Development of clinical guidelines for prone positioning in critically ill adults

Catherine Rowe

SUMMARY

• Literature reveals evidence that prone positioning can improve the oxygenation of critically ill patients suffering from acute lung injury or acute respiratory distress syndrome
• Multicentre evidence, however, does not support the claim that it improves patients’ outcome
• The implementation of multiprofessional guidelines by which to direct the manoeuvre will facilitate the safe and effective management of patients in the prone position. They will thus heighten multiprofessional awareness of the technique and promote its proactive use at such time so as to achieve maximum clinical benefit

Key words: Clinical guidelines • Enhanced oxygenation • Proactive management • Prone positioning

INTRODUCTION

Historically, within our general intensive care/high dependency units, prone positioning has been used in a relatively ad hoc manner, mainly as a last-ditch attempt to improve patients’ oxygenation when maximum ventilatory support has failed. Although it has been encouraging to note that the pronation of patients has increased sporadically, staff remain reluctant to instigate the manoeuvre, despite enthusiastically reporting that it has improved patients’ oxygenation (PaO₂), thus allowing the reduction of the fraction of inspired oxygen (FiO₂) and levels of positive-end expiratory pressure (PEEP).

On reflection, our decision to develop and implement comprehensive multiprofessional guidelines to direct the prone manoeuvre resulted from a belief that they would facilitate the delivery of the safe, effective and appropriate use of the technique and would raise multiprofessional awareness and prompt consistent and proactive utilization.

The following guidelines primarily identify the most significant clinical indications for use of the prone position before addressing potential exclusion criteria or reported contraindications. They explore the main manoeuvre detail, address care considerations prior to and following the manoeuvre and identify potential documented complications before culminating in a comprehensive bedside algorithm to direct clinical care.

LITERATURE REVIEW

Critical evaluation of the available literature suggests that critically ill adults, who are exposed to either the hypoxic consequence of acute lung injury and acute respiratory distress syndrome or the iatrogenic complications of mechanical ventilation, may benefit from being managed in the prone position (Vollman, 1997; Marini and Hotchkiss, 1999).

Extensively, the evidence claims that prone positioning may optimize patients’ oxygenation (Pappert et al., 1994; Fridrich et al., 1996) and minimize the risk of iatrogenic lung injury resulting from mechanical ventilation (Broccard et al., 1997; Gosheron et al., 1998). It can enhance the mobilization of pulmonary secretions, thus optimizing the effectiveness of physiotherapy techniques (Chatte et al., 1997), it improves ventilation to previously atelectic lung regions (Ryan and Pelosi, 1996; Mure et al., 1997) and has been shown to minimize the risk of ventilator-acquired pneumonia (Pappert et al., 1994; Brazzi et al., 1999).

Despite these exhaustive claims, Gattinoni et al. (2001) more recently published the results of a multicentre, randomized trial that compares the clinical
outcome of 304 patients with varying degrees of acute lung injury. Half the eligible patients were randomly assigned to be conventionally managed within the supine position, whilst the other half were managed prone for at least 6h a day for a period of 10 days.

Results revealed that there was no significant difference in the mortality rates of either group at the end of the 10-day study period, at the time of discharge from intensive care or after 6 months. However, it is important to note here that the study results sustain the claim that prone positioning undoubtedly improved oxygenation in more than 70% of patients, thereby rendering it a useful option in the management of patients with severe hypoxaemia.

The study also expounds that the incidence of position-related complications was similar in both the groups and that the most significant in relation to pronation was the need to increase sedation, facial oedema and the immediate need for airway clearance. Accidental extubation only occurred in four of the 721 manoeuvres undertaken.

Interestingly enough, the authors reveal that pronation of the sickest patients resulted in a transient survival advantage during the 10-day study period and has led them to recommend a further trial to clarify the role of pronation in those patients suffering from severe acute respiratory distress syndrome.

