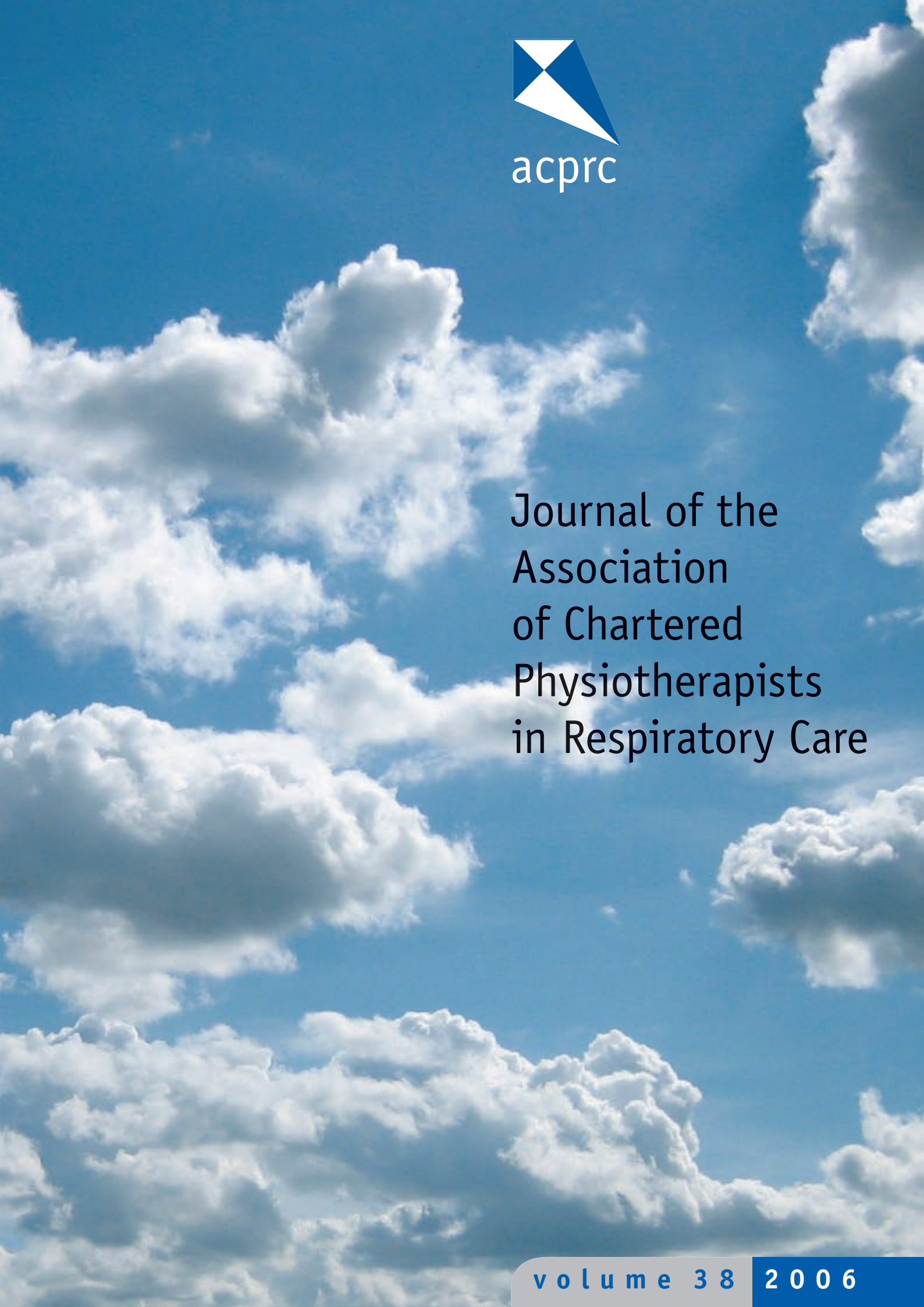


Journal of the Association of Chartered Physiotherapists in Respiratory Care

volume 38 2006

volume 38 2006

Contents

acprc

Editor
ALEX HOUGH
www.alexhough.com

Design and layout
STEVENS DESIGN ASSOCIATES,
London
Tel: 020 8675 0255
www.stevens-design.com

Printing
SNOWDONIA PRESS

Introduction

Physiotherapy continues to evolve as the NHS evolves, and new research enlightens practice. Several issues that used to be controversial are still the subject of debate today. The use of saline instillation was under fire in our junior days, and the decision to use it appeared to be determined subjectively. Similarly, the effectiveness of airway clearance techniques was then being questioned in the research, which itself was limited and not reflective of practice. We find it compelling, and rightfully so, that these issues are still waiting to be answered and are topics in this year's journal.

Other changes beg us to ask: 'Are the days when physiotherapy was offered Monday to Friday from 8:30 to 16:30 a thing of the past, along with an on-call service outside these hours?' There are no less than two contributions on late-shift working in this issue, so pore over them with your managers.

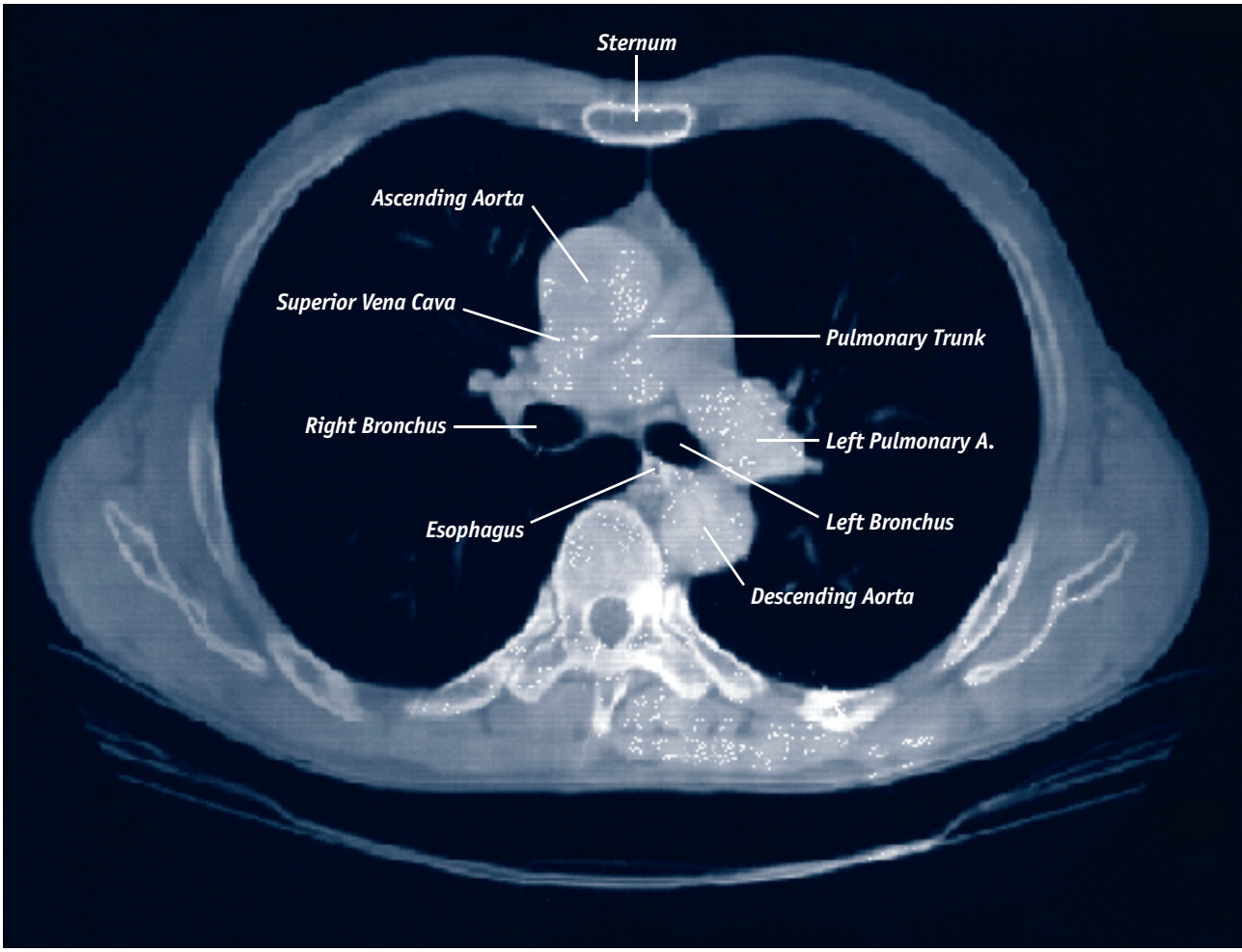
And leaping swiftly on to the next issue, who fancies writing something on tracheostomies? Lit. review? Practical ideas? Case study? And if anyone is interested in getting their trachy protocols published (think of your CV…), they'd be most welcome. And now that COPD is coming in out of the cold, how about sharing your experiences, ideas and tips? Overcoming obstacles in setting up rehab in the community? Educating other professionals? Getting Breathe Easy Clubs going? And a little controversy never goes amiss. Do you disagree (amicably) with a colleague about a technique or idea? Would you both be willing to have a discussion on it? Tape it and we'll transcribe it and check it back with you both.

