

NEBULISER GUIDELINES

Why use a nebuliser?

A nebuliser is a device which turns an aqueous solution of a drug into a mist of fine particles for inhalation. The aim of nebuliser therapy is to deliver a therapeutic dose of the desired drug within a short delivery time, usually 10 minutes.

This is most beneficial when:

- Large inhaled drug doses are required
- Patients are too unwell or are unable to co-ordinate drug delivery devices
- Drugs are unavailable in hand held inhalers and a wider choice is needed
- Direct pulmonary therapy is required

Therapeutic areas:

Asthma
Bronchiectasis
Immunocompromised Children
Cystic Fibrosis
Prophylaxis

Equipment:

Nebulised therapy should be delivered by a mouthpiece whenever possible as it provides increased lung drug deposition. Lung delivery is two- to threefold higher for oral inhalation than nasal inhalation (ie, by mask).¹ Additionally, some medications, such as ipratropium bromide can potentially cause eye damage. Children under five and other children who are unable to use a mouthpiece should use a mask. If a corticosteroid is being nebulised via a mask, the child should have their face wiped afterwards.

Mask for children under 5 years
Mouthpiece - provides increased drug deposition
Jet Nebuliser chamber
Gas Supply or Compressor

How does a Nebuliser work?

- Nebulisers use compressed gas (normally from a wall outlet, but can be from a canister or compressor) to produce a fine mist of droplets containing active drug.
- This mist can be delivered deep into the patient's lungs to help with the presenting condition.
- In the jet nebulisers used at BRHFC the driving gas passes through a very small hole, a jet, producing an area of negative pressure.
- The solution is sucked up the tube to the baffle and turned into tiny droplets that are inhaled.

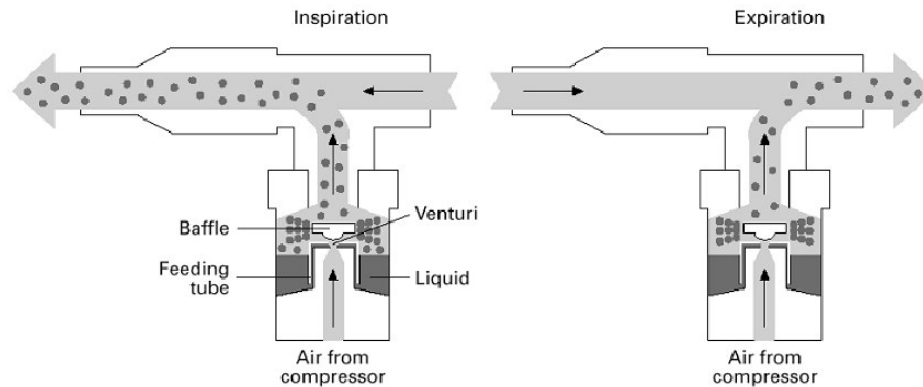


Figure 1 Conventional nebuliser design. Air from the compressor passes through a small hole (Venturi). Rapid expansion of air causes a negative pressure which sucks fluid up the feeding tube system where it is atomised. Larger particles impact on baffles and the walls of the chamber and are returned for re-nebulisation. Small aerosol particles are released continuously from the nebuliser chamber. On expiration the nebuliser continues to generate aerosol which is wasted.

O'Callaghan C, Barry PW. The science of nebulised drug delivery. Thorax 1997;52(Suppl 2):S31

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- The specialist nebuliser systems used with rhDnase, Pentamidine, Ribavirin and TOBI® contain a valve that reduces the drug lost straight to the atmosphere when the patient exhales.

Equipment Used throughout Children's Directorate

(with the exception of NICU):

Mask or Mouthpiece



- Intersurgical Cirrus® 1483/1510
- Mouthpiece (preferred delivery method) or Aerosol Mask with chamber
- Tubing only to be used with non-luer fitting

Jet Nebuliser Chamber



- Intersurgical Cirrus® 1501
- For repeated use for a single patient - discard at discharge

Images courtesy of Intersurgical Ltd (UK)

Correct use of nebulisers:

Correct technique has a dramatic effect on drug delivery so the correct procedure **MUST** be followed:

1 DRIVING GAS:

In acute asthma whilst giving Salbutamol, Terbutaline, Ipratropium or Duovent® use OXYGEN as the driving gas. In all other situations use AIR. Patients with severe asthma are often hypoxic. Giving a bronchodilator via air may worsen hypoxaemia. The appropriate gas should be indicated by the prescriber.

- In acute asthma use oxygen
- All other times use air

N.B. Compressors ONLY deliver air

2 DILUENTS & FILL VOLUMES

All nebuliser chambers leave a residual volume of between 0.5 and 1.0ml. The residual volume in the Intersurgical Cirrus Chamber is 0.9ml. This means that 0.9ml of the drug does not reach the patient, and this should be considered when the dose is calculated. Increasing the fill volume by adding a diluent leads to a decrease in the amount of active drug wasted.

