## Breathing system

1. Patient cassette



2. Oxygen flush

3. MAN/AUTO ventilation switch

4. APL valve

5. Volume reflector

6. AGS (Anaesthetic Gas Scavenging) flow indicator

7. Patient tubing

8. Manual breathing bag with tubing

9. Y-piece

10. AFGO – Additional Fresh Gas Outlet

11. Water trap and sampling line

12. Carbon Dioxide Absorber

13. Auxiliary oxygen and suction module (option)

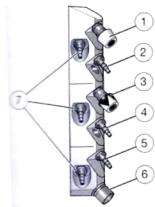
## Vaporizer unit

The vaporizer unit holds one or two vaporizers, either Isoflurane, Sevoflurane or Desflurane.



## Gas Connections

1. Oxygen outlet (option)
2. Oxygen inlet
3. Air outlet (option)
4. Air inlet
5. Nitrous oxide inlet
6. AGS outlet
7. Gas cylinder inlets for oxygen, air and nitrous oxide (option)



## System Startup

Start the system by means of the Power button found directly above the emergency ventilation system.

## System Checkout

A prompt to start the system checkout procedure is automatically displayed at system startup:

1. Bypass the System checkout
2. Start the System checkout

The system checkout can also be initiated via the Menu membrane button during Standby.

The procedure includes the following main areas:

1. Preparations
2. Checks requiring user interaction
3. Automatic checks

The compliance compensation calculations are performed on the current set-up of the system, and are subject to changes in the breathing system volume. When patient tubing is changed, or if additional equipment adding volume to the breathing system is mounted onto the system, previous compliance calculation data and tidal volume data become obsolete. A new system checkout must be performed to update the system and have the correct administration of gas flow and anaesthetic agent.

To ensure correct system functionality, optimal performance and patient safety, the System checkout procedure must be performed as follows:

1. Once a day, or before connecting the first patient within a running 24 hour period.
2. After replacing the patient cassette.
3. After the system has been transported.

If the system needs to be used immediately, i.e. during an emergency, values and results from the last successful System checkout remain in effect.

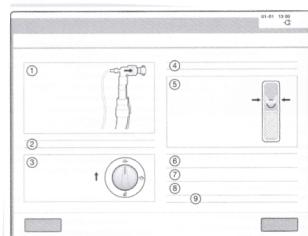
Press the Start touch pad in the System checkout window to begin the procedure.

### Preparations

The first part of the System checkout procedure ensures that the system is correctly prepared for use. Check the components listed on the screen and press the 'Continue' touch pad located in the bottom right of the screen when finished.

An in-depth description follows:

1. Check that the breathing circuit is correctly mounted and connected to the test plug (A).
2. Check the water trap and sampling line. Discard/empty any water present in the trap.
3. Check that the absorber is correctly mounted and unsaturated. Also check that the switch is in the 'locked' position.



4. Check that the vaporizers contain sufficient agent.
5. Check that the Anaesthesia Gas Scavenging (AGS) flow indicator is above the dashed area. Optimal position is indicated by the arrows. CAUTION: Ensure that the AGS is correctly connected or anaesthetic agent will be emitted into the operating environment.
6. Check that the central gas supplies are connected
7. Check that the backup cylinders are opened. Close the cylinders after completing the system checkout. WARNING! If the backup gas supply pressure is higher than the central gas supply pressure [Which it should be!], the backup cylinder gas will be used during the system checkout. Make note of the backup cylinder pressure presented on the control panel screen during the system checkout.
8. Check that the manual resuscitator is readily available and is working correctly.
9. Check for adequate suction pressure in the suction unit and that the auxiliary oxygen flow is functioning properly.

#### Checks requiring user interaction

The second part of the system checkout procedure requires the user to perform a few actions before proceeding to the next step:

- A. Manually test the Oxygen flush:
  - a. Press the 'Start check' touch pad.
  - b. Fully depress the oxygen flush button for approximately 3 seconds. If the test is successful, 'Passed' appears on the panel screen. Continue to the next step, otherwise repeat the test.
- B. Inspect the function of the inspiratory and expiratory unidirectional valves:
  - a. Open the patient cassette lid.
  - b. Press 'Start check' and ensure that the unidirectional valves are moving up and down.
  - c. Confirm by pressing 'Yes' on the panel screen prompt.
  - d. Close the patient cassette lid and press 'Continue'.

#### Automatic checks

The third part of the System checkout procedure contains a number of tests that the system automatically performs. These are as follows: Internal tests, Barometer, Gas supply pressure, Pressure transducers, Safety valve, Vaporizer inlet/outlet valve, Flow transducer, AUTO ventilation leakage, MAN ventilation leakage, Gas analyzer, Battery, Vaporizer 1, Vaporizer 2, Technical alarms.

Components listed on the screen are individually tested. 'Passed' (green text) or 'Failed' (red text) is displayed after each test depending on the outcome.

The automatic check procedure ends when all tests are performed. This procedure can at any time be bypassed by pressing the Bypass touch pad located in the lower left are of the panel screen...

