Original article

Clinical guidelines for the use of the prone position in acute respiratory distress syndrome

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The mortality associated with acute respiratory distress syndrome (ARDS) remains high. It has been suggested that use of the prone position may improve survival. However, approaches to the use of the position are often haphazard. The development of clinical guidelines indicating the need for the prone position in ARDS and the process by which the manoeuvre may be performed were thought to be important for two reasons. Primarily, we sought to improve oxygenation through the use of the prone position whilst promoting patient safety. Secondly, we wished to standardize our approach to the use of the prone position and make recommendations for practice so that its use was no longer seen as a last resort in the management of ARDS. The process associated with the development of clinical guidelines is first described. This is followed by presentation of the clinical guidelines. Included in these are the criteria and discussion which indicate consideration of the prone position, potential exclusion criteria, pre-turn considerations, the turning technique, monitoring the effectiveness of the prone position, passive movements and limb positioning and, finally, documentation of the problems associated with use of the prone position. The paper concludes with discussion concerning the potential for future research in this area.

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Introduction

Acute respiratory distress syndrome (ARDS) has an associated mortality of 50–70% (Roupie et al. 1999). It has been suggested that use of the prone position may improve survival (Stocker et al. 1997). However, in our intensive care units (ICUs), approaches to the use of the position have often been haphazard. The use of the prone position appeared to depend upon particular staff being on duty and the clinical triggers used to determine the need for the prone position were arbitrary. Use of the prone position to improve oxygenation in ARDS is well documented (Ball 1999; Curley 1999). The use of innovative approaches in the management of ARDS has also been called for (Luce 1998; Brandsetter et al. 1997; Jolliet et al. 1997; Phiel & Brown 1976; Douglas et al. 1974), particularly in relation to the continued high mortality rate associated with the syndrome (Monchi 1998).

In the light of all these factors, one of the nursing teams of the St Bartholomew's ICU decided to develop clinical guidelines in order to promote patient safety and standardize our approach to the use of this technique. We were aware many other ICUs were also in the process of developing guidelines. In order to discuss developments in the management of ARDS, the topic was placed on the agenda of the Pan London Practice Development Forum for Critical Care. At this meeting, participants emphasized the techniques used to turn patients, untoward

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side-effects and the criteria used to monitor the effectiveness of the intervention.

Following this discussion, a draft proposal was written for review by the Directors of the ICUs of the Bart's and the London NHS Trust (BLT). We also circulated the draft proposal, for critical appraisal, to two ICUs outside the Trust. This led to the development of criteria to trigger use of the prone position and the safe management of chest drains during the manoeuvre. It was also imperative to ensure, following the European Directive related to the prevention of back injury, that manual handling guidelines emphasized the prevention of back strain. Physiotherapists were also invited to contribute by outlining safe positioning of limbs and joints following placement in the prone position. Drafts of the clinical guidelines were presented at various national study days. The result of systematic review, peer review and the feedback received from conference presentations led to the formulation of the clinical guidelines which follow.

The essential elements of the Clinical Practice Guidelines

The criteria which follow indicate the need for use of the prone position. These were based on the American European Consensus Conference on ARDS (Bernard et al. 1994). However, they have been altered in one area. The PaO2/FIO2 or oxygenation indices (OIs) which indicate the presence of ARDS have been reduced from 200 to 150. This is because we felt the indices were rather generous in relation to the severity of illness patients experience in English ICUs, compared to those of Europe and the USA (Edbrooke et al. 1999). For help with calculating OIs, please refer to Ball (1999). We also decided to retain the use of mmHg when calculating OIs, as suggested by the American European Consensus Conference on ARDS, because recent research (Jolliet et al. 1998; Chatte et al. 1997; Mure et al. 1997; Stocker et al. 1997; Fridrich et al. 1996) has utilized these figures to evaluate the effectiveness of the prone position in ARDS. It was felt that utilization of kPa, in the calculation of OIs, would not promote understanding and communication between centres. This was seen as particularly important if future research were to be based on the clinical guidelines.

