

Guidelines for Use of Nebuliser Systems in the Home Environment



Irish Thoracic Society

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Revision Number	1	Approved by	Anáil, Irish Thoracic Society, Chartered Physiotherapists in Respiratory Care, Irish Society of Chartered Physiotherapists
Approval Date	November 2016	Review Date	November 2018

Acknowledgements

The working group wish to thank

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1.0 Introduction

Following the release in 2015, of the Irish Guidelines on Long term Oxygen Therapy (LTOT) in Adults it was realised that similar guidelines on other respiratory aids and appliances provided in the community would be of benefit to both patients and health care professionals and providers. This guideline on nebuliser systems for individuals living in their home environment was identified.

2.0 Methodology

The Working Group consisted of representatives from the Irish Thoracic Society (ITS), Respiratory Nurses Association of Ireland (Anáil), Chartered Physiotherapists in Respiratory Care (CPRC) and Public Health Medicine, as listed below, who undertook the task of developing this document

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The time frame (6 months) for the work of the group was both to ensure, where relevant, the guideline could inform the work both of the National Procurement group involved with developing new national service level agreements with suppliers and the development of national standard operating procedures, and then if indicated to bring to the Winter meeting of ITS, Anáil and CPRC any areas identified for further additional work.

The literature search focussed on English language indications, guidelines or recommendations. The MESH terms used were: nebulizers OR nebulisers OR vaporizers OR vaporisers AND meta-analysis OR systematic review OR guideline OR best w1 practice AND last 5 years. The search strategy had to remain general because it wasn't linked to a condition (which would have made it more effective). The sites searched focussed both on the best clinical summaries products (Up To Date & Dynamed, plus Pubmed, Google Scholar) and then also guidelines via sites like Trip, NICE, and Guidelines Clearing House.

In addition the websites of the following national and international bodies – American Thoracic Society (ATS), British Thoracic Society (BTS), Canadian Thoracic Society (CTS), European Respiratory Society (ERS), Irish Thoracic Society (ITS), National Institute for Health and Care Excellence (NICE), Scottish Intercollegiate Guidelines Network (SIGN), Thoracic Society of Australia and New Zealand (TSANZ) - were searched for English language indications, guidelines or recommendations for the preceding twenty years (ie since 1995).

Group representatives obtained relevant local Irish guidelines.

3.0 Nebuliser Therapy

Drug delivery via inhalation is the mainstay of treatment for many respiratory diseases. The lungs provide an efficient route for the administration of several classes of drugs, as they allow receptors in the airways to be targeted by therapeutic agents. There are a number of devices and delivery methods available for the administration of specific drugs, which include metered-dose inhalers (MDIs), breath-actuated inhalers and dry powder inhalers. Nebulisation is also an important and common method of delivering drugs to the airways. Those caring for patients receiving nebuliser therapy should understand the advantages and limitations of nebulisers use.

The **aim of nebuliser therapy** is to safely and effectively deliver a therapeutic dose of the required drug to the patient as an aerosol in the form of respiratory particles.

The aim of this document is to help improve practice in the use of nebulised therapy in Ireland. It will provide practical advice for those prescribing nebuliser therapy for individuals, for health services supplying and maintaining nebulisers, for those involved in the care of people who use nebulisers and for those whom nebulisation is prescribed. Its focus is on the individual patient in their home environment so this document does not cover nebuliser use in acute hospital settings, emergency care or primary care locations.

The aims are to:

- improve clinical practice
- enhance the safety and efficacy of nebuliser use
- serve as a resource for healthcare professionals
- serve as a resource for health service organisations

Clinical guidelines assist both practitioners and service users in decisions about appropriate healthcare for specific clinical circumstances, across the entire clinical spectrum. Clinical guidelines can improve health outcomes, reduce

variation in practice, improve quality of clinical decisions, influence health service policy and inform service users and the public about the service they should be receiving.

4.0 Definitions

Nebuliser: a device for changing a liquid into a mist of fine particles for inhalation. It is used to deliver drugs into the lungs via a mist of droplets small enough to reach the bronchioles and, in some cases, the alveoli.

Compressor Unit: is the device which drives the nebuliser. It compresses room air and blasts it at a high velocity through a liquid medicine to turn it into a mist of fine droplets which is then inhaled by the individual. Jet nebulisers must be connected by tubing to a compressor to work.

Aerosol output: the mass per minute of particles in aerosol form produced by the nebuliser.

Respirable particles: particles <5 µm diameter.

Respirable fraction: the mass of respirable particles expressed as a percentage of the aerosol output.

Respirable output: the mass of respirable particles produced per minute.

Drug output: the mass of drug produced per minute as an aerosol.

Factors affecting drug output include driving gas flow rate, nebuliser chamber design, residual volume, fill volumes, physical properties of the drug solution/suspension and breathing pattern of the patient.

5.0 Audience

This document is aimed at a wide group of healthcare professionals - doctors, nurses, pharmacists, physiotherapists, – working in hospital, community and institutional settings involved in the care of patients in their home environment, who require nebuliser therapy on an ongoing basis. It is also aimed at health care organisations and their staff involved with approval, provision and maintenance of nebulisers.

6.0 Scope

This document covers individuals of all ages who require nebulisation therapy on an ongoing basis in their home setting/daily lives. It is relevant for all health care professionals involved in the care of such patients and to health service organisations involved in approval, provision and maintenance of such nebulisers. Given the different requirements of those in the paediatric age group – neonates, infants, pre-schoolers, 5-12 year olds, adolescents – at a future date additional sections may be added to identify nebuliser use based on age-physiology.

7.0 Responsibilities

7.1 Prescriber (See Section 11)

Each health professional involved in the prescribing of nebulised medication is responsible for his/her practice.

The person who prescribes a nebulised medication is responsible for ensuring that the use of nebulised drugs is appropriate for that patient.

The prescriber should ensure that the patient (or carer/guardian as appropriate) has been observed to correctly use the nebuliser at commencement of therapy and at regular intervals thereafter.

The prescriber of nebulised medication should ensure that the patient (or carer/guardian as appropriate) is directed to appropriate advice and information, both verbally and in writing, on its use. In particular this should include information on:

- the drug(s) to be nebulised
- how to use the nebuliser
- how to care for it
- what to do in the case of malfunction

and a check on the patient's (or carer/guardian as appropriate) understanding of information given.

7.2 HSE Local Office (in case of individuals with general medical services card (GMS) /long term illness card (LTI) (See Section 11)

It is the responsibility of all health care organisations involved in approval and provision of nebuliser units to ensure an acceptable standard of nebuliser service is provided (see Section 11).

Nebulisers should be approved ideally within one working day of request being received by the local health office. In some instances patients may need more than one nebuliser (see Sections 8, 9). A portable or travel nebuliser should be approved where patient circumstances indicate it is warranted.

Approval should include both an initial two sets of consumables (i.e. drug chamber, interface and tubing) as appropriate for each nebuliser and arrangements for their replacement on an ongoing basis as specified by the manufacturer (see Section 11).

Technical servicing arrangements should be in place and clearly communicated to the patient. This service should be carried out as recommended by the manufacturer.

7.3 Supplier (See Section 11)

It is the responsibility of the supplier to ensure that the patient knows how to care, clean and maintain the equipment, what to do in the case of malfunction, how and when it should be serviced and how to return/dispose of it when no longer required. This should include clear written instructions on all of these aspects.

With the nebuliser compressor the initial supply should include at least two sets of consumables (i.e. drug chamber, interface and tubing) as appropriate for each nebuliser, written information on where, when and how to replace same plus a leaflet explaining use, care, cleaning, maintenance and servicing of unit.

Technical servicing arrangements should be in place and clearly communicated to the patient. This service should be carried out as recommended by the manufacturer.

7.4 Manufacturer

All nebuliser systems should have accompanying written instructions regarding use, care, cleaning, maintenance, technical service and how to dispose of it when no longer needed.

7.5 Patient (or carer/guardian as appropriate) (See Section 11)

It is the patient's responsibility to take care of the nebuliser (see care, cleaning, maintenance - Section 11), to treat it gently and to store on a firm dust free surface.

It is his/her responsibility to dispose of/return the nebuliser if it is no longer needed. It should not be directly passed onto another user.

The patient should have written instructions on how to return a nebuliser which is on loan and likewise how to safely dispose of it if it is no longer required.

8.0 Clinical Indications for Nebuliser Use

For most patients, nebulisers should be the exception rather than rule, and should be prescribed and monitored by specialist respiratory services.

The correct inhalation therapy (and device) for patients relates to patient characteristics, the required drug and inhalation specifications (table 1). Nebuliser treatment may be considered when:

- Patient is unable to use other devices or where cooperation with other devices may be problematic
- Large doses of inhaled medication are needed
- Drugs are unavailable in any other inhaled format

Table 1: Factors determining aerosol delivery (ref Gellar D 2008)

Aerosol factors (drug)	Patient factors
Particle size distribution	Adherence with Treatments
Aerosol density	Tidal volume
Hygroscopic properties	Respiratory Rate
Viscosity and surface tension	Inspiratory flow rate
Suspension vs. solution	Breath-hold time
	Upper airway anatomy
	Lower airway obstruction
	Age
	Cognitive and physical abilities

The individual's and or carer's ability to use the nebuliser should be assessed before prescribing and appropriate support and maintenance of equipment should be available (see Section 11). Nebuliser treatment should be continued where there is benefit for the patient - improvement in symptoms, daily living activities, exercise capacity or lung function.