The current leakages for manual and automatic ventilation are displayed separately in ml/min. A maximum leakage of up to 150ml/min is allowed for each of the ventilation modes.

WARNING! If the System checkout is unsuccessful, the system must not be connected to the patient until the malfunction is corrected.

## Finalization

Once all checks are completed, a summary is displayed on the screen. Press the Standby touch pad located at the bottom right of the screen to enter Standby mode. Checks can be repeated by pressing any of the touch pad buttons located in the bottom left area of the panel screen:

1. Redo System checkout, 2. Redo leakage check, 3. Redo vaporizer check.

These checks can also be initiated in Standby mode via the Menu membrane button.

The results of each test can also be viewed by pressing the 'Results' touch pad in the Standby mode main screen, or by accessing the System checkout sub-menu via the Menu membrane button. CAUTION! Close the backup cylinders after completing the System checkout to avoid unintentional use or leakage of the backup gas.

## Bypassing System checkout

In emergencies, the System checkout can be bypassed at any stage of the procedure. This, however, is not recommended. With an emergency startup situation, Manual ventilation and fresh gas dosage are ready for use within 15 seconds. Monitored parameters have full accuracy after a maximum of 15 minutes. However, pressure, flow and volume displays will be 90-95% accurate after approx 2 mins.

### Leakage check

Performs a leakage check of the manual and automatic breathing circuits. It shall be performed after each change of tubing, breathing bag or filter. Leakage check preparatory phase contains four steps, equivalent to steps 1, 2, 3 and 6 performed during the full system check.

### Vaporizer check

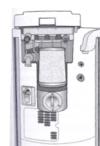
Performs a leakage check of the manual and automatic breathing circuits and a check of vaporizer functionality. It shall be performed after a vaporizer has been connected to the system.

The first part is identical to the Leakage check and is made to ensure that no agents leak out into the operating room during Run mode. Vaporizer check preparatory phase contains six steps, equivalent to steps 1 to 6 performed during the full System checkout.

### Start case

Once a successful system checkout has been performed, the system is ready to start a patient case. Customize the case by defining the patient category, ventilation mode, ventilation mode settings, and alarm limits. Press the 'Start case' membrane button to start the case.

## Carbon Dioxide Absorber



The pre-packed Carbon Dioxide absorber contains 700ml of absorbent (soda lime). The CO<sub>2</sub> absorber switch can be in three positions: Unlocked (not in use), Bypassed, Locked (in use).

### Unlocked

In this position, the absorber can be mounted or dismounted from the system. Once mounted, turn the locking switch counter-clockwise to return the absorber to the system.



### Bypassed

In this position, the patient cassette seals the gas flow and bypasses the absorber. Turn the switch counter-clockwise to return the absorber into the breathing system. The system compensates for the change in compliance when the CO<sub>2</sub> absorber is bypassed.



### Locked

In this position, the expired gas flows through the CO<sub>2</sub> absorber, i.e. normal position.



### Replacement of absorber

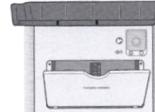
During use, a pink (white-to-pink grade) or violet (white-to-violet grade) colour will develop and successively deepen in intensity, indicating exhaustion of the soda lime. A slowly increasing inspiratory carbon dioxide concentration will usually begin to occur when the colour change has penetrated to around half the depth of the absorber canister.

Colour changes of the soda lime can however be misleading, and suitable monitoring of inspired carbon dioxide is required to assess when to replace absorber. If the CO<sub>2</sub> absorber is not used for prolonged periods of time, the colour indicating soda lime exhaustion may fade due to drying out. The lifetime will depend not only on the original soda lime performance but also on the amount of CO<sub>2</sub> absorbed. Spent soda lime may still contain some absorbed or entrained anaesthetic agent which needs to be assessed and managed according to hospital routines. As a rough guide, the absorber will absorb approx. 140l of CO<sub>2</sub> per kg. This equates to about 8 hours per soda lime canister (for adults).

### Please note the following:

- If an unexpected increase in inspiratory carbon dioxide occurs shortly after a change of absorber, please manually move the absorber up and down. In rare cases the absorber sealing may interfere with the absorber bypass valve.

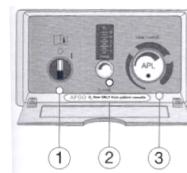
### Emergency system ventilation



In case of a total power (i.e. mains power and battery) or system failure, this system will allow the patient to be manually ventilated.

The emergency ventilation system comprises:

1. Activation switch
2. Oxygen gas supply and flowmeter, graded up to 10l/min
3. Mechanical APL.



To operate the Emergency Ventilation, perform the following:

- a. Activate emergency ventilation (On/Off switch to I)
- b. Adjust oxygen flow
- c. Adjust pressure level

When settings have been made, ventilate the patient using the manual breathing bag. If the emergency ventilation is activated, either during a patient case or when testing the system, the emergency ventilation APL valve must be set to minimum before resuming normal ventilation (AUTO or MAN) or starting a new patient case.

**WARNING!** If the emergency ventilation system is activated while the anaesthesia system is in operation, the anaesthesia system will be shutdown.

