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Non-invasive positive pressure ventilation (NPPV) in the emergency unit

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Non-invasive ventilation has become a frequently used modality in intensive care units in South Africa. Although it is not yet standard practice in our country, new research proves that there is a definite place for non-invasive positive pressure ventilation (NPPV) in the emergency unit when managing a patient in acute respiratory failure.¹ Managers of emergency units should consider the proven benefits for patients, adding this treatment modality to their units. All staff using NPPV should be adequately trained. The availability of a pulmonary physiotherapist helps a great deal with the implementation and management of NPPV.

Definitions

Acute respiratory failure. The presence of 2 of the following 4 criteria indicates acute respiratory failure: (i) acute dyspnoea; (ii) arterial oxygen partial pressure (P_aO_2) of less than 50 mmHg at room air; (iii) arterial carbon dioxide partial pressure (P_aCO_2) of more than 50 mmHg; and (iv) significant respiratory acidaemia.²

CPAP. Continuous positive airway pressure.

BiPAP. Bi-level positive airway pressure. It allows positive air pressure at two different levels – an inspiratory positive airway pressure (pressure support) and an expiratory airway pressure (positive end-expiratory pressure). These pressures are controlled and adjusted separately.

NPPV in the emergency unit

Indications

- Acute severe asthma not responding to conventional treatment.³⁻⁵
- Acute exacerbation of chronic obstructive pulmonary disease (COPD).⁶
- Near drowning.⁷
- Acute pulmonary oedema.⁸
- Severe thoracic trauma.^{9,10}
- Severe pneumonia.³
- Restrictive airway disease with respiratory failure (e.g. neuromuscular disease).¹
- When intubation is not indicated (terminal illness).³

NPPV requires an awake, co-operative patient who is haemodynamically stable. It should not be used with the gasping near-death patient.

Contraindications^{1,3,11,12}

- Hypovolaemia.
- Hypotension (systolic BP < 90 mmHg).
- Confused, unco-operative or comatose patient.
- Respiratory arrest, or gasping patient.
- P_aO_2 < 60 mmHg or saturation < 90% on a rebreather mask.
- Uncontrolled cardiac ischaemia or arrhythmias.

Table I. Setting up a patient for NPPV^{5,11}

Requirements

- A ventilator that has non-invasive ventilation modes, or a dedicated CPAP or BiPAP ventilator
- Cardiac monitor
- Non-invasive blood pressure monitoring
- Oximeter
- One nurse per patient for serial vital signs measurement and continued observation
- Patient lies at a > 45° angle.

Procedure

Pressure settings

- Set expiratory positive pressure, CPAP or positive end-expiratory pressure (PEEP) at 3 - 5 cm
- Set inspiratory pressure (or pressure support) at 8 - 10 cm
- Inspiratory pressure should be set higher than expiratory pressure
- If the patient has difficulty during inspiration, triggering breaths, increase the expiratory positive airway pressure
- If tidal volumes are shallow (< 7 ml/kg), increase inspiratory pressures
- In hypoxic patients, increase the expiratory pressure at increments of 2 cm H_2O , keeping the inspiratory pressure constant
- In patients with hypercapnia, increase the inspiratory pressure at increments of 2 cm H_2O , increasing the expiratory pressure at 1 cm H_2O for every 2.5 cm increase in the inspiratory pressure
- Total pressures > 15 - 20 cm will rarely be tolerated
- $F_{I}O_2$ is titrated to achieve S_aO_2 of more than 90%

Connect oxygen

Apply headgear

Check for air leaks

If required, continue nebulisations

Continue monitoring of vital signs and clinical response

Episodic removal of mask or reduction of pressures can be attempted when improvement is significant and has persisted for \pm 4 hours



Fig. 1. A typical non-invasive face-mask.



Fig. 2. A non-invasive mask strapped to a 'patient's' face.



Fig. 3. A dedicated non-invasive ventilator.

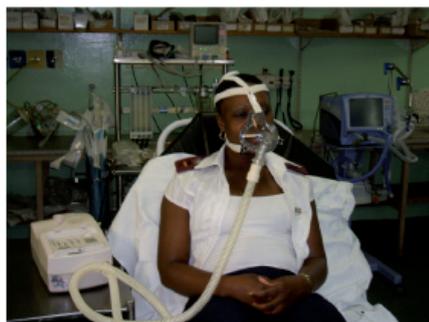


Fig. 4. A demonstration of the non-invasive ventilation system.

