Paediatric Intensive Care Unit

Inhalational Anaesthesia using the AnaConDA Device (Anaesthetic Conserving Device) in PICU/CICU

Staff relevant to:	PICU/CICU medical & nursing staff
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Contents

1. Introduction and Who Guideline applies to

AnaConDa (Anaesthetic Conserving Device) is an anaesthetic delivery system developed for the administration of volatile anaesthetics such as Isoflurane or Sevoflurane, as inhalational sedation to invasively ventilated patients in PICU/CICU in a safe and controlled manner. These guidelines are designed to standardize the care of the child receiving inhaled sedation in PICU/CICU and are not a substitute for training and competency assessment.

Background

Volatile agents, such as isoflourane and sevoflurane, are common inhalational anaesthetic agents used in the Operating Theatre for induction and maintenance of general anaesthesia. All volatile anaesthetic agents share the property of being liquid at room temperature, but evaporating easily for administration by inhalation.

Volatile anaesthetic agent use in the adult intensive care unit, aided by technological advances, has become more accessible to critical care doctors. With increasing concern over adverse patient consequences associated with current sedation practice, there is growing interest to find non–benzodiazepine-based alternative sedatives. Research has demonstrated that volatile-based sedation may provide superior awakening and extubation times in comparison with current intravenous sedation agents (propofol and benzodiazepines). Volatile agents may also possess important end-organ protective properties mediated via cytoprotective and anti-inflammatory mechanisms, as well as having known broncho- and pulmonary vasodilator and anticonvulsant effects (see table below).

The AnaConDa is a less complicated alternative to an anaesthestic machine, providing a small and simple alternative, enabling the use of volatile agents for inhalational sedation in invasively ventilated patients in intensive care. No vaporizer or circle system (CO_2 absorbers and valves) are required. AnaConDa works with any ventilator and syringe pump to deliver the same efficiency as an anaesthesia machine, and has recently been adapted and approved for use in paediatric critical care patients.

2. Guideline Standards and Procedures

Table 1. Potential Advantages, Disadvantages, and Settings for the Use of Volatile Anesthetics for Critical Care Patients

Advantages	Disadvantages	Potential Clinical Settings
Pharmacokinetic and pharmacodynamic properties		
Rapid onset/offset of action No significant tolerance/tachyphylaxis or withdrawal Drug clearance via pulmonary exhalation Low levels of hepatic metabolism, no active metabolites Bronchodilation Anticonvulsant effect No alteration to renal or hepatic laboratory markers	Dose-dependent cerebral vasodilation, rise in intracranial pressure Dose-dependent hypotension Risk of malignant hyperthermia in genetically predisposed patients Rise in serum fluoride levels but currently no evidence of nephrotoxicity	**Short-term (<24 h) postoperative sedation** Volatiles have been shown to provide shorter time to extubation and faster recovery of higher executive function when compared with intravenous sedatives. **Longer-term (>24 h) sedation** Volatiles have shown faster time to extubation after discontinuation of sedation with opioid-sparing effects when compared with intravenous sedatives among general medical-surgical ICU patients. **Complex and failure of sedation** Scenarios using intravenous sedatives (e.g., burns, chronic pain, drug abuse, and status asthmaticus and epilepticus) are well managed using inhalational techniques.
Drug delivery and specialized equipment		
Easy to titrate to clinical endpoint Real-time bedside breath-by-breath monitoring of inspired and expired gas concentration Expired (end-tidal) gas concentration provides good correlate of cerebral concentration	Specialized volatile delivery systems such as the AnaConDa and MIRUS devices Gas scavenging and end-tidal gas monitoring required Recommended minimum tidal volume with AnaConDa is 350 ml and MIRUS is 300 ml Use of volatiles in the ICU is off-label and specialized medical licensing is recommended Optimal drug delivery may become impractical in patients with high-volume bronchial secretions	
End-organ effects		
Potential therapeutic end-organ protective properties on heart, lung, bowel, liver, kidney, and brain	Potential neurotoxicity on the developing brain and elderly patients	

Definition of abbreviation: ICU = intensive care unit.

Inhalative sedation is gaining increasing favour in adult respiratory patients in particular, because of the above properties particularly, improving airway resistance, pulmonary vasodilation and VQ mismatch. In additional there is increasing evidence that the anti-inflammatory properties improve PF ratios in ventilated adults with ARDS (Jahaudon M et al, AJRCCM 2017).

Monitoring volatile agents:

In order to compare the different potencies of the inhaled anaesthetics, a common measure has been developed: the minimum alveolar concentration (MAC).