Meanwhile, happy reading, and afterwards leave your copy in the staff room so they'll all realise how evidence-based respiratory physios are. If it's nicked, that's a good sign, and you'll still have your own copy on the website with the internet links to boot.

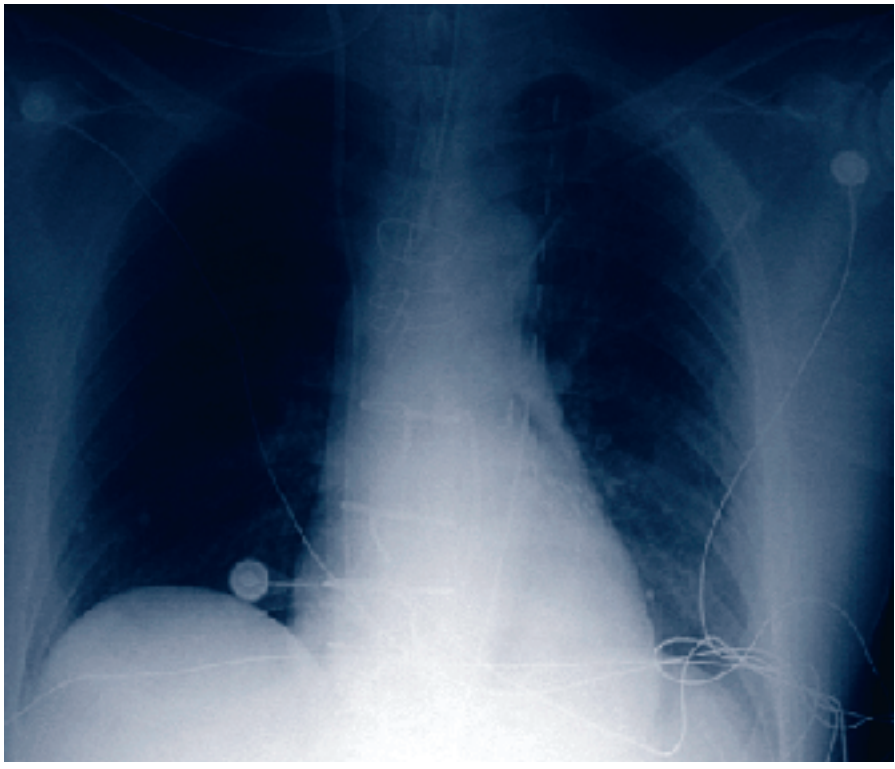
Kelly Redden-Rowley
Out-going Chair

Alex Hough
In-coming editor

Imaging info



CT of normal lung



Q. Into what position are you going to turn this post-CABG radiologist?

A. To nip in the bud the developing left lower lobe atelectasis, position him in right-side lying (or better still, take him for a walk to visit his mates in radiology).

TB Hunter, MS Taljanovic, PH Tsau, WG Berger and JR Standen (2004) Medical Devices of the Chest. RadioGraphics, 24, 6, 1725 - 46. with permission

Q.

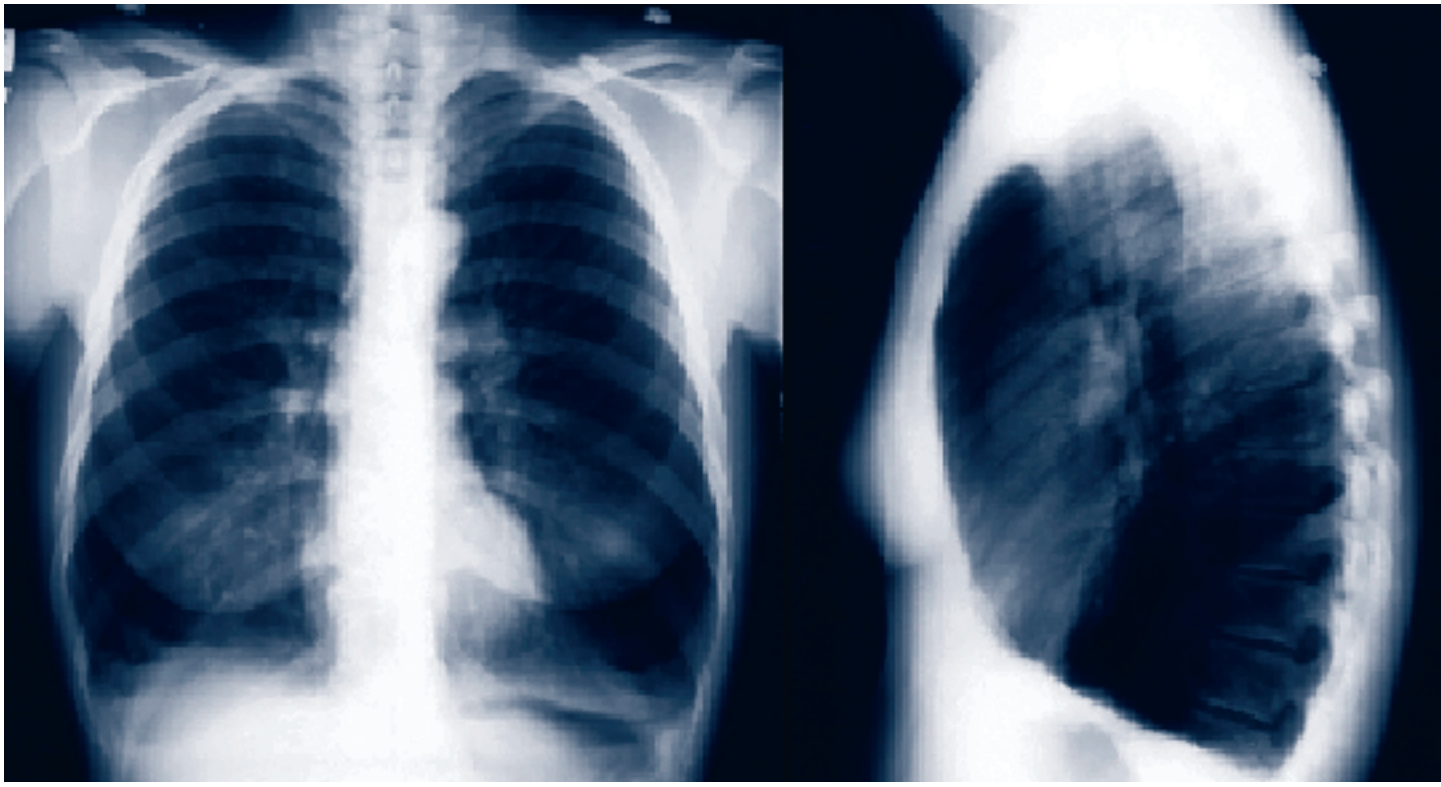
- Secretions (a) frothy or (b) mucoid?
- PAWP (a) high or (b) normal?
- Albumin (a) low or (b) normal?
- Fluid balance?

A.

Yes you were right:

- (a) is right for the first 3 questions
- for the last question, the patient is retaining fluid
- and the enlarged heart and hilar flare?

... so it must be pulmonary oedema!



Ponder: Discrepency between age and condition?

Answers

She's a young woman but has the hyperinflated lungs of emphysema:

- low flat diaphragm
- narrow heart
- increased AP dimension
- dark lung fields

So she must have alpha-1-antitrypsin deficiency.

In other journals...

Some bedside reading to stimulate your adrenaline and update your neurones. (Internet access, where available, is on the ACPRC website).

Baillard C (2006) **Noninvasive ventilation improves preoxygenation before intubation of hypoxic patients.** *Am J Respir Crit Care* Med, 15, 174, 2

- here's another way for NIV to save a few brain cells

Binnekade JM (2006) **The reliability and validity of a new and simple method to measure sedation levels in intensive care patients.** *Heart Lung*, 35, 2, 137-43

- sedation scale which reduces over-sedation and simplifies assessment

Borges JB et al (2006) **Reversibility of lung collapse and hypoxemia in early ARDS.** *Am Rev Respir Crit Care Med*, 174, 268-78

- perhaps this is where bagging is going – this describes the success of a stepwise maximum-recruitment strategy using multi-slice CT and continuous blood-gas hemodynamic monitoring

Bradley JM, Moran FM, Elborn JS (2006) **Evidence for physical therapies (airway clearance and physical training) in cystic fibrosis.** *Respir Med*, 100, 2, 191-201

- five Cochrane systematic reviews which show the benefit of PT

Chang AT, Boots RJ Henderson R et al (2005) **Case report: inspiratory muscle training in chronic critically ill patients.** *Physiother Res Internat*, 10, 4, 222-6

- a clever way, after prolonged IPPV, of improving inspiratory muscle strength and endurance without fatigue, leading to improved ADL and exercise tolerance

Chanques G (2006) **Impact of systematic evaluation of pain and agitation in an intensive care unit.** *Crit Care Med*, 34, 6, 1691-9

- systematic evaluation of pain and agitation was associated with reduced duration of mechanical ventilation and nosocomial infections

Christenbery TL (2005) **Dyspnea self-management strategies: Use and effectiveness as reported by patients with COPD.** *Heart Lung*, 34, 6, 406-14

- useful tips, with the most helpful strategies are associated with movement and/or pacing

Dodd ME, Prasad SA (2005) **Physiotherapy management of cystic fibrosis.** *Chronic Respir Dis*, 2, 3, 139-49

- a review on the evidence for exercise, airway clearance and management of the emerging problems of musculoskeletal complications and incontinence

Duiverman ML, Bladder G, Aafke F et al (2006) **Home mechanical ventilatory support in patients with restrictive ventilatory disorders.** *Respir Med*, 100, 1, 56-65

- evidence for the long-term efficacy of NIV, IPPV and negative-pressure ventilation

Ferrer M et al (2006) Early

noninvasive ventilation averts extubation failure in patients at risk. *Am J Respir Crit Care Med*, 173, 164-70
- just as it says on the tin

Granja C (2005) **Patients' recollections of experiences in the intensive care unit may affect their quality of life.** *Crit. Care*, 9, R96-R109
- use this to encourage your ICU teams to set up a follow-up clinic: it shows how nearly half the patients had poor sleep 6/12 after discharge, had poor concentration & memory, and over half still suffered fatigue.