8.1 Situations/conditions where nebuliser may be considered

8.1.1 Patient Factors - general

- Nebulisers may be necessary for patients of any age who cannot perform the correct inhalation manoeuvre with metered dose inhaler (MDI) and spacer, with or without a facemask e.g. **patients with special needs, or altered mental state.**
- **Cognitive decline** means that more complex manoeuvres with hand held devices may become challenging for patients as they age.
- Similar situations arise with or are compounded by **dexterity issues.** Factors such as arthritis, failing eyesight, reduced inspiratory flow and complexity of treatment regimens should be considered when choosing inhaled devices. The clinician is obligated to prescribe a delivery system that a patient can and will use effectively. For many with limited abilities to adopt complex inhalation manoeuvres, the simplicity of a jet nebuliser may need to be considered.
- Healthcare providers should be aware of emerging problems for patients, be it dexterity or cognitive decline etc and consider the need to change to use of home nebuliser especially for those with chronic lung disease.
- Nebuliser therapy may be considered for patients with **distressing or disabling breathlessness** despite maximal therapy with inhalers.
- Paediatrics: Given the wide range covered by the paediatric age group with their changing physiological abilities, their requirements for inhalation devices including nebulisers changes greatly as they move from neonates to adolescence, in addition to the changing nature of their disease. As with their older counter-parts when able and when drug is available in pMDI + spacer format, nebulisation adds little if anything to outcome.

8.1.2 Patient Factors - Symptoms, Diseases

Home nebulised therapies are available for use in different respiratory conditions. Although there are a number of conditions, those listed in table 2 are the most common. The choice of nebuliser therapy may also depend on other disease factors.

- In **acute asthma with life threatening features** the nebulised route (oxygen-driven) is recommended. In severe asthma that is poorly responsive to initial bolus dose of beta2 agonist, consider continuous nebulisation with an appropriate nebuliser.
- A small cohort of asthmatic subjects may develop **sudden or severe attacks despite little preceding instability**. They require treatment with high dose beta agonist often by nebuliser. Prolonged treatment times favour the nebuliser route of administration.
- Nebulisers can be used in **patients with severe asthma or COPD, particularly those with altered consciousness** as patient coordination is not required. Nebulised corticosteroids should be avoided if possible in those with COPD in view of concerns of risk of pneumonia.
- **Paramedics attending to patients with acute severe asthma or COPD** may administer bronchodilators using a nebuliser, whilst transferring patient to the emergency department. The nebuliser is usually driven by oxygen but exercise caution in COPD patients who may be vulnerable to CO₂ retention.
- The use of a nebuliser in the home is a reasonable approach for patients with obstructive lung disease such as COPD who **cannot achieve a good inhaler technique due to fatigue, frailty**, or other reasons.
- **Bronchiectasis**: some patients with significant bronchiectasis may require home nebuliser therapy. In addition they may require nebulised antibiotics (see below).
- **Bronchiolitis**: nebuliser therapy may be required under special circumstances.
- **Cystic Fibrosis (CF)**: those with CF may require nebulisers for a number of drugs (bronchodilators, steroids, Dornase alpha, antibiotics, mucolytics eg hypertonic saline 7%) may require more than one nebuliser due to drug interaction issues and may require different types of nebulisers to meet both their treatment burden and lifestyle needs.
- **Intubated and Mechanically Ventilated/ Tracheostomy patients**; aerosols can be administered to intubated and mechanically ventilated patients via the 'Aerogen Solo[®]' product, but it may be less time consuming and more convenient to use a nebuliser with appropriate connection for this patient group.
- **Lung infections**: Prevention and Treatment (see below).
- **Palliative care**: nebulisers may be used for the palliation of patients with cough or breathlessness related to advanced lung disease. Nebulised bronchodilators, local anaesthetics, B₂ agonist, mucolytics, opioids, steroids, all in their nebulised format may have a role depending on a patient's symptoms. Nebulised opioids are off license.

Nebulised bronchodilators may be used in treatment of severe coexisting COPD in patients with lung cancer. The use of nebulised saline and mucolytics to loosen airway secretions in patients with advanced cancer remains of unproven value. Nebulised opiates have been shown to be ineffective in the treatment of breathlessness and this therapy is not recommended.

- Treatment Burden/Quality of Life/Lifestyle: Nebulisers are indicated for **patients with significant inhalation treatment burden** e.g. many with CF, some with non CF bronchiectasis, by virtue of their disease, age profile, treatment requirements, lifestyle, etc. This aspect should also be taken into account when considering the type(s) of nebulisers required.

Table 2: Diseases/Conditions for which Nebulisers *may be* required as treatment

Asthma	Other Obstructive or Interstitial lung diseases
Bronchiectasis	Palliative Care: Symptom relief
*Bronchiolitis	Post lung transplant
COPD	Pulmonary Hypertension
Cystic Fibrosis	Respiratory Infection: prevention or control
Intubated patients/those with tracheostomy	

*Special circumstances

8.2 Drug Factors where nebuliser use may be considered

In addition to the patient indications in the above section, nebulisers may be needed to dispense drugs that are not available for delivery by hand held devices or are required in large doses. In some circumstance, drugs other than those listed in the table below may be available for use via a nebuliser in special circumstances under specialist care.

Table 3: Examples of Drugs which may be used in Nebulisers

*Drug Class	*Drug	*Nebuliser Requirement
β2 agonists	E.g. salbutamol	Jet nebuliser/compressor system
Antimuscarinics (anticholinergics)	E.g. ipratropium bromide	Jet nebuliser/compressor system
Combination therapy	E.g. Salbutamol with ipratropium bromide	Jet nebuliser/compressor system
Corticosteroids	E.g. Budesonide, Fluticasone	Jet nebuliser/compressor system
Mucolytics	Normal saline	Jet nebuliser/compressor system or Ultrasonic nebuliser
	Hypertonic saline	Jet nebuliser/compressor system; breath assist open vent jet nebulisers e.g PARI LC Plus, PARI Sprint® or Respironics Ventstream® - useful as they filter for exhaust
	Dornase alpha /DNase	Jet nebuliser/compressor system or a general purpose electronic vibrating membrane nebuliser e.g. Pari eFlow® Rapid nebuliser
Antibiotics	Aztreonam	Altera Nebuliser Handset and Altera Aerosol Head connected to an eBase Controller or an eFlow® rapid Control Unit must only be used
	Colistimethate Sodium	Jet nebuliser/compressor system; breath assist open vent jet nebulisers e.g PARI LC Plus®, PARI Sprint® or Respironics Ventstream® - useful as have filter for exhaust
	Tobramycin	PARI LC Plus® nebuliser with suitable compressor
Pulmonary Vasodilator	Iloprost	I-Neb® AAD nebuliser.

* This list is not exhaustive (e.g. excludes some antibiotics which can be nebulised eg pentamidine)

Special requirements for patients – other than nebuliser requirements – or drug side effects, special precautions are not dealt with in this section.

8.2.1 Bronchodilators: (nebuliser and other formulations)

β2 agonists Salbutamol Nebuliser Solution is indicated for use in the routine management of chronic bronchospasm unresponsive to conventional therapy and the treatment of acute severe asthma. Patients may require it every 4-6 hours or more frequently in acute episodes.

Nebuliser requirement: Jetnebuliser/ compressor system.
Attach to nebuliser unit with a mouthpiece or mask.

Antimuscarinic (anticholinergic) Ipratropium bromide is indicated for the treatment of reversible bronchospasm associated with chronic obstructive pulmonary disease (COPD). Patients may require it every 6 hours. Ipratropium bromide is indicated, when used concomitantly with inhaled beta₂-agonists, for treatment of reversible airways obstruction as in acute and chronic asthma. Under specialist guidance, ipratropium can be of use for symptom relief during the first year of life when short-acting β₂-agonists may be ineffective.

Nebuliser requirement: Jetnebuliser/ compressor system
Attach to nebuliser unit with a mouthpiece (preferably not a mask).

Combination therapy Combivent is indicated for the management of bronchospasm in patients with COPD or asthma who require regular treatment with ipratropium and salbutamol. It is used every 6-8 hours.

Nebuliser requirement: Jetnebuliser/ compressor system
Attach to nebuliser unit with a mouthpiece (preferably not a mask).

8.2.2 Corticosteroids: (nebuliser and other formulations)

Budesonide (as nebuliser) indicated for use with bronchial asthma where use of a pressurised inhaler or dry powder formulation is unsatisfactory or inappropriate. For the same reasons it is occasionally used for those with COPD although not recommended in view of pneumonia risk. It is used every 12 hours. It may also be recommended for use in infants and children with croup in which hospitalisation is indicated.

Nebuliser requirement: Jet nebuliser/ compressor system with mouthpiece

Fluticasone is used in prophylactic management in severe asthma (patients requiring high dose inhaled or oral corticosteroid therapy). It is used every 12 hours. It is also used to treat acute exacerbations of asthma.

Nebuliser requirement: Jetnebuliser/ compressor system with mouthpiece

8.2.3 Antibiotics: Nebuliser only

The antibiotics listed below are of value in those respiratory infections often due to underlying immune suppression for a variety of reasons including CF but are also of value for those prone to respiratory infections due to other underlying respiratory problems.

