Prone positioning of patients with acute respiratory distress syndrome: a systematic review
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Authors' objectives
To describe the practice and iatrogenic complications of prone positioning in critically ill patients with acute respiratory failure.

Searching
MEDLINE was searched from 1976 to 1998 for English language publications, using the key terms 'prone position', 'ARDS' and 'respiratory insufficiency'. The reference lists of research and review articles were also examined.

Study selection
Study designs of evaluations included in the review
The inclusion criteria were not defined in terms of study design. Primary studies were either randomised controlled trials (RCTs), prospective non-randomised trials, case reports or of unspecified design.

Specific interventions included in the review
The inclusion criteria were not defined in terms of intervention, although the review implied that studies of prone positioning were eligible. The prone positioning protocols varied in frequency, duration and timing in relation to initial lung injury. Where specified, frequency ranged from once to over eleven times, duration ranged from 20 minutes to 42 hours, and timing ranged from 4 hours to 7 days after the start of mechanical ventilation. Interventions included the use of the following: CircOlectric bed, manual 2-step procedure, and a lightweight portable frame. In most studies, 5 people (range: 3 to 5) were used to turn the patient. Positions of the abdomen included: protrusion allowed with the use of chest and pelvic cushions; restraint on the bed surface; and partial restraint using air suspension beds. Both head-down and head-up positions were used, and in some studies prone positioning was part of a multicomponent intervention. Cointerventions included sedation for comfort, and the use of paralytic agents to allow various modes of mechanical ventilation.

Participants included in the review
Adults and children were eligible, whereas neonates were excluded. The participants were predominantly adults with acute respiratory distress syndrome (ARDS), defined as: pulmonary insufficiency; acute respiratory failure; acute lung injury; ratio of the partial pressure of oxygen in arterial blood to the fraction of inspired oxygen (PaO2/FiO2) of less than 150; and according to the operational definition of ARDS developed at the American-European Consensus Conference on ARDS (see other Publications of Related Interest). The mean age of patients was 39 years (range: 0.4 - 95). The children studied included those with relatively normal lung mechanics, severe restrictive lung disease, and severe obstructive airways disease.

Outcomes assessed in the review
Studies that assessed complications were eligible. Complications were classified as: critical events, clinical problems or patient injuries. Other outcomes assessed included: patients' responses to prone positioning, factors predictive of patients' responses, patterns of responses, mortality and recommendations. Patients were classified in primary studies as responders or nonresponders. The definition of 'responder' varied and included: an increase in partial pressure of arterial oxygen of more than 10 mmHg within 30 minutes of prone positioning; and an increase in the PaO2/FiO2 ratio of more than 20% within 2 hours of prone positioning.

How were decisions on the relevance of primary studies made?
The author does not state how the papers were selected for the review, or how many of the reviewers performed the selection.

Assessment of study quality
The author does not state that they assessed validity, although it is reported that 'the scientific rigour of each study was evaluated'.

**Data extraction**

The author does not state how the data were extracted for the review, or how many of the reviewers performed the data extraction. Tables containing the following information were presented: author and year of publication; details of prone positioning, i.e. timing after injury, frequency and duration; differences between responders and nonresponders, and the worsening status in nonresponders when prone; peak or sustained effect; and whether the effect was sustained after the patient was repositioned supine.

**Methods of synthesis**

How were the studies combined?

The studies were combined in a narrative review, and the efficacy results were presented as overall percentages.

How were differences between studies investigated?

Differences between the studies were described within the text of the review.

**Results of the review**

Twenty studies (297 patients) were included: 3 RCTS, 14 prospective non-randomised trials, 1 case report, and 2 of unspecified study design.

Patients’ responses to the prone position.

1. Studies classifying patients as responders versus nonresponders (213 patients): 69% (148 out of 213) patients were classified as responders.

2. Factors predictive of response: apart from early intervention, predictive factors were not consistent among studies and initial responses were not always predictive of subsequent responses. Patients with extrapulmonary ARDS appeared to respond consistently to prone positioning (2 studies). 3. Mortality (15 studies): the overall mortality rate was 44%.