1. Use of the prone position should be considered when:

ventilation has been optimized, i.e. pressure control ventilation (Amato et al. 1998), inverse inspiratory: expiratory ratio, increasing positive end expiratory pressure (PEEP), and monitored for effect. However, optimal ventilation does not mean that the FIO2 is at 1 (100%). High concentrations of oxygen are known to be toxic to lung tissue (Jenkinson 1993). This toxicity may enhance the inflammatory processes associated with ARDS and therefore have a deleterious effect.

Despite optimizing ventilation, there is/are:

- PaO2/FIO2 of 150 or less;
- PEEP of 7.5 or more (cm H2O);
- pulmonary artery occlusion pressure (PAOP) of < 18 mmHg (or no clinical sign of left ventricular failure);
- bilateral infiltrates on the anterior–posterior chest X-ray (APCXR).

In the first instance, the observation chart is used to record OIs for monitoring purposes. OIs are calculated each time an arterial blood gas is taken and utilized to monitor deterioration or improvement in the patient's oxygenation status. Once the OI has reached 150, the OI graph (Fig. 1) should be used to record deterioration or improvement in gaseous exchange.

The above selection criteria are used to trigger a multidisciplinary team discussion regarding the patient's suitability for prone positioning, taking into consideration any exclusion criteria, specialist opinions and risk assessment. Risk assessment includes evaluation of the patient's need for improved oxygenation and individual factors which may outweigh use of the prone position, e.g. raised intra-cranial pressure. This ensures the patient's condition is not allowed to continue to deteriorate without use of the prone position being considered.

2. Exclusion criteria

Prone positioning may be considered for all patients with a PaO2/FIO2 of <150, when ventilation has been optimized. However, the following exclusion criteria were derived following critical appraisal of several draft