Aztreonam is used for treatment of *Pseudomonas aeruginosa* chronic infections and is especially used by patients with CF. It is used in cycles of 28 days. It is used every eight hours for the duration of therapy. Patients should use a bronchodilator before each dose of aztreonam.

Nebuliser requirement: Aztreonam can only be used with the Altera Nebuliser Handset and Altera Aerosol Head connected to an eBase Controller or an eFlow® rapid Control Unit. Other medicinal products should not be put in the Altera Nebuliser Handset.

Colistimethate Sodium is used for treatment for *Pseudomonas aeruginosa* colonisation of the lungs, many of whom have CF. It is used twice daily.

Nebuliser requirement: Jetnebuliser/ compressor system with mouthpiece; Breath assist open vent jet nebulisers e.g PARI LC Plus, PARI Sprint® or Respironics Ventstream are useful as they have a filter for the exhaust.

Tobramycin may be used for the long-term management of chronic pulmonary infection due to *Pseudomonas aeruginosa* (aged 6 years and older, although unlicensed it can be used for those under 6years). In Ireland many of these are people with CF. It is used in cycles of 28 days during which it is used twice daily.

Nebuliser requirement: Tobramycin should be administered via PARI LC Plus® nebuliser with a filter and suitable compressor.

8.2.4 Mucolytics: Nebuliser only

Nebulised Sodium chloride 0.9%:(Saline nebs): can be indicated to aid expectoration of respiratory secretions and may be used for added humidification.

Nebuliser requirement: Jetnebuliser/ compressor system with mouthpiece

Hypertonic saline (3%, 6%, 7%) can assist expectoration of respiratory secretions and is frequently used by patients with CF.

Nebuliser requirement: Jet nebuliser/compressor system with mouthpiece; Breath assist open vent jet nebulizers such as the PARI LC PLUS®, PARI Sprint® and the Respironics VentStream® are useful for hypertonic saline as they have a filter for the exhaust to prevent environmental contamination.

Note: Positive expiratory pressure (PEP) therapy may be added to certain nebulisers during nebulisation of saline to aid with the expectoration of pulmonary secretions or airway clearance in certain groups e.g. those with Cystic Fibrosis. This should be completed under the guidance of a Physiotherapist. Examples include PARI PEP S System® for

use with PARI LC PLUS® and PARI Sprint® nebulisers or PARI PEP System II® for use with PARI LC PLUS® and PARI Star® nebulisers.

Dornase alpha/DNase: Dornase alpha hydrolyses DNA in the sputum and reduces sputum viscosity, making it easier for patients to expectorate. It frequently benefits patients with cystic fibrosis.

Nebuliser requirement: It may be administered in conjunction with a jet nebuliser/compressor system or the Pari eFlow® Rapid nebuliser, a general purpose electronic vibrating membrane nebuliser.

8.2.5 Pulmonary Vasodilator: Nebuliser only

Iloprost is used for treatment of Pulmonary arterial hypertension (PAH) in adults with New York Heart Association Class III or IV symptoms. It is used three hourly 6-9 times daily. Each inhalation takes approximately 6-10 minutes depending on the patient’s breathing pattern. Iloprost has been used in children with PAH, although long-term safety and efficacy in paediatric patients has not been established.

Nebuliser requirement: The medication is inhaled through the mouth using the I-Neb® AAD nebuliser. AAD stands for Adaptive Aerosol Delivery system; INeb® senses each patient's breathing pattern and delivers iloprost in the form of a mist only during inhalation. No other drug should be used via the I-Neb®.

8.3 Inhaler Factors/Specifications when considering Nebuliser Use

In addition to patient factors and drug factors, inhaler specifications impact on which to use in what circumstances. There are significant differences between nebulisers, which need to be considered, some of these are listed in the table below. These relate to the discussion in Section 9.

Table 4: Nebuliser Specifications: Physical Parameters

Physical Parameters	Particle mass, inhaled mass, respirable mass
	Lung dose
	Output and output rate
	Residual Volume
	Particle size distribution
	Polydisperse and Monodisperse aerosols
	Administration Time
	Drug Waste during aerosolisation

9.0 Generic and Specific Nebuliser systems

9.1 Overview of nebuliser systems:

The type of nebuliser used is critical to the efficiency of inhalation and deposition of the drug. With all systems it is important to match the correct nebuliser with the correct flow of driving gas or air from a compressor. Different compressors have varying levels of output. Although traditional jet-nebulisers are still widely used for nebulised therapy, “intelligent nebulisers” such as the Pari eFlow® are becoming far more commonplace for patients with Cystic Fibrosis. These are smaller, quicker devices that give improved deposition of a range of medications and ultimately impact on reducing the burden of care.

9.1.1 Ultrasonic nebulisers

Ultrasonic nebulisers are not widely used today. They produce an aerosol via a rapidly vibrating piezoelectric crystal (1.6–3 MHz). The particle size varies from 1–6 µm, Ultrasonic nebulisers are quiet and useful for nebulising large volumes of liquid such as water and saline. They also have a heating effect (1–2°C) which may denature thermally sensitive drugs such as proteins and may also not be suitable for nebulising some suspensions e.g. Dornase alpha/DNase .

9.1.2 Jet nebulisers

Jet nebulisers require a compressed gas source to drive them to create the aerosol. A jet of compressed air is forced through a small hole under pressure and expands rapidly. This causes negative pressure and suction. Fluid is pulled up through a secondary jet and atomised. Liquid droplets hit, or pass around a baffle and are either inhaled or impact on the internal wall of the chamber. Jet nebulisers are continuous and as such more than half of the drug is wasted during exhalation. Jet nebulisers are however inexpensive, have a fill volume of 2–5 mls and a residual volume of approximately 0.8 mls. Eighty per cent of the drug output is below 5 µm² and they are useful for drugs such as bronchodilators, inhaled steroids, saline and Dornase alpha/DNase.

9.1.3 Breath assist open vent jet nebulisers

These jet nebulisers have a breath enhanced valved system which again utilizes inspiratory flow to increase nebulisation rate. However, less medication is lost during expiration as the valve closes. These nebulisers have a greater predicted lung delivery but may have longer treatment times as there is less wastage during expiration. They are useful for hypertonic saline, inhaled steroids and nebulised antibiotics (using a filter for the exhaust to prevent environmental contamination). Examples of this device include the PARI LC PLUS®, PARI Sprint® and the Respironics VentStream®.

9.1.4 Vibrating mesh nebulisers

New nebulisers based on vibrating mesh technology have recently been introduced into the market. They can generally operate with batteries and are small enough to be carried. They do not require a compressed air source unlike jet nebulisers. They are efficient, lightweight and silent.

Pari eFlow® uses an annular piezoelectric element circling a domed mesh which causes a to and fro motion acting as a micro pump to create the aerosol. It vibrates at a frequency of 116 kHz, produces a median particle size of 3–4 µm and is licensed in children over 2 years of age. Most drugs can be nebulised through the eFlow® but suspensions should be avoided. It has a fill volume of 2–6 mls.

Aeroneb® Go, Aerogen Ultra® and Respironics I-neb AAD system® are all examples of vibrating mesh nebulisers available on the market today.

9.1.5 Portable nebulisers

If deemed clinically necessary e.g. for travel, work, to aid with nebulisation when outside the home, a portable nebuliser should be approved and supplied to the patient in conjunction with their nebuliser compressor system. Patients should be supplied with suitable/appropriate battery/connection to allow system to operate efficiently.

9.2 Choice of Face Masks or Mouthpieces:

Patients who are breathless generally prefer to use a face mask, as this minimises exertion and feels more comfortable, although for others the mask can feel suffocating and a mouthpiece may be preferable.

Mouthpieces should be used for:

- nebulised corticosteroids (see hazards/cautions below)
- nebulised anti-cholinergics (see hazards/cautions below)
- nebulised antibiotics (see hazards/cautions below)
- those using Dornase alpha/DNase
- those using hypertonic saline

10.0 Hazards and Cautions

Drugs: Most drugs have the potential to cause adverse effects or side effects. The nebulised delivery aspect brings added potential effects.

- Any known allergy to the drug to be nebulised or its components is a contra-indication.
- Drugs should only be added to the nebuliser chamber immediately prior to administration, as nebuliser drugs do not contain preservatives.
- Where the drug to be nebulised requires dilution, depending on the drug the diluent may be water, saline, or 50% water/50% saline (ref www.hpra.ie)
- Bronchodilators and steroids need separate units – they should not be mixed.
- Dornase alpha/DNase should not be used with an ultrasonic nebuliser.

- Nebulised antibiotics require specific nebuliser systems (see section 8.2.3) and nebulisation should take place in a well ventilated room.
- Nebulised antibiotics may cause airway sensitivity, as may hypertonic saline:
 - A first test-dose challenge test is recommended for all new inhaled therapies and provides an opportunity for the clinician to teach the correct technique while advising on the likelihood of side-effects that can occur in some individuals
 - In adults (and children who are able to perform spirometry), pre- and post-inhalation dose spirometry should be performed, in addition to oxygen saturation monitoring, and the percentage constriction (if any) should be calculated
 - If patients are already prescribed a bronchodilator, they may benefit from the inhalation of this prior to the antibiotic (or hypertonic saline) inhalation, in order to reduce bronchospasm
 - In all cases local policies and protocols should be referred to both for those with CF and those without CF (who require nebulised antibiotics/hypertonic saline).