**CAUTION!** The emergency flow is always delivered via the patient cassette outlet and thus the patient tubing must always be connected to patient cassette outlets when emergency ventilation is used.

Checking emergency ventilation: To manually check its operation, perform the following:

1. Activate the Emergency ventilation system using the activation switch for emergency ventilation.
2. Set the oxygen flow to 10l/min.
3. Check at various APL settings that the test lung can be ventilated using the manual breathing bag.

If the emergency ventilation is activated, either during a patient case or when testing the system, the emergency ventilation APL valve must be set to minimum before resuming normal ventilation (AUTO or MAN) or starting a new patient case.

**CAUTION!** Staff working with the system should practise regularly using the emergency ventilation system.

## Vaporizers

The vaporizer unit can hold two vaporizers, where you can use Isoflurane, Sevoflurane or Desflurane. Just above the vaporizer, an LED lamp shows the status of the vaporizer or the vaporizer slot:

LED colour	Vaporizer status
Green	Selected vaporizer has passed the System checkout or vaporizer check and is ready to deliver agent.
Yellow	<ul style="list-style-type: none"><li>• The vaporizer slot is selected but no vaporizer is present.</li><li>• The selected vaporizer slot holds an unchecked vaporizer.</li><li>• The selected slot's vaporizer is being filled.</li><li>• The selected slot's vaporizer has triggered an alarm, i.e. vaporizer nearly empty.</li></ul>
Red	The vaporizer is disabled. The power to the vaporizer is shut off.
Not lit/Off	The vaporizer slot is not selected.

### Connecting a vaporizer

Vaporizers can be connected during Standby and Run mode. There is a short delay before a vaporizer can be used after it has been connected due to calibration. A vaporizer check should always be performed after connecting a vaporizer to the system, but in an emergency, or if the system is in Run mode, the check can be bypassed. A 'Vaporizer check bypassed' system message will be displayed in the message area and an entry is made in the event log.

### Connecting in standby mode

Before inserting the vaporizer in the vaporizer slot, a visual check of the exterior and the mesh on the vaporizer inlet and outlet shall be performed. Insert the vaporizer into the vaporizer slot and push into

place until a click is heard. A prompt window appears: 'A vaporizer check should be performed before the vaporizer is used'. Press Start to initiate the check.

#### Connecting in run mode

As above. The vaporizer check cannot be performed during Run mode. A 'Vaporizer check bypassed' message will be displayed on the screen and an entry is made in the event log.

**WARNING!** Bypassing the vaporizer check removes the possibility to detect leakage between the vaporizer and main system. Agent may thus leak out into the room undetected.

#### Selecting active vaporizer

1. Press the vaporizer touch button on the screen.
2. The Select vaporizer window appears. It displays the connected vaporizer's current liquid level (1) and vaporizer type (2).
3. To select a vaporizer, press the required vaporizer type and confirm by pressing Accept. This activates the vaporizer. The agent name is shown on the Vaporizer setting touch pad.

When a second vaporizer is activated, the other vaporizer is automatically de-activated... and unlocked.

#### Refilling a vaporizer

The liquid level can be seen in the monitor tube on the front of the vaporizer, or in the Select vaporizer window. An alarm message will be displayed when the liquid level of the vaporizer is low. A vaporizer can be refilled while connected to the system as well as when it is disconnected from the system. The vaporizer agent level shall never be below the minimum level or exceed the 250ml level (max). The min and max levels are indicated by markings located on the vaporizer monitor tube. To ensure that the correct agent is used when refilling the vaporizers, agent specific adapters are used.

#### Refilling while connected

There is no need to turn off the vaporizer. Perform the following:

1. Lift the vaporizer lid. The vaporizer is depressurised and agent delivery is shut off. The LED above the vaporizer turns yellow. The agent concentration touch pad is grayed out and cannot be selected when the lid is open. A system message is displayed in the system message area until the lid is closed.
2. Position the adapter onto the vaporizer. Again the specific adapter will only match the correct vaporizer. Press the bottle downwards so that the agent liquid flows into the vaporizer. The liquid level can be monitored by looking at the monitor tube.
3. Remove the bottle, close the vaporizer lid. The LED above the vaporizer turns green and agent delivery resumes with the same concentration used prior to the refilling procedure.

Press down on the outer ring on the Desflurane vaporizer connector to release the adapter. If refilling when disconnected, the procedure is identical.

#### Disconnecting a vaporizer

Before disconnecting a vaporizer, it needs to be deactivated. This is done either by setting the vaporizer to non-active in the select vaporizer window, or by using the rotary knob to deactivate the vaporizer. It is not possible to remove a vaporizer that is not deactivated.

To deactivate the vaporizer using the rotary knob, perform the following:

1. Turn the rotary knob counter-clockwise past '0% agent' until 'OFF' is displayed.
2. Press the knob to confirm the new setting. The vaporizer is depressurised, flushed and unlocked.
3. A system message appears when the process is completed: 'Vaporizer OFF, unlocked and ready to remove.'



When the system message appears in the message area, lift the locking handle upwards and remove the vaporizer.