Despite medical and therapeutic advancements, there is still no definitive treatment for acute respiratory distress syndrome. Although they have declined over the past decade, the mortality figures associated with the disease are estimated at between 32 and 45% (Udobi et al., 2003). For patients who present with the clinical injustice of increased dyspnoea, advancing hypoxaemia, deterioration in lung compliance and diffuse bilateral infiltrates on chest radiography, we can merely offer supportive management and fundamental care to minimize the associated iatrogenic events. However, given the evidence available, this management should, I suggest, include the proactive use of prone positioning.

For clarity, the following dialogue will reflect the contents of the clinical guidelines, which we have developed and adopted for use within our clinical area in order to encourage the proactive use of the manoeuvre.

INDICATIONS FOR USE OF THE PRONE POSITION
For prone positioning to be effective, the literature suggests that it should be undertaken early in the patients’ disease pathway (Vollman, 1997), as it has been shown to preferentially re-expand dorsal alveoli and is particularly effective in the early oedematous phase of acute lung injury and acute respiratory distress syndrome (Table 1) (Blanch et al., 1997). However, as the disease progresses, it has been reported that the subsequent development of associated pulmonary fibrosis may interfere with alveolar re-recruitment and the potential for the patient to benefit from the manoeuvre will be greatly reduced (Pappert et al., 1994).

In addition, prone positioning has been shown to enhance the mobilization of chest secretions, maximize the effects of physiotherapy and enhance ventilation to previously atelectic lung regions, thus reducing the risk of ventilator acquired pneumonia (Chatte et al., 1997; Mure et al., 1997; Brazzi et al., 1999).

Exposure to high levels of both oxygen and PEEP reportedly contribute to progressive lung damage in mechanically ventilated patients and may result in the development of pulmonary atelectasis and alveolar and interstitial oedema, which will further contribute to the impairment of gaseous exchange. The literature suggests therefore that the pronation of mechanically ventilated patients will minimize the development of the iatrogenic events associated with prolonged exposure to mechanical ventilation, where those ventilatory mechanisms involved have been shown to cause or propagate lung injury (Broccard et al., 1997; Chatte et al., 1997; Mure et al., 1997; Gosopheron et al., 1998; Brazzi et al., 1999; Marini and Hotchkiss, 1999).

POSSIBLE EXCLUSION CRITERIA
From the evidence presented, Table 1 summarizes conditions or clinical scenarios, which have been cited as potential exclusion criteria and which should precipitate a risk/benefits analysis to be undertaken when considering the prone positioning of patients.

Table 1: Indications for use of the prone position

<table>
<thead>
<tr>
<th>Indications for use of the prone position</th>
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</thead>
<tbody>
<tr>
<td>- Patients diagnosed with acute lung injury (Bernard and Artigas, 1994), with an acute lung injury score ≥ 2 (see Appendix 1)</td>
</tr>
<tr>
<td>- Patients diagnosed with acute respiratory distress syndrome (Bernard and Artigas, 1994), with an acute lung injury score ≥ 2.5 (see Appendix 1)</td>
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<tr>
<td>- Patients diagnosed with bilateral basal consolidation/collapse (Mure et al., 1997)</td>
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<td>- Patients requiring postural drainage of pulmonary secretions (Chatte et al. 1997)</td>
</tr>
<tr>
<td>- Patients in whom their oxygen index ≤ 300 or who are requiring progressively increased concentrations of oxygen and/or levels of PEEP in order to maintain individually accepted oxygenation values (Gosopheron et al., 1998; Brazzi et al., 1999)</td>
</tr>
<tr>
<td>- Patients who are expected to require prolonged periods of mechanical ventilation (Broccard et al., 1997; Brazzi et al., 1999)</td>
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</table>
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Table 2 Potential exclusion criteria for prone positioning of patients