Mouthpieces:

- Mouthpieces should be used with anti-cholinergics to reduce deposition to the face and eyes thereby reducing the risk of glaucoma, particularly when given with nebulised salbutamol (and possibly other β_2 agonists).
- Mouthpieces should be used for nebulised steroids and antibiotics in order to reduce deposition to the face and eyes with its associated skin and eye effects (cataract).
- Mouthpieces should be used with hypertonic saline and with Dornase alpha/DNase .

A precautionary measure with **nebulised antibiotics** is the need to filter or exhaust the exhaled gas to avoid the nebulised antibiotic circulating in the room air and therefore being inhaled by other family/household members. This is especially important with cystic fibrosis patients if there are siblings at home to reduce the risk of antibiotic resistance developing. The patient should be advised also to maintain a good seal around the mouthpiece to prevent the escape of nebulised antibiotics. As previously mentioned nebulisation should take place in a well ventilated room.

Use of Oxygen - caution: Normally, nebulised drugs are delivered via compressed air. In exceptional situations, e.g. acute asthma, oxygen may be used. This must be discussed and specifically prescribed before it is instigated. Oxygen should be used with caution in patients with COPD as some may be vulnerable to episodes of hypercapnic respiratory failure.

Respiratory Infection: Respiratory Infection: if nebulisers become contaminated there is the potential for infection. It is of utmost importance that the cleaning regime is adhered to (see section 11.1).

11.0 Nebuliser Care (See Section 7)

11.1 Cleaning

As nebulised drugs are delivered directly to the lungs they may be a source of infection if equipment is or becomes contaminated. Nebuliser usage should be for single patient use, with careful cleaning and disinfection of the whole nebuliser system on a regular basis. Cleaning nebuliser equipment involves getting rid of drug residues as well as dirt and microbes.

It is important that nebulisers are thoroughly cleaned and dried. The **patient** (or carer/guardian as appropriate) should ensure the following:

Compressor

- Always clean the compressor unit as per manufacturer's guidelines
- Commonly the regular cleaning process involves using a clean cloth and warm, soapy water e.g. washing up liquid, to wipe the unit clean on a daily basis
- It should always be left to air dry.

Chamber, interface and tubing

- Always clean the chamber, interface i.e. facemask/mouthpiece and tubing as per manufacturer's guidelines
- After each use, dismantle the interface and chamber from the tubing and compressor unit
- Let the compressor unit with the tubing connected run for a few seconds
- Discard residual solutions from the chamber after each use as otherwise fill volume will be increased which will reduce the efficacy of the nebuliser
- Wash the chamber and interface in warm soapy water and then rinse thoroughly with clean water. Let the chamber and mouthpiece/facemask air dry or pat dry with paper towel if necessary. The nebuliser chamber should not be cleaned with a brush as this may cause damage.
- At least once a week, sterilise the nebuliser chamber and interface. Disinfect with solution recommended by the manufacturer, rinse with clean water and leave to air dry or pat dry with paper towel if necessary. 'Intelligent nebulisers' such as the I-Neb® AAD nebuliser and the Pari eFlow® nebuliser have strict cleaning and decontamination protocols that must be followed. It is vitally important that these devices are cleaned and cared for as per the manufacturers' guidelines.

11.2 Maintenance

11.2.1 Patient (or carer/guardian as appropriate)

- Should check the tubing regularly for kinking or holes as these may affect the performance of the nebuliser. Tubing should be replaced and filters replaced (in systems with filters) as per manufacturers guidelines.

11.2.2 Mouthpiece/facemask, chamber, tubing and filters

- Initially two sets of these should be provided for nebuliser systems which require such items.

- For compressors with filters or compressors with tubing these should be changed and recorded in line with manufacturer's recommendations.
 - For tubing this usually means replacement at a minimum every six months but more frequently if there are signs of fraying or cracks in tubing.
 - For filters the interval depends on the filter type but should be changed more frequently if there are signs of discolouration.
- Masks and mouth pieces should be changed regularly as per manufacturer's guidelines.
- Changes of these items should be scheduled and recorded by the local service provider / supplier, or as per special local arrangements.

11.3 Malfunction

If a nebuliser is not working, patients should know that the compressor must be checked.

Patients should be provided with a written plan of what to do in case of an emergency or malfunction.

- If the nebuliser times are becoming slower, for example > 10 minutes the equipment should be cleaned by the patient.
- If time is still slow a spare nebuliser unit should be used and the original compressor unit sent for a service.
- Compressors should be available for replacement or loan (while servicing or repairs are carried out).

11.4 Technical Service

- All equipment should be checked for electrical safety and performance before issue.
- Servicing should be carried out as recommended by the manufacturer – at a minimum this is usually annually but may be more frequent.
- The service by the supplier, local service provider or as per special local arrangements includes cleaning and checking for safety and efficiency. The whole nebuliser system should be brought for this check-up.
- This service should be both documented on the underside of the compressor and records of nebuliser service should be kept on a computerised database.
- Cleaning of compressors prior to inspection, repair, or service should be in line with cleaning of healthcare equipment best practice.
- Patients for whom nebulisers are recommended should be advised verbally and in writing of servicing arrangements.

12.0 Domiciliary Nebuliser Service

While not available nationally at present, a structured Domiciliary Nebuliser Service in line with international best practice is recommended.

Currently those with medical cards or long term illness cards are provided with their nebulisers and compressors after approval by the Local Appliance Officer (formerly LHO/CHO). The situation varies by Local Area as to whether nebulisers are provided directly or via a contract with the suppliers. In turn this affects the maintenance, service and provision of consumables such as tubing, masks, mouth pieces, filters etc.

All other patients ie those without medical cards or long term illness cards, although prescribed medication - covered under the drug refund scheme - which requires a nebuliser must purchase their own equipment. These costs cannot be claimed back under the drug refund scheme. The cost can be claimed as part of tax returns. Other drug delivery devices are provided on prescription. The result is the nebuliser purchased/sourced by the patient may not have been assessed for that patient, the patient may not be aware of the service requirements – or how to access same – or maintenance, cleaning and care requirements and nebuliser chambers may not be cleaned or replaced regularly all of which can have therapeutic implications (see Section 11).

The service outlined below should be available to all who require nebulisers – regardless of medical card status. In that way the service for all nebuliser users would be standardised. Pending a change in the provision of the actual nebuliser, those without medical/LTI cards would continue to purchase their own nebulisers.

12.1 Organisation

An appropriately trained health care professional should assess whether nebuliser therapy is indicated. Assessments should be undertaken using standard protocols (see section 12.2). If nebuliser therapy is prescribed, the patient should have access to an appropriate local domiciliary nebuliser service which provides equipment, advice and support for patients who require long-term nebuliser therapy.

The local service should:

- Ensure that access to the service is based on clinical need for nebulised therapy, not on financial need
- Be provided locally according to local needs
- Be organised and administered by a designated medical practitioner or a group of medical practitioners with a consensus view
- Day to day management should be by a named and appropriately trained individual healthcare professional, with technical and clerical support

The service should include:

- ensure provision of compressors, nebulisers and disposables
- ensure provision of equipment for emergency replacement in case of breakdown
- a system for repair, servicing and maintenance
- patient and staff education
- advice for healthcare professionals on indications for nebulisers

- ongoing training for staff providing a nebuliser service
- detailed schemes for assessing the suitability of patients for long term treatment including assessment and advice for patients
- Patients of primary care physicians should have ready access to a local service for assessment of their medical condition before they are established on long term nebuliser treatment.
- provision of training for patients including practical demonstration
- standard written instructions for patients about the use and cleaning of equipment and the local arrangements for servicing and replacement including telephone numbers for emergency replacements
- audit of all aspects of nebuliser use in the catchment area.

12.2 Patient Assessment

All patients should be assessed prior to a nebuliser being recommended for ongoing home use.

Such assessment should take place over at least a two week period, to assess the response to each treatment. The assessment should include:

- Checking the diagnosis and confirming the severity and baseline disability (Symptoms/ lung function/ qualitative assessment of functional ability).
- Checking and ensuring that the patient uses their existing inhaler device effectively
 - This includes checking the patient's inhaler technique and correcting errors.
- Maximising current medications as per best practice disease guidelines
 - Existing asthma or COPD therapy or treatment for other respiratory problems must be optimised using a hand-held inhaler which the patient is able to use
 - This may include using a pressurised meter dose inhaler through a large volume spacer device to gain maximum benefit / effect
 - The patient's response should be recorded. For asthmatics a peak flow diary is helpful.
- If the patient responds well to treatment at any stage, the assessment should be stopped and this treatment regime should be continued long term.
- If the patient responds poorly **to all** of the above measures, only then consider a referral/assessment for nebuliser. Patients sent for assessment may be deemed suitable for inhalers by assessor making nebuliser treatment unnecessary.
- Ideally, all patients should have a first treatment under supervision before commencing their domiciliary use.