Guilfoy C (2006) **Short-term yoga training expands breathing and lung capacity in young, healthy adults.** *Experimental Biology* conference, Thailand.
- some objective evidence on how yoga improves lung expansion, FEV1, FEV25-75 and FVC

Giuliano KK (2000) **Implementation of a pet visitation program in critical care.** *Crit Care Nurs*, 19, 3, 43-9
- how about a little conversation with your infection-control teams?

van Helvoort HAC et al (2006) **Supplemental oxygen prevents exercise-induced oxidative stress in muscle-wasted patients with COPD.** *Am J Respir Crit Care Med*, 173, 1122-9

Holland AE, Button BM (2006) **Is there a role for airway clearance techniques in chronic obstructive pulmonary disease?** Chronic Respir Dis, 3, 2, 83-91
- a challenging title, and even more challenging are the implications for ACBT – it says nice things about PEP and autogenic drainage, but advises caution with techniques that involve forced expiration

Hsu LL, Batts BK, Rau JL (2005) Positive Expiratory Pressure Device acceptance in hospitalized children with sickle cell disease is comparable to incentive spirometry. *Respir Care*, 50, 5, 624-7

Huang CJ, Lin HC (2006) **Association between adrenal insufficiency and ventilator weaning.** *Am J Respir Crit Care Med*, 173, 276-80

Mackay MR, Ellis E, Johnston C (2005) **Randomised clinical trial of physiotherapy after open abdominal surgery in high risk patients.** *Austr J Physiother*, 51, 151-9
- yet more research telling us that we don't need to do breathing exercises routinely after surgery; maybe someone will notice it this time and we won't get bright-eyed graduates wasting their time on routine breathing exercises (although between you and me, I've never agreed with the technique described in all the similar articles since 1988, but never mind…)

6 internet access wasn't available at time of going to press, but should be available now via

Mancebo J (2006) **A multicenter trial of prolonged prone ventilation in severe ARDS.** *Am J Respi. Crit Care Med*, 173, 1233-9
- at last someone brave enough to prone their patients early enough and long enough – with predictably-successful outcomes

McKenzie CA, McKinnon W, Naughton DP et al (2005) **Differentiating midazolam over-sedation from neurological damage in the intensive care unit.** *Crit Care*, 9, R32-R36
- how to distinguish over-sedation from neurological damage

Murphy R (2006) **Capillary blood gases in acute exacerbations of COPD.** *Respir Med*, 100, 4, 682-686
- now we can all become extended-scope practitioners and not wait for blood gases – ear capillary blood gases have now been shown to provide accurate assessment of PCO_2, H^+ and HCO^3- , so along with oximetry, we can now do it all by our ickle selves

Oga T (2006) **Dyspnoea with activities of daily living versus peak dyspnoea during exercise in male patients with COPD.** *Respir Med*,100, 6, 965-971
- dyspnoea with ADL is better for evaluating COPD severity than dyspnoea during exercise

O'Neill B, Mahon JM, Bradley J (2006) **Short-burst oxygen therapy in chronic obstructive pulmonary disease.** *Respir Med*, 100, 7,1129-1138
- wave this around your respiratory medicine departments – this puts the case against the widespread prescription of short-burst oxygen

Patel BD et al (2006) **Smoking related COPD and facial wrinkling: Is there a common susceptibility?** *Thorax*, 61, 568-71
- cigarette smoking causes accelerated facial wrinkling and both processes may share a common susceptibility; accelerated wrinkling could signal the need for studies of lung function

Rowe C (2004) **Development of clinical guidelines for prone positioning.** *Nurs Crit Care*, 9,50-57
- everything you need to know about the practicalities of proning

Sano Y (2006) **Effects of nebulized sodium cromoglycate on adult**

patients with severe refractory asthma. *Respir Med*, 100, 3, 420-433
- so we've come full circle! Dear old Intal, even with its patent out of date, is effective for severe asthma

Simpson M (2000) **Why can't you tickle yourself?** *StudentBMJ*, 8, 451
- now you can learn how the sex of the tickler affects the tickle threshold via the somatosensory cortex: essential reading for the respiratory physio…

Skumlien S, Hagelund T et al (2006) **A field test of functional status as performance of activities of daily living in COPD patients.** *Respir Med*, 100, 2, 316-323
- an ADL test that is valid and reliable for rehab programs.

Smith MD, Russell A, Hodges PW (2006) **Disorders of breathing and continence have a stronger association with back pain than obesity and physical activity.** *Austr J Physiother*, 52, 11-16
- if you've discussed the diaphragm with your musculoskeletal colleagues, you'll have found what a useful collaboration it can be; this article pulls it all together by exploring the dual role of the diaphragm and transverses abdominis for both breathing and posture; and it makes sense – if your COPD patient's diaphragm is knackered, how can it adequately support the spine?

(try also - Hagins M (2006) Natural breath control during lifting tasks. Euro J Appl Physiol, 96, 4, 453-8)

Tsuchida S (2006) **Atelectasis causes alveolar injury in nonatelectatic lung regions.** *Am J Respir Crit Care Med*, 174(3), 279-89.
- it's the distal airways and remote alveoli that might be most affected by atelectasis – at least in an ARDS-like model

Unoki T (2004) **Effects of expiratory rib cage compression combined with endotracheal suctioning on gas exchange in mechanically ventilated rabbits.** *Respir Care*, 49, 896-901
- another challenging one - rib cage compression is thought to exacerbate atelectasis

Wark PAB, McDonald V (2004) **Nebulised hypertonic saline for cystic fibrosis** *(Cochrane Review)*
- evidence that nebulised hypertonic saline improves mucociliary clearance in CF

http://www.cochrane.org/reviews/en/ab001506.html

Wysocki M (2006) **Reduced breathing variability as a predictor of unsuccessful patient separation from mechanical ventilation**. *Crit Care Med*, 34, 8, 2076-2083
- using the breathing pattern to predict weaning success

Young P (2005) **Ambulatory and training oxygen: a review of the evidence and guidelines for prescription.** *NZ J Physiother*, 33, 1, 7-12
- everything you always wanted to know about oxygen prescription for both exercise training and the home - succinct and evidence-based.

Zamanian M, Marini (2006) **Pressure-flow signatures of central-airway mucus plugging.** *Crit Care Med*, 34, 1, 223-6
- airway pressure and flow tracings may identify central airway mucus plugging

…and from the universe

Ventilator waves and loops:
http://www.adhb.govt.nz/newborn/TeachingResources/Ventilation/RespiratoryFunctionMonitoringAndGraphics.htm

Guidelines on respiratory palliative care (secretions, breathlessness, cough):
http://www.prodigy.nhs.uk/guidance.asp?gt=Palliativecare

American respiratory guidelines:
http://www.rcjournal.com/online_resources/cpgs/cpg_index.asp

More exciting stuff on hypertonic saline and CF:
http://clinicaltrials.gov/show/NCT00271310

COPD NICE Guidelines
http://www.nice.org.uk/download.aspx?o=cg012niceguideline

Chest x-rays (lovely and easy)
http://www.studentbmj.com/issues/00/12/education/444.php (collapse and consolidation)
http://www.studentbmj.com/issues/00/11/education/408.php (lung fields)

And download for your patients the BLF's new patient-friendly leaflet on healthy eating for people with respiratory disease:
http://www.lunguk.org/healthy-eating.asp?lung=11

Evaluating the introduction of a late shift respiratory physiotherapy service

Eleanor Douglas

Division of Physiotherapy Education
University of Nottingham
Tel: 0115 8231799
e-mail: eleanor.douglas@nottingham.ac.uk

Pauline Pilling

Clinical Manager, Physiotherapy Department
Nottingham City Hospital

Sarah Beckett

Senior Respiratory Physiotherapist
Nottingham City Hospital

Summary

The aim of this paper is to share our experience of introducing a respiratory physiotherapy late shift. It demonstrates the successful implementation of a respiratory late shift in reducing emergency weekday evening call-outs and providing a cost improvement to the physiotherapy department. Further investigations are warranted regarding staff and patient evaluation of the service and how it can be developed in the future to provide improved patient care.