- Acute haemodynamic instability or acute shock (Fridrich et al., 1996; Vollman, 1997)
- Recent cardiac arrest, cardiac surgery or sternotomy (Chatte et al., 1997; Ball, 1999)
- Weight >90kg and girth >50 inches (Vollman, 1997). Note: For patients who exceed the weight and girth parameters identified, additional considerations must be employed, including the use of hoists to aid repositioning or the use of available rotational beds
- Pain and/or agitation (Mims, 1989)
- Formation of a tracheostomy within 24h (Ball, 1999)
- Bronchopleural fistula (Pappert et al., 1994)
- Grossly distended abdomen, ischaemic bowel, recent abdominal surgery or abdominal stoma (Pappert et al., 1994; Stocker et al., 1997; Ball, 1999)
- Pregnancy (second/third trimester.) (Gosheron et al., 1998; Ball, 1999)
- Acute head injury raised intracranial pressure/frequent seizures (Fridrich et al., 1996; Blanch et al., 1997; Vollman, 1997; Gosheron et al., 1998)
- Raised intraocular pressure/recent ophthalmic surgery (Ball, 1999)
- Unstable cervical spinal injury, spinal instability, evidence of osteoporosis (Fridrich et al., 1996; Ryan et al., 1996; Stocker et al., 1997)
- Multiple trauma, acute pelvic fracture, external pelvic fixation, rib or sternal fractures, and traction (Ryan et al., 1996; Chatte et al., 1997; Ball, 1999)
- Acute asthma, chronic obstructive pulmonary disease or pulmonary abscess (Blanch et al., 1997; Jolliet et al., 1998)
- Acute haemoptysis or acute alevolar haemorrhage (Jolliet et al., 1998)
- Chest wall abnormalities/kyphoscoliosis or advanced arthritis (Blanch, 1997; Ball, 1999)
- Extensive inguinal/abdominal soft-tissue injury (Stocker et al., 1997; Jolliet et al., 1998)
- Facial trauma or following oral maxillary facial surgery (Fridrich et al., 1996; Blanch et al., 1997)

Manoeuvre technique

Preparation of patient and the environment

The patients’ suitability for proning must be assessed from a multiprofessional perspective prior to the event in order to aid communication and encourage a multidisciplinary approach to patient care.

Preparation of the patient and their immediate environment then becomes of primary importance, as thorough consideration and planning of the manoeuvre will minimize the occurrence of its associated risks, for example, accidental displacement of the patients’ airway and/or invasive monitoring or lines.

Consideration should also be given to the timing of the turns and to all the necessary assessments and clinical interventions required. Only by means of effective and coordinated care can the patients safety be guaranteed and unnecessary repositioning be avoided.

The patient should be nursed on an appropriate pressure-relieving mattress, with a sliding-sheet in situ to aid repositioning. Their pressure areas must be assessed in advance of the turn and areas of concern highlighted, documented and appropriately alleviated in accordance with Trust tissue viability recommendations. An individual care regime should then be developed in order to minimize the risk of pressure area development, whilst the patient is maintained within the prone position.

Prior to commencement, the manoeuvre should be explained to both the patient and their relatives, thus highlighting the potential clinical benefits and side effects, in order to promote effective communication, to gain cooperation and to reduce resultant anxieties or concerns.

An arterial blood gas analysis must be performed prior to commencement of the turn and the oxygen index calculated by dividing the patients’ PaO2 by their FiO2, as expressed as a decimal. This should then be documented accordingly in order to facilitate the accurate establishment of the Responder–Non-responder patient status and to prospectively evaluate the effectiveness of the manoeuvre on individual patient’s oxygenation.

Electrocardiogram electrodes should be removed from the patients’ anterior chest wall, and all non-essential monitoring and invasive lines disconnected. That deemed essential by its continued presence must be adequately secured and flexible enough to accommodate all aspects of the turn, thus minimizing the risk of accidental displacement or removal and to maintain patient safety throughout (Canter, 1989; Stocker et al., 1997).

Pulse oximetry with an effective pulsatile trace should remain in situ and be visible or audible at all times to provide effective monitoring during the manoeuvre and to alert staff to potential deterioration. If at any time, the patient develops an unacceptable deterioration in physiological status, the turn should be abandoned to re-establish stability, and should a cardiac arrest situation arise, the patient must be returned to the supine position for resuscitation to be effective (Gosheron et al., 1998).