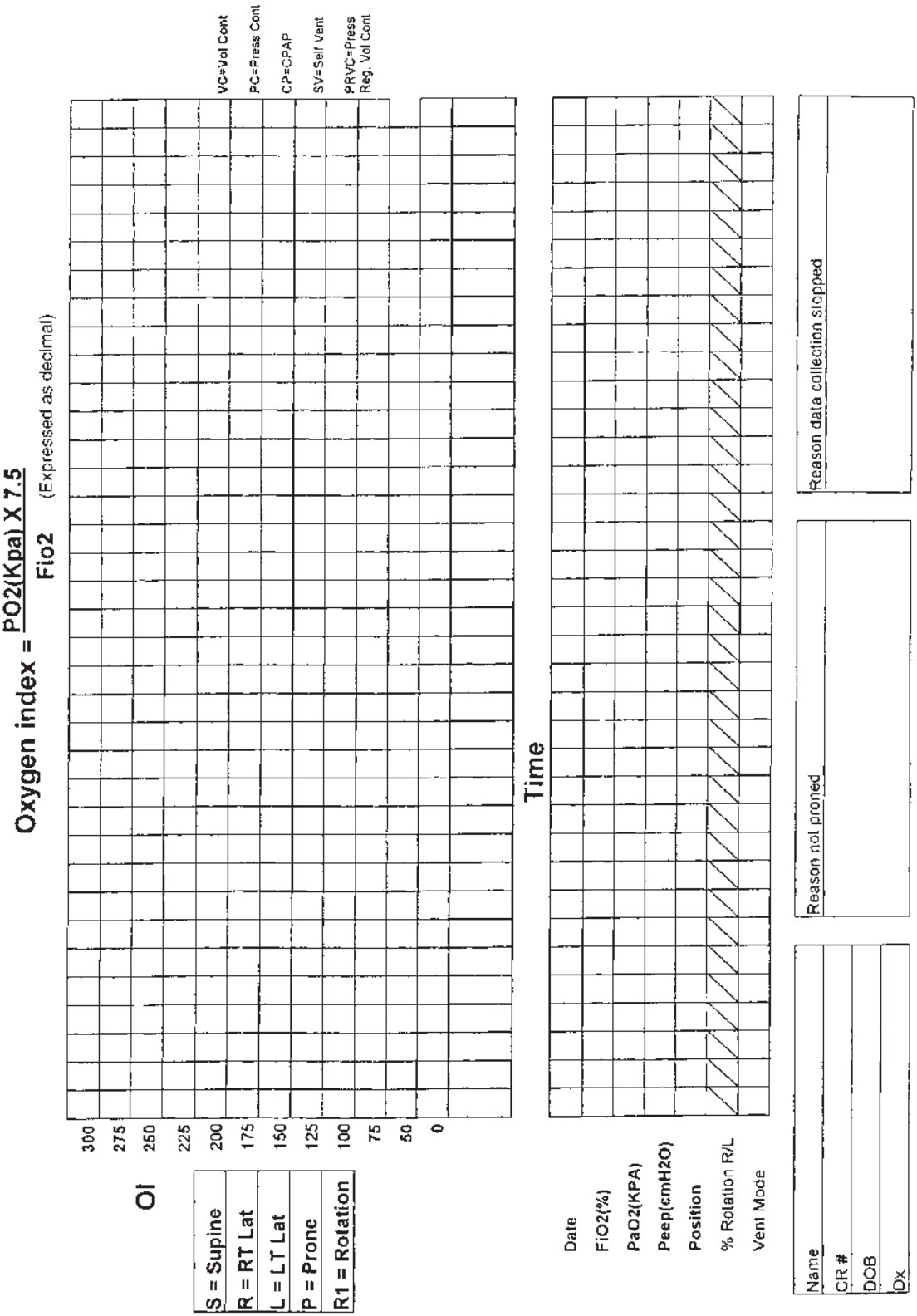

Fig. 1 Oxygenation index.

proposals. They may be considered as *potential* contraindications:

Do not resuscitate order;
Asthma;
Head injury – raised intracranial pressure (ICP);
Patients experiencing seizures;
Spinal injury requiring spinal precautions, spinal instability, osteoporosis;
Recent abdominal surgery, recent stoma formation, open abdomen, large abdomen;
Pregnancy (2nd/3rd trimester);
Open chest, right ventricular assist device, left ventricular assist device;
Intraaortic balloon pump;
Recent cardiothoracic surgery/unstable mediastinum;
Recent cardiopulmonary arrest;
New tracheostomy (< 24 hours);
Multiple trauma, external pelvic fixation;
Maxillofacial surgery;
Recent pelvic or chest fractures;
Acute bleeding;
Traction;
Advanced osteoarthritis, rheumatoid arthritis;
Increased intraocular pressure;
History of poor tolerance of prone positioning;
Haemodynamic instability MAP < 60 mmHg or SBP < 90 mmHg regardless of fluid resuscitation or inotropes;
Weight >135 kg;
Kyphoscoliosis.

3. Pre-turn considerations

If, following consideration of the exclusion criteria and risk assessment, the patient is a suitable candidate for use of the prone position, the following measures should be undertaken:

- pressure area risk calculated and assessment made for use of specialist mattress, as per ICU standard;
- eye care – as per ICU standard: importantly, clean and lubricate with simple eye ointment. Maintain eye closure using geliperm or tape to avoid corneal abrasion.
- mouth care – as per ICU standard: also suction all excess fluid from mouth and oropharynx;
- check PERLA (pupils equal and reacting to light accommodation) before and following turn;
- insert closed suction equipment, date and change as per product guidelines;
- check all central venous and arterial access sites for inflammation/need to change;
- wound dressings required on the anterior aspect of the body to be performed;
- ensure endotracheal tube (ETT) and tracheostomy tapes are checked to ensure that they are secure;
- tracheostomy care and dressing change according to unit/Trust guidelines;
- ensure CXR taken, if ordered;
- document grade of intubation and length of ETT in cm, at teeth. This is to ensure correct placement of the ETT following the turn;
- assess the patient's level of sedation, need for analgesia and muscle relaxants and document;
- aspirate nasogastric (NG) feed. Stop NG feed for the duration of the turn, check placement of tube before recommencing feed;
- chest drains – whilst current practice dictates that chest drains should not be clamped (and obviously not lifted above the level of the chest drain insertion site), please discuss this issue with the medical consultant if the chest drains are restricted and/or difficult to move round the edge of the bed. Always ensure any clamped drains are unclamped immediately after the turn, reposition so that chest drains are secure and re-levelled/re-zeroed;
- if the abdomen is distended, consider use of the Respicare® bed and adjust comfort control settings to remove pressure from abdomen or alternatively place pillows under the chest and hips;
- disconnect any non-essential i.v. lines and luer lock, reconnect following the turn;
- ensure there is a sufficient length of i.v. tubing available for essential infusions;
- remove ECG electrodes from anterior chest wall and reposition following the turn;
- anaesthetist takes responsibility for turning the patient's head and safety of ETT. The patient should not be disconnected from the ventilator during the turning procedure.

4. Placing the patient in the prone position

Manual handling guidelines were developed for local use. However, it is realized that several

techniques may be used to place the patient in the prone position and manual handling guidelines are the subject of frequent updates. Therefore, for the purposes of publication, we will not describe our turning technique here as it may be subject to change as a result of European directives. To comply with current European guidelines, a hoist is used if the patient weighs over 90 kg. The turning procedure should only to be performed when there are sufficient personnel available.

5. Monitoring the effectiveness of the prone position

The patient is nursed in the prone position, if oxygenation improves, for up to 20 hours per day (Fridrich 1996), providing oxygenation does not deteriorate and the patient does not demonstrate signs of discomfort. The patient is then turned supine to allow for appraisal of the following issues by clinicians during the multidisciplinary ward round:

1. response to the prone position (persistent responder, non-persistent responder (Chatte et al. 1997);
2. occurrence of pressure sores or increased risk (particularly breasts, genitalia, knees and shins);
3. eye and mouth care (this is still undertaken in the prone position but it is realized access is difficult and therefore scrupulous attention is paid to these areas when the patient is in the supine position);
4. physical assessment by the attending medical consultant and physiotherapists on the ward round;
5. joint mobility is also evaluated by physiotherapists.

Method for monitoring response to the prone position

- Note oxygen saturation (Sp02), in the supine position prior to turning the patient into the prone position;
- arterial blood gas sample to be taken before placing the patient in the prone position and the Pa02/FIO2 OIs calculated;
- once in prone position, oxygenation is monitored using the Sp02; if this deteriorates below the supine value for more than 10 minutes, turn back to supine;
- if the patient responds to the prone position by increasing Sp02 beyond that achieved in the supine position take an arterial blood gas after one hour and calculate OI;
- thereafter, monitor oxygenation using the Sp02 and perform arterial blood gases as required. An acceptable range of Sp02 and PaO2 should be established for the individual patient;
- one hour prior to turning back to the supine position, take an arterial blood gas and calculate Ol;
- once back in the supine position, take an arterial blood gas and calculate Ol. If the patient's oxygenation status deteriorates (OI < 150) in the supine position, return to prone position.

6. Passive movements and limb positioning whilst in the prone position

There is little literature available to guide us concerning passive movements and limb positioning. It is known that the stimulus for soft tissue deterioration is lack of movement. Muscles also become shorter and stiffer leading to impaired function. If joints are difficult to move, forceful movement may cause microtears in the muscles and other soft tissue structures around the joints. Torn fibres will bleed which may result in calcification. This form of heterotrophic ossification (e.g. myositis ossificans) produces further loss of mobility, making movement extremely painful (Butler 1991). This does not respond to (or is made worse by) intervention. Conversely overstretch of soft tissues may also lead to symptoms resulting from adverse neural tension and damage to connective tissue. Thus it is important to maintain soft tissue length and mobility within a normal range of movement and in normal resting postures.