Keywords

late shift, on call working, physiotherapy, respiratory service

Introduction

Nottingham City Hospital is an 1100-bedded acute teaching trust that provides a service to 55 000 in-patients a year. There is no A&E department but we share responsibility for taking emergency medical admissions with Queen's Medical Centre [with which Nottingham City has since merged]. The Hospital has High Dependency Units for children and adults, a general Adult Intensive Care Unit and Cardiac Intensive Care Unit. Specialities include cardio-thoracic surgery, haematology including bone marrow transplantation, abdominal surgery, burns and plastics, and cystic fibrosis services.

In 2003 an audit of our on-call service was undertaken, revealing that the majority of our call-outs were between 6 and 9 pm. In response to this, and as part of a cost- saving exercise, we proposed the trial of a respiratory late shift whereby one of the respiratory team would work between 1 and 9 pm on a week day.

Method

Staff Consultation

The initial idea was suggested in a respiratory unit meeting, where a 'Strengths, Weaknesses, Opportunities and Threats' (SWOT) analysis took place. This was followed by a general staff survey which set out potential advantages and disadvantages, then asked for comments and either agreement or disagreement with the proposal. Table 1 indicates the results of the SWOT analysis and staff responses, showing an overall positive response, and an agreement to trial the service for 3 months.

Aims and Objectives of the Service

- To respond to the results of the on call audit carried out in 2003
- To provide a better quality of service to respiratory patients by extending the time during which a respiratory physiotherapist would be available to assess and treat
- To achieve greater cost effectiveness and efficiency
- Development of 'New ways

TABLE 1. SWOT analysis and Staff Consultation Survey Responses

STRENGTHS	WEAKNESSES
Continuity of care for patients Better spacing of treatments Improved patient care Personal flexibility (time off am) Confidence for juniors Other teams finish on time Seniors commitment Review of patients from theatre Evening on call person can have tea/go home Be there for patient extubations Reduce call outs/costs Free up time in outpatients for physio on call at the end of the day Better use of resources More attractive to non respiratory staff More complex patients seen by a respiratory physio Reduce travel claims	Less morning cover on respiratory units Getting to patients during mealtimes & visiting times Sickness cover Other evening commitments De-skilling of non-respiratory staff Lone working
OPPORTUNITIES	**THREATS**
Students can shadow emergency work Paediatric service integration	Late person cover for sickness/absence New juniors competence Do we have enough staff? Support for junior staff when lone working

of Working' within the NHS by providing a more flexible working pattern
- To forge links with the newly-extended outreach service
- As a step to providing a 7-day respiratory service

Criteria for the Late Shift

Any respiratory patient who has been assessed by their ward physiotherapist during the day as being at risk of deterioration should be seen on the late shift.

The late shift is predominantly to provide a continuation of high quality respiratory provision to patients. It is not for completing work which others did not have time to complete during the day.

If the late shift person receives an emergency call out, this takes precedence over the pre-arranged late shift patients. The therapist will then need to assess the on-call emergency patients and prioritise accordingly

Late Shift Policy

- Juniors do not start late shifts until they have completed 2 months of their first respiratory rotation.
- A handover from the day staff to the late shift physiotherapist takes place between 4 -4.30pm
- The late shift operates between 4.30pm and 9pm Monday to Friday except on Bank Holidays. In the event of sickness, the evening on call person takes over at 4.30pm and the service reverts to an on call service only.
- The late shift covers any areas in which respiratory patients need to be seen including Paediatrics, Burns & Plastics, Orthopaedics, Oncology and Neurology.
- A respiratory senior draws up the rota, then partial self-rostering is undertaken by staff selecting days that are convenient for them, as well taking account of the less popular Friday evening shift.

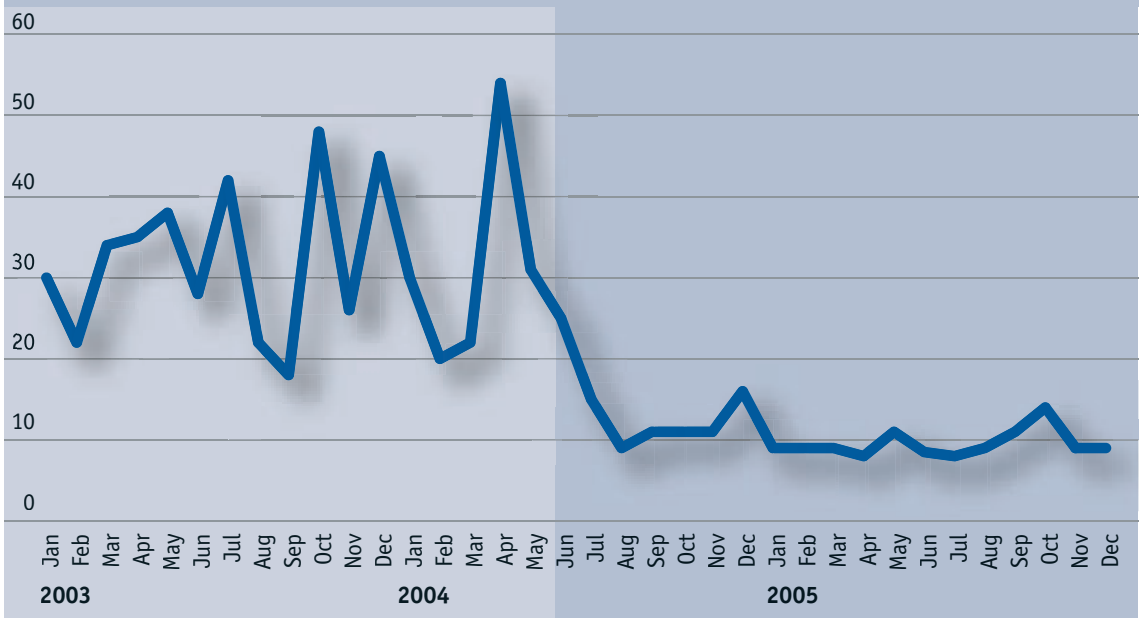
Evaluation Results

Workload

The late shift began in June 2004 and was evaluated during the 3 month pilot of the service. The total number of patients seen in this period was 183, an average of 4 patients per shift. This included 26 patients not already on the list, demonstrating the additional patients to whom the on-call physiotherapist would have normally been called. The service was deemed to be successful and it continued.

A second evaluation took place between January and March 2006. A total of 26 late shifts

FIGURE 1. The number of monthly weekday callouts from 2003-2005. Note the late shift was introduced in June 2004



were evaluated. During this time, 103 patients were treated during late shift hours, an average of 4 patients per shift. The physiotherapists were called to 10 patients not on the list, representing the number of other potential emergency call outs.

Minimal problems have been encountered accessing patients during late shift hours.

Emergency Callouts

The number of weekday emergency call outs has decreased dramatically since the introduction of the late shift. Figure 1 represents the number of weekday callouts before and after the introduction of the late shift. The reduction in emergency callouts has produced a cost saving in excess of £10 000 per year on emergency payments and travel expenses.

Thirty three members of staff took part in the evaluation (Table 2), which consisted of a questionnaire asking participants to rate different statements on a 5-point Likert Scale from 'strongly disagree' to 'strongly agree'. 21 staff had worked a late shift and 12 staff had not worked a late shift.

The responses show staff opinion to be that the late shift is a success, not only in improving quality of care to patients, but as a good use of resources and for improving working lives of staff. Staff working late shifts commented that it allows them to have a 'lie in' and gives them time when they 'can do jobs like going to the bank'. Staff views are less positive when asked if a late shift should be introduced at weekends, commenting on problems with childcare and family commitments. This is interesting in relation to potential 7-day working.

In the initial staff consultation a potential weakness was that it may de-skill non-respiratory staff as they would be called out less frequently. From the staff survey, there was strong opinion that this is not the case, which may be because they still work at weekends regularly and their respiratory skills are therefore maintained.

The respiratory team, including Pauline Pilling who is in mufti, Eleanor Douglas who is next to her on the left and Sarah Beckett who is next on the left

The Future

Due to its success, the service has continued. Further auditing

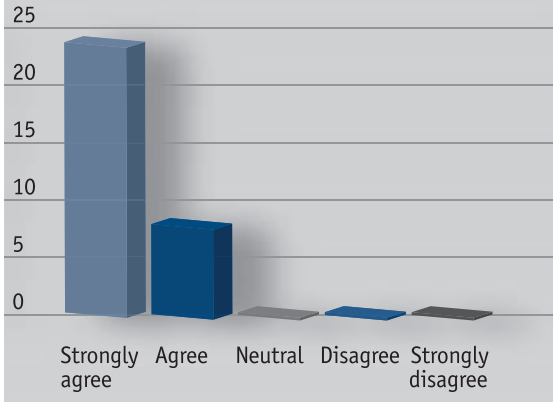
needs to take place to ensure that policy requirements are being met. The idea of working a 12-hour shift requires further investigation before a trial, and future plans for providing a 7-day respiratory service are currently under investigation.