The patients’ enteral feed should be temporarily halted prior to the turn and their nasogastric tube aspirated to reduce risk of regurgitation of the feed, which may predispose to aspiration of gastric contents and the development of aspiration pneumonitis (Gosheron, 1998).

It is essential that particular attention be given to the security of the patients’ endotracheal/tracheostomy tube to reduce the risk of accidental tube displacement or extubation. In addition, tube size, length at lips and grade of intubation should be noted. All appropriate intubation equipment should be immediately available.
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so as to facilitate effective repositioning/re-intubation, should the need arise (Canter, 1989; Gosheron et al., 1998; Ball, 1999).

Endotracheal/tracheal suctioning should be undertaken prior to turning and a closed suction system placed in line to accommodate ease of access to the patients’ airway, as pronation may precipitate the mobilization of copious pulmonary secretions, which require immediate and ongoing removal (Ball, 1999).

An individual eye assessment should be undertaken prior to commencement of the manoeuvre, as the patients’ eyes are particularly vulnerable both during and after the turn.

Care must be taken to ensure that the eyelids remain closed at all times and appropriate lubrication instilled to reduce the risk of corneal drying, abrasion or infection (Canter, 1989).

There must be five team members available before initiation of the turn, one of which must be an experienced anaesthetist or possess competent intubation skills. In addition to coordination of the turn, this person should remain responsible for the patients’ head and airway management and be immediately available to re-intubate the patient, should accidental displacement of the airway occur (Blanch et al., 1997; Gosheron et al., 1998; Pelosi et al., 1998; Ball, 1999).

At this stage, the patients’ pain/sedation status should be assessed, and where required, prescribed analgesia/sedation is accordingly administered to optimize sedation, prevent pain, minimize discomfort and avoid agitation during the turn (Canter, 1989; Jolliet et al., 1998). Should interference with mechanical ventilation become problematic in the presence of optimal sedation, the administration of pharmacological muscle relaxants may be considered and administered, in order to prevent ventilatory interference and optimize oxygenation and stability (Jolliet et al., 1998).

Turning the patient prone

Prior to commencement of the turn, it is essential to ensure that the patients’ arms are positioned close to their sides, with the palms facing inwards (Figure1). Pillows should then be carefully placed across their chest, pelvis and knees (Pelosi et al., 1998). Ensuring all essential lines are safely secured and directed towards the patients’ head, the coordinator should be positioned likewise, with two additional staff members on either side. The bottom sheet must be pulled straight and taut and a second sheet laid across the patient, ensuring that all corners are matching. The patients’ head and face are then uncovered, and the staff either side should proceed to roll the matching edges of the sheets together tightly, effectively cocooning the patient inside.

Once the patient has been secured, and it is safe to proceed the patient should be glided across the bed, away from the ventilator, to as near the opposite edge of the bed as is safely possible. Whilst maintaining sheet integrity and affording all personnel the opportunity to swap over supporting hands, the patient should then be primarily manoeuvred into the lateral position and then lowered carefully onto the supporting pillows and into the prone position. Finally, the patient can be glided into a more central position in the bed, for more detailed consideration to be given to the supporting pillows (Figure2).

The upper pillow must support the patients’ upper chest, allowing their shoulders to fall forwards slightly and reducing the risk of overdistension of the anterior capsule of the shoulder joint and injury to the brachial plexus (Figure3). The middle pillow should be positioned under the patients’ pelvis, thus maintaining them in an abdomen-free position to promote

Figure 1 Sheet preparation prior to turn.

Figure 2 Patient is initially placed in lateral position.
diaphragmatic excursion and to optimize functional residual capacity and basal lung expansion (Vollman, 1997). In addition, the abdomen-free approach is reported to minimize the risk of bacterial translocation of the gut, which may predispose to sepsis (Ball, 1999), the risk of caval compression and its potential haemodynamic consequences and will promote the tolerance of enteral feeding.