There is no literature to suggest how often the patient's position should be changed or how often limbs should be moved passively. Patients in intensive care are usually turned every 2–4 hours to prevent pressure sores developing. In the absence of evidence to support other regimes, we suggest that the prone patient should also have their position modified every 2–4 hours.

Before considering any trunk, spinal or limb position, the pre-morbid pathology in these areas should be considered.

Options for modifying the prone position

A. Prone position – reducing pressure

Whilst in the prone position, the patient should be positioned so that pressure is minimized over the abdomen (Gibson & Rutherford 1999). This allows movement of the diaphragm and improves basal expansion of the lungs. Pressure should also be avoided over the femoral canal. In the female, consideration must be given to allow a comfortable position for the breasts, and in males to avoid pressure over the genitalia.

Options

1. Pillows or foam pads may be placed under the upper chest and lower abdomen, to avoid pressure in the areas identified above.
2. Care should be taken to allow the shoulders to fall forwards slightly. This avoids overdistension of the anterior capsule of the shoulder joint and allows arm positions to be more freely modified (Butler 1991). It also helps to ensure that abnormal postures for the brachial plexus are avoided (Fig. 2A).
3. The prone position itself may be modified as follows: 3/4 prone facing right, prone, 3/4 prone facing left utilizing pillows to support the side to be lifted.
4. The arm and leg on the side towards which the patient is facing may be flexed (Fig. 2B).

B. The head and neck

Be aware of the patient's natural posture, i.e. they may have a fixed kyphosis or a condition such as rheumatoid arthritis or cervical spondylosis.

Options

1. The head of the bed may be elevated to try to minimize facial oedema. In principle, the head should be placed in such a position that the neck is not extended and the head supported by the mattress alone. If the use of pads for head support is to be considered, this must be discussed with the physiotherapist prior to placement.

C. The upper limbs

If neural tissue is maintained in a stretched position for a prolonged period of time, adverse effects may result (Butler 1991). Therefore positions for the shoulder girdle, shoulder joint and arm need to be found which avoid stretching the brachial plexus.

Options

1. Both shoulders should be abducted with elbows flexed, maintaining some protraction of shoulder girdle and degree of flexion at the shoulder joint.
2. One arm parallel to the body and the other as demonstrated in Figure 2C and D.

D. The lower limbs

Care should be taken to avoid:

- pressure on knees;
- overstretch on the soft tissues over the anterior aspect of the ankle joints;
- shortening of the Achilles tendon;
- pressure over the head of the fibula resulting in injury to the common peroneal nerve.

Options

1. In the full prone position:
   - abduct hips;
   - flex knees over pillow, allowing the ankle to fall forward. (**NB:** avoid pressure on the tips of toes and protect knees.)
2. In 3/4 prone:
   - flexion and abduction of the hip on the side to which the patient is facing flexed knee;
   - ankle in the neutral position between inversion and eversion.

The patient's position whilst prone and the positioning of limbs should be discussed with the physiotherapist on the ICU. The aim is to maintain soft tissues so that the patient achieves maximal functional outcome on discharge.

