Using non-invasive ventilation in acute wards: part 1

Non-invasive ventilation (NIV) is being used increasingly in acute wards to provide supplementary ventilatory support. The benefits and potential problems that their use is confined to specialist areas such as intensive care units (ICUs). ICU admission may be detrimental to the patient's wellbeing and is often not available. NIV is used to provide ventilatory support: Continuous positive airway pressure (CPAP), ventila-
tion intermittently with nasal mask, where patients have acute respiratory failure, or post-operative respiratory failure, pulmonary oedema and other short-term uses of NIV identified in the first part of the article includes pre-surgical optimisa-
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In addition to these medical contraindications, refusal lists a number of contraindications to NIV (Box 1). One of the main goals of managing respiratory failure this may rise to 25-30 per cent (Hinds 1999). The decision to attempt NIV should, therefore, include preparations for early intubation or adequate support, but it is difficult to predict which patients will need invasive ventilation (Poponcik et al 2000). The British Thoracic Society (2002) recommends that patients with severe respiratory failure often develop "impaired consciousness. Whether CPAP improves cardiac function (in some patients). Increased alveolar pressure reduces cardiogenic pulmonary oedema (BTS 2002, Masip et al 2000). 

Atelectasis/recruit alveoli:

- Reverse atelectasis/recruit alveoli.
- Improve cardiac function (in some patients).
- Reduces pulmonary oedema.
- Increases alveolar ventilation, this suggests that significant alveolar recruitment can occur in one hour (Delclaux 2000). 

Carbon dioxide clearance from alveoli, resulting in decreased hypoventilation (low respiratory rates or depth, or both) causes insufficient carbon dioxide removal. There is virtually no pressure impedes venous return, increasing intracranial hypertension and out of the lungs (Anderson et al 2000). 

Carbon dioxide in blood forms carbonic acid, so decreasing the amount of carbon dioxide means that the carbonic acid is removed from the body, leading to a rise in blood pH (BTS 2002). 

Hyperventilation increases carbon dioxide clearance from alveoli, resulting in decreased hypoventilation (low respiratory rates or depth, or both) causes insufficient carbon dioxide removal. There is virtually no pressure impedes venous return, increasing intracranial hypertension and out of the lungs (Anderson et al 2000).
CPAP circuits may be either high-flow or low-flow systems. Low-flow systems use small volumes of air or oxygen to create sufficient pressure to provide low pressures of CPAP. In community and first-aid settings these low-flow systems can provide useful, simple and compact support. However, acute settings such as hospitals traditionally use high-flow circuits that can achieve higher and more effective pressures. High-flow systems are described below. Some low-flow systems have been marketed in acute settings, so readers could encounter systems that use significantly different principles and equipment to those described. Before investing in new systems, readers are recommended to evaluate evidence of their effectiveness carefully.

Some systems use self-contained circuits or equipment, while others use flow generators to which further items need to be added. This article describes flow generator circuits (Figure 1). Although different systems may look dissimilar, the principles of CPAP remain generic. CPAP circuits should include the items listed in Box 2. The CPAP valve is shown in Figure 2.

Flow generator

Systems produced for domestic use only require low flow, which can be provided by air compressors. In acute care settings CPAP relies on high flow to maintain positive airway pressure. As supplementary oxygen is almost invariably needed, flow generators can be attached to oxygen supplies. Many systems indicate flow only by a triangle or ramp rather than precise volumes, but flows often need to exceed 75 litres per minute, five times the maximum volume from standard oxygen flow meters. Such high flows can quickly drain oxygen cylinders, so whenever possible CPAP should be connected to piped oxygen.

Flow may be generated by bellows or a Venturi system. The Venturi system relies on rapid oxygen flow past a valve to create a vacuum, which entrains atmospheric air. The percentage of oxygen delivered depends on how much air is entrained by the Venturi system. Theoretically, oxygen percentages could range from 21-100 per cent, but many systems can only deliver around 30-95 per cent. Atmospheric air contains bacteria, and hospital air contains disproportionately large numbers of potentially pathogenic organisms (Humphreys 2001). Air should therefore be filtered by adding a bacterial filter, such as a heat moisture exchanger (HME) or a bacteriostatic filter to the air entrainment port.