Finally, the lower pillow should be positioned such that the patients’ knees are allowed to remain in a flexed position with the ankles slightly forwards. This will prevent overstretching of the soft tissues surrounding the ankles joints, avoid shortening of the Achilles’ tendon and reduce the pressure exerted over the head of the fibula, which may injure the common peroneal nerve.

Stringent attention to detail must then be given to the positioning of the patients’ head and limbs. They should be maintained within the swimmers position, ensuring that their face looks towards the prominent arm, the opposite one being positioned carefully down by their side.

It is essential that the shoulder position of the prominent arm be maintained at 80° abduction, whilst the elbow is flexed to 90° to minimize the risk of injury of the neural tissue and prevent overextension or development of limb contractures (Gosheron et al., 1998; Ball, 1999). In addition, a small-rolled pillowcase should be placed in the palm of the prominent hand to extend the wrist and allow flexion of the fingers.

Care must be taken with any subsequent repositioning of the patients’ arms, and carers must at all times avoid pulling on the patients’ wrist to elicit a response (Canter, 1989) (Figure 4). Once established in the prone position, the bed should be placed in a reverse Trendelenburg’s position, i.e. tilted foot down 30–45° (Gosheron et al., 1998), to reduce the severity of facial and periorbital oedema. Immediate attention must be given to the patients’ individual eye care regime, with the initial assessment maintaining that they remain closed and free from direct pressure, thus minimizing the risk of iatrogenic ophthalmic complications and to avoid corneal drying, abrasion or ulceration (Gosheron et al., 1998; Ball, 1999).

It is essential to continue to mobilize the patient whilst in the prone position, thus avoiding pressure area development, soft-tissue injury and muscle deterioration and to optimize effective sputum drainage, clearance and removal. An individual repositioning regime must be negotiated (Figure 5), as directed by the patients’ tolerance level and physiological requirements. However, it should at least incorporate a modified repositioning approach, whereby the patients’ swimmers position is alternated every 2–4h and the position of their supporting pillows changed, thus rendering them three-quarter prone.

All non-essential monitoring equipment removed prior to the proning manoeuvre must be re-attached at
this stage and the patients’ previous enteral feeding régime resumed.

As previously stated, pronation of the patient may result in the mobilization of copious pulmonary and oral secretions, which will require immediate and ongoing removal (Wayne et al., 1994; Chatte et al., 1997). In addition, it may be essential to provide additional protection under the patients’ head and face using absorbent material and to ensure that soiled or wet linen there is changed promptly to avoid excori- ation or breakdown of skin in this area.

The patients’ response to prone positioning should be assessed after 30min, assuming no immediate and unacceptable physiological deterioration has occurred. An arterial blood gas analysis should be undertaken and the oxygen index calculated compared to supine and documented accordingly.

If the patients’ PaO₂ has increased by 1·3kPa (10mmHg) or more, or their oxygen index has increased by 20mmHg or more, they can be classed as a Responder (Chatte et al., 1997; Gattinoni et al., 1997; Jolliet et al., 1998). Although most patients respond very quickly, there are those who will benefit from proning but show a more gradual positive response. In the absence of an immediate improvement in oxygenation and assuming there is no prolonged or unacceptable deterioration in the patients’ condition, the prone position should be maintained for an additional 3–6h in order to afford the patient the opportunity to gain Responder status (Canter, 1989; Gattinoni et al., 1997). Conversely, there are patients whose oxygenation will not improve or may deteriorate to an unacceptable level. These patients are classed Non-responders. If the patient therefore does not respond after pronation of 6h or if an unacceptable deterioration occurs, they should be returned to the supine position. However, it is important to note here that this initial lack of response does not automatically mean the patient will never respond in a positive manner. It should not therefore preclude subsequent proning attempts, if considered necessary (Jolliet et al., 1998; Trotti, 1998).

The evidence suggests that patients can be maintained prone for as long as they continue to demonstrate a positive response (Stocker et al., 1997; Webster, 1997; Jolliet et al., 1998). However, it is essential that they undergo modifications to their position, every 2–4h, as previously directed, unless extreme circumstances dictate. If the patient has indeed demonstrated an unacceptable deterioration when being returned supine, it may be necessary to maintain them in the prone position for longer than the 12-h maximum period routinely recommended within our clinical area.