12.3 Follow-up of patients

- Patients should be re-assessed soon after treatment starts (1 month) and then re-assessed regularly (at least annually) to determine whether their treatment is still necessary and effective and to ensure that the patient continues to use the nebulised treatment safely and effectively.
- This evaluation should include lung function testing, assessment of symptom control and breathlessness and sense of well-being. The patient's nebuliser technique should also be assessed using their own nebuliser system. The local nebuliser service should maintain good communication with other health services which the patient attends especially the primary care physician.

12.4 Education/Information: staff, patient

A nebuliser service should provide information for relevant staff and patients (and their carers).

Topics covered should include:

- description of equipment and its use
- drugs use, doses and frequency
- equipment maintenance
- action plan to follow if treatment becomes less effective
- action plan to follow including emergency telephone number to use in case of equipment breakdown.

Abbreviations and Acronyms

ANÁIL: Respiratory Nurses Association of Ireland

ATS: American Thoracic Society

BTS: British Thoracic Society

CF: Cystic Fibrosis

CHO: Community Health Office

COPD: Chronic Obstructive Pulmonary Disease

CPRC: Chartered Physiotherapists in Respiratory Care

CTS: Canadian Thoracic Society

DPI: Dry Powder Inhaler

DPS: Drug Payment Scheme

ED: Emergency Department

ENT: Ear, Nose and Throat

ERS: European Respiratory Society

FEV₁: Forced Expiratory Volume in one second

FVC: Forced Vital Capacity

GOLD: Global Initiative for Chronic Obstructive Lung Disease

GMS: General Medical Services

GP: General Practitioner

HCW: Health Care Worker

HSE: Health Service Executive

ICGP: Irish College of General Practitioners

ICS: Inhaled Corticosteroids

ISCP: Irish Society of Chartered Physiotherapists

ITS: Irish Thoracic Society

LHO: Local Health Office

LTI: Long Term Illness

LTOT: Long Term Oxygen Therapy

MDI: Metered Dose Inhaler

NICE: National Institute for Care and Health Excellence

PCRS: Primary Care Reimbursement Service

PEF: Peak Expiratory Flow

PEP: Positive Expiratory Pressure

SIGN: Scottish Intercollegiate Guidelines Network

TSANZ: Thoracic Society of Australia and New Zealand

WHO: World Health Organisation

Glossary

Aerosol output: the mass per minute of particles in aerosol form produced by the nebuliser.

Allergen: a substance which can cause an allergy but which is harmless to most people.

Asthma: is a heterogeneous disease characterised by chronic airway inflammation. Chronically inflamed airways are hyper-responsive; they become obstructed and airflow is limited (by bronchoconstriction, mucus plugs and increased inflammation) when airways are exposed to various risk factors.

Bronchiectasis: the bronchial tubes become enlarged and distended forming pockets where infection may gather. The walls become damaged which results in impairment to the lung's complex cleaning system. Mucus and bacteria accumulate, infection develops and is difficult to remove.

Bronchiolitis: inflammation of the bronchioles. It usually occurs in children aged less than 2 years with most aged 3-6 months.

Bronchodilators: substances that relax contractions of the smooth muscle of the bronchioles to improve ventilation to the lungs.

Bronchospasm: an abnormal contraction of the smooth muscle of the bronchi, resulting in an acute narrowing and obstruction of the respiratory airway.

Compressor: uses compressed air to turn the liquid medication into an aerosol mist that penetrates the lung.

Compressor Unit: is the device which drives the nebuliser. It compresses room air and blasts it at a high velocity through a liquid medicine to turn it into a mist of fine droplets which is then inhaled by the individual. Jet nebulisers must be connected by tubing to a compressor to work.

COPD: Chronic Obstructive Pulmonary Disease is a disease, which is characterised by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and co-morbidities contribute to the overall severity in individual patients.

Cystic Fibrosis: is an autosomal recessive disorder. Cystic Fibrosis (CF) is caused by a dysfunction of the exocrine glands and is characterised by abnormal thick mucus secretions that block ducts. The main cause of mortality and morbidity is bacterial lung infection leading to progressive damage of the lungs and ultimately respiratory failure and premature death. CF is a multisystem disease that may involve other organs such as the pancreas, liver and fertility organs.

Drug output: the mass of drug produced per minute as an aerosol.

Exacerbation is the worsening or flare-up of a condition.

Forced Expiratory Volume in 1 second (FEV1): an individual test measure used to assess limitations in airflow, which measures the amount of air exhaled in one second.

Glaucoma: an abnormal condition of elevated pressure within an eye because of obstruction of the outflow of aqueous humour.

Hypercapnoea /Hypercapnoeic: an abnormally high level of carbon dioxide level in arterial blood.

Hypoxic drive: the low arterial oxygen pressure stimulus to respiration that is mediated through the carotid bodies.

Hypoxia: reduced level of oxygen in the tissues.

Inhaler: small devices, which ensure that very small amounts of medication are delivered directly into the lungs. It is important to ensure that an inhaler device delivers the drugs to the airways consistently and in the right quantity.

Interface: A mask or mouthpiece that connects to the nebuliser tubing.

Nebulisation: is the changing of a liquid drug into a mist or suspension of particles small enough to reach the bronchioles and in some cases the alveoli.

Nebuliser: device for changing a liquid into a mist of fine particles for inhalation. It is used to deliver drugs into the lungs via a mist of droplets small enough to reach the bronchioles and, in some cases, the alveoli.

Nebuliser delivery: a compressor or oxygen provides the appropriate output flow to deliver a particle size of a drug of less than 5 microns. This is required to penetrate the distal airways of the respiratory tract. Therefore different compressors are required for use with different nebuliser chambers appropriate for the desired drug.

Palliative care: aims to achieve the best quality of life possible for the patient and their family through active identification, holistic assessment and appropriate management of problems, when progressive advanced disease is not responsive to curative treatment.

Peak expiratory flow rate (PEFR): a test that measures the maximum rate at which a person can forcibly expel air from the lungs at any time, expressed in litres per minute.

Primary Care: the first point of contact for people outside hospitals in local settings. Primary care health professionals include local GPs, community nurses, social workers, pharmacists, physiotherapists, occupational/speech/language therapists, opticians and dentists among others.

Pulmonary Hypertension: abnormally high pressure within the pulmonary circulation.

Right Heart Failure/ Right Ventricle Failure: a condition in which the heart fails to pump enough blood through the lungs.

Respirable particles: particles <5 um diameter.

Respirable fraction: the mass of respirable particles expressed as a percentage of the aerosol output.

Respirable output: the mass of respirable particles produced per minute.

Rhinitis: inflammation of the mucous membranes of the nose.

Type 2 Respiratory Failure: ventilatory failure characterised by the inability to adequately exhale the carbon dioxide generated by the body, e.g. due to a decrease in the area of lung available for gas exchange as occurs in eg COPD.

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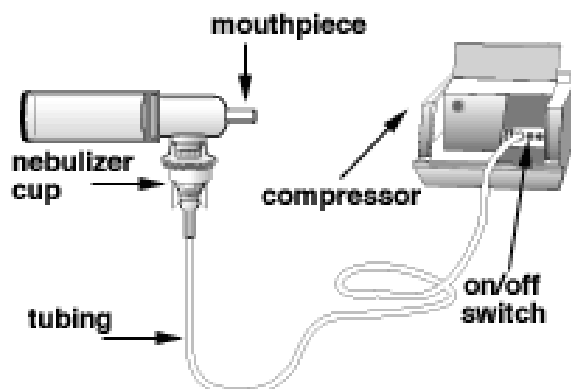
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- www.bnf.org
- www.drugs.com How to use your nebuliser
- www.hpra.ie
- www.medicines.ie SPC or SmPC (summary of product characteristics)
- www.mims.ie

Appendix 1: Useful Resources/Websites

www.drugs.com	How to use your nebulizer-what you need to know
www.asthma.org.uk/advice/inhalers/nebulisers	Asthma Information Website
www.rtmagazine.com	Dec 21 st 2007 Publication The Right Fit: Choosing the Best Nebulizer for Your Patient
www.justnebulizers.com	Nebuliser website
www.asthmasociety.ie	Asthma Society of Ireland
www.copd.ie	Chronic Obstructive Pulmonary Disease (COPD) website
www.irishthoracicsociety.com/lungdisease/copd	Irish Thoracic Society Website
http://www.cff.org/	Cystic Fibrosis Foundation
http://www.cysticfibrosis.org.uk/	Cystic Fibrosis Trust
https://www.blf.org.uk/supportforyou/nebuliser	British Lung Foundation
www.bronchiectasis.com.au	Bronchiectasis Toolbox endorsed by Thoracic Society of Australia and New Zealand

Appendix 2:

Patient Information Leaflet on How to Use your Nebuliser/Breathing Treatments



What is a nebuliser?

A nebuliser is a device that is used for breathing treatments. It changes liquid medicine into a fine mist. The mist goes into your lungs when you inhale (breathe in).

How does a nebuliser work?

A nebuliser consists of a machine (compressor) to power the nebuliser and a tube that connects the machine to the medicine cup (nebuliser chamber). The medicine is changed into a mist in the medicine cup. You breathe in the mist through a mask or mouthpiece.