- Inability of the patient to protect his/her airway.
- Persistent vomiting.
- Facial trauma or anatomical abnormalities of the face, which would prevent the mask from fitting correctly.
- Recent orofacial, oesophageal or gastric surgery.

Advantages

- Patient's dyspnoea is relieved.
- Patient can talk and eat once stable, and requires less sedation.
- Intubation and its complications such as trauma and nosocomial infections can be avoided.

How it works

NPPV eases the work of breathing. Respiratory muscles are unloaded and therefore muscle fatigue is avoided. Oxygenation is improved by improving ventilation-perfusion mismatching, recruitment of collapsed alveoli and dilating bronchioles, and by forcing fluid out of the alveoli.³

Non-invasive ventilation should not be seen as a modality that reduces the nursing and monitoring requirements of the seriously ill patient. Patients on NPPV require strict monitoring of their vital signs, cardiac rhythm, dyspnoea, accessory muscle use and blood gas values. If there is no improvement of these signs after 30 minutes - 2 hours, the patient should be considered for endotracheal intubation and mechanical ventilation.

In the emergency unit, CPAP or BiPAP are most commonly delivered via a full-face mask (see Figs 1-4). Because most patients feel claustrophobic when the mask is applied, they require assistance and calming during the early stages of therapy. Initially the mask is held to the patient's face and is not strapped onto him/her, as this worsens the sensation of claustrophobia. After a few minutes, as the patient becomes accustomed to the mask and starts to relax, the mask is then strapped to him/her. See Table I for the requirements and procedure of setting up a patient for NPPV.

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Management of the choking victim

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Foreign-body airway obstruction (choking) is probably the most frightening, yet potentially the most reversible acute emergency imaginable. If the airway is completely obstructed, progressive hypoxia develops within seconds, with unconsciousness and death following shortly thereafter, unless immediate relief is provided. The fact that this can happen to anyone at any time, regardless of state of health, physique or age, is testimony to the need to know exactly what actions are required at a moment's notice.

Conscious victim

Ask the victim 'Are you choking?'

- If the victim is able to cough, talk or breathe, encourage the victim to

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cough vigorously. Do not interfere, but stay with the victim, watching for improvement or deterioration.



Fig. 1. The Heimlich manoeuvre.

- If an adult or child is not able to cough, talk or breathe, indicate that you are able to help. Stand or kneel behind the victim and place your fist around his/her abdomen, just above the navel. Grab your fist with your other hand, and perform a rapid inward and upward abdominal thrust – the Heimlich manoeuvre (Fig. 1). Repeat the abdominal thrusts up to 5 times if necessary.
- If the 5 abdominal thrusts have been unsuccessful, lean the victim forward and perform up to 5 back slaps. Use the palm of your hand to hit the upper back between the shoulder blades.
- If unsuccessful and the victim is still conscious, repeat up to 5 abdominal thrusts and up to 5 back slaps until the object is dislodged or the victim becomes unconscious.
- If the victim is markedly obese or in late pregnancy, perform up to 5 rapid chest thrusts instead of abdominal thrusts. This is done by placing your arms under the victim's armpits around the chest, and rapidly pulling the centre of the chest inwards. If unsuccessful, perform up to 5 back slaps. Repeat up to 5 chest thrusts and up to 5 back slaps until the object is dislodged or the victim becomes unconscious.
- If the victim is an infant, kneel down on both knees. Holding the baby's face in the palm of your hand, straddle the baby face down over your forearm, resting your forearm on your thigh. Deliver up to 5 quick back slaps between the baby's shoulder blades. If unsuccessful, support the back of the baby's head with the palm of your other hand and turn the baby over, face up, keeping the head below the chest. Using 2 or 3 fingers,

give up to 5 quick chest thrusts on the centre of the baby's chest just below the nipples. (NB: Do **NOT** do abdominal thrusts on an infant as this could damage the vital organs.) Repeat up to 5 back slaps and up to 5 chest thrusts until the object is dislodged or the baby becomes unconscious.

Unconscious victim

- If the victim becomes unconscious, **immediately call for assistance** (dial 112 on any cellphone or 10177 on a landline or your nearest ambulance service number).
- **A** – using a head tilt/chin lift manoeuvre, open the **airway** and look in the victim's mouth. Remove any visible foreign material, being very careful not to push it further down. Never do blind finger sweeps, as this could aggravate the obstruction.
- **B** – check for **breathing**. If the victim is breathing adequately, turn the victim onto his/her side (the 'recovery position') and watch for continued adequate breathing. Reassess the victim continuously until professional assistance arrives.

