NETS WA
Newborn Emergency Transport Service

Air Transport (Special Features of)

Scope (Staff):	Nursing and Medical Staff
Scope (Area):	NETS WA

Child Safe Organisation Statement of Commitment

CAHS commits to being a child safe organisation by applying the National Principles for Child Safe Organisations. This is a commitment to a strong culture supported by robust policies and procedures to reduce the likelihood of harm to children and young people.

This document should be read in conjunction with this disclaimer

Aim

This guideline summarises the physiological effects of altitude to consider when transporting a newborn baby by air.

Risk

Neonatal aeromedical retrievals are challenging retrievals. Personnel undertaking these retrievals must understand the changes in physiology that occur during air transport with special considerations to the newborn to ensure a safe retrieval

Stressors of flight

Altitude hypoxia

- As altitude increases, the atmospheric pressure decreases leading to a lower partial pressure of oxygen in the atmosphere. Although the percentage of oxygen in the air remains 21%, the oxygen delivery to the alveoli is decreased leading to relative hypoxia.
- At 8000ft (normal cruising cabin altitude), oxygen saturations will decrease to the low 90's in normal healthy adults due to the decrease in pO_2 (Fig 1) Healthy adults normally tolerate this without complication. However, in newborns with underlying cardiorespiratory conditions, the decrease in oxygen saturations may be more pronounced.

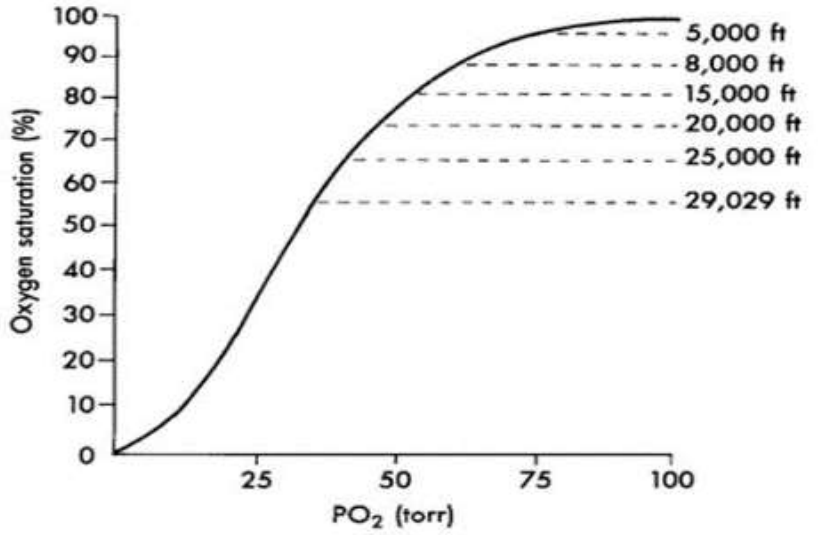

Fig 1: Oxygen Haemoglobin Dissociation Curve. Approximate oxygen saturations are marked for different altitudes with no oxygen supplementation [1]

Management

- All neonates may require supplemental oxygen during the flight even if oxygen saturations are within normal range prior to departure. Altitude induced hypoxia is treated by giving supplemental oxygen at altitude – this can be given via nasal prongs, cot oxygen or by increasing the FiO_2 if on respiratory support.

It is important to consider whether an increase in oxygen requirement at altitude is due to normal physiological changes of altitude or due to a clinical deterioration.

