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Reducing the Duration of Mechanical Ventilation

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Summary

Dr Macnaughton presents the case for organisational improvements to respiratory care.

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The requirement for mechanical ventilatory support is the most common reason that patients are admitted to an Intensive Care Unit, with around 2/3rds of admissions receiving this therapy in England and Wales. Patients require ventilatory support when their own ventilator capacity cannot meet the increased ventilatory demands imposed by diseases such as sepsis or following major surgery, or when ventilator capacity is reduced from the effects of drugs or disease upon the lungs. Once the imbalance between ventilatory capacity and demand improves, the focus shifts from providing to successfully withdrawing ventilatory support, a process termed weaning. Approximately 50% of the time that a patient is receiving ventilatory support is taken up by weaning, which therefore represents a considerable workload and financial burden to the typical Intensive Care unit. The duration of ventilatory support and length of Intensive Care stay is increased if weaning is delayed inappropriately. Delayed weaning also exposes the patient to increased risks of complications such as ventilator associated pneumonia (VAP) and upper airway damage from prolonged endotracheal intubation. This needs to be balanced against the risks of premature discontinuation of ventilatory support, which is associated with an increased mortality.

Conventionally patients have an endotracheal tube inserted, usually under deep sedation or anaesthesia, for ventilatory support to be provided by a mechanical ventilator. Non-invasive ventilation (NIV) describes the technique of applying mechanical ventilator support with a facemask and avoiding the complications of endotracheal intubation. In selected patient groups, such as patients with Chronic Obstructive Airways Disease, there is clear evidence that NIV reduces morbidity, length of ICU stay and mortality, compared to conventional mechanical ventilation [1]. NIV may also facilitate weaning of patients with underlying chronic respiratory disease. However when applied inappropriately, NIV may adversely affect outcome as it may delay endotracheal intubation and expose the patient to the risk of sudden decompensation with cardiorespiratory arrest.

Appropriate patient selection is essential when applying NIV, but the ability to provide NIV is an important therapy that intensive care units should offer. Even in the best hands, for some 25% of patients who are treated with NIV, the treatment does not suffice and the patients require conventional ventilation. There are a wide range of patient interfaces (masks) including nasal, full face and total face that can therefore be tailored to the individual patient increasing the likelihood of success. Although when first described NIV was applied with a conventional 'invasive ventilator', there are now a large number of devices available specifically designed for NIV, which cope with the demands of NIV much better and therefore increase success. Effective NIV requires an adequate nurse to patient ratio, particularly in the first few hours and has been reported to be equally demanding in terms of nursing time compared to conventional respiratory support with endotracheal intubation. Although NIV has been used successfully outside the Intensive Care Unit, this is generally in less severely ill patients who do not require such close monitoring. Overall, when NIV is used in the place of conventional ventilatory support, the demands in terms of use of Intensive Care resources are equally high.

During NIV, normal upper airway function is preserved (e.g. coughing, swallowing, speech) with the result that the risk of developing a hospital acquired pneumonia is considerably reduced. Prolonged endotracheal intubation is a significant risk factor for ventilator associated pneumonia (VAP). VAP is the most common reason prolonging the duration of ventilatory support, with an estimated additional financial burden of between \$5000 and \$20,000 for each episode.

Aspiration into the respiratory tract of oropharyngeal secretions colonised with pathogenic bacteria is considered the main pathogenic mechanism of VAP. A number of non pharmacological approaches have been shown to reduce the incidence of VAP including nursing patients in the semirecumbent position (30–45 degrees) rather than supine, minimising the duration of ventilator support, avoiding unnecessary manipulation or changes in the respiratory circuit and the prevention of ventilator circuit condensate either by regular drainage or the use of heat and moisture exchangers. The organisms responsible for VAP are ubiquitous in the ICU and transmission between patients occurs via the hands of healthcare workers that have become contaminated. Meticulous hand washing and disinfection by all healthcare workers will reduce cross infection and the ready availability of alcohol-based lotions at every bed space improves compliance. Despite numerous publications recommending these simple and cost effective strategies to reduce the burden of VAP, a number of studies have revealed that compliance rates may be as low as 33%. A significant reduction in the incidence of VAP has been demonstrated following a comprehensive multidisciplinary educational programme combined with audit [2].