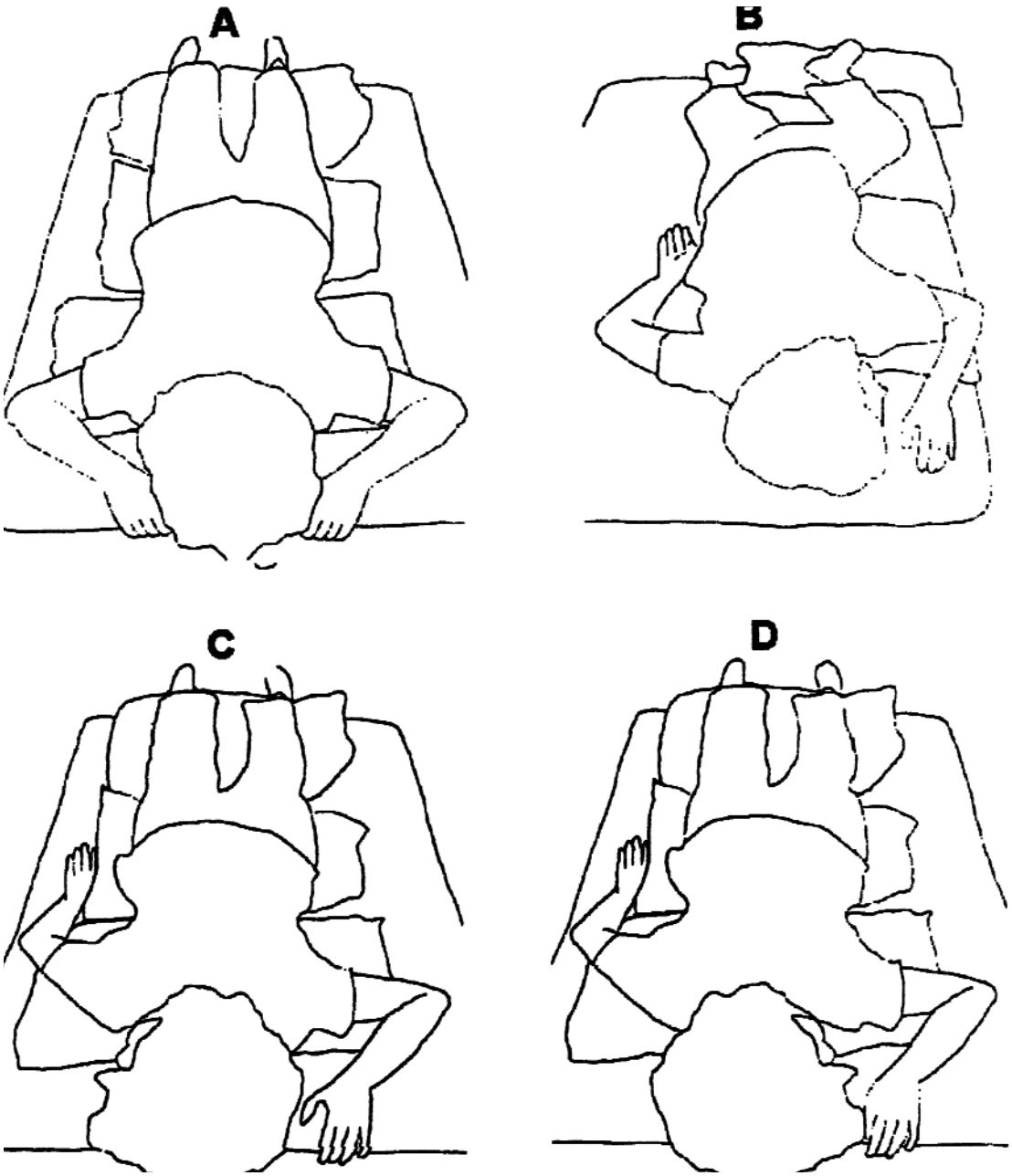

Fig. 2 Options for modifying the prone position. (Illustration By Rachel Beadle, City University, St Bartholomew's School of Nursing & Midwifery, London, UK)

7. Other data to be collected

Problems are associated with use of prone positioning. The following are documented on the OI chart (Fig. 1) and will form the first stage of research following implementation of the clinical guidelines and the standardization of practice:

- occurrence of facial oedema, and whether this subsides in the supine position;
- pressure sore formation on the chest wall, breasts, genitals, shins;
- description, intervention and evaluation of untoward events (e.g. dislodgement of i.v. lines, ETT, corneal abrasion);

- any specific problems encountered during turning procedure and/or whilst in prone position.

To summarize the clinical guidelines and ease use at the bedside, an algorithm has been developed (Fig. 3).