**CAUTION!** When a vaporizer is removed from the system, the gas connector on the rear of the vaporizer can be hot (>47°C).

## Additional Fresh Gas Outlet (AFGO)

AFGO is an option to the anaesthesia system that allows the use of an external partial rebreathing system, such as Bains, Jackson Rees or Mapleson D. When using AFGO the circle system is bypassed and the following can be set: Gas mix, oxygen concentration, fresh gas flow and agent concentration. When AFGO is in use, some parts of the screen have an ORANGE background.

Fresh gas flow ranges are from 1 to 20 l/min . Pre-selecting or activating AFGO in the ventilation dialogue window requires user confirmation. On selecting the AFGO touchpad, a pop-up dialogue appears asking the user to confirm the action.

When the MAN/AUTO switch is set to AUTO it is possible to preset MAN mode to AFGO in the ventilation dialogue window. AFGO is activated when the MAN/AUTO switch is then turned to MAN.

Before using the AFGO outlet, make sure that normal system checkout procedures have been performed and the following requirements are fulfilled:

1. An external breathing circuit is connected to the AFGO outlet (A).
2. The external breathing circuit is connected to the patient gas monitor.
3. The function of the external breathing circuit has been tested according to hospital routines.

### Manage AFGO settings

When the AFGO function is installed on the system, AFGO ventilation is selection in the dialogue window produced by pressing the ventilation mode



available for touch pad.

Pressing the ventilation mode touch pad produces the ventilation mode selection dialogue:

1. Manual
2. Additional Fresh Gas Outlet (AFGO)
3. Automatic Ventilation modes
4. Additional settings.



### Preset and activate AFGO

- Select 'Additional Fresh Gas Outlet (AFGO)' and confirm selection in the dialogue.
- Set the AFGO ventilation parameters by selecting each parameter and adjusting them to the desired value using the rotary knob.
- Adjust the external circuit pressure relief valve to an appropriate value.
- Turn the MAN/AUTO switch to MAN.
- To activate AFGO when preset, press 'Start case' membrane button.
- Verify there is flow at the Y-piece of the external breathing circuit connected to the AFGO outlet.

Remember to consider using scavenging on the external circuit.

Ensure that the fresh gas flow rate is sufficient to avoid unwanted CO<sub>2</sub> rebreathing.



## Ventilation modes

The following modes of ventilation are available from the AUTO settings. Remember that if you want to use the ventilator mode, you need to switch to MAN/AUTO switch to AUTO as well as select the mode on screen.

- Controlled Ventilation
  - Pressure Control
  - Volume Control
  - Pressure Regulated Volume Control (PRVC)
- Supported ventilation
  - Pressure Support
- Combined ventilation
  - PS backup ventilation (PS ventilation combined with PC backup ventilation)
  - SIMV (PC) + PS
  - SIMV (VC) + PS
  -

Please see the manual for further information on these modes of ventilation and the various settings. However, please note these few things:

- The I:E ratio is not fixed and if you adjust the respiratory rate, the I:E ratio will change; remember to adjust it to what you would like.
- Volume cannot be set less than 20mls so it is not suitable for all neonates; use Pressure Control.
- The tolerances for Volume control are +/- 15% or +/- 15 ml whichever is greater and for Pressure control are +/- 15% or +/- 3 cmH<sub>2</sub>O whichever is greater.

## Brakes

Please note there are 4 brakes, one for each wheel, so you may have to release several before you can move the machine.

## Ergonomical positioning

The machine can be moved up and down over a range of about 20cm by pressing the up or down buttons near to the attachment of the clear writing table to the body of the machine.

**APPENDIX 4 – Maquet Flow-i Preparation for Malignant Hyperthermia susceptible patients.**  
Please note that there are filters available for immediate preparation of the machine for an MH susceptible patient if required.



**MALIGNANT HYPERTHERMIA -  
PREPARING THE FLOW-i FOR  
SUSCEPTIBLE PATIENTS**

**MAQUET**  
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**CRITICAL CARE**

**Malignant hyperthermia (MH) - causes, effects and treatment**

Malignant hyperthermia (malignant hyperpyrexia) is a condition caused by an uncontrolled release of  $\text{Ca}^{2+}$  from calcium deposits in the muscle tissue. Triggering factors include certain drugs used for general anesthesia, such as the volatile anesthetic agents Desflurane, Sevoflurane and Isoflurane and the neuromuscular blocking agent succinylcholine<sup>1,2</sup>.

The extreme levels of  $\text{Ca}^{2+}$  induce drastically increased oxidative metabolism in the skeletal muscles. The demand for oxygen increases and carbon dioxide accumulates in the body. End tidal concentration of  $\text{CO}_2$  increases as a result.

The ability to regulate body temperature also decreases. These effects may, if left untreated, lead to multi organ failure and death<sup>1,3</sup>.

The only known treatment after onset of MH is intravenous administration of dantrolene and supportive therapy to combat the symptoms<sup>2</sup>. This, together with preventive measures, has contributed to a decrease in the mortality rate from around 80% during the 1970, to less than 5% today<sup>2-5</sup>.