A **minimum fill volume of 4ml** and a **maximum of 10ml** should be used when administering a solution via a nebuliser.
If a diluent is required, unless stated, **ONLY use Sodium Chloride 0.9%.**
Water must not be used as a diluent as it induces bronchospasm.

3 FLOW RATES

Gas flow rate influences both nebulisation time and the size of the droplets being dispersed. An increased flow rate means that although nebulisation time is shorter, the size of the droplets is smaller. For efficient drug delivery to the bronchial tree, the optimum droplet diameter is 1-5 microns.

To achieve this:

The flow rate should be set at **8 litres per minute.**

(NB. Domiciliary oxygen cylinders do not provide an adequate flow rate)

4 DELIVERY TIME

The nebuliser will never run dry due to the residual volume. Dependent upon the drug and nebuliser, up to 80% of the total dose is administered within the first five minutes of delivery. But compliance drops with longer administration time. The nebuliser chamber should be tapped when spluttering occurs.

The delivery time should not exceed **10 minutes.**

5 PATIENT POSITION

The patient should be comfortable and sitting upright. Ensure the mask fits properly and is comfortable and encourage the patient to breathe steadily through the mouth (not nose) where possible. The patient should avoid talking as this reduces the efficiency of drug delivery. Leaning slightly forwards gives maximum expansion of the lungs. **It is important that the nebuliser chamber remains upright at all times.**

6 NEBULISER CARE

Each patient should have their own nebuliser which must be disposed of on discharge. Bacterial colonisation of nebuliser chambers with micro-organisms such as *Burkholderia* spp. has been shown to occur and increases the risk of patient infection. Patient who are receiving long term nebulised therapy should replace the chamber every 3 months.

Therefore:

The nebuliser should be **rinsed after each use** and dried with a soft tissue.
Run the chamber empty for a couple of minutes before the next use to complete drying

Home Nebulisers:

All asthmatic children should additionally have a spacer and bronchodilator available at home. Generally, the hospital does not advocate the use of home nebulisers for asthma as there is a tendency for parents to rely to heavily on them resulting in a delay in their seeking medical attention.

Staff caring for children with cystic fibrosis requiring home nebulisers should contact a Cystic Fibrosis Nurse Specialist on extension 8191 for further information.

Staff caring for children with other respiratory disorders should contact the Respiratory Nurse Specialist for further information.

A record must be kept of all children with a home nebuliser to ensure:

- (a) the appropriate provision of compressors, nebulisers and disposables
- (b) provision of equipment for emergency replacement
- (c) a system for repair, service and maintenance
- (d) patient education
- (e) provision of standard written instructions about the use and cleaning of equipment

Nebulisers should be serviced annually via MEMO.

Two sets of nebuliser disposables should be provided and should be replaced every 3 months.

Drugs Used Via A Nebuliser:

The information contained in this table is for guidance only.
 For further information, read the Product Information Sheet,
 or contact your Ward Pharmacist or the Respiratory Specialist Nurse (x8248).

- Beta agonists, anti-cholinergics, corticosteroids and antibiotics are the main drugs commonly administered by nebuliser - Other medications are used in specialist areas.
- If a diluent is required, unless otherwise stated, only Sodium Chloride 0.9% for injection should be used, as hypotonic solutions can cause bronchospasm. If further advice is required, speak to your ward pharmacist.

DRUG ⁱⁱ	STRENGTH	COMMENT
<i>All mixtures must be visually checked for compatibility</i>		

Bronchodilators

- relax airway smooth muscle and allow easier breathing:

Salbutamol (Ventolin®)	Nebule 2.5 mg in 2.5ml Nebule 5 mg in 2.5 ml Licensed all ages, but caution in <18months	<ul style="list-style-type: none"> • Dilute with Sodium Chloride 0.9% to 4ml • May be mixed with budesonide • May be mixed with ipratropium
Terbutaline (Bricanyl®)	Respule 5 mg in 2ml Licensed for >25kg Respirator Solution 200mg in 20ml (Must be diluted prior to use with Sodium Chloride 0.9%) Licensed for all ages	<ul style="list-style-type: none"> • Dilute with Sodium Chloride 0.9% to 4ml • May be mixed with budesonide • May be mixed with ipratropiumⁱⁱⁱ - check visually before administration as recent formulation change may affect compatibility^v
Adrenaline (Epinephrine)	Injection 1:1000 Licensed for ≥ 1 year	<ul style="list-style-type: none"> • May be diluted with Sodium Chloride 0.9% to 4mls • Observe closely with ECG and monitor oxygen saturation^v