Key Points

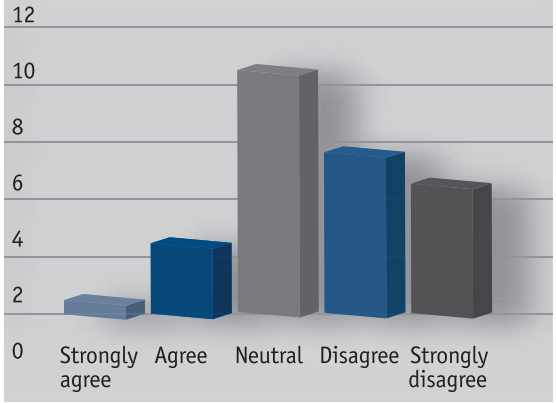
- After an audit revealed that most call-outs were before 9pm, staff consultation led to a 3-month trial of a respiratory service between 4.30 and 9 pm.
- Strict criteria and a late-shift policy were drawn up, and the service was staffed by a member of the respiratory team.
- The late shift led to an improvement in the working lives of staff and a cost saving of over £10 000 per year.

TABLE 2: Staff evaluation of the late shift

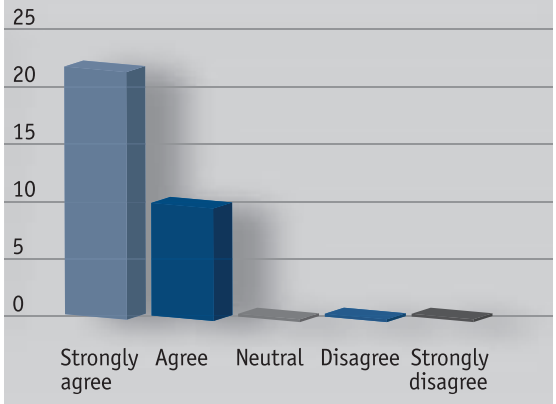
The late shift provides quality of care to patients



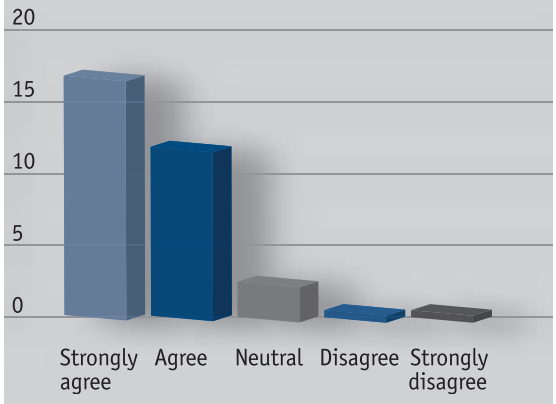
The late shift should be provided at the weekend



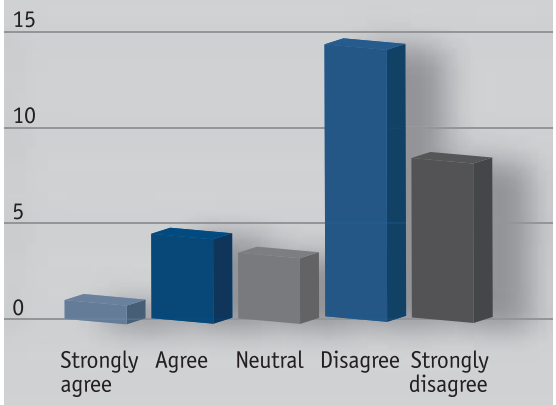
Introducing a late shift has been a success



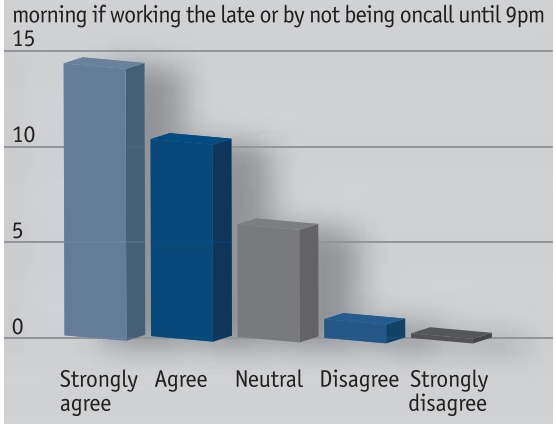
The late shift is a good use of time/resources



Having a late shift de-skills non-respiratory staff



The late shift improves working lives for staff e.g. free morning if working the late or by not being oncall until 9pm



Audit of a passive movement protocol in intensive care

Janis Harvey

Physiotherapy Dept, Western General Hospital, Edinburgh
email: janis.harvey@luht.scot.nhs.uk

Summary

Passive movements are an intervention that physiotherapists can provide to minimise the adverse effects associated with immobility. From a pilot study, a protocol for providing passive movements to sedated, adult intensive care patients was developed. The purpose of this study was to audit the protocol to determine effectiveness in maintaining joint range of movement (ROM) in this patient group.

Key words

Passive movement, passive stretch, intensive care, audit.

Introduction

The health and strength of joint structures is dependent on a certain amount of stress and strain (Norkin and Levangie, 1992). Sedated and/or paralysed patients in the intensive care unit (ICU) are therefore at risk of developing limitations in joint ROM, pain associated with joint stiffness, and muscle weakness as the ability to move is temporarily withdrawn.

Passive movements and stretches

The provision of passive movements to sedated and/or paralysed ICU patients may be an intervention that physiotherapists can provide in an attempt to minimise the adverse effects of immobility. Although passive movements will not prevent muscle atrophy, increase strength or assist circulation to the extent that active exercise can, they may maintain joint ROM and soft tissue integrity, minimise contractures, maintain muscle elasticity and preserve kinaesthetic sense (Kisner and Colby, 1990).

Periodically moving body segments through available range may be sufficient to maintain ROM in some patients. However, should a limitation of movement be identified on assessment of range, a programme of manual passive stretches may be indicated. The aim of passive stretching is to lengthen the shortened structures, restoring ROM. Bandy, Irion and Briggler (1997) found that 30 seconds of stretch was as effective as 60 seconds in increasing hamstring flexibility. Kisner and Colby (1990) suggest that the stretch force is applied for at least 15-30 seconds and repeated several times in a session.

The therapist should recognise the potential deleterious effects of passive movements and stretches, especially for the paralysed patient as the protective withdrawal reflex is inhibited. It should also be noted that, while performing passive movements, there are other potential changes which can occur, for example, increases in oxygen consumption (Norrenberg et al, 1995) and minute volume (Chang, Paratz and Rollston, 2002). Changes in haemodynamic variables (Richard, Staley and Miller, 1994) and intracranial pressure (Brimioulle et al, 1997) may not be significant.

The Evidence

Stiller (2000) reviewed the evidence regarding physiotherapy effectiveness for intensive care patients which included provision of 'limb exercises'. The literature search at that time demonstrated 'no published data regarding the ability of (passive) limb exercises to maintain joint ROM and soft tissue length'. A more recent review considering passive stretching similarly concludes that there is insufficient evidence that these techniques are clinically effective for prevention or treatment of contracture due to unconsciousness (NHS Quality Improvement Scotland, 2005). Comparing studies that do exist is difficult due to the lack of technique description and quantification of movements

performed (Chartered Society of Physiotherapy, 2002). As a result of this lack of evidence, the use of passive exercise in ICUs has been identified as a research priority by the Chartered Society of Physiotherapy (2002).

Current practice

Despite the lack of evidence, passive movements for the sedated patient are integral to physiotherapy in the ICU. Lewis (2003) questioned physiotherapists about the provision of rehabilitation in the ICU. The results demonstrated that 97% of respondents carried out passive movements as a component of rehabilitation.

TABLE 1. Subject details

Subject	Age	Sex	Reason for admission
1	52	M	Post-operative care
2	42	M	Intracranial haemorrhage
3	43	M	Sub-arachnoid haemorrhage
4	72	M	Sub-dural haematoma
5	34	M	Sub-arachnoid haemorrhage
6	67	F	Sub-dural haematoma
7	70	F	Pneumonia
8	78	F	Cardiac arrest
9	68	F	Ventriculitis
10	68	F	Sub-arachnoid haemorrhage
11	79	F	Post-operative care
12	74	F	Sub-arachnoid haemorrhage
13	43	M	Cerebral infarct
14	45	F	Pneumonia
15	32	F	Multi-trauma, extra-dural haematoma
16	63	M	Post-operative care
17	41	M	Diffuse axonal injury
18	40	F	Traumatic head injury
19	80	M	Post-operative care
20	54	M	Pneumonia
21	43	M	Sub-dural haematoma
22	34	F	Intra-cerebral haemorrhage
23	65	M	Chest infection
24	38	M	Traumatic head injury
25	73	F	Sepsis

Aim

As limited evidence exists regarding frequency and duration of passive movements and stretches, a local, consensus-based guideline was written as a starting point from which an audit could be conducted and a local protocol devised.

