Use of rotational therapy in the treatment of early acute respiratory distress syndrome (ARDS): A retrospective case report

Robert Goddard BSc (Hons) Physiotherapy, Superintendent Physiotherapist, Darlington Memorial Hospital, UK

E-mail: robert.goddard@cddah.nhs.uk

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SUMMARY

- Rotational therapy could have a significant effect on improving oxygenation.
- In this case report, oxygenation was vastly improved, weaning from ventilation was facilitated and no complications were noted.
- Existing research gives no clear guidelines for best practice in the use of rotational therapy.
- Further larger scale trials are indicated to demonstrate the effectiveness of this therapy.

INTRODUCTION

'Healthy man spends most of a day in a variable degree of motion. Even while asleep, he moves about every quarter of an hour. This has been termed as the minimal physiological mobility requirement' (Keane 1979).

This statement has been an integral part of research into patients immobilised with varying diagnoses. Within critical care, mechanically-ventilated patients are commonly left in a supine position for long periods throughout the day. This immobility can lead to numerous circulatory and respiratory complications which have been well documented over a number of years. Specific complications for the ventilated patient include:

- Increased risk of pneumonia (Kirschenbaum et al., 2002; Drakulovic et al., 1999);
- Atelectasis due to reduced tidal volume and decreased mucociliary transport (Sahn 1991);
- Poor drainage of secretions (Dolovich et al., 1998).

Continuous rotational therapy is an intervention whereby the patient is continually rotated through a set number of degrees. Resting periods can be set at extremes of rotation, such as lying on the left or right side, or supine. The degrees of rotation refer to the angle of the patient's body while lying on their side. By providing continuous rotation, the negative effects of immobility could be reduced.

This article presents a retrospective case report that demonstrates a vast improvement in oxygenation through the use of rotational therapy. It facilitated successful weaning from ventilation and prevented the need for prone positioning. Furthermore, no complications were noted.

LITERATURE OVERVIEW

Rotational therapy has been reported as a way of improving the problems that mechanically-ventilated patients can experience, and there have been a number of studies into its effects. However, within critical care, the evidence available gives no specific guide as to the most beneficial use of rotational therapy. Literature searching through the CINAHL, Cochrane, PubMed and Medline databases reveals a limited amount of research into the use of rotational therapy within the last five years. Table 1 describes a selection of the findings from the available studies. Research articles from 1998 to the present day, specifically looking at the effects of rotating mechanically-ventilated patients, are included. The use of combined therapies, for example percussion therapy, is outside the scope of this review.

Author	Research focus	Methods/No. of patients	Rotation used	Conclusions
Wang et al. (2003)	Medical intensive care unit (ICU)	5 rotated patients compared with 35 control patients	Continuous, over five days	Improved oxygenation and reduced incidence of pneumonia in rotated patients
Kirschenbaum et al. (2002)	Incidence of pneumonia during long-term ventilation	17 rotated patients compared with 20 control patients	Continuous, 18 hours daily through 60 degrees	Reduced pneumonia incidence for rotated patients. No difference in mortality or ICU stay
Staudinger et al. (2001)	Comparison with prone positioning	12 patients prone compared with 14 patients rotated	Continuous through 124 degrees	When prone positioning is inadvisable, rotational therapy could be an alternative

MacIntyre et al. (1999)	Prevention of respiratory complications	Prospective randomised multi-centre trial comparing rotation with standard care	Continuous through 64 degrees	No statistically significant advantage to rotation in preventing complications
Bein et al. (1998)	Effect on ventilation-perfusion inequality	10 patients with acute lung injury (ALI) observed for 24 hours	Continuous	Ventialtion:perfusion mismatch improves with rotation in mild to moderate ALI but not in progressive ARDS
Dolovich et al. (1998)	Mucus transport	13 patients underwent same patient comparison testing	90 minutes through 60 degrees	Short duration rotation did not stimulate significant mucus removal

ALI = acute lung injury; ARDS = acute respiratory distress syndrome

Table 1: Summary of available literature on rotating mechanically-ventilated patients

Throughout the evidence summarised in Table 1 there was only one noted complication, which was an incidence of haemodynamic instability. This was corrected by reducing the degree of rotation and so providing a smaller range of motion for the patient to move in.