The majority of patients developing MH have mutations in receptors regulating intracellular levels of  $\text{Ca}^{2+}$  in muscle tissues. These genotypic variants predispose individuals to develop MH when challenged with triggering factors<sup>1,6</sup>.

Maquet Critical Care AB  
SE-171 54 Solna, Sweden  
Phone: +46 8 730 73 00  
[www.maquet.com](http://www.maquet.com)



## MALIGNANT HYPERTHERMIA WASHOUT PROCEDURE

### Incidence

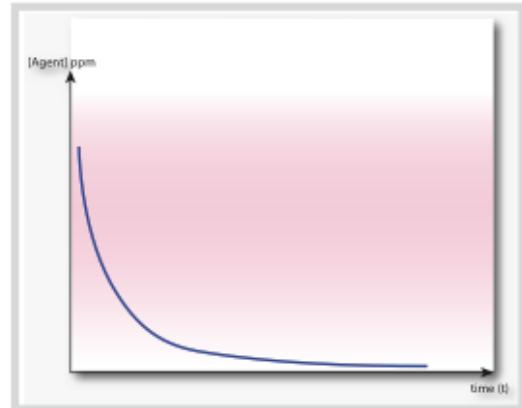
Estimates of the number of susceptible individuals range from 1 in 2000 to 1 in 3000, based on patient genotyping and review of the relatives' medical histories<sup>4</sup>. The incidence of MH ranges from 1 in 10 000 to 1 in 220 000 general anesthesia procedures. Reported cases indicate a bias towards younger patients and male patients<sup>3,4,7</sup>.

### Preventive measures when working with the FLOW-i anesthesia system

During a patient case using Sevoflurane, Isoflurane or Desflurane, a small amount of the agent is absorbed and retained by the parts comprising the breathing circuit. After delivery of agent has been discontinued, absorbed agent is released into the breathing circuit volume. Typical levels are in the ppm (parts per million) range, e.g. 30–60 ppm<sup>10</sup>.

The level of anesthetic agent in the breathing circuit gas volume decreases with time when ventilating using fresh gas only. The illustration to the right shows a typical decrease in detectable agent when a washout procedure is implemented.

While the minimum dose for triggering MH is unknown, a consensus concentration of ≤5.0 ppm has been adopted when preparing anesthetic systems for patients with a known history of MH, or who are suspected of being predisposed to MH<sup>8–10</sup>.

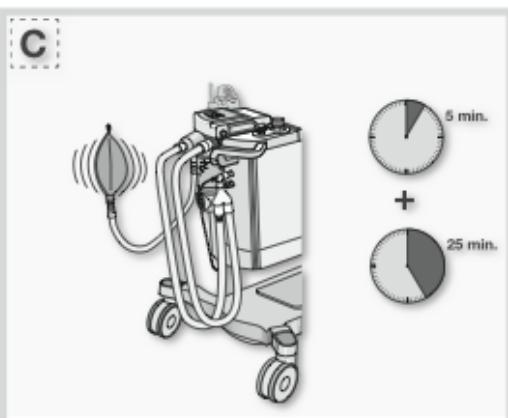
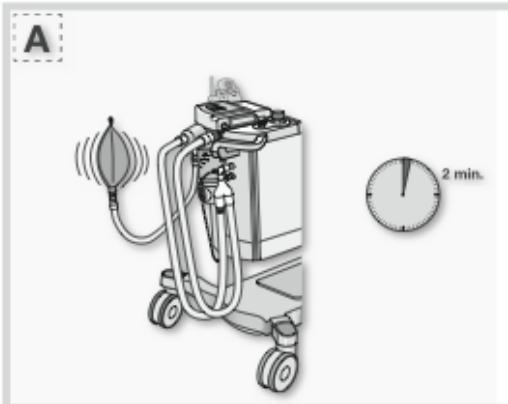


Detectable concentrations of agent in the breathing circuit gas volume. The initial level of agent and clearance rate depend primarily on agent solubility in the parts comprising the anesthetic system<sup>10</sup>.

### **Washout procedure**

The following procedure describes how to clear the FLOW-i of remaining anesthetic agent so as to ensure an agent level <5 ppm.

- 1) Disconnect the absorber and vaporizer. Discard the absorber.
- 2) Attach the patient tubings to the test plug.
- 3) Ventilate vigorously for 2 minutes using manual (MAN) ventilation with a FGF setting of 17 l/min and an APL setting of 10 cmH<sub>2</sub>O (A).
- 4) Replace the patient tubings, manual breathing bag, sampling line and water trap bag with new parts (B).
- 5) Ventilate vigorously for 5 minutes using the same settings as in step 3. Thereafter, leave the system for 25 minutes in MAN mode with the fresh gas flow still at 17 l/min (C).
- 6) Turn off Manual ventilation.  
Attach a new absorber.