How do I use a nebuliser? (also read the written instructions which came with your nebuliser)

- Wash your hands with soap and water and dry thoroughly.
- Place the air compressor on a sturdy surface. Plug the cord from the compressor into an electrical outlet.
- Connect the tubing to both the compressor machine and nebuliser cup.
- Unscrew the top of the nebuliser cup. Then twist off the top of the medication vial, measure the medication exactly as you have been instructed by your health professional and put it into the nebuliser cup. Most medications today come in premeasured unit dose vials so measuring is not necessary.
- Screw on the top of the nebuliser chamber again and attach the facemask or mouthpiece to the top of the cup/chamber.
- Sit up straight in a comfortable chair or in bed. You may also watch television or read a book while you are inhaling the medicine for your relaxation.

- **Adults and older children:** Place the mouthpiece in your mouth. Breathe in and out slowly through your mouth until all the medicine is gone.
- **Infants and younger children:** Place the mask on your child's face and put the strap over his/her head. You may need to distract your child during the treatment to keep him/her from removing the mask.
- Turn on the machine. Keep the medicine cup in an upright position and breathe in and out as normal. Towards the end of the treatment you may need to tap the sides of the cup with your finger to knock down droplets of medicine attached there. This will help the last of the medicine become mist. The whole treatment may take 10- 15 minutes.
- The treatment is over when there is no more mist coming out. The nebuliser may also make a sputtering noise, and the cup may have a little fluid remaining.

How Do I Care for My Nebuliser? (also read the written instructions which came with your nebuliser)

Cleaning

- Cleaning and disinfecting your nebuliser equipment is very important as proper care prevents infection.
- Follow these instructions when cleaning your nebuliser:
 - After each treatment, rinse the nebuliser cup thoroughly with warm water, shake off excess water and let air dry or pat dry with paper towel if needed.
 - At the end of each day, wash the nebuliser cup, mask, or mouthpiece in warm soapy water using a mild detergent, rinse thoroughly in clean water, and let air dry or pat dry with paper towel if needed.
 - Connect medicine cup and tubing to the compressor. Switch on the compressor and blast air through the tubing and cup for a few seconds to allow the system to dry out completely.
 - Weekly, after washing your equipment, disinfect the equipment using a disinfectant solution as recommended by the manufacturer of your nebuliser. Rinse well under a steady stream of clean water, shake off the excess water and let air dry or pat dry with a paper towel if needed. Connect medicine cup and tubing to the compressor. Switch on the compressor and blast air through the tubing and cup for a few seconds to allow the system to dry out completely.

Storing

- Cover the compressor with a clean cloth when not in use.
- Do not put the air compressor on the floor either for treatments or for storage.
- Medications should be stored in a cool, dry place. Some medications require refrigeration and some require protection from light. Check them often. If they have changed colour or formed crystals, return them to your pharmacy for disposal. If there is a product defect the Pharmacist can alert the manufacturer. Ideally medicines should not be disposed of in regular waste. Always check the expiry date of your medicine vials and do not use any that are past their use by date.

Other Tips

- Always have an extra nebuliser cup and mask/ mouthpiece in case you need it.

- Check the nebuliser tubing and medicine cup regularly for kinks and cracks and replace as needed, or as recommended by your supplier.
- Do not mix medicines in the same cup/chamber. Use separate medicine cups for each medication you need to inhale.
- Check with your manufacturer/ machine supplier regarding servicing your nebuliser. Replace or clean the filter/filters according to the directions from your equipment supplier/manufacturer.

When should I seek medical advice?

Contact your doctor if:

- Your hands, arms, or legs shake after the treatment.
- You have a fast heartbeat or feel dizzy.
- You have a fever and sore mouth or throat.
- Your symptoms do not improve, even with treatment.
- You have questions or concerns about your condition or treatments.

When should I seek immediate care?

Seek care immediately or call 999/112 if:

- You have increased shortness of breath.
- You feel confused or sleepy after your treatment.
- You suddenly have chest pain.

Care Agreement

The above information is an educational guide only.

It is not intended as medical advice for individual conditions or treatments.

Talk to your doctor, nurse or pharmacist before following any medical treatment to check if it is safe and effective for you. Keep all medicines out of reach of children.

Appendix 3: Information for Community Health Professionals

Purpose

Nebulisers provide doses of drugs to the lungs as an aerosol. They are useful:

- a) When large doses of drugs are needed
- b) When patients are too ill or otherwise unable to use hand held inhalers;
- c) When drugs are not available in hand held inhalers – e.g. mucolytics, antibiotics

Indications

1 May be used for emergency treatment of asthma and exacerbations of COPD.

2 Less frequently for:

- a) Long term treatment of chronic airflow obstruction with bronchodilators;
- b) Prophylactic drug treatment- e.g. corticosteroids and disodium cromoglycate in asthma ;
- c) Antimicrobial treatment in cystic fibrosis, bronchiectasis and HIV/AIDS;
- d) Symptom relief in palliative care.

Long term treatment

The BTS recommends that long term treatment with nebulised drugs should usually be initiated only after assessment by a hospital specialist such as a chest physician or a paediatrician and by general practitioners only after specific training.

Equipment

Jet nebulisers are generally the most suitable. They consist of an electrical compressor with a standard flow rate of 6-8l/min or a higher flow rate of > 8l/min and disposables including connecting tubing, the nebuliser chamber(performance depends on design) mouthpiece or mask (these are interchangeable but masks are better for emergencies and infants). However, different types of nebulisers may be required to deliver different drug types, for different respiratory problems or to meet other patient needs.

Nebuliser use

Drug Volume: Most nebulisers work with drug volumes of 2-5 ml. If the system used has a residual volume of more than 1.0 ml (shown on packing) the drug volume should be made up with 0.9% sodium chloride (not water) to a minimum of 4.0 ml.

Nebulising time: "Dryness" should not be used as an end point. Patients should be advised to nebulise until about a minute after spluttering occurs. This should take 5-10 minutes. An upper limit for treatment time should be specified. *Cleaning:* Patients using nebulisers regularly should clean them daily, and patients using them intermittently should clean them after each use. The nebuliser and mouthpiece or mask should be disconnected, disassembled, washed in warm water with little detergent, and allowed to drip dry. The nebuliser should be run for a few seconds with no drugs in it before the next treatment.

Maintenance: Disposable components (plastic tubing, the nebuliser cup, mask or mouthpiece) should be changed as per manufacturer's guidelines. Compressors should be serviced as per manufacturer's guidelines.

Breakdown: Patients must know what to do if their equipment breaks down. If nebulisation is slow the nebuliser should be disassembled and washed and treatment tried again. If it is still inefficient a spare one should be used. If

nebulisation is slow or the compressor is faulty the patient should ask for medical help and meanwhile self- treat with multiple doses of hand held inhalers (previously advised). Patient must know who to contact in the event of an emergency- for example, the local nebuliser service or practice nurse.

Oxygen: Patients with acute severe attacks of asthma need additional oxygen. Nebulisers will run with a flow rate of 6-8 l/ min. If available cylinders do not produce this flow rate, electrical compressors should be used for immediate treatment. Simultaneous use of oxygen by nasal cannulae at 4/l min is appropriate.

Patient instruction: Firstly, patients must be shown how to use their nebuliser. The first treatment should always be done under supervision. For longer term use patients should have written instructions provided by their local nebuliser service or derived from the BTS guidelines.

When to use nebuliser treatment

For the treatment of acute severe and chronic persistent asthma and of COPD, nebuliser treatment may be a component of disease management (see Guidelines).

Acute severe Asthma

Adults

Severity: cannot complete sentences, RR>25/ MIN, HR>110/min, PEF< 50 % best.

Treatment: Supplementary oxygen, (plus) oral steroids, plus nebulised beta agonists, e.g salbutamol 5 mg or terbutaline 10 mg (or 0.3mg/kg) repeated 1-4 hourly if better. If not, add ipratropium bromide 500mcg to beta agonist and consider hospital admission.

Paediatrics

Severity: Infants (< 2years): increased work of breathing (retractions)

Reduced oral intake

RR> 60/minute

Pre-school (2-5years): increased work of breathing (retractions)

HR >150-160/min

RR> 50-60/minute

5-12 year olds: cannot talk or feed,

RR>50/min,

HR>140/min,

PEF<50% predicted.

Treatment: oxygen plus nebulised salbutamol 5 mg (or 0.15mg/kg) or terbutaline 10 mg (or 0.3mg/kg) repeated 1-4 hourly if better. If not, repeat at 30 minutes after adding ipratropium bromide 250 micrograms. Continue 1-4 hourly and consider transfer to hospital and oral steroids.

Brittle asthma (patients needing to self-treat with nebulisers for sudden attacks)

These patients are uncommon but difficult to treat. It is recommended that a written treatment plan is agreed with a local hospital specialist. Patients should be encouraged to seek medical help early in an attack. Suggested drug regimens are as above plus oral steroids.

Chronic Persistent Asthma

Regular nebulised bronchodilator treatment should only be undertaken after formal evaluation of its benefit (a service provided by most specialist units) and where treatment with a hand held inhaler at appropriate doses has failed.

Acute exacerbations of COPD

Mild episodes: usually inhaler will meet need for most patients.

Moderately severe: as above

Severe (cyanosed, RR>25/min, cannot make sentences, reduced activity)

Consider admission to hospital, meanwhile nebulise Beta agonists as for acute asthma or ipratropium bromide 250-500mcg 4-6 hourly. If more severe or not improving, consider combination of a Beta agonist with ipratropium bromide 500mcg 4-6 hourly. Do not nebulise with oxygen. A 24 %Venturi mask is suitable in between treatments. May need higher dose of supplementary oxygen, aim is to maintain O2 sats between 88%-92%.