Although continuous rotational therapy was used in all the studies identified in Table 1, the study designs differed in terms of the length of resting period at the extreme point of rotation and in the supine state, in the speed and degree of rotation, and in the type of rotational bed or mattress used. Consequently, comparisons between the studies are difficult to make. These difficulties are further exacerbated by the small sample sizes used and the differing outcomes used to measure effectiveness. Rotational therapy has a number of potential benefits for mechanically-ventilated patients. However, the lack of valid and reliable research means that any generalisations about the benefits are hard to make.

Figure 1

CASE REPORT

The patient

This retrospective case report focuses on a 52-year-old woman who was admitted to hospital with abdominal pain and initially diagnosed with gallstone pancreatitis. A decrease in her oxygen saturations and urinary output led to her being transferred to the high dependency unit (HDU) the following day. Over the next three days she deteriorated and developed extensive basal consolidation in both lungs, despite the use of non-invasive ventilation. She was then admitted to the intensive care unit (ICU). Four days after initial admission she was intubated, due to increasing oxygen requirements and fatigue resulting in respiratory distress. On admission to the ICU, she was diagnosed with early acute respiratory distress syndrome (ARDS).

Rotational therapy began on the second day in ICU and was used over a 91-hour period. After a total of 21 days in ICU, she was discharged to HDU, then to a general surgical ward, and was eventually discharged home 44 days after initial admission.

Rotational therapy

The decision to use rotational therapy was made following a significant fall in the patient's oxygenation level and her continued secretion retention. The ICU would normally use prone position ventilation under these circumstances, but the potential benefits of rotational therapy (specifically, improvement in oxygenation and postural drainage) meant that a deviation from standard practice could be justified. The change in practice was implemented following discussion of the case with the team providing her care.

The Acer® Mattress Replacement System supplied by Huntleigh Healthcare Ltd was used to provide the rotational therapy (see Figure 1). This system allowed staff to select precise angles of turn, while providing options to make adjustments at any stage according to changes in the patient's condition (see Figure 2). The patient was rotated in an arc of 80 degrees, with 30-minute rest periods in the central supine and extreme lateral rotation positions. The arc of 80 degrees was achieved by the mattress rotating the patient from lying on her right hand side at 40 degrees, through supine, to lying on her left side at 40 degrees. This rotation can be reduced or stopped at any point in the event of any complications. Nursing and therapeutic interventions such as bed bathing usually took place when the patient was resting in the central supine stage of therapy. Consequently, this phase was occasionally prolonged.

FINDINGS

Oxygenation and ventilation

The changes in oxygenation that took place while the patient was rotating or supine are summarised in Tables 2 and 3 below. Oxygenation was calculated as a ratio of partial pressure oxygen and the fraction of inspired oxygen needed by the patient. This is calculated as follows:

$(PaO_2 \times 7.5) / FiO_2$ = oxygenation index

For example, a normal patient with PaO_2 = 13Kpa breathing 21% oxygen:

$(13 \times 7.5) / 0.21 = 464$

compared with a patient with PaO_2 = 10Kpa ventilated with 60% oxygen:

(10 x 7.5) / 0.6 = 125

During rotational periods, there was a mean increase in the oxygenation index calculated, while during supine periods, oxygenation decreased. It also appears to be true that during longer periods of rotation improvements were greater, and longer periods in supine led to a greater reduction in oxygenation. For example, in the first rotational period from 16.00-02.00, a total of 10 hours' rotation shown in Table 2, there was an oxygenation increase of 147.11. However, in shorter periods, like the fourth and the final rotational periods of only five hours and two hours respectively, there were increases of only 16.87 and 23.44. Table 3 illustrates that with the exception of only one resting period, all supine periods led to reduced oxygenation.