Oxygen analyser

The oxygen dials on flow generators seldom indicate the percentage of oxygen delivered, so an oxygen analyser is added to the circuit (via a T-piece). The analyser should be calibrated before setting up the circuit and at least once every shift. If analysers become moist they are more liable to malfunction, so water humidifiers should always be placed after the analyser.

Pressure relief valve

To maintain positive airway pressure, most circuits are closed except for the exit valve. Any obstruction before the exit valve, such as tubing being trapped in bed mechanisms, would rapidly result in dangerously large volumes of gas entering the patient's lungs, probably causing a pneumothorax. An escape valve is, therefore, attached near the start of the circuit via a T-piece. Because this valve should not normally open and some pressure is lost as gas flows through semi-pliant circuit materials, it is important that the pressure relief valve be operable.
Box 3. The main problems caused by CPAP

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Discomfort</td>
<td>Noise, gastric/gut distension, cardiovascular instability, humidification, reduced lung compliance, hypercapnia, pressure ulcers</td>
</tr>
<tr>
<td>Non-compliance with NIV therapy</td>
<td>Nurses should seek advice from hospital technicians about reliability, because some systems designed for short-term emergency (e.g. paramedic) use are not sufficiently reliable.</td>
</tr>
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</table>

Saturated at 20˚C (Ballard 2000), moisture. Room air in the UK is about 50 per cent so air fully saturated at 20ºC absorbs airway carry more water vapour than cold air (Brown 2000), and warmed to body temperature. Warm air can tens air, so alveolar air is 100 per cent saturated humidifier routinely.

In acute hospitals, however, full-face masks with face. Design and appearances of these straps vary, although discomfort relieved by a looser mask may be offset by greater discomfort around the nasal bridge.

Some systems can create sufficiently large flows to compensate for leaks, but before investing in equipment, nurses should seek advice from hospital technicians about reliability, because some systems designed for short-term emergency (e.g. paramedic) use are not sufficiently reliable.

Heated humidification can prevent drying of the upper airway warms and moistens inspired air, thereby improving mucociliary clearance and reducing the risk of infection. Heated humidifiers should be regulated by a thermometer and nurses should check water levels frequently with alarms and nurses should check humidification should be regulated by a thermometer, so staff should check water levels frequently.

Some systems use 20cmH2O pressure relief valves at the exit valve (if possible). In the author's experience, some units use 20cmH2O pressure relief valves at the exit valve (if possible).

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Some systems can create sufficiently large flows to compensate for leaks, but before investing in equipment, nurses should seek advice from hospital technicians about reliability, because some systems designed for short-term emergency (e.g. paramedic) use are not sufficiently reliable.
and thus isolating patients. Difficulty in removing
urements were taken after five minutes it is possible
bral blood flow in volunteers, although as meas-
five and 10cmH2O did not significantly affect cere-
sion reduces perfusion, so the benefits of increased
oxygen saturations should be weighed against
tribute further to hypotension.
reduce cardiac sympathetic nervous activity (Kaye
in people who had atrial fibrillation. CPAP can also
of alveolar walls can be reduced by prolonged CPAP,
that remain continuously inflated, the stretch (tone)
result in raised blood carbon dioxide levels (hyper-
ping in the alveoli. CPAP may therefore paradoxically
continuous positive pressure also causes gas trap-
\[\text{REFERENCES}\]
Douglas N (1998) Systematic review of
Brown L (2000) Back to basics: if it's dry,
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Brown L (2000) Back to basics: if it's dry,


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Divisions of Critical Care Nursing Dimensions of Critical Care Nursing 1994 1 All ER 819 established the principles of informed consent. Every effort should be made to obtain informed consent as far as the patient is concerned regarding and managing CPAP should explain the benefits of CPAP take about 20 minutes to be obvious, and any equipment-related problems for patients and nurses. Bilevel NIV, which is then strapped on to the face, can be frightening and can refuse life-saving treatment (Dimond 2002). Discussion of legal and ethical dilemmas is beyond the scope of this article, although the psychological effects of stress may be detrimental. Distress cues. Reversing life-threatening hypoxia is usually more important than gaining informed consent as far as the patient is concerned. Intensive Care Medicine 26, 42-45.