1 MAC is the agent-specific end-tidal concentration (F_{ET}) at which 50% of healthy volunteers will move and 50% lay still, upon surgical stimulation. F_{ET} = alveolar concentration, which in turn correlates with blood concentration of an inhaled anaesthetic, which in turn correlates with brain concentration.

MAC is thus a standardised measure of the concentration for a given effect of an inhaled anaesthetic.

In middle-aged persons, 1 MAC for isoflurane is 1.15%. For Sevoflurane 1 MAC is 2%. Neonates and pediatric patients will have higher MAC values. MAC decreases with increasing age (older patients are more sensitive), hypothermia, sepsis and the use of concomitant anaesthetics/opiates.

The effect of inhaled anaesthetics is dose-dependent, from sedation effects at 0.2-0.7% MAC, to surgical anaesthesia at 1-1.5% MAC. For treatment of bronchospasm or status epilepticus, doses of approximately 1% MAC have been found to be effective

2.1 Indications for use of Inhalational Anaesthetic agents in PICU and CICU patients

- Status Asthmaticus
- Status Epilepticus
- Children who are difficult to sedate using conventional agent; or to control withdrawal reactions
- Procedural sedation (esp. consider for investigations where spontaneous breathing is required e.g. bronchogram/bronchoscopy/diaphragm screening)
- Children who require short term ventilation and prompt wakening/fast neurological assessment
- Consider in patients with severe ARDS

2.2 Patient exclusion

- Excess secretions requiring frequent suctioning (hence frequent disconnection)
- Patient on HFOV
- Elevated ICP
- Family history of malignant hyperpyrexia

2.3 AnaConDa strategy in PICU/CICU

Select indication for treatment (see above)

Requires patient to be invasively and conventionally ventilated (ETT or tracheostomy)

Use Isoflourane

Starting dose of isoflurane 2ml/hr (see AnaConDA guidance) Aim FET 0.2-0.7% (good correlation between FET and MAC)

Dosing of inhaled anaesthetic is individual and depends on the patient´s condition and haemodynamic status, and the target level of inhaled anaesthetic effect.

The suggested initial infusion rates are merely approximations. Frequent clinical evaluation in the start of therapy will guide further dosage.

(NB. as humidified circuits are standard in our centre, Anaconda will always be placed in the inspiratory side of the circuit. See set up)

The start pump rate of isoflurane is 2 ml/h with inspiratory side placement. Dose titration is done in steps of 0.5–1 ml/h. Bolus doses of up to 0.3 ml with inspiratory side placement give an effect within a minute. Reduced dosing should be considered in hemodynamically compromised patients. High minute ventilation requires higher pump rates to maintain a specific dose and effect.

Titration (0.5–1 ml/h): Increases and decreases of drug delivery in order **to achieve clinical effect** are done in steps of 0.5-1 ml/h. The effect of titration can be evaluated after a few minutes, even though steady state may take longer.

Bolus (max 0.5 ml in standard setup**, max 0.3 ml in inspiratory side placement);** If a short term increase in effect is required, for example for turning or suctioning, a bolus of max 0.5 ml (**0.3 ml in inspiratory side placement**) can be administered. Attention should be paid to the haemodynamic status of the patient, since inhaled anaesthetics are vasodilatory. If necessary, another bolus can be administered after a few minutes

Requires control parameter monitoring (COMFORT score). Titrate dose to achieve sedation/COMFORT score required

Clinical evaluation is the primary method to assess effect when using the AnaConDa. F_{ET} or MAC are merely indicators of the amount of drug in the brain. Remember the surgical anesthesia dose is MAC/FET 1-1.5% so if clinically indicated can go above the stated sedation range of 0.2-0.7% up to this value.

When clinical evaluation is impossible (for example patients receiving neuromuscular blocking agents), the possibility to measure drug concentration with F_{ET} or MAC, as effect indicators, poses an advantage over intravenous alternatives.

During physiotherapy, or periods that require long disconnection from ventilator, can either give a pre disconnection bolus, or move the AnaConDa device from the inspiratory limb of the ventilator to the patient end of the bagging circuit and continue administering isoflurane at the appropriate rate (note the isoflourane will not be being scavenged in this scenario, but

environmental levels have always been measured as extremely low, even when used longer term without scavenging).

Use in combination with analgesia (e.g. Morphine) as per UHL PICU Analgesia and Sedation policy.