Gas Expansion

- According to Boyles Law, gas will expand with increasing altitude as the atmospheric pressure falls. During an aeromedical retrieval, gas expansion can adversely affect the patient, the crew and equipment. Gas in an enclosed space (gut, lungs, sinuses, middle ear) will expand by 30% when flying from sea level to 8000ft (normal cruising cabin altitude) with potential clinical implications [2]

Gas expansion is important to consider when transporting neonates with the following conditions:

- Pneumothorax
- Bowel Obstruction
- NEC with pneumatosis/acute abdomen
- Congenital diaphragmatic hernia/ Ventilated trache-oesophageal fistula

Management

- The decision whether to insert an intercostal catheter in a pneumothorax for transport may be challenging due to the balance of clinical status, risk of

deterioration, length of flight and risk of complications of drain insertion. A small pneumothorax may expand at altitude causing clinical compromise although there are case reports of neonates with pneumothoraces being safely transported by air without intercostal catheter insertion [3] Always discuss with NETS Consultant whether drain insertion is required.

- Chest drains should be positioned correctly, secured, and attached to a portable Heimlich valve (fig 3). Bile bags can be attached to the distal end of the Heimlich valve if there is fluid draining e.g., chylothorax. A bile bag should not be required in a simple pneumothorax.
- Insert nasogastric/ orogastric tube on free drainage if on respiratory support. Aspirate the stomach prior to transport in all neonates.
- There is a risk of tracheal necrosis with pressure from a cuffed ETT due to expansion of air in the cuff at altitude. The cuff pressure should be checked at altitude with consideration to deflate the cuff for flight [4]