- **C** – if not breathing, start **CPR**. If you are on your own, give 2 breaths followed by 30 compressions. If the victim is an infant or child and 2 trained health care professionals are present, give 2 breaths followed by 15 compressions. Each time you open the airway to ventilate, look for and remove any visible object.

Knowing what to do in an emergency is a rewarding experience. Remember the words: 'You will never forget the first time you save a life, nor the first time you don't.....'

Fig. 2 depicts the choking algorithm for adults and children, drawn up by the Resuscitation Council of Southern Africa (www.resuscitationcouncil.co.za).

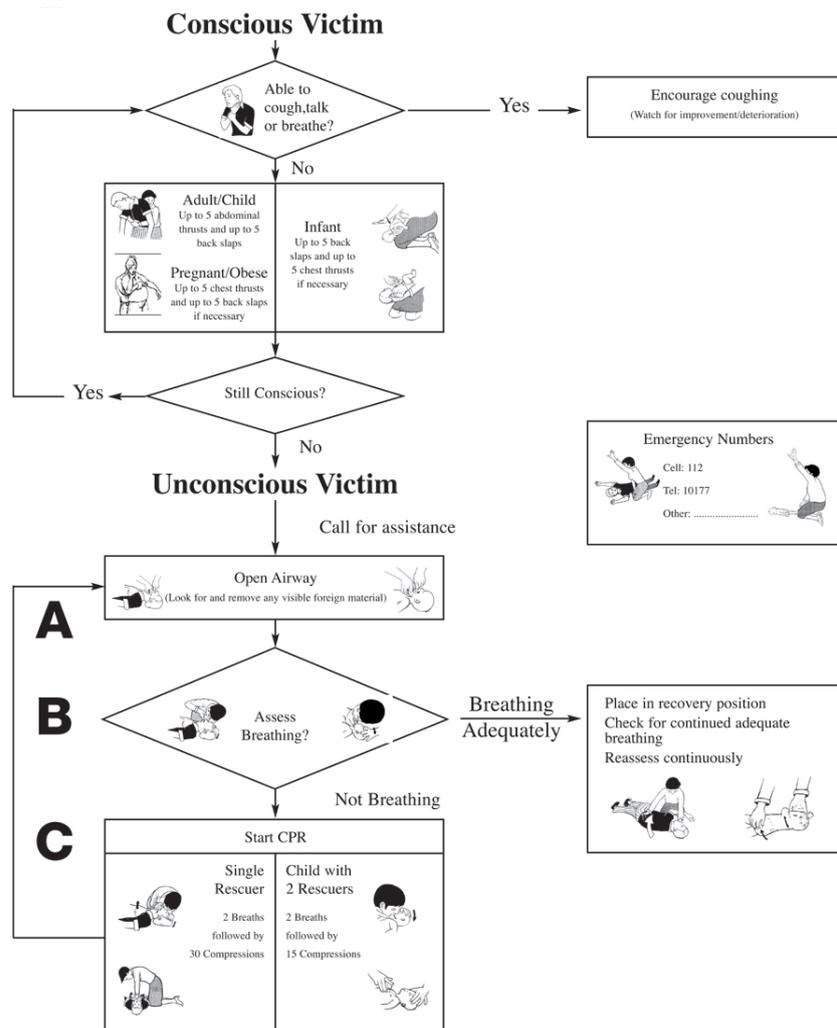


Fig. 2. Choking algorithm for adults and children.

*Basic life support for
health care providers
- new resuscitation
guidelines for adults
and children*

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When a patient suddenly collapses and stops breathing, that person's fate is determined solely by the actions of the nearest bystanders, whether they be health care professionals or lay witnesses. Unless immediate steps are taken to commence effective resuscitation, irreversible brain damage and death will result within approximately 4 - 8 minutes. A systematic approach is provided, based on the latest international recommendations,¹ as a guide to the initial management of a cardiac arrest victim.

H – Hazards?

- Ensure that it is safe to approach the patient.
- Take universal precautions; put on gloves.
- Have a barrier device ready (e.g. protective mouthpiece or bag-valve-mask if available).

H – Hello?

- Tap and/shout 'hello' to determine if the patient is responsive.
- If responsive, treat illnesses or injuries as necessary and get assistance. if needed; reassess patient continuously.
- If unresponsive, shout for help.

H – Help!

- Call for assistance.
- Send someone to fetch a manual defibrillator or automated external defibrillator (AED) immediately.