If used first line can escalate sedation further if required following UHL PICU Analgesia and Sedation guideline (clonidine/midazolam etc.) -see Analgesia and Sedation UHL Paediatric Intensive Care Guideline UHL C10/2009

Duration of therapy

Use of Inhalational Anaesthesia in PICU/CICU will mostly be used as a short term therapy (24-48hrs), used in patients who are expected to recover/wake up quickly with the above indications. However, if it is working, or required for longer, there is no reason to discontinue therapy. Like all sedative drugs used long term, it should be weaned off slowly to minimise withdrawal symptoms.

Concurrent use with INO

There are no adverse reports of interaction between INO and inhaled anaesthesia, the only reported issue is delivery of INO, which is reduced by concurrent delivery of inhalational anaesthesia via the anaconda (thought to be related to the INO being filtered by the Anaconda device). There are reports that this can be overcome by placing the INO system into the breathing system after rather than before the anaconda device.

2.4 Side effects

1. Hypotension-potent vasodilators

Cardiovascular stable children may require 10ml/kg fluid bolus on initiation of therapy. As with all sedative agents, use cautiously in patients with cardiovascular instability.

2. Malignant hyperpyrexia (genetically predisposed patients)

MH is a rare condition that runs in some families. In affected people some anaesthetic drugs can cause a rapid and dangerous rise in body temperature. The MH reaction begins with increased heart rate and CO2 retention. As it continues the body temperature rises very quickly and muscle cells (including cardiac) are damaged. Success in management lies in maintaining a high degree of suspicion, early diagnosis and institution of treatment.

Please refer to UHL Malignant Hyperthermia Crisis Management Guideline for details including how to administer dantrolene. Malignant Hyperthermia UHL Anaesthetic Guideline UHL C47/2007.

There is also a ‘crisis card’ used in LRI theatres and attached to this guideline

Follow link: Crisis card v1 2019.pdf

Dantrolene dose is 7.5mg/kg.

At Glenfield Dantrolene is kept in Adult ITU and theatres.

In LRI Dantrolene is located (in order of closeness to CICU) in Ward 27 Theatre, Adult ITU and in theatres.

3. Neurological effects

Reports of pupillary changes (mid-size, unreactive) and clonus during therapy which fully reverse once sedation is stopped.

4. Dead space effects

Anaconda device (can be used in all patients, AnaCOndaS has 50ml dead space and rated down to 200ml tidal volume) are mitigated in patients with smaller tidal volumes by placing device in the inspiratory limb of the vent circuit which is the usual set up in UHL as all vent circuits are humidified (see set up below).

Monitoring device

Current Vamos FET monitor requires additional T piece at patient end of circuit in order to measure FET (see set up below). If dead space clinically detrimental, then would need to choose to discontinue continuous FET monitoring or inhalational sedation. Consultant decision based on clinical situation.

5. Rise in serum Fluoride levels with prolonged use

No evidence of associated organ damage (theoretical risk of nephro and neurotoxicity

2.5 AnaConDa Set-up

AnaConDa Set-up

Equipment:

Alaris Syringe Driver

AnaConDa Syringe

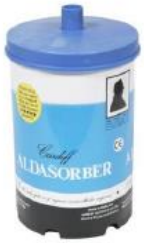
Green Connector/Elbow with Sampling Port

Vamos FET monitor

Anesthetic agent with filling adapter

Gas Monitoring Line

AnaConDa S Device



FlurAbsorb scavenging Filter

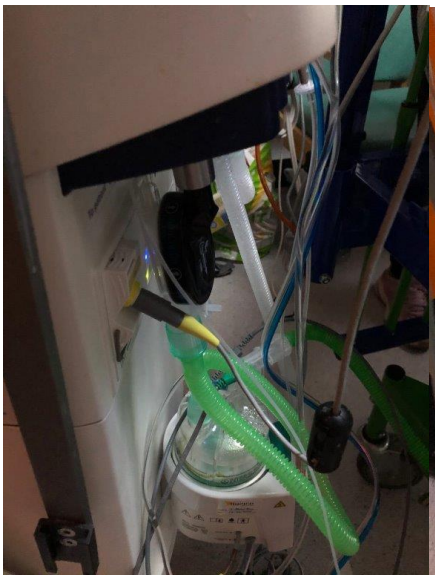
800mm x 22mm Flexi hose

Filling the AnaConda Syringe:

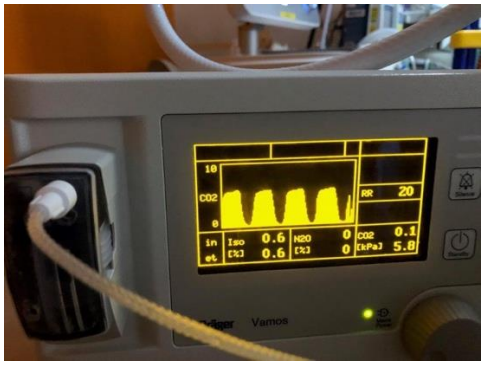
	ACTION	RATIONALE
1.	Ensure anaesthetic agent, dose and route is clearly prescribed. To be checked with two nurses, one of which has received AnaConDa training.	Medicines management Medicines policy
2.	Personal protective equipment: gloves, apron, face visor to be worn. Fill the syringe with air and firmly connect to filling adapter.	To maintain personal safety.
3.	Push air into bottle, invert bottle and allow anaesthetic agent to fill syringe.	To equalise the pressure and prevent spray effect when removing the syringe from bottle.
4.	With syringe still connected to bottle, expel all air	To prevent exposure to anaesthetic agent.
5.	Turn bottle right way up, remove syringe and immediately replace red cap.	To prevent exposure to anaesthetic agent.
6.	Label syringe and sign as policy	
7.	**Important: place syringe into syringe driver with red cap in place**	To prevent a purge and exposure to anaesthetic agent.

2.6 AnaConDa and Ventilator Set up

As all our patients are ventilated with humidified circuits, the AnaConDa device is installed on the inspiratory side of the ventilator, before the humidifier. The AnaConDa replaces the viral filter on the inspiratory side of the ventilator circuit.



With this set up, to monitor FET using the Vamos Monitor , an additional elbow with sampling port, is installed between the flow sensor (Hamilton) or Y connector on the vent tubing (servo I) and the ETT tube



3. Education and Training

None

4. Monitoring Compliance

None identified at present.

What will be measured to monitor compliance	How will compliance be monitored	Monitoring Lead	Frequency	Reporting arrangements

5. Supporting References

1. Link to Sedana Medical e learning modules
   The AnaConDa - Sedana

2. Machester Childrens Hospital and Our Lady's Childrens Hospital, Ireland Inhalational Anaestheisa guidance

3. Volatile anaesthetics. Jerath et al. Am Jounal of RCCM 2016, Vol 193, 1202-1212

4. Decreased nitric oxide concentration when usd in conjunction with AnaConDa device. Letter to editor. Anaesthesia-Analgesia. Sept 2011, Vol 113, No 3, Pg 664-665

5. Isoflourance therapy for severe refractory status asthmaticus in children. Shankar et al, ICM (2006) 32. 927-933

6. Long term Inhalative Sedation in children with pulmonary diseases, Mayberg et all, Journal of ICM, 2020 *NE*

6. Key Words

Isoflourance, Sedation, Ventilation

The Trust recognises the diversity of the local community it serves. Our aim therefore is to provide a safe environment free from discrimination and treat all individuals fairly with dignity and appropriately according to their needs.
As part of its development, this policy and its impact on equality have been reviewed and no detriment was identified.

CONTACT AND REVIEW DETAILS	
Guideline Lead (Name and Title) Claire Westrope - Consultant	**Executive Lead** **Chief Medical Officer**
Details of Changes made during review: **April 2024** **No changes**	

Appendix 1: Isoflurane prescription chart

ISOFLURANE Volatile Sedation via AnaConDa (Anaesthetic Conserving Device) Prescription Chart

Addressograph

Change AnaConDa device every 24hrs					
Date					
Time					
Check 1					
Check 2					

Change Scavenger every 3 or 10 syringes					
Date					
Time					
Size					
Check					

Ward: Weight: Is there a family history of hyperpyrexia?.....

Infusion (withdraw isoflurane from bottle into specific AnaConDa syringes)

Date	Drug	Route	Volume	Rate (range) ml/hr	FET% range	Prescriber signature	Print name	Pharm
	ISOFLURANE	ETT via AnaConDa	50ml					

Date																			
Time																			
Drawn up by																			
Checked by																			
Started by																			

Bolus: (given from 50ml infusion)

Date	Drug	Route	Bolus range (ml)	Prescriber signature	Print name	Pharm
	ISOFLURANE	ETT via AnaConDa				

Date																			
Time																			
Bolus (ml)																			
Given by																			
Checked by																			

S.Wheeler (Pharmacy) Dec2020 vs2

Bolus: (given from 50ml infusion)

Date	Drug	Route	Bolus range (ml)	Prescriber signature	Print name	Pharm
	ISOFLURANE	ETT via AnaConDa				

Date																			
Time																			
Bolus (ml)																			
Given by																			
Checked by																			

Rate changes:

Date	Time	Rate	FET%	Sedation score/reason

Date	Time	Rate	FET%	Sedation score/reason

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