Conclusions and future research

The Ol chart has already been the subject of a pilot study. During the period June–October 2000, data were collected on 71 patients. Of these, 7 were placed in the prone position. Five were

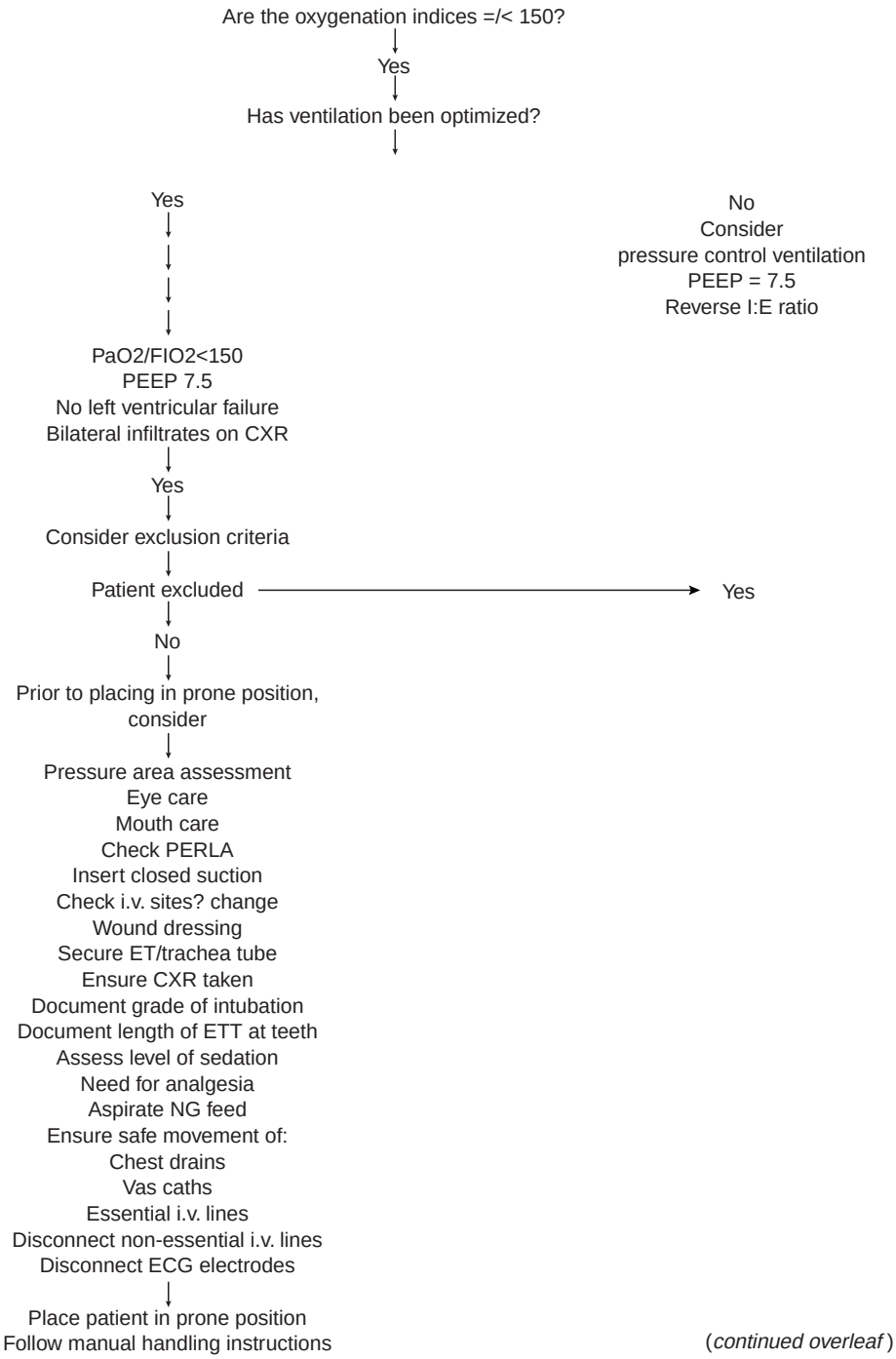

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Fig. 3 Algorithm for the use of the prone position.