A – Airway

- If you do not suspect a neck or spinal injury, open the airway by tilting the head back with one hand and lifting the chin upwards with the other hand (head tilt-chin lift manoeuvre) to prevent the tongue blocking the airway.

- If you suspect a neck or spinal injury, rather attempt a jaw thrust (if 2 rescuers are present) or just a chin lift (if you are alone) if possible.
- Open the mouth and remove any visible foreign material.
- If there is vomitus, turn the patient onto his/her side to clear the mouth; use a suction device if immediately available.
- Place your ear next to the patient's mouth and look, listen and feel for adequate breathing for up to 10 seconds.

B – Breathing

- If the patient is breathing adequately (more than the occasional gasp), place the patient into the recovery position by rolling the patient onto his/her side. Watch for continued breathing and reassess continuously.
- If the patient is not breathing, or not breathing adequately (e.g. gasping), give 2 effective breaths, preferably using a protective mouthpiece or bag-valve-mask (with 100% oxygen) if available.
- Allow 1 second for each breath.
- Ensure that the chest rises with each breath. If not, reposition the patient's head and your mouth or the mask to get a better seal.
- Feel for a pulse for up to 10 seconds (check for the presence of a carotid pulse in an adult or child; check for a brachial pulse in an infant) (Fig. 1).
- If a definite pulse is felt but the patient is not breathing adequately, continue giving rescue breaths at a rate of 10/minute for adults and 12 - 20/minute for children.

C – Circulation

- If a definite pulse is not felt within 10 seconds, or if you are not sure if a pulse is present, start chest compressions.
- With the patient on a firm flat surface, kneel at the side of the patient with your knees slightly apart.
- Expose the chest and place one hand on the sternum in the middle of the chest, in the midline in line with the nipples.
- Place the second hand over the first, interlocking and raising your fingers so that only the heel of one hand is resting on the sternum (Fig. 2).
- With your shoulders directly above the patient's chest and your arms



Fig. 1. Pulse check – adult and child.



Fig. 2. Hand placement – adult and child.

straight and elbows 'locked', press firmly down on the chest 30 times at a rate of 100 compressions per minute (almost 2 compressions per second). Ensure full chest recoil between each compression.

- If the patient is an adult (post-puberty), compress to a depth of 4 - 5 cm using both hands. Push hard and push fast.
- If the patient is a child (pre-pubertal), compress to a depth of $\frac{1}{3}$ - $\frac{1}{2}$ the diameter of the chest wall. Use either 1 or 2 hands, depending on the size of the patient and the strength of the rescuer.
- If the patient is an infant (less than 1 year old), place 2 or 3 fingers just below an imaginary line drawn between the infant's nipples, and compress down $\frac{1}{3}$ - $\frac{1}{2}$ the diameter of the chest (Fig. 3).



Fig. 3. Hand placement – infant.

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- After 30 chest compressions, give 2 breaths.
- Continue cycles of 30:2, without interruptions, until help arrives or the patient recovers.
- When a second competent rescuer becomes available, switch the compressor role after every 5 cycles (approximately every 2 minutes) as rescuers will tire very quickly. Do not take any longer than 5 seconds to swap places.
- For children and infants, when a second competent rescuer becomes available, provide cycles of 15 compressions followed by 2 breaths.

Cricoid pressure (Sellick's manoeuvre)

If there are 2 or more rescuers, 1 rescuer may provide pressure on the cricoid cartilage (Sellick's manoeuvre) to prevent air entering the stomach and regurgitation of gastric contents with subsequent pulmonary aspiration.

First locate the thyroid cartilage (Adam's apple) with thumb and index finger, then slide your fingers inferiorly until you feel another smaller cartilage below (the cricoid cartilage). Using the tips of the thumb and the index finger, press firmly down on the cricoid cartilage, compressing the oesophagus.

D – Defibrillation

- Continue cycles of compressions and ventilations, without interruptions, until a manual defibrillator or AED becomes available and is switched on and ready for use.
- Immediately place paddles or pads on the patient's bare chest and analyse the rhythm.
- If the rhythm is shockable (ventricular fibrillation or pulseless ventricular tachycardia), deliver one shock and immediately resume CPR for 2 minutes:
 - if using a monophasic (older) defibrillator, use 360 Joules
 - if using a biphasic (newer) defibrillator, use between 120 and 360 Joules, depending on the recommendations of the specific manufacturer
- if defibrillating a child, use 4 Joules/kg, irrespective of the make and age of defibrillator.
- Repeat the shock after every 2 minutes of CPR if the rhythm remains shockable (VF/VT).