Anticholinergic drugs

- relieve bronchoconstriction:

Ipratropium bromide (Atrovent®)	Nebule 250 mcg in 1ml Nebule 500mcg in 2ml Licensed for >3 years	<ul style="list-style-type: none"> • Dilute with Sodium Chloride 0.9% to 4ml • Use of mouthpiece preferable to mask to reduce risk of damage to eye • May be mixed with budesonide • May be mixed with salbutamol • May be mixed with terbutaline
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Corticosteroids

- are prophylactic in asthma by suppressing the inflammatory process:

Budesonide (Pulmicort®)	Nebule 500mcg in 2ml Nebule 1mg in 2ml Licensed for >3 months	<ul style="list-style-type: none"> Mouthpiece preferable as reduces drug particle deposition around the mouth which can cause a facial rash - wipe face after nebuliser finished Dilute with Sodium Chloride 0.9% to 4ml May be mixed with terbutaline May be mixed with salbutamol May be mixed with ipratropium
Fluticasone (Flixotide®)	Nebule 500mcg in 2ml Nebule 2mg in 2ml Licensed for >16years	<ul style="list-style-type: none"> Dilute with Sodium Chloride 0.9% to 4mls Mouthpiece preferable as reduces drug particle deposition around the mouth which can cause a facial rash

Combination Products

- contain a premixed Anticholinergic and Bronchodilator

Combivent®	Nebule (Ipratropium bromide 500mcg Salbutamol 2.5mg) in 2.5ml Licensed for >12years	<ul style="list-style-type: none"> Should not be diluted or mixed with other drugs Use of mouthpiece preferable to mask to reduce risk of damage to eye Only licensed for use in COPD
Duovent®	Nebule (Ipratropium bromide 500mcg and Fenoterol 1.25mg) in 4ml Licensed for >14years	<ul style="list-style-type: none"> Dilute with Sodium Chloride 0.9% to 4ml Use of mouthpiece preferable to mask to reduce risk of damage to eye

Mucolytics including rhDNase

- Patients with Cystic Fibrosis experience frequent respiratory infections linked to increased sputum viscosity due to DNA released into bronchial secretions.
- Specialist nebulisers available from the Physiotherapy Department deliver rhDNase that cleaves the DNA allowing the sputum to be expectorated.

Dornase Alfa (Pulmozyme®)	Nebuliser Solution 2.5mg in 2.5ml Licensed for >5years	<ul style="list-style-type: none"> Should not be diluted or mixed with other drugs Should be stored in a refrigerator Special nebuliser required - PARI LC PLUS chamber with exhaust tubing and filter
Hypertonic Saline	A Sodium Chloride 5% - 6ml dose Or B Sodium Chloride 7.5% - 5ml dose for CF sputum induction (Using Sodium Chloride 30% Injection) Unlicensed preparation	<ul style="list-style-type: none"> Loosens secretions and is used to induce sputum for diagnosis A Prepare by mixing 1ml Sodium Chloride 30% with 5ml Water for Injections B Prepare by mixing 1ml Sodium Chloride 30% with 4ml Water for Injections May cause nausea and retching Pre-treatment of the patient with a bronchodilator may reduce any bronchospasm Sodium Chloride 0.9% can be used if Hypertonic saline is not tolerated

ANTI-INFECTIVES

Antibiotics

- Antibiotics may be administered to penetrate the focus of an infection in the sputum
- Nebulised antibiotics should always be administered after physiotherapy or bronchodilator treatment, using a mouthpiece.
- Flow rates may need to be increased or a more powerful compressor used - advice should be sought from the Respiratory Specialist Nurse.
- A one-way valve must be used on the exhaust tubing to prevent staff sensitisation and antibiotic resistance - Exhaust either via a window or a filter system - filters should be replaced twice a day
- Use a new ampoule or vial for each dose and dilute as directed in the table below. This will maintain the correct tonicity, therefore preventing bronchospasm.

Colistimethate Sodium/Colistin (Colomycin®)	Injection 1Mu/vial as powder Licensed for all ages	<ul style="list-style-type: none"> • Dissolve with Sodium Chloride 0.9% to 4ml • Should not be diluted further or mixed with other drugs <i>except gentamicin if time factor is crucial</i> • Special nebuliser required - PARI LC PLUS chamber with exhaust tubing and filter
Gentamicin	Injection 80mg/2ml as liquid Not licensed for nebulisation	<ul style="list-style-type: none"> • Dilute up to 4ml with Sodium Chloride 0.9% • May be mixed with Colistin if time factor is crucial^{vi}
Tobramycin	Injection 40mg/ml as liquid Injection 80mg/2ml as liquid Not licensed for nebulisation	<ul style="list-style-type: none"> • Dilute up to 4ml with Sodium Chloride 0.9% • Should not be mixed with other drugs^{vii}
Tobramycin (TOBI®)	Nebuliser Solution 300mg/5ml Licensed for >6years	<ul style="list-style-type: none"> • Special nebuliser required - PARI LC PLUS chamber with exhaust tubing and filter • Should not be diluted or mixed with other drugs and given after all other nebulised drugs • Should be stored in a refrigerator