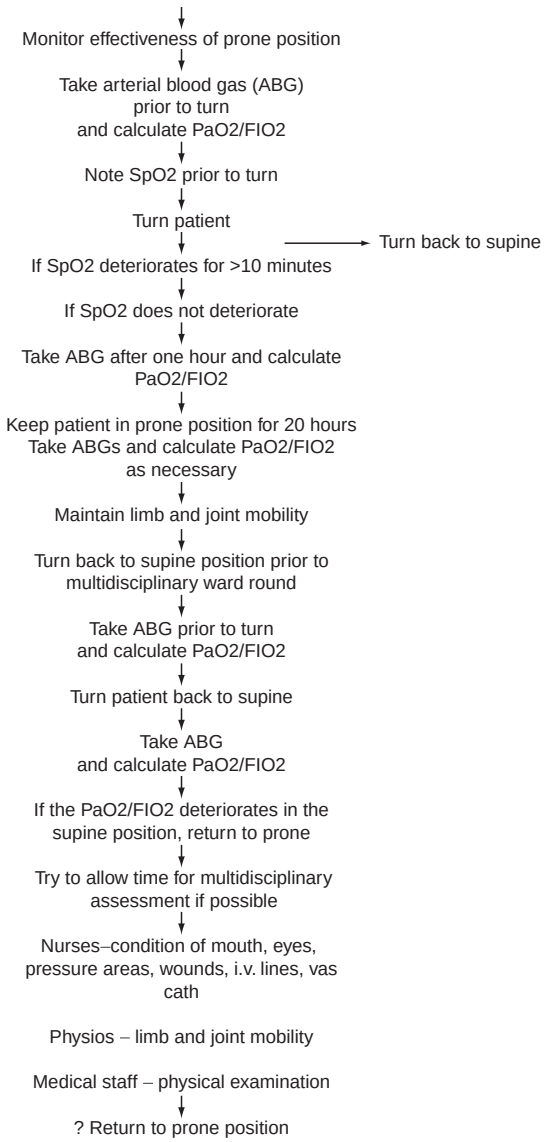

Fig. 3 (*continued*).

non-persistent responders and two patients did not respond (Chatte et al. 1997). There is some debate surrounding the procedure to be followed in the later group. Some ICUs recommend continued attempts at the prone position to evaluate patient response. Others advocate that the position is not utilized again as a failure to respond indicates the surface area available for gaseous diffusion is considerably reduced and use of the prone position is unlikely to improve oxygenation. The mortality rate is certainly increased in non-responders (Ball 1999; Chatte et al. 1997). The OI chart was found to be a practical tool for monitoring the effectiveness of the prone position. It was, however, updated to include ventilatory modes, a key by which patient position could be identified and rationale provided for both the discontinuation of the prone position and if the patient met exclusion criteria. The final version is portrayed in Figure 1. Future research will address two key areas. Firstly, untoward events associated with use of the prone position will be documented as an exploratory study. Secondly, we will conduct an evaluation study of the clinical guidelines in order to monitor their effectiveness in practice.

We had planned to conduct a research study which evaluated the use of the prone position in relation to patient outcome. However, following discussion on the ICUs of our Trust, we felt this was a naïve endeavour. The reasons for this were that there were too many confounding variables affecting the critically ill patient which could lead to a successful or unsuccessful outcome. Use of the prone position provides a window of opportunity for recovery, but could not be manipulated as an independent variable associated with patient outcome from critical illness. Finally, we hope to pilot the use of the OI chart in the management of acute lung injury (Bernard et al. 1994) and the use of continuous lateral rotation therapy (Whiteman et al. 1995).

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