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**MAQUET**  
GETINGE GROUP

Maquet Critical Care AB  
171 54 Solna, Sweden  
Phone: +46 8 730 73 00  
[www.maquet.com](http://www.maquet.com)

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**FLOW-i**

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## Checklist for Anaesthetic Equipment 2012

AAGBI Safety Guideline

**Checks at the start of every operating session**

**Do not use this equipment unless you have been trained**

**Check self-inflating bag available**

**Perform manufacturer's (automatic) machine check**

<b>Power supply</b>	<ul style="list-style-type: none"><li>• Plugged in</li><li>• Switched on</li><li>• Back-up battery charged</li></ul>
<b>Gas supplies and suction</b>	<ul style="list-style-type: none"><li>• Gas and vacuum pipelines – 'tug test'</li><li>• Cylinders filled and turned off</li><li>• Flowmeters working (if applicable)</li><li>• Hypoxic guard working</li><li>• Oxygen flush working</li><li>• Suction clean and working</li></ul>
<b>Breathing system</b>	<ul style="list-style-type: none"><li>• Whole system patent and leak free using 'two-bag' test</li><li>• Vaporisers – fitted correctly, filled, leak free, plugged in (if necessary)</li><li>• Soda lime - colour checked</li><li>• Alternative systems (Bain, T-piece) – checked</li><li>• Correct gas outlet selected</li></ul>
<b>Ventilator</b>	<ul style="list-style-type: none"><li>• Working and configured correctly</li></ul>
<b>Scavenging</b>	<ul style="list-style-type: none"><li>• Working and configured correctly</li></ul>
<b>Monitors</b>	<ul style="list-style-type: none"><li>• Working and configured correctly</li><li>• Alarms limits and volumes set</li></ul>
<b>Airway equipment</b>	<ul style="list-style-type: none"><li>• Full range required, working, with spares</li></ul>

**RECORD THIS CHECK IN THE PATIENT RECORD**

**Don't Forget!**

- Self-inflating bag
- Common gas outlet
- Difficult airway equipment
- Resuscitation equipment
- TIVA and/or other infusion equipment

This guideline is not a standard of medical care. The ultimate judgement with regard to a particular clinical procedure or treatment plan must be made by the clinician in the light of the clinical data presented and the diagnostic and treatment options available.

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## CHECKS BEFORE EACH CASE

### Breathing system

Whole system patent and leak free using 'two-bag' test  
Vaporisers – fitted correctly, filled, leak free, plugged in (if necessary)  
Alternative systems (Bain, T-piece) – checked  
Correct gas outlet selected

### Ventilator

Working and configured correctly

### Airway equipment

Full range required, working, with spares

### Suction

Clean and working

## THE TWO-BAG TEST

**A two-bag test should be performed after the breathing system, vaporisers and ventilator have been checked individually**

- i. Attach the patient end of the breathing system (including angle piece and filter) to a test lung or bag.
- ii. Set the fresh gas flow to  $5 \text{ l}.\text{min}^{-1}$  and ventilate manually. Check the whole breathing system is patent and the unidirectional valves are moving. Check the function of the APL valve by squeezing both bags.
- iii. Turn on the ventilator to ventilate the test lung. Turn off the fresh gas flow, or reduce to a minimum. Open and close each vaporiser in turn. There should be no loss of volume in the system.

This checklist is an abbreviated version of the publication by the Association of Anaesthetists of Great Britain and Ireland 'Checking Anaesthesia Equipment 2012'. It was originally published in *Anaesthesia*.  
(Endorsed by the Chief Medical Officers)

If you wish to refer to this guideline, please use the following reference: Checklist for anaesthetic equipment 2012. *Anaesthesia* 2012; **66**: pages 662–63. <http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2044.2012.07163.x/abstract>

# PARENTERAL FLUID THERAPY FOR CHILDREN & YOUNG PEOPLE (AGED OVER 4 WEEKS & UNDER 16 YEARS)

## Essential Monitoring, Observations & Reassessment

### INITIALLY

Admission Weight.

U&E (unless child is well  
& for elective surgery)

### Each shift

Handover and review fluid management plan.

**12 Hourly -**  
Clinical assessment, fluid balance, glucose

**24 Hourly -**  
Clinical reassessment.  
U&E (more often if abnormal; 4-6 hourly if  $\text{Na}^+ < 130 \text{ mmol/L}$ ).  
Weight and weight changes

### ILL CHILDREN

**Hourly** - HR, RR, BP, GCS. Fluid balance (urine osmolality if volume cannot be assessed). **2 - 4 hourly** – glucose, U&E, +/- blood gas.

**Enteral Intake and Medications:**  
Assess and record the volume and type of enteral fluids and IV medications.

If plasma  $\text{Na}^* < 130 \text{ mmol/L}$  or  
 $> 150 \text{ mmol/L}$  or plasma  $\text{Na}^*$  changes  
 $> 5 \text{ mmol/L}$  in 24 hours get senior help