There are two distinct steps in weaning. First, the clinician needs to recognise that the patient's condition has improved and that it is appropriate to consider discontinuation of ventilatory support. The ability of the patient to cope is then evaluated as support is withdrawn, either gradually or abruptly, in a weaning trial. Prompt recognition of suitability for weaning combined with an appropriate trial will reduce length of ICU stay. This needs to be balanced against the potential adverse effect on both the physical and mental condition of the patient if weaning trials are conducted before the patient is ready. Although many clinicians use their clinical experience and judgement to assess suitability for weaning, daily screening of patients with physiological measurements is effective. A number of studies have investigated the optimum method of conducting a weaning trial and the consensus is that a short (30 minutes) trial of unassisted breathing (T piece trial) is most effective. If a patient fails this T piece trial, then gradual withdrawal of ventilatory support with pressure support ventilation may be appropriate. Once a patient can tolerate 30 minutes of spontaneous breathing without signs of respiratory distress they are considered ready for extubation, subject to their ability to protect their airway unassisted. The use of a protocol to guide non physicians allows nurses or respiratory therapists, for example, to undertake weaning confidently and may be more effective than physician directed weaning; such protocols have been associated with a shorter duration of ventilator support and overall ICU stay [3, 4].

NIV may be used to assist with weaning difficult patients. Patients with chronic respiratory disease such as COPD often fail conventional weaning trials with the result that they require prolonged periods of respiratory support. An alternative approach is to convert the patient to NIV without the patient completing a weaning trial and then gradually reduce the level of support applied non-invasively. This strategy has been demonstrated to reduce morbidity, duration of ICU stay and mortality compared to continuing conventional ventilator support with further attempts at T piece trials. Most patients wean from ventilator support without difficulty, but the occasional patient may fail repeated attempts and require very prolonged ventilator support (e.g. over 4 weeks). Although small in number these patients represent a significant burden on ICU resources. A multidisciplinary approach with a clear long-term plan for gradually increasing periods of spontaneous breathing is usually successful. Very rarely patients may fail to wean at all, usually because of previously unrecognised chronic respiratory disease; in this case consideration will need to be given to providing permanent ventilatory support outside the intensive care unit.

Mechanically ventilated patients commonly require some degree of sedation to alleviate the distress and discomfort associated with ventilatory support and endotracheal intubation. However, administration of excessive sedation may be an important factor which delays weaning from mechanical ventilation.



This is particularly a problem in elderly patients requiring prolonged periods of ventilator support. Daily interruption of sedative infusions ensures that the continuing requirement for sedation is regularly reviewed and excessive administration avoided. This simple practice has been shown to reduce duration of mechanical ventilator support and length of ICU stay and should be included in all sedation protocols.

Some centres, particularly in North America, have established weaning units that specialise in the management of patients requiring longer term respiratory support (e.g. over 2 weeks). By admitting only stable patients requiring respiratory support, resources and expertise may be targeted to the particular requirements of the difficult to wean patient without having to provide the range of organ support and monitoring required in a general ICU. These units may be more cost effective as the stable long-term patients are managed with a lower nurse to patient ratio and the concentration of expertise in weaning may increase success with reduced time. Weaning units increase the availability of scarce ICU beds for patients requiring multisystem support and there is increasing interest in establishing such centres in the UK [5]. The organization of ventilatory support within ICU will influence outcome. Protocols are required to minimise the risk of developing VAP, encourage daily interruption of sedative infusions and allow nonphysician directed weaning. Appropriate use of NIV complements invasive support. Whilst a single change may have a

limited effect upon outcome, combining all these changes into what has been termed a respiratory care bundle is likely to have a significant effect on length of stay ensuring that ICU beds are used efficiently. The Critical Care physician needs to take an active role in leading such service improvements.

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