- If the rhythm is found to be non-shockable (pulseless electrical activity or asystole), immediately resume CPR for 2 minutes, then reanalyse the rhythm. If organised electrical activity returns (identifiable QRS complexes), check for the return of a pulse for 10 seconds. If a definite pulse is felt, check for breathing and commence post-resuscitation care.
- If the pulse is absent or the rhythm is asystole, immediately resume CPR for another 2 minutes before reanalysing the rhythm again.

E – Endotracheal intubation

- Protection of the airway using an invasive airway device such as an endotracheal tube (ETT), laryngeal mask airway (LMA) or tracheo-oesophageal combitube (TOC) can be done when rescuers with the necessary skills, expertise and equipment become available.
- Once the patient has an invasive airway device in place (ETT, LMA or TOC), chest compressions are performed continuously at a rate of 100/minute, with no pause in compressions for the delivery of breaths.

- Ventilations are given every 6-8 seconds (approximately 8-10 ventilations/min) while chest compressions continue uninterrupted.
- High-quality, continuous compressions will be tiring. It is recommended that the rescuers doing ventilations and compressions swap tasks every 2 minutes, while the rhythm is being analysed. Ensure that the interruption takes no more than 10 seconds.

Conclusion

A systematic approach, using an alphabetical sequence and supported by an algorithm endorsed by the Resuscitation Council of Southern Africa and the Emergency Medicine Society of South Africa, is provided as a memory aid for the immediate management of a sudden unexpected collapse of a victim in respiratory or cardiac arrest (Fig. 4). The mortality and morbidity of that patient is determined by the actions taken by the nearest rescuer within the subsequent few minutes – every second counts!

Recommended Reading

International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2005; 67(2-3): 157-314.

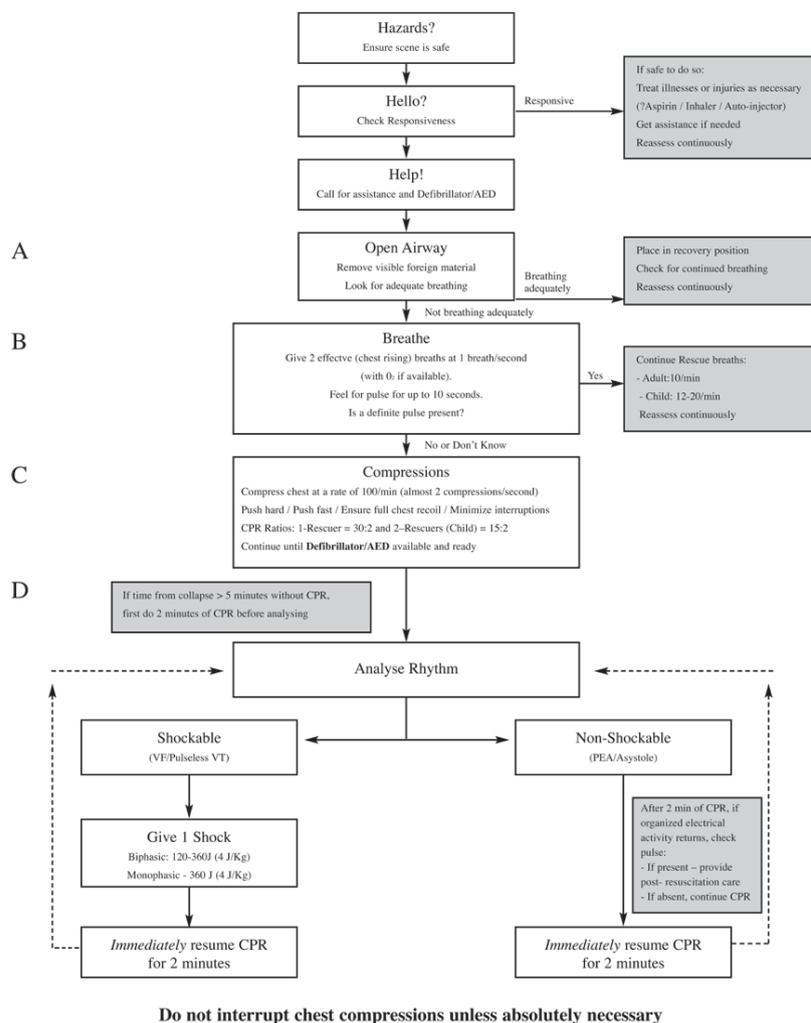


Fig. 4. Basic life support for health care providers (adult and child).