Chronic severe COPD

Most patients are managed well by hand held inhalers. Only a few will benefit from higher dose treatment. Patients should be referred to a local specialist for assessment. This should include a review of the diagnosis, and evaluation of different treatment regimes. If GPs wish to initiate long term treatment, the same standard of assessment is appropriate.

The Elderly

- a) Asthma and COPD: treatment as above
- b) Rarely Beta agonists may precipitate angina. A first treatment should be supervised.
- c) Because glaucoma may be worsened by ipratropium, a mouthpiece should be used where possible

The Young

Given the wide range covered by the paediatric age group with their changing physiological abilities, their requirements for inhalation devices including nebulisers changes greatly as they move from neonates to adolescence in addition to the changing nature of their disease. As with their older counter-parts when able and when drug is available in pMDI + spacer format, nebulisation adds little if anything to outcome.

Palliative Care

Advanced neoplastic disease

Nebulisers may be used for symptom relief in patients known to have advanced neoplastic or other disease. Treatment should be reviewed within three days to check efficacy.

Breathlessness with diffuse airflow obstruction (not stridor): Consider bronchodilators as for COPD

Severe non-productive cough: Lignocaine 2%, 2-5 ml; bupivacaine 0.25%, 2-5 mls repeated up to four hourly, preceded by a Beta agonist given by hand held inhaler (2-4 actuations) .Nil by mouth for one hour afterwards.

Poor expectoration: Consider 2-5 ml 0.9% sodium chloride repeated up to four hourly.

Other use of Nebulisers

Those with other requirements for nebulisers should be under the care of hospital specialist services e.g. those with cystic fibrosis, chronic lung infections, bronchiolitis (special circumstances) etc. Nebulisers tend to be needed in patients with complex problems and treatment is best initiated and supervised by appropriate hospital or hospice specialists.

Appendix 4: Additional Drug Information

Additional drugs information provided in box underneath. More detailed information about each product is available in the Summary of Products Characteristics (SmPCs).

Drug Class Drug Name Tradename on Product File	Inhaler format	Indications for Nebuliser Product (from SmPCs)	Special Instructions/ Precautions
<i>β2 agonists</i>			
Salbutamol (Salamol steri neb 2.5mg/2.5ml)	Yes	Salamol Steri-Neb is indicated for the routine management of chronic bronchospasm, unresponsive to conventional therapy. Salamol Steri-Neb is also indicated in the treatment of acute severe asthma (status asthmaticus). Salamol Steri-Neb is indicated in adults, adolescents and children 4 to 11 years. For babies and children under 4 years of age, see SmPC. Administration: jet nebuliser/ compressor system should be used attached to mouthpiece/facemask Caution using oxygen as driving force with Type 11 respiratory failure patients.	Salbutamol can cause tremor Salbutamol can cause tachycardia and cardiac arrhythmias, particularly at higher doses. Salbutamol can reduce serum potassium.
Salamol steri neb 5mg/2.5ml	yes	As above	As above
Ventolin 2.5mg/2.5ml nebules neb soln	yes	Ventolin Nebules are indicated in adults, adolescents and children 4 to 11 years. For babies and children under 4 years of age, see SmPC. Ventolin Nebules are indicated for the treatment or routine management of bronchospasm. They provide short acting (four hours) bronchodilation in reversible airways obstruction due to asthma and chronic obstructive pulmonary disease (COPD) such as chronic bronchitis and emphysema. For patients with asthma, salbutamol may be used to relieve symptoms when they occur and to manage them prior to a known trigger. Administration: jet nebuliser/ compressor system should be used attached to mouthpiece/facemask Caution using oxygen as driving force with Type 11 respiratory failure patients.	As above
Ventolin 5mg/2.5ml nebules neb soln	Yes	As above	As above
<i>Antimuscarinics (anticholinergics)</i>			
Ipratropium (Atrovent 250mcg/1ml)	Yes	Ipramol is indicated in adults, adolescents and children aged 12 years and above.	Use with caution in those

UDV Neb soln)		<p>Atrovent 250 UDVs, 1ml are indicated for maintenance treatment of bronchospasm associated with chronic obstructive pulmonary disease and, when used concomitantly with inhaled beta2-agonists, for treatment of acute and chronic asthma and acute bronchospasm associated with chronic obstructive pulmonary disease.</p> <p>Administration: jet nebuliser/ compressor system should be used attached to mouthpiece/facemask</p> <p>Caution using oxygen as driving force with Type 11 respiratory failure patients.</p>	<p>with glaucoma</p> <p>Increasing the frequency of administration of ipratropium will not increase the patient's response to the drug.</p>
Ipratropium (Atrovent 500mcg/2ml UDV Neb soln)	Yes	As above	As above
Ipratropium bromide (Steri Neb Ipratropium 250mcg/1ml neb)	No	<p>Indicated for maintenance treatment of bronchospasm associated with chronic obstructive pulmonary disease and, when used concomitantly with inhaled beta2-agonists, for treatment of acute and chronic asthma and acute bronchospasm associated with chronic obstructive pulmonary disease.</p> <p>Administration: jet nebuliser/ compressor system should be used attached to mouthpiece (preferably not a mask).</p> <p>Caution using oxygen as driving force with Type 11 respiratory failure patients.</p>	As above
<i>Combination therapy</i>			
salbutamol & ipratropium bromide (<i>Combivent</i>) Combivent udv 2.5ml neb soln	No PA inhaler withdrawn in 2010	<p>Combivent UDVs are indicated for the management of bronchospasm in patients suffering from chronic obstructive pulmonary disease who require regular treatment with both ipratropium and salbutamol.</p> <p>Administration: jet nebuliser/ compressor system should be used attached to mouthpiece (preferably not a mask).</p> <p>Caution using oxygen as driving force with Type 11 respiratory failure patients.</p>	<p>Salbutamol can cause tremor</p> <p>Salbutamol can cause tachycardia</p> <p>Salbutamol can reduce serum potassium.</p> <p>Use with caution in patients with glaucoma</p>
salbutamol & ipratropium bromide (Ipramol 0.5/2.5mg Steri nebs 2.5ml)		<p>Ipramol Steri-Neb is indicated for the management of bronchospasm in patients suffering from chronic obstructive pulmonary disease (COPD) who require regular treatment with both ipratropium bromide and salbutamol.</p> <p>Administration: jet nebuliser/ compressor system should be used attached to mouthpiece (preferably not a mask).</p> <p>Caution using oxygen as driving force with Type 11 respiratory failure patients.</p>	As above

Corticosteroids			
<i>Budesonide</i> (<i>Pulmicort Respules</i>) 0.5mg budesonide in 2mls, 1mg budesonide in 2mls.	yes	Administration: jet nebuliser/ compressor system should be used attached to mouthpiece Caution using oxygen as driving force with Type 11 respiratory failure patients.	Patients should be advised to rinse their mouth with water and spit out the water after use to prevent oral candidiasis. Patients should be advised to wash their face after use.
<i>Fluticasone</i> (<i>Flixotide</i>) 0.5mg fluticasone in 2mls, or 2mg fluticasone in 2mls.	yes	Administration: jet nebuliser/ compressor system should be used attached to mouthpiece Caution using oxygen as driving force with Type 11 respiratory failure patients.	Patients should be advised to rinse their mouth with water after use to prevent oral candidiasis. Patients should be advised to wash their face after use.
Mucolytics			
Dornase alpha or DNase (Pulmozyme) 2.5mg/2.5ml nebuliser soln	No	Management of cystic fibrosis patients with a forced vital capacity (FVC) of greater than 40% of predicted and over 5 years of age to improve pulmonary function. It hydrolyses DNA in sputum and reduces drug viscosity. Jet nebuliser/compressor system attached to a mouthpiece or the Pari eFlow® Rapid nebuliser, a general purpose electronic vibrating membrane nebuliser It is a high tech drug.	Dornase alpha must be stored in the fridge. Keep vials in foil pack as they are light sensitive.
Sodium Chloride 0.9% (Saline sterile neb 0.9% neb soln 2.5ml)	No	For the dilution of solutions for nebulisation. Also used to aid expectoration of respiratory secretions. Administration: jet nebuliser/ compressor system should be used attached to mouthpiece/facemask.	If saline nebulisers are prescribed, sodium chloride 0.9% should be administered, unless a different strength is specified.
Sodium Chloride 3% (Sodium chloride 3% neb soln 15ml ulm poa)	No	Unlicensed Used to assist expectoration of respiratory secretions. Administration: jet nebuliser/ compressor system should be used attached to mouthpiece; breath assist open vent jet nebulisers e.g PARI LC Plus, PARI Sprint® or Respironics Ventstream® are useful as they have a filter for the exhaust	Sodium chloride 3% can cause bronchospasm. If patients are already prescribed a bronchodilator, they may benefit from the inhalation of this prior to sodium chloride 3% in order to reduce bronchospasm If saline nebs are prescribed, sodium chloride 0.9% should be administered, unless a different strength is specified. All saline nebs should be taken just prior to chest