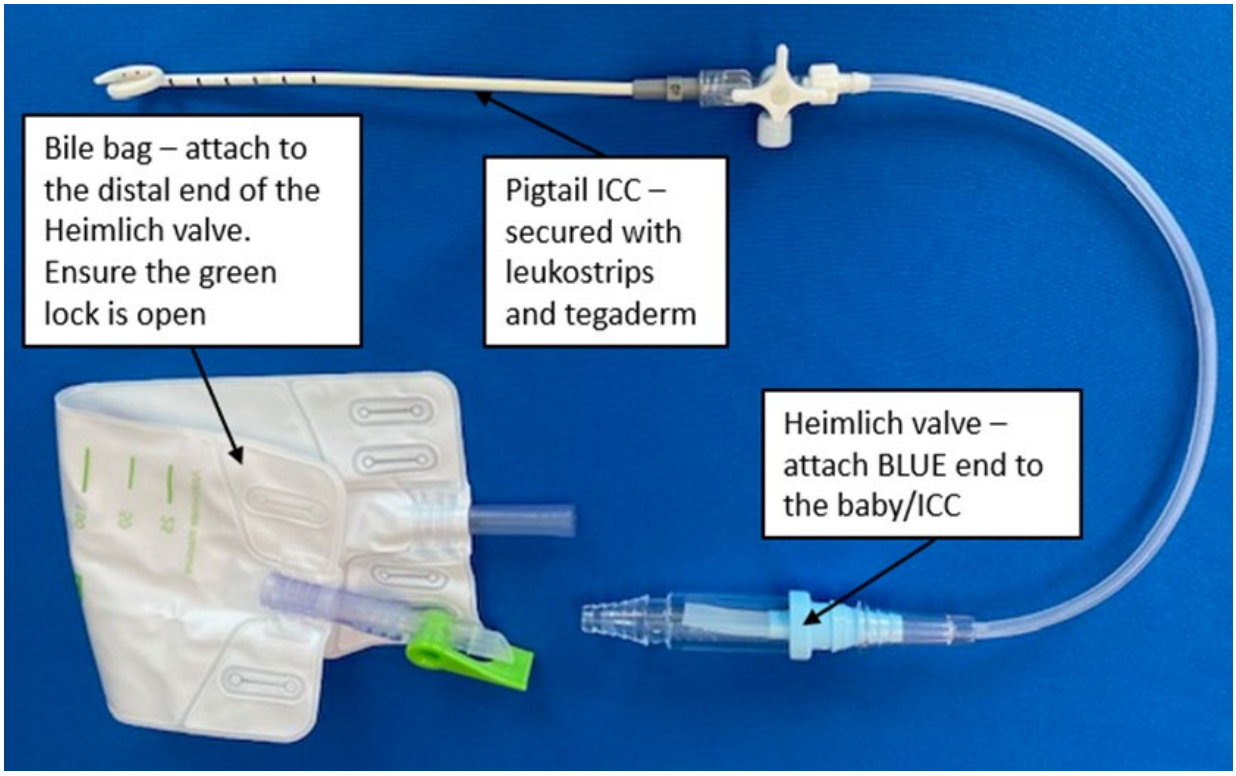

Fig.3 Pigtail ICC and Heimlich valve

Cabin Pressurisation

Depending on the type of aircraft used and the length of flight, cruising altitude during WA retrievals is usually between 13 - 43,000ft. To maintain a safe and comfortable environment for patients and crew, the cabin is pressurised to 6 – 8000ft. Cabin pressurisation is achieved by pumping air into the cabin which maintains the ambient altitude significantly lower than the flight altitude.

In a sea level cabin, there is additional pressurisation to maintain the atmospheric pressure inside the cabin the same as sea level/ original altitude to minimise the impacts of altitude induced hypoxia and gas expansion.

A sea level cabin may be required when the effects of altitude induced hypoxia or air expansion may be detrimental to patients e.g.,

- Critically unwell baby with high oxygen/ ventilator requirements e.g., MAS/PPHN
- Bowel obstruction
- Ventilated trache-oesophageal fistula
- Pneumothorax

However, there needs to be consideration between flying with normal cabin pressurisation and the consequences of a sea level cabin. With the extra pressurisation to a sea level cabin, aircraft are heavier, fly slower and lower with a higher risk of turbulence and higher fuel consumption.

Always discuss cabin requirements with the flight nurse and pilot prior to take off.

Noise

Noise is the most difficult and troublesome stressors encountered in aeromedical retrievals. Neonates will often be exposed to >80 dB during an aeromedical transport (Fig 4)[5] compared to the recommended level of 45 dB in a Neonatal Intensive Care Unit.[6] Excess noise can lead to stress and discomfort particularly in the critically unwell/ extreme preterm who are more vulnerable to noise than others. A neonatal incubator will decrease some exposure to noise but only by about 6dB.

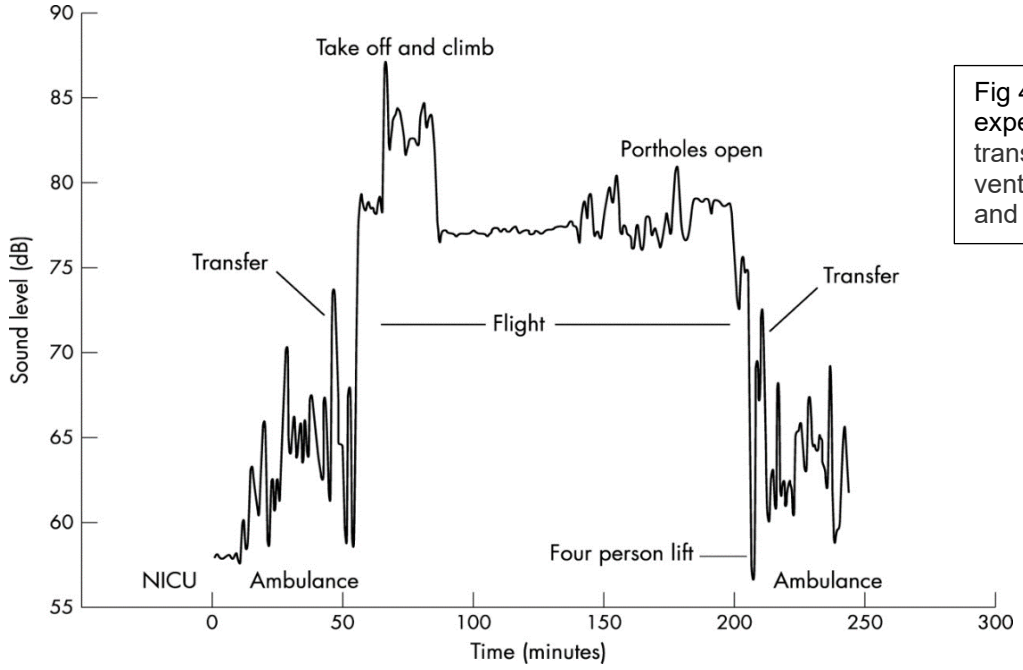

Fig 4: Sound level experienced during transport of a non-ventilated infant by air and road ambulance [5]