### Routine Maintenance [Uses Weight]

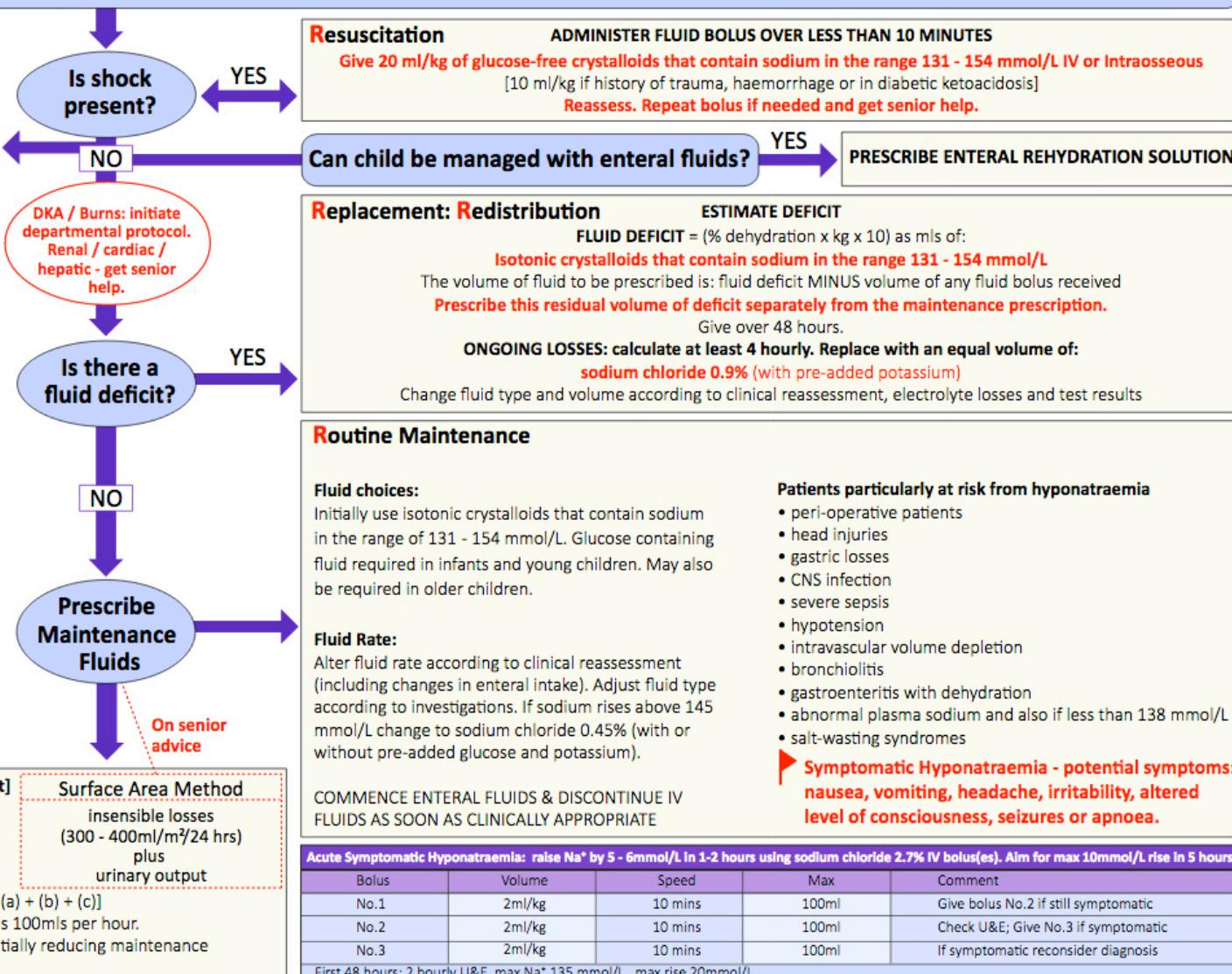
#### CALCULATION OF 100% RATE

- (a) for first 10 kg: 4ml/kg/hr
- (b) for second 10 kg: 2ml/kg/hr
- (c) for each kg over 20 kg: 1ml/kg/hr

[for 100% daily maintenance add together (a) + (b) + (c)]

**MAXIMUM:** females 80 mls per hour; males 100 mls per hour.

If risk of hyponatraemia is high consider initially reducing maintenance volume to two thirds of maintenance.



Hypokalaemia (< 3.5 mmol/L): Check for initial deficit. Maintenance fluid with pre-added potassium required. For concentration > 40mmol/L **get senior help.**

**Hypoglycaemia (< 3 mmol/L). Medical Emergency:** give 2 ml/kg bolus of glucose 10%. Review maintenance fluid, consult senior and recheck level after 15-30 mins. **INTRA-OPERATIVE PATIENTS:** consider monitoring glucose.