Pilot study

The original guideline involved a process of an initial ROM assessment consisting of moving all joints twice through full ROM, in all planes of motion. If any joint restriction to range was identified, stretches in that plane would be done twice daily. Stretches involved moving the affected joint to end range, applying a sustained stretch for 15-30 seconds and repeating five times. A re-assessment of ROM was made every Monday and Friday.

Details of ROM and a record of stretches were kept for each patient.

Ten ICU patients were assessed in the two-week pilot project.

Findings were:

Some patients missed the fixed assessment days due to instability.

Incomplete assessments may

TABLE 2. Categorisation chart

	CATEGORY 1 Low risk	CATEGORY 2 Moderate risk	CATEGORY 3 High risk
Full assessment	Weekly	Weekly	Minimum weekly Re-assess as clinically indicated
Daily stretch regime	TA stretches	TA stretches Identified problem areas	TA stretches Identified problem areas

have occurred due to Mondays and Fridays often being the busiest clinical days of the week.
Twice weekly re-assessment of some patients showed no change in their ROM.
Twice weekly re-assessment of other patients highlighted development of new ROM restrictions.
It was observed that documentation, and possibly occurrence, of stretches were often omitted from weekend treatments.
In summary, a fixed guideline, as originally described, was too frequent for some patients but not frequent enough for others. Documentation and encouragement of physiotherapists to comply with the appropriate stretches also needed to be addressed.
From these findings a revised guideline was developed and documentation amended. An audit was then undertaken to assess the efficacy of the revised protocol in maintaining joint ROM.

Method

Twenty-five new patients (mean age 55.9 years, range 32-80) admitted to ICU who required intubation and ventilation were assessed (Table 1).

Ethical considerations

In this ICU, passive movements are a standard intervention. As this was an audit of current practice, inclusive of all patients, neither ethical approval nor consent for inclusion was sought.

Passive movement protocol

Standard 1
Within three days of ICU admission, all patients will have full assessment of joint ROM as described in the pilot study. If the patient is too unstable for assessment, this would be documented and the initial assessment carried out as soon as appropriate. Details of assessment findings and any restrictions would be noted in the audit record chart and physiotherapy patient record.

Standard 2
Following assessment, the physiotherapist will use clinical judgement, based on the patient's history and current condition, to categorise the patient according to the perceived risk of deterioration in ROM. Intervention will then be carried out as per the protocol for that category (Table 2).

All categories ensure that even for low risk patients (category 1) there is at least a minimum weekly full assessment plus daily stretches to any identified restricted joints. Daily stretches to the achilles tendons (TA) were also included in each category as these are a high risk area for all sedated patients (Woodard and Jones, 2002). It was agreed by the team that a patient's category should be amended following weekly assessment if the patients' risk of movement restriction changed.
All stretches completed were recorded in the individual audit record chart and physiotherapy patient records.

Protocol implementation

On patient admission, an indication was made on the patient record as to when day three in ICU would occur (Standard 1 of the protocol). The physiotherapist allocated to that patient would perform an initial assessment and allocate the patient to a risk category. Stretches and findings of repeat assessments were carried out according to the protocol for that category (Standard 2).
For audit purposes, two records of assessment and intervention were kept. An individual audit record for each patient detailed assessments made, findings and any intervention given (Appendix).

Results

Patient 25 was not included in the results as by day three in ICU the patient was extubated. Of the 24 remaining patients, the diagnoses were:

- 62% neurological
- 21% medical
- 17% surgical

Standard 1
75% (18/24) of initial assessments were made within three days of admission (Figure 1).

Figure 2 displays reasons for 25% (6/24) of assessments being made after day three of admission.

21% (5/24) of the initial assessments made were incomplete. The reasons for this were the presence of an intra-aortic balloon pump, external fracture fixation, knee brace and

FIGURE 1. Number of days to initial assessment from admission (Standard 1)

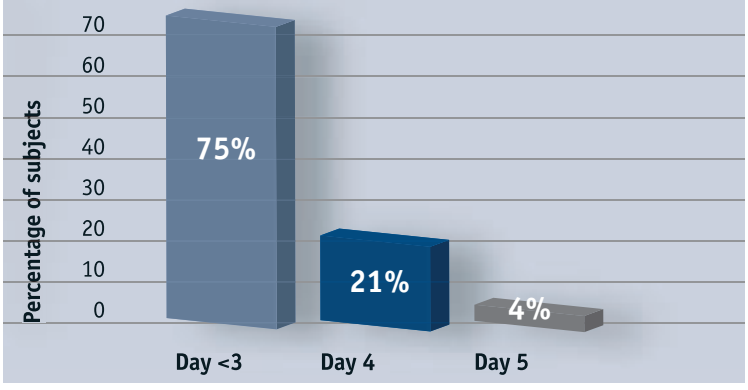
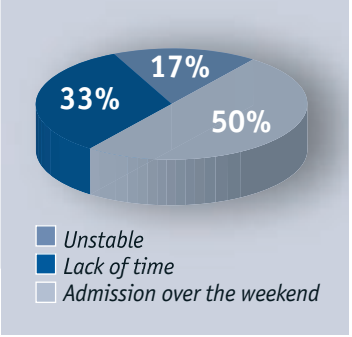


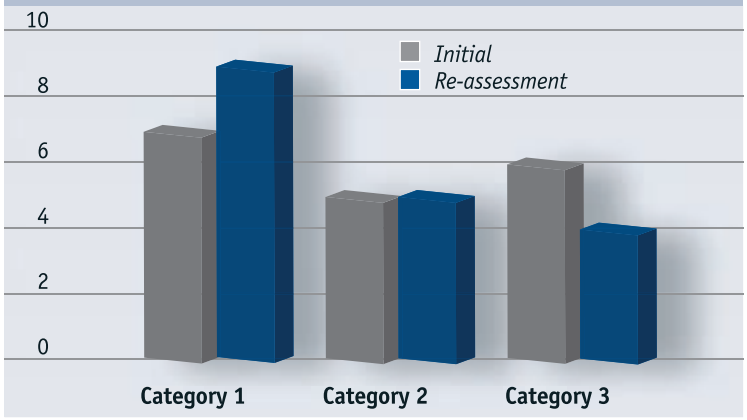
FIGURE 2. Reasons for delayed assessment after day three of admission



- seven patients remained in category 2 or 3 following re-assessment i.e. demonstrated ongoing restriction of ROM.

No patient on any re-assessment demonstrated deterioration in ROM; all had either maintenance or improvement of ROM. Figure 3 demonstrates a shift in patient category from high to lower risk on initial and re-assessment of ROM.

FIGURE 3. For those patients reassessed, comparison of category on initial and re-assessment of ROM



increased tone.

The incidence of patients having ROM restriction on initial assessment was 46% (11/24).

Standard 2

All patients were allocated to a risk category. Of the initial assessments made:

- 33% were in category 1 (low risk)
- 46% in category 2 (moderate risk)
- 21% in category 3 (high risk).
- Eleven patients did not have repeated assessment due to discharge from ICU care or cessation of the audit before repeat assessment was due.

Eighteen repeat assessments were carried out on 54% (13/24) of patients. Of the reassessments made:

- 83% (15/18) of patients remained in the same category
- 17% (3/18) became lower in category

Discussion

This audit has demonstrated that implementing a protocol for joint ROM assessment and passive stretching can successfully maintain, if not improve, ROM in sedated and/or paralysed ICU patients. As no similar research evidence could be found in this area, no comparison of these findings can be made.

Standard 1

Standard 1 stated that full joint ROM assessment would be made within three days of admission to ICU. This was not met in 25% of patients. The two main reasons identified for not achieving this standard were lack of time and patient admission over a weekend. During periods of staff shortages, a clinical prioritisation chart is in place for physiotherapy service to critical care. Respiratory care takes priority and passive movements can be prioritised during that time. Similarly, weekend and emergency physiotherapy is primarily directed at acute respiratory care, and initial ROM assessment is therefore not a priority. This level of achievement of standard 1 was considered acceptable as it reflected reduced staffing and varied patient admissions over weekends.

Standard 1 also involved recording ROM restrictions on initial assessment, which was achieved in 46% (11/24) patients for various reasons - external fracture fixation, chronic soft tissue restrictions, increased tone, peripheral oedema and a potentially unstable cervical spine. Only two of the 11 instances of restriction could not be accounted for. One of these patients had delayed initial assessment (day four). It is impossible to state whether restriction in this patient was due to this fact alone, as other patients who had delayed assessments demonstrated no restriction on initial assessment. The other patient demonstrating restriction was assessed on day two.

Standard 2

Standard 2 stated that, following full assessment, patients would be categorised to a regime according to the perceived risk of deterioration in ROM. Of those patients who had re-assessments, the majority remained in the same category (83%) and the remainder were re-categorised into a lower risk group. This finding demonstrates that the physiotherapists involved were appropriately using their clinical judgement in considering the risk of limitation to ROM.

Following allocation to a category, daily passive stretches were performed. Although full assessment was not expected on weekends, specific stretches

to restricted joints were. Daily stretches throughout the weekend may also have contributed to maintenance of ROM.

As a consequence of the categorisation, patients received appropriately-timed intervention which continued over weekends, resulting in maintenance, improvement or resolution of restrictions in joint ROM.