			Physiotherapy Discard the bottle 3 days after first opening.
Sodium Chloride 6% (Sodium chloride 6% neb soln 15ml ulm poa)	No	As above	As above
Sodium Chloride 7% (Sodium chloride 7% neb sol ulm poa)	No	As above	As above
Pulmonary Vasodilator			
Iloprost (Ventavis) 10mcg/ml	No	Treatment of adult patients with primary pulmonary hypertension (PAH), classified as NYHA functional class III, to improve exercise capacity and symptoms. Iloprost has been used in children with PAH, although long-term safety and efficacy in paediatric patients has not been established. Administration: requires I-Neb® AAD nebuliser High Tech drug	The most common side effects include flushing, increased cough, low blood pressure, headache, nausea, and jaw discomfort. Dizziness, light-headedness can occur if the blood pressure drops too low. The solution can irritate the eyes and skin. Patients should be careful not to expose others while taking a treatment. It has not been evaluated in pregnant women or women who are breastfeeding so should only be used if the potential benefit justifies the risk. It has been used in children with PAH.
Antibiotics			
Tobramycin (Tobi 300mg/5ml neb soln 28 day pack)	Yes	Long-term management of chronic pulmonary infection due to <i>Pseudomonas aeruginosa</i> in cystic fibrosis (CF) patients aged 6 years and older. Consideration should be given to official guidance on the appropriate use of antibacterial agents. Administration: viaPari LC Plus® nebuliser, fitted with a filter and attached to a suitable compressor. High Tech drug	Must be stored in the fridge Can cause bronchospasm If patients are already prescribed a bronchodilator, they may benefit from the inhalation of this prior to tobramycin Should be administered after chest physiotherapy
Aztreonam (Cayston)	No	Used to treat <i>Pseudomonas aeruginosa</i> chronic infections in patients. Aztreonam is indicated for the suppressive therapy of chronic pulmonary infections due to <i>Pseudomonas aeruginosa</i> in patients with cystic fibrosis (CF) aged 6 years and older Administration: must be administered via the	Patients should use a bronchodilator before each dose Nebulised aztreonam should be administered after chest physiotherapy

		Altera nebuliser handset and altera aerosol head connected to an eBase controller or an eFlow® rapid control unit.	
Colistimethate sodium(Colomycin)	No	<p>Used to treat <i>Pseudomonas aeruginosa</i> colonisation in the lungs. management in adult and paediatric of chronic pulmonary infections due to <i>Pseudomonas aeruginosa</i> in patients with cystic fibrosis. Needs to be reconstituted with saline or water.</p> <p>Administration: Jet nebuliser/compressor system attached to mouthpiece; breath assist open vent jet nebulisers e.g PARI LC Plus®, PARI Sprint® or Respironics Ventstream® are useful as they have a filter for the exhaust</p> <p>High Tech drug</p>	<p>Can cause bronchospasm and wheeze</p> <p>If patients are already prescribed a bronchodilator, they may benefit from the inhalation of this prior to Colistimethate sodium</p> <p>Some patients may prefer to use different volumes of sodium chloride 0.9%, or to use water for injections to reconstitute the drug, as it may help to minimise wheeze. If this is the case, the patient's instructions should be followed.</p> <p>Nebulised Colistimethate sodium should be administered after chest physiotherapy</p>

Appendix 5: Sample Order forms (developed by St Vincent’s University Hospital)

These could form the basis for developing an agreed national form.

As these are specific to that hospital they currently include nebuliser brand names.

		
<h2 style="margin: 0;">Respiratory Medicine</h2> <h3 style="margin: 0;"><u>Nebuliser Therapy Prescription</u></h3>		Name: _____ MRN: _____ <p style="text-align: center; color: gray; font-size: 1.2em;">AFFIX PATIENT LABEL HERE</p>
Medical Card Number: _____ OR Drug Scheme: _____		
The following items are required as indicated (<i>tick each item required</i>):		
1.	<input type="checkbox"/> Aerocare nebuliser compressor	KARE001
2.	<input type="checkbox"/> Econoneb Compressor	CC00005
3.	<input type="checkbox"/> Innospire Deluxe compressor complete with patient accessory kit	RES 1112279
4.	<input type="checkbox"/> Turboneb compressor with accessory kit	CC00006
5.	<input type="checkbox"/> Pari Turbo Boy SX compressor	085G3204
6.	<input type="checkbox"/> Pari Boy Mobile S compressor	047G1004
7.	<input type="checkbox"/> Angled mouthpieces	RES 1605E
8.	<input type="checkbox"/> Patient kit durable P-50-Ventolin	RES1225A
9.	<input type="checkbox"/> Patient kit durable, pulmozyme	RES1237
10.	<input type="checkbox"/> Coiled durable tubing	RES 1015A
11.	<input type="checkbox"/> Bacterial filter with tube	RES1214
12.	<input type="checkbox"/> Air inlet filter for Innospire Deluxe	
13.	<input type="checkbox"/> Inlet and Outlet Filter for Aerocare Minineb	
14.	<input type="checkbox"/> Pari LC Nebuliser	022G8104
15.	<input type="checkbox"/> Pari adult mouthpiece with Exp valve	022E3050
16.	<input type="checkbox"/> Pari adult mouthpiece without exp valve	021E1720
17.	<input type="checkbox"/> Y-piece (Pari neb)	41E0530
18.	<input type="checkbox"/> Exhalation filter (Pari Neb)	041G0500
19.	<input type="checkbox"/> Filter pad pack of 100 (Pari neb)	041B0523
20.	<input type="checkbox"/> Pari Smart mask	041G0740
21.	<input type="checkbox"/> Ventstream nebuliser c/w mouthpiece and duratube	RES1183
22.	<input type="checkbox"/> Reusable filter housing & pack of 50 filter elements	RES1221
23.	<input type="checkbox"/> Replacement filter elements (Ventstream)	RES1220
24.	<input type="checkbox"/> Disposable Sidestream nebuliser with adult mask, tubing	RES4446
25.	<input type="checkbox"/> Disposable Sidestream nebuliser with angled mouthpiece, tubing	RES4448
26.	<input type="checkbox"/> Disposable nebuliser with adult mask-year pack	CM00001 Adult
27.	<input type="checkbox"/> Disposable nebuliser with mouthpiece-year pack	CM00013 Adult
Signed: _____ Date _____		
PRINT NAME: _____		
Please direct any enquiries to Respiratory Nurse Specialists Telephone No. 01 221 4000 and ask for pager 183 or 172 or Direct line 01 221 4280 and leave a voicemail.		
Please order products with code numbers RES from Cardiac services on 01 8307499. Items 1, 2, 4, 13, 26 and 27 from Air Liquide on 01850 240 202. Other items available from Oxygen Care Limited on 01 276 9700.		
Q-Pulse Ref. No: PCT-RESP-5 Printing Ref. No: N/A	Active Date: 15.12.15	Version Number: 02
Filed: Section 11, Prescribed Medications		

Equipment Prescription (CF patients)

To Whom It May Concern:

Our patient: _____

Of: _____

Phone number: _____

Has been prescribed **nebulised medications**. To deliver the medication aerosol to the lungs effectively the patient needs a compressor unit and a regular supply of nebuliser chambers and filters. The following items are required as indicated:

1. Porta-Neb 50 complete with patient accessory kit	RES1802	<input type="checkbox"/>
2. Turbo Boy	085G3204	<input type="checkbox"/>
3. Pari Boy Mobile S	047G1004	<input type="checkbox"/>
4. Angled mouthpieces pack of 5	HC/1605E	<input type="checkbox"/>
5. Patient kit durable P-50 - Ventolin	2010A	<input type="checkbox"/>
6. Patient kit durable, Pulmozyme, CR-50 - Dnase	2010 A	<input type="checkbox"/>
7. Durable tubing DURATUBE	HC/2150	<input type="checkbox"/>
8. Air inlet filter (element type)	HC/2155	<input type="checkbox"/>
9. Dome for filter element	1052437+1052466	<input type="checkbox"/>
10. Bacteria filter with tube	1214	<input type="checkbox"/>
11. Ventstream nebulizer c/w mouthpiece and duratube (ONE ONLY)	HC/1183	<input type="checkbox"/>
12. Reusable filter housing & pk of filter elements (pk of 50)	1221	<input type="checkbox"/>
13. Replacement filter elements	1220	<input type="checkbox"/>
14. Exhalation filter (Pari neb)	HC/041G0500	<input type="checkbox"/>
15. Filter pad (Pari neb) (Pack of 100)	041B0522	<input type="checkbox"/>
16. Y-piece (Pari neb)	HC/041E0530	<input type="checkbox"/>
17. Pari Smart Mask	HC/041G0740	<input type="checkbox"/>
18. Pari LC Plus Nebuliser	HC/022G8000	<input type="checkbox"/>
19. Pari Adult mouthpiece with exp valve	HC/022E3050	<input type="checkbox"/>
20. Pari Adult mouthpiece without exp valve	HC/021E1720	<input type="checkbox"/>
21. Eflow aerosol head	178B2603	<input type="checkbox"/>
22. Eflow Nebuliser handset	178G8012	<input type="checkbox"/>
23. New Eflow with ebase (v2)	178G1005	<input type="checkbox"/>
24. Pari Boy Year Pack (Turbo Boy or Mobile S)	HC/023G1011	<input type="checkbox"/>