APPENDIX 7: AAGBI Guideline on Management of Severe LA Toxicity

**\*\*INTRALIPID is located in the bottom drawer of the red emergency trolley in Recovery\*\***

# AAGBI Safety Guideline

## Management of Severe Local Anaesthetic Toxicity



<b>1</b> <b>Recognition</b>	<b>Signs of severe toxicity:</b> <ul style="list-style-type: none"><li>• Sudden alteration in mental status, severe agitation or loss of consciousness, with or without tonic-clonic convulsions</li><li>• Cardiovascular collapse: sinus bradycardia, conduction blocks, asystole and ventricular tachyarrhythmias may all occur</li><li>• Local anaesthetic (LA) toxicity may occur some time after an initial injection</li></ul>
<b>2</b> <b>Immediate management</b>	<ul style="list-style-type: none"><li>• Stop injecting the LA</li><li>• Call for help</li><li>• Maintain the airway and, if necessary, secure it with a tracheal tube</li><li>• Give 100% oxygen and ensure adequate lung ventilation (hyperventilation may help by increasing plasma pH in the presence of metabolic acidosis)</li><li>• Confirm or establish intravenous access</li><li>• Control seizures: give a benzodiazepine, thiopental or propofol in small incremental doses</li><li>• Assess cardiovascular status throughout</li><li>• Consider drawing blood for analysis, but do not delay definitive treatment to do this</li></ul>
<b>3</b> <b>Treatment</b>	<p><b>IN CIRCULATORY ARREST</b></p> <ul style="list-style-type: none"><li>• Start cardiopulmonary resuscitation (CPR) using standard protocols</li><li>• Manage arrhythmias using the same protocols, recognising that arrhythmias may be very refractory to treatment</li><li>• Consider the use of cardiopulmonary bypass if available</li></ul> <p><b>GIVE INTRAVENOUS LIPID EMULSION</b> (following the regimen overleaf)</p> <ul style="list-style-type: none"><li>• Continue CPR throughout treatment with lipid emulsion</li><li>• Recovery from LA-induced cardiac arrest may take &gt;1 h</li><li>• Propofol is not a suitable substitute for lipid emulsion</li><li>• Lidocaine should not be used as an anti-arrhythmic therapy</li></ul> <p><b>WITHOUT CIRCULATORY ARREST</b></p> <p>Use conventional therapies to treat:</p> <ul style="list-style-type: none"><li>• hypotension,</li><li>• bradycardia,</li><li>• tachyarrhythmia</li></ul> <p><b>CONSIDER INTRAVENOUS LIPID EMULSION</b> (following the regimen overleaf)</p> <ul style="list-style-type: none"><li>• Propofol is not a suitable substitute for lipid emulsion</li><li>• Lidocaine should not be used as an anti-arrhythmic therapy</li></ul>
<b>4</b> <b>Follow-up</b>	<ul style="list-style-type: none"><li>• Arrange safe transfer to a clinical area with appropriate equipment and suitable staff until sustained recovery is achieved</li><li>• Exclude pancreatitis by regular clinical review, including daily amylase or lipase assays for two days</li><li>• Report cases as follows:<ul style="list-style-type: none"><li>in the United Kingdom to the National Patient Safety Agency (via <a href="http://www.npsa.nhs.uk">www.npsa.nhs.uk</a>)</li><li>in the Republic of Ireland to the Irish Medicines Board (via <a href="http://www.imb.ie">www.imb.ie</a>)</li></ul></li><li>If Lipid has been given, please also report its use to the international registry at <a href="http://www.lipidregistry.org">www.lipidregistry.org</a>. Details may also be posted at <a href="http://www.lipidrescue.org">www.lipidrescue.org</a></li></ul>

**Your nearest bag of Lipid Emulsion is kept .....**

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**IMMEDIATELY**

Give an initial intravenous bolus injection of 20% lipid emulsion  $1.5 \text{ ml}.\text{kg}^{-1}$  over 1 min

**AND**

Start an intravenous infusion of 20% lipid emulsion at  $15 \text{ ml}.\text{kg}^{-1}.\text{h}^{-1}$

**AFTER 5 MIN**

Give a **maximum of two** repeat boluses (same dose) if:

- cardiovascular stability has not been restored or
- an adequate circulation deteriorates

Leave 5 min between boluses  
A maximum of **three** boluses can be given (including the initial bolus)

**AND**

Continue infusion at same rate, but:  
Double the rate to  $30 \text{ ml}.\text{kg}^{-1}.\text{h}^{-1}$  at any time after 5 min, if:

- cardiovascular stability has not been restored or
- an adequate circulation deteriorates

Continue infusion until stable and adequate circulation restored or maximum dose of lipid emulsion given

***Do not exceed a maximum cumulative dose of  $12 \text{ ml}.\text{kg}^{-1}$***

**An approximate dose regimen for a 70-kg patient would be as follows:**

**IMMEDIATELY**

Give an initial intravenous bolus injection of 20% lipid emulsion 100 ml over 1 min

**AND**

Start an intravenous infusion of 20% lipid emulsion at  $1000 \text{ ml}.\text{h}^{-1}$

**AFTER 5 MIN**

Give a **maximum of two** repeat boluses of 100 ml

**AND**

Continue infusion at same rate but **double** rate to  $2000 \text{ ml}.\text{h}^{-1}$  if indicated at any time

***Do not exceed a maximum cumulative dose of 840 ml***



This AAGBI Safety Guideline was produced by a Working Party that comprised:  
Grant Cave, Will Harrop-Griffiths (Chair), Martyn Harvey, Tim Meek, John Picard, Tim Short and Guy Weinberg.

**This Safety Guideline is endorsed by the Australian and New Zealand College of Anaesthetists (ANZCA).**