Limitations

This study was conducted in a general ICU which also serves a regional neurosciences department. The majority of patients involved (62%) had neurological diagnoses with the remainder of patients being surgical or medical. The spread of patient diagnoses may limit extrapolation of results to more general or specialist ICUs.

Each physiotherapist involved made an assessment of ROM by visual estimation. Being a subjective tool, this may have affected reliability of the ROM documented. ROM may have been more objectively measured by goniometry. However there is varying evidence on the comparable reliability of these two methods (Hayes et al, 2001). Further, the goniometer itself may be influenced by intra- and inter- rater reliability, including clinician experience, the joint being measured and patient position (Somers et al, 1997).

Four physiotherapists were involved in data collection which may have had both positive and negative influences. None could be blinded to changes in ROM, but, as a number of physiotherapists of varying grades were involved, this may add to inter-rater reliability because all patients demonstrated either maintenance or improvement of ROM.

Only 54% of patients had full re-assessment of ROM made within the study period. The results could be more clinically valuable if more re-assessments had been made.

Further research

Repeating a similar study, on a larger cohort of patients and for a longer study period, would contribute to the evidence on the use of a protocol for passive movements to maintain ROM.

Future studies may further consider the duration and frequency of passive movements. Further work in this area may use a single therapist to assess ROM, thus blinding those providing the intervention to the outcome. Further work may also utilise an objective measuring tool.

Clinical implications

Passive movements are recognised as an integral component of physiotherapy for the sedated and/or paralysed ICU patient, despite a lack of supporting evidence.

A protocol for provision of passive movements in sedated ICU patients has been presented and has been demonstrated to be effective in maintaining or improving joint ROM in this patient group.

Key Points

- Passive movements are integral to the physiotherapy management of sedated patients in the ICU, as are passive stretches to joints identified as limited in movement
- To identify the optimum frequency and duration of passive movements and stretches, a consensus-based guideline was written, an audit conducted and a local protocol devised
- Implementing a protocol for joint ROM assessment and passive stretching can successfully maintain, if not improve, ROM in sedated and/or paralysed ICU patients.

Appendix Individual audit record

ICU Physiotherapy audit of passive movement/stretching

Patient name

D.O.B.

	Mon	Tue	Wed	Thur	Fri	Sat	Sun
1st week							
2nd week							
3rd week							
4th week							

		Initial Ax		Re-assessments					
		ICU Day:		ICU Day:		ICU Day:		ICU Day:	
		Date:		Date:		Date:		Date:	
Joint	Movement	R	L	R	L	R	L	R	L
Ankle	P/F								
	D/F								
	Inversion								
	Eversion								
Knee	Flex								
	Ext								
Hip	Flex								
	Ext								
	Med rot								
	Lat rot								
	Abduction								
	Adduction								
Fingers	Flex								
	Ext								
Wrist	Flex								
	Ext								
Elbow	Flex								
	Ext								
	Supination								
	Pronation								
Shoulder	Flex								
	Ext								
	Abduction								
	Adduction								
	Med rot								
	Lat rot								

Post Ax Category				

REFERENCES

Bandy WD, Irion JM, Briggler M (1997) The effect of time and frequency of static stretching on flexibility of the hamstring muscles. Phys Ther, 77, 1090-96

Brimioulle S, Moraine J, Norrenberg D, Kahn RJ (1997) Effects of positioning and exercise on intracranial pressure in a neurosurgical intensive care unit. Phys Ther, 77(12), 1682-89

Chang A, Paratz J, Rollston J (2002) Ventilatory effects of neurophysiological facilitation and passive movement in patients with neurological injury. Austr J Physiother, 48, 305-309

Chartered Society of Physiotherapy (2002) Priorities for physiotherapy research in the UK: Topics prioritised by the cardiorespiratory expert panel (Annex 1). CSP, London

Hayes K, Walton JR, Szomor Zl, Murrell GAC (2001) Reliability of five methods for assessing shoulder range of motion. Austr J Physiother, 47, 289-294

Kisner C, Colby LA (1990) Therapeutic Exercise - Foundations and Techniques. 2nd ed. FA Davis, Philadelphia, pp.20 and 120

Lewis M (2003) Intensive care unit rehabilitation within the United Kingdom. Physiother, 89, 9, 531-8

NHS Quality Improvement Scotland (2005) Manual passive stretching for adults unable to move their own joints. Evidence note 12. www.nhshealthquality.org. Accessed 09/08/2006

Norkin C, Levangie P (1992) Joint Structure and Function. 2nd ed. FA Davis, Philadelphia, p. 86-9

Norrenberg M, De Backer D, Moraine JJ, Melot C, Kahn RJ, Vincent JL (1995) Oxygen consumption can increase during passive leg mobilisation. Int Care Med, 21, S177

Richard R, Staley M, Miller SF (1994) The effect of extremity range of motion on vital signs of critically ill patients and patients with burns. J Burn Care Rehab, 15, 281-4

Stiller K (2000) Physiotherapy in intensive care - towards evidence-based practice. Chest, 118, 6, 1801-13

Somers Dl, Hanson JA, Kedzierski CM, Nestor, KL, Quinlivan KY (1997) The influence of experience on the reliability of goniometric and visual measurement of forefoot position. J Ortho Sports Phys Ther, 25, 3, 192-202

Woodard FH, Jones M (2002) Intensive care for the critically ill adult. In: Pryor JA, Prasad SA, eds. Physiotherapy for Respiratory and Cardiac Problems, 3rd ed. Churchill Livingstone, London, p.359

The effects of pre-oxygenation after saline instillation and suctioning in mechanically ventilated patients – A pilot study

Emily Woodhouse

South Bank University, London SE1 0AA
email: woodhoue@lsbu.ac.uk

Completed as part of an MSc in Cardiorespiratory Physiotherapy, University College, London, August 2004.

Summary

Saline instillation and suctioning remains a controversial topic in critical care. This randomised controlled crossover study aims to investigate whether pre-oxygenating ventilated patients with 100% oxygen via a ventilator prior to 5mls saline instillation and one suction prevents the oxygen desaturation that is commonly seen with suction and saline instillation alone.

Key words

Saline instillation, endotracheal suction, mechanical ventilation, physiotherapy.

Introduction

The instillation of normal saline before endotracheal suctioning used to be a widespread practice in the U.K. Although saline instillation has been shown to increase sputum yield (Screuder and Jones 2004) there have been growing concerns in both the nursing and physiotherapy literature over the use of saline instillation in intubated, ventilated patients (Sole et al 2003). Studies have shown that this practice may be of little benefit and could even be detrimental to the patient by causing a significant drop in total oxygen levels (Bostick and Wendelgass 1987, Kinloch 1999, Ackerman et al 1996).

Although clinicians are now more cautious in the use of saline in ventilated patients, surprisingly little research has been conducted into the use of pre-oxygenation as a method for counteracting the drop in oxygen levels.

Aim

The aim of the study was to investigate whether pre-oxygenating ventilated patients, prior to the instillation of saline and suctioning, prevents a drop in oxygen saturation levels.

Method

A randomised controlled crossover design study was performed on ventilated patients in a 9-bedded medical and surgical Intensive Care Unit (ICU) at a district general hospital.

Ethics

The study was approved by Merton and Sutton Local Research Ethics Committee, and all patients or their next of kin gave their written informed consent.

TABLE 1. Characteristics of participants

Subject	M/F	Age	Length ITU Stay	Diagnosis	Smoker	FiO2	Ventilator Settings
1	F	67	38	R total hip replacement Sepsis	No	0.35	CPAP 5
2	M	63	6	Road traffic accident Haemopneumothorax	No	0.35	SIMV 6 PEEP 10
3	F	42	22	Oesphageal varices Alcoholic liver disease	Yes	0.39	SIMV 2 PEEP 9
4	M	32	4	RTA Sub-arachnoid hematoma	No	0.32	PS 14 PEEP 4

Criteria

Patients were included in the study if they were:

- haemodynamically stable, defined as a heart rate of 60 to 120 beats per minute and systolic blood pressure within the range 120-170 mmHg
- intubated via an endotracheal or tracheostomy cuffed tube and receiving mechanical ventilation
- receiving regular chest physiotherapy at least once a day
- requiring saline instillation when suctioning to clear thick bronchial secretions.

Subjects were excluded from the study if they:

- had suffered an acute head injury
- had oxygen saturations below 90% and PaO_2 less than 65mmHg (8.66kPa) (Sasse et al 1994)
- were unable to be positioned in the 45 degree sitting position
- had undergone suctioning by ICU staff within one hour of the study.

Randomisation

Patients were given a study number and randomly allocated to either (i) the pre-oxygenation group or ii) the standard intervention group. The randomisation process was carried out by an ICU technician who was blind to the study design.

Participants

Four ventilated patients (Table 1) were entered into the pilot study, mean age 51 years (32-67 years). The mean intubation duration from insertion to the start of the study was 17.5 days. Only one subject was a known smoker. All subjects were receiving varying amounts of ventilatory support via Servo 300/300A Siemens ventilators, which were set to deliver a mean fraction of inspired oxygen of 0.35. All subjects were adequately hydrated and had an Intersurgical heat moisture exchanger in the ventilation circuit. All subjects were connected and suctioned via the Vygon closed circuit suction system.