Rotation period (24-hour clock)	Oxygenation index Pre-rotation	Post-rotation	Change in oxygenation
16.00 – 02.00	54.84	201.95	147.11
23.30 – 06.00	297	225	-72
16.00 – 03.00	222	303.75	81.75
10.00 – 17.00	195	211.87	16.87
22.00 – 05.00	173.81	303.75	129.94
08.00 – 10.00	249.93	201.37	-48.56
13.00 – 15.00	184.68	208.12	23.44

Table 2: Oxygenation during periods of rotation

Supine period	Oxygenation index Pre-rotation	Post-rotation	Change in oxygenation
08.00 – 16.00	147.84	54.84	-93
02.00 – 23.30	201.95	297	95.05
06.00 – 16.00	225	222	-3
03.00 – 10.00	303.75	195	-108.75
17.00 – 22.00	211.87	173.81	-38.06
05.00 – 08.00	303.75	249.93	-53.82
10.00 – 13.00	201.37	184.68	-16.69
		Mean change	**-31.2**

Table 3: Oxygenation during supine periods

Initially, the ventilatory settings used were: BiPAP 100% O_2, 1:1 inspiratory:expiratory (I:E) ratio with PEEP at 10cmsH_2O. After the final rotational period, ventilation was BiPAP 40% O_2, 1:2 I:E ratio with PEEP at 5 cmsH_2O. Oxygenation, as indicated by the oxygenation index, improved from 54.84 to 208.12. Her PaO_2 had increased from 7.312 Kpa with 100% oxygen to 11.1Kpa with 40% oxygen. With these improvements in oxygenation, ventilation was successfully weaned, PEEP was reduced and a normal I:E ratio was achieved.

Time spent rotating

Throughout the 91-hour period, the patient rotated for a total of 43.5 hours; in effect, 47.8% of the time. This was equivalent to rotating 11.5 hours per day. Rotational therapy was stopped because her ventilation had significantly improved. Sedation was then reduced and she began spontaneously breathing with reduced ventilator support. Successful weaning followed without any further rotational therapy.

Secretion clearance

Thick secretions were yielded on tracheal suction throughout the ICU admission and there were no changes in secretion clearance highlighted during periods of rotation.

Drug therapy

The patient needed inotropic support to maintain adequate cardiovascular function and no significant changes were noted during rotational therapy.

Pressure area care

No additional pressure area care was needed while using rotational therapy. The Acer® Mattress Replacement System provided adjustable, zoned, low air loss pressure relief/reduction during use and the patient's pressure areas remained intact.

CONCLUSION

For this particular patient, rotational therapy appeared to give the following benefits:

- Improved oxygenation;
- Facilitated weaning from mechanical ventilation;
- Provided an alternative to prone position ventilation.

This case report highlights clinically significant improvements in the patient's oxygenation by using lateral rotational therapy. This adds to the body of evidence investigating rotational therapy and indicates several potential benefits of this therapeutic technique. The improvements noted in this case support the work of Bein (1998) and Staudinger (2001), who also reported improvements in ventilation and the use of rotational therapy as an alternative to prone position ventilation.

Rotational therapy was used for approximately four days, for an average of 11.5 hours a day. This was a shorter period of rotation than that used in other studies, but was the most practical for this particular clinical setting. As a way of increasing the periods of rotation and providing longer uninterrupted rotation, rotational therapy could be used overnight when there are potentially fewer interventions needed for the patient. This particular patient was rotated overnight on three occasions; two of these gave the greatest improvement in oxygenation. So far, this aspect has not been discussed in the related literature.

The primary limitation of this report is that it focuses on a single patient retrospectively. More large-scale studies in this clinical area could provide definite conclusions as to the benefits of lateral rotation for mechanically-ventilated patients. However, the results of this report do agree with the related literature, thus adding reliability to the findings.

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