Complications of prone position.

1. Critical events: 12 studies in which 240 patients experienced 746 prone cycles. The percentage of episodes per prone cycle were: for haemodynamic instability, 1.1% (8 cases); for inadvertent endotracheal tube extubation, 0.4% (3 cases); for decreased oxygen saturation, 0.3% (2 cases); for apical atelectasis, 0.3% (2 cases); for obstructed endotracheal tube, 0.1% (1 case); for kinked endotracheal tube, 0.1% (1 case); for obstructed chest tube, 0.1% (1 case); for dislodgement of central venous catheter, 0.1% (1 case); for dislodgement of femoral haemodialysis catheter 0.1% (1 case); for compression of tubing infusing vasoactive medication, 0.1% (1 case); and for transient episode of ventricular tachycardia, 0.1% (1 case).

2. Clinical problems included: prevalent cutaneous problems, i.e. reversible dependent oedema of the face and anterior chest wall; pressure ulcers of the skin reported in studies with longer periods of prone positioning; contractures of hip and shoulder joints; and problems with enteral feeding.

3. Patient injuries: infectious corneal ulceration requiring immediate corneal transplantation was noted in one patient; and one patient developed septic shock after being turned prone.

Recommendations reported in primary studies.

The interventions recommended to prevent critical events related to prone positioning included: ensuring the endotracheal tube was securely anchored and all extraneous intravenous catheters and tubing were disconnected; having...
in place a rapid-response plan to reposition a patient supine for cardiopulmonary resuscitation; interventions to preserve skin integrity; and avoidance of nonphysiological movements of the patients extremities during the change.

Authors’ conclusions
Current evidence supports continued study of prone positioning as a therapeutic intervention to improve systemic oxygenation in patients with acute lung injury or ARDS. The potential benefits associated with early repeated prone positioning include improved arterial oxygenation, and the use of less toxic inspired levels of oxygen and arterial airways pressures. When patients’ acuity is considered, the low prevalence of critical events and complications was surprising.

CRD commentary
The aims were stated and the inclusion criteria were defined in terms of the participants and outcomes. The inclusion criteria were not defined in terms of the intervention or study design, and the methods used to select the studies were not described. The literature search was limited to English language publications in one database, and so other relevant studies may have been omitted. In addition, there was no attempt to locate unpublished material, thus raising the possibility of publication bias. Some relevant information was presented in tabular format but the lack of consistency in the reporting of statistical tests, and the lack of information on study design, made it difficult to assess the results concerning efficacy. The methods used to extract the data were not described and study validity was not assessed.

Given the heterogeneity among studies, in particular of the intervention, a narrative review was appropriate and details of the practice of prone positioning were comprehensively summarised. However, evidence of efficacy of the prone positions was presented as the overall percentage of patients ‘responding’ to the intervention, without any regard for study quality, weighting for sample size, or consideration of any statistical heterogeneity in efficacy between studies. Hence, the author’s conclusions regarding efficacy of the prone position must be interpreted with caution. Conclusions regarding the rarity of complications were based on information presented in studies, the comprehensiveness of which was unclear.

Implications of the review for practice and research
Practice: The author states that unless contraindicated, patients meeting the criteria established at the American-European Consensus Conference on ARDS for acute lung injury should be considered candidates for prone positioning. In addition, they state that prone positioning should be considered as soon as the PaO2/FiO2 ratio is 300 or less, especially in patients with ARDS from extrapulmonary causes.

Research: The author states that phase 1 studies, focusing on how to safely turn and care for critically ill patients positioned prone for prolonged periods, are needed.

Bibliographic details

PubMedID
10553180

Other publications of related interest

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Subject indexing assigned by NLM
MeSH
Adult; Humans; Prone Position; Respiration, Artificial; Respiratory Distress Syndrome, Adult /therapy

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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.