Pre-Oxygenation Group

Subjects allocated to the pre-oxygenation group were positioned at 45-degrees high sitting using a goniometer to accurately measure the bed angle. The ventilator was set by the researcher to deliver 100% oxygen for one minute.

Immediately after one minute, the researcher instilled 5 millilitres (mls) of 0.9% sodium chloride (saline) solution at room temperature, via a syringe, into the injection port on the closed circuit suction system and suctioned the patient once. The suctioning guidelines (1) were adhered to, ensuring standard procedures throughout the study period. The catheter size used for suctioning was dependent on the size of the artificial airway and was no greater than half the diameter of the tube. The amount of negative pressure used during suctioning was 20kPa.

Standard Intervention Group

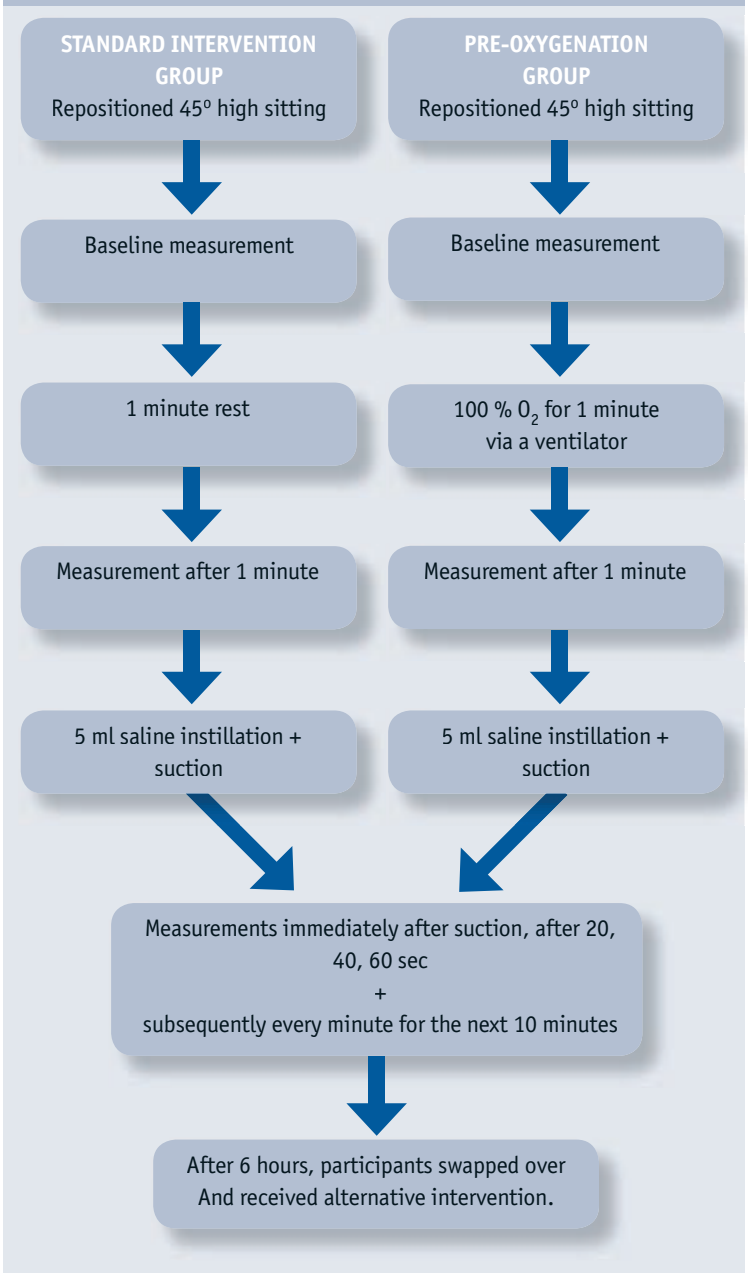
The procedure was repeated with the standard intervention group but they did not undergo pre-oxygenation before saline instillation and suctioning. After 6 hours the two groups crossed over and received the alternative intervention (Figure 1).

Data Collection

Oxygen saturation was measured and recorded with a oximeter (Siemens Monitoring Software) connected to the subject's finger. Accuracy for the Siemens Pulse Oximeters at 68 - 100% saturation levels was +/ - 1%.

The researcher recorded saturations at baseline, one minute after pre-oxygenation (or the resting period in the standard intervention group); immediately after suctioning; after 20, 40 and 60 seconds and subsequently after every minute for the next ten minutes. A stop

FIGURE 1 . Study design



watch was used to accurately measure the time intervals.

Analysis

The Student's t test was used to determine the significance of the difference in oxygen saturations between the 2 groups for each of the specific time periods. A p value of >0.05 was considered statistically significant.

Results

Pre-oxygenation Group

Initially pre-oxygenation caused a statistically and clinically significant rise in saturation levels from baseline (p=0.02). For all the subjects in this group, the saturations dropped after saline instillation and suctioning from between 2% to 15% below the initial baseline values, with 2 subjects failing to recover their baseline values after 10 minutes. The time taken to reach the maximum desaturation value varied in participants between 20 seconds to 360 seconds (Figure 2).

Standard Intervention Group

The general trend after saline instillation and suctioning shows a drop in saturation levels from 1% to 6% from baseline values, one subject failing to return to their baseline values within 10 minutes of the study. The time taken to reach the maximum desaturation value is between 20 seconds and 360 seconds (Figure 2).

The results show no statistical or clinical significance in the oxygen saturation levels between the pre-oxygenated group and the standard intervention group.

Discussion

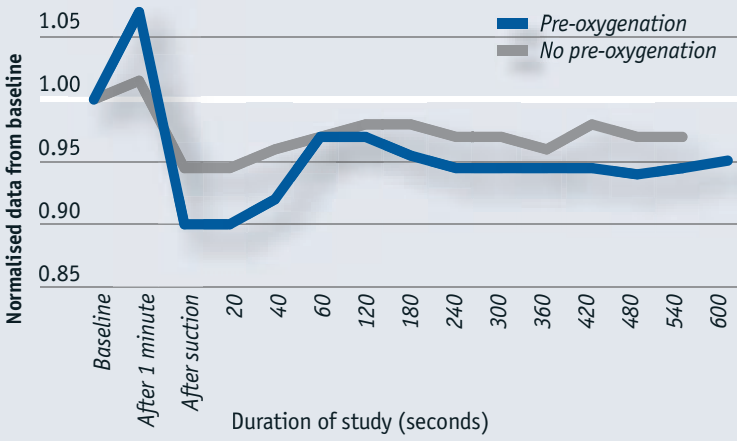
No previously published studies have compared the effects of pre-oxygenation versus no pre-oxygenation when using saline and suction. The closest design to the present study involved delivering 100% oxygen to the patient via a ventilator for one minute and compared saline instillation and suctioning against suctioning alone (Ackerman 1993). Ackerman's study showed that normal saline instillation has a detrimental effect on oxygen saturations in critically ill male patients; however, the level of decrease in saturations was clinically insignificant, leaving the findings open to question. The discussion will be organised into different aspects of the topic and related to other studies.

Subjects

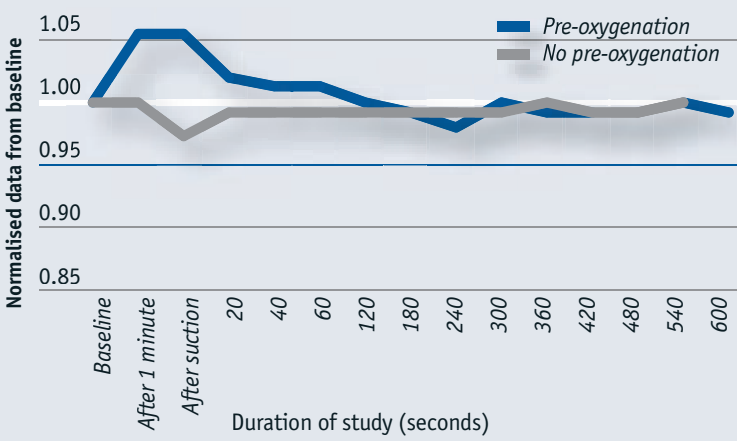
Saline instillation has been found to be clinically more effective in ventilated patients with thick pulmonary secretions (Ackerman and Mick, 1998). As a result, the present study consisted purely of patients with thick tenacious pulmonary

Fig 2. Normalised date against baseline values

Study 1
Comparison of oxygen saturation levels for baseline normalised date (Baseline = 1)



Study 2
Comparison of oxygen saturation levels for baseline normalised date (Baseline = 1)



secretions who were intubated and receiving mechanical ventilation.

Pre-oxygenation

In this study, the ventilator was used to deliver 100% oxygen over a one minute. The ventilator has been suggested as a more controlled source of oxygen and volume delivery compared to a reservoir bag (Anderson, 1989). Interestingly, previous studies have shown a time delay between oxygen adjustment and delivery, due to the dead space volume