### POTENTIAL CLINICAL CONSEQUENCES OF NURSING A PATIENT PRONE

Table 3 summarizes potential side effects associated with pronation. However, with adequate preparation and compliance to our guidelines, these should be reduced but will be subject to ongoing clinical scrutiny.

Although our guidelines offer a comprehensive guide to all aspects of prone positioning, they constitute quite an extensive document; therefore the following bedside algorithm is used to direct the clinical process (Figure 6).

### CONCLUSION

Despite being labour intensive when undertaken by a confident and competent multiprofessional team, the pronation of patients has been shown to be relatively straightforward and safe, with the incidence of potential side effects minimal (Gattinoni et al., 2001).

Although there is lack of statistical evidence to support the claim that it improves patients’ survival, there is overwhelming evidence to say that pronation has a positive impact on oxygenation in responder patients (Blanch et al., 1997; Vollman, 1997; Gattinoni et al., 2001).

Although mortality from acute lung injury and acute respiratory distress syndrome is not directly attributable to hypoxaemia, its proactive management will facilitate the reduction of ventilatory support; thus the risk of iatrogenic complications associated with mechanical ventilation may be avoided or minimized.

The development and introduction of our guidelines will help direct, safe and effective care for those patients who may clinically benefit from being managed prone and reduce the clinical risks associated with the manoeuvre. Moreover, they will help us achieve our initial clinical quest, which was to initiate the use of prone positioning early within the patients’ care pathway as a proactive management strategy so as to maximize clinical effect rather than to use it in desperation, when conventional management has failed.

### Table 3: Potential side effects of pronation

- Accidental displacement or removal of the patients’ artificial airway
- Difficulty in performing eye care, oral toilet and facial care due to reduced access
- Displacement, compression of, or difficulty in accessing or re-siting intravenous lines, enteral feeding lines or invasive monitoring devices
- Pressure on the cheeks, breasts, genitalia, knees and pelvic area
- Gastric regurgitation, intolerance of enteral feed and translocation of abdominal bacteria
- Joint stiffness, overextension, nerve compression or the development of contractures
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REFERENCES


Figure 6 Care algorithm for prone positioning of patients.
APPENDIX 1

The acute lung injury score (Murray et al., 1988).

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest radiograph score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No alveolar consolidation</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Alveolar consolidation in one quadrant</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Alveolar consolidation in two quadrants</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Alveolar consolidation in three quadrants</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Alveolar consolidation in all four quadrants</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Hypoxaemia score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PaO2/FiO2 ≥300</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>PaO2/FiO2 225–299</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>PaO2/FiO2 175–224</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>PaO2/FiO2 100–175</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PaO2/FiO2 &lt;100</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Respiratory system compliance score (if mechanically ventilated)</td>
<td></td>
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<tr>
<td>Compliance ≥80ml/cm H2O</td>
<td>0</td>
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</tr>
<tr>
<td>Compliance</td>
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</tr>
<tr>
<td>Compliance 60–79ml/cm H2O</td>
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<tr>
<td>Compliance 40–59ml/cm H2O</td>
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</tr>
<tr>
<td>Compliance 20–39ml/cm H2O</td>
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<tr>
<td>Compliance ≤19ml/cm H2O</td>
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<tr>
<td>Positive-end expiratory pressure (PEEP) score</td>
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<tr>
<td>PEEP ≤5cm H2O</td>
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<tr>
<td>PEEP 6–8cm H2O</td>
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</tr>
<tr>
<td>PEEP 9–11cm H2O</td>
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</tr>
<tr>
<td>PEEP 12–14cm H2O</td>
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</tr>
<tr>
<td>PEEP ≥15cm H2O</td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

The final value is obtained by dividing the aggregate sum by the number of components that were used.

No lung injury 0
Mild to moderate lung injury 0.1–2.5
Severe lung injury >2.5

FiO2, fraction of inspired oxygen; PaO2, patients' oxygenation.