Pentamidine

- Pentamidine is a potentially toxic drug with many side effects and should only be administered by those experienced in its use - Normally BMT and ODB.
- Protective clothing - mask, apron and gloves - must be worn by staff administering pentamidine.
- As considered a teratogenic agent, women of childbearing age should avoid drug contact.
- Nebulised pentamidine is as prophylaxis against and second line treatment for *Pneumocystis carinii* pneumonia (PCP).
- All patients should be pre-treated with a bronchodilator before beginning the pentamidine dose.
- Nebulisation should be carried out in a separate room away from the main ward area at an air or oxygen flow rate of 8L/min.
- A sealed extraction line and reservoir must be fitted to the nebuliser to reduce exposure to personnel, minimise atmospheric pollution and prevent contamination.

Pentamidine Isethinoate (Pentacarinat Ready-to-Use Solution®)	Nebuliser Solution 300mg/5ml Licensed in Adults	<ul style="list-style-type: none"> • The Product Insert Leaflet should be read before using the drug • May be diluted with Water for Injection • A mouthpiece and exhaust tubing with a filter must be used
Pentamidine Isethinoate (Pentacarinat ®)	Injection 300mg/vial as powder Licensed in Adults	<ul style="list-style-type: none"> • MUST BE MANUFACTURED BY PHARMACY - DO NOT RECONSTITUTE ON WARDS AS TOXIC FUMES ARE GIVEN OFF - Contact Pharmacy Production on x2685 • A mouthpiece and exhaust tubing with a filter must be used

Antifungal Agents

- Amphotericin (Fungizone®) may be nebulised and used to treat fungal lung infections - **Abelcet® must not be used.**
- A test dose must always be given prior to the first full dose and lung function tests recorded - Changes in lung function must be reported to the responsible medical team.

Amphotericin B (Fungizone®)	Injection 50mg/vial as powder Not licensed for nebulisation	<ul style="list-style-type: none"> • Dissolve with 3ml water for injection or Glucose 5% • Concurrent GI and oral eradication may be necessary^{viii}
Liposomal Amphotericin B (AmBisome®)	Injection 50mg/vial as powder Not licensed for nebulisation	<ul style="list-style-type: none"> • Reconstitute vial with 12 ml water for injections • Swirl vial contents just before slowly adding to nebuliser chamber • Special nebuliser required - PARI LC PLUS chamber with exhaust tubing and filter • Respiratory function tests should be performed before and after the first dose to check that bronchospasm has occurred^{ix}
Amphotericin B Lipid Complex (Abelcet®)	Injection 100mg/vial as powder Not licensed for nebulisation	<ul style="list-style-type: none"> • Not recommended for nebulisation as molecule too large^x

Ribavirin

- Ribavirin is a potentially toxic drug with many side effects and should only be administered by those experienced in its use - Normally BMT and ODB.
- Protective clothing - mask, apron and gloves - must be worn by staff administering ribavirin.
- As considered a teratogenic agent, women of child bearing age should avoid drug contact.
- Ribavirin can be used to treat severe Respiratory Syncytial Virus Bronchiolitis most commonly in infants.

Ribavirin (Virazole®)	Nebuliser Powder 6g/vial for inhalation solution Licensed for infants and children only	<ul style="list-style-type: none"> • The Product Insert Leaflet should be read before using the drug • Special nebuliser required - SPAG Generator (available on PICU)
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Nebuliser Protocol Summary:

- The Driving Gas in acute asthma should be **oxygen** otherwise air – the gas to be used should be stated by the prescriber.
- The Gas Flow Rate should be **8 litres per minute**.
- The Delivery Time should be **10 minutes** and any remaining solution should then be discarded .
- Drugs should be diluted with normal saline to a **minimum volume of 4mls** and a maximum of 10 mls.
- Asthmatic patients over the age of 7 years, where possible, must have **pre- and 15 min post- bronchodilator peak flow** measurements charted to enable evaluation of the effects of therapy.
- The nebuliser must be **rinsed after each use**.

References

Unless stated, all data reproduced in this document has been obtained from

BTS guidelines on current best practice for nebuliser treatment. *Thorax* 1997 Apr 52 (Suppl 2): 1-106.

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Drug References

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