Management

- Apply earmuffs to *every* neonate – this decreases noise levels by 7dB
- Noise may interfere with ability to hear monitor alarms therefore ensure they have a visual warning as well.
- It may be impossible to auscultate accurately during flight therefore must rely on clinical acumen to assess patients – close monitoring of clinical observations, abdominal distension, and discomfort levels.
- Communication between team members and parents may be challenging. Be careful not to lift headsets from ears to assist with communication due to the risk of hearing damage

Vibration

The most common source of vibration is the aircraft engines and turbulence. Vibration may interfere with equipment and monitoring.

Management

- Beware of acceleration and deceleration forces during take-off and landing – there may be pooling of blood in upper/ lower body which may cause bradycardia/ apnoea.
- Ensure all lines/ETT are well secured and insertion sites easily visible to allow continuous observation.
- Ensure the baby is restrained securely in case of turbulence particularly if the baby is muscle relaxed. Babies can be restrained using the Neo-Restraint in the Voyager cot (fig 5) or single strap in the Mansell cot (fig 6)

Fig 5. Baby secured in voyager cot with Neo-restraint

Fig 6. Mansell Cot with single strap restraint

Temperature

Thermoregulation is critically important during the transport of a neonate. Hypo and hyperthermia have known deleterious effects to the baby's outcome. Despite being in an incubator, a neonate may become hypo/hyperthermic quickly during loading and unloading of aircraft due to radiant and convective heat loss e.g., a cold windy night in winter or hot summers day with sun streaming through the incubator walls. These effects can be minimised by covering the incubator with a cover/blanket but ensuring the baby can always be seen.

Special Clinical Considerations

Special consideration should be given to the cardiac neonate on prostaglandin infusion. Discussion should be held with the NETS Consultant regarding whether intubation is required prior to retrieval.

Aeromedical Challenges

- Retrievals can be long and fatiguing
- Make sure you have a drink/snack with you
- If you suffer from travel sickness, consider taking medication prior to travel.
- Anticipate the need for deterioration and have the appropriate equipment easily accessible. Clinical deterioration may not always be obvious in a noisy/ vibrating/ dimly lit environment.
- There is a satellite phone on all aircraft which allows communication between the team on board the aircraft and the NETS consultant in the event of deterioration or concerns

Related CAHS internal policies, procedures, and guidelines

Neonatology Clinical Guidelines

NETS WA Guidelines

- Pneumothorax

References

1. Sutton JR et al. Operation Everest II: Oxygen Transport during exercise at extreme simulated altitude J Appli Physiol 64;1309:1988
2. Martin T Aeromedical Transportation: A Clinical Guide 2nd edition Ashgate Publishing Ltd 2006
3. Halibullah I, Hammond F, Hodgson K, et al. Management of pneumothorax in neonatal retrieval: a retrospective cohort study Arch Dis Child Fetal Neonatal Ed 2023;108:F182–F187
4. Britton T et al. Managing endotracheal tube cuff pressure at altitude: a comparison of 4 methods. J Trauma Acute Care 2014;77(3 suppl 2): s240-s244
5. Buckland et al. Excessive exposure of sick neonates to sound during transport. Arch Dis Child Fetal Neonat Ed 2003;88:F513-516
6. Darbyshire JL, Young JD. An investigation of sound levels on intensive care units with reference to the WHO guidelines. Crit Care. 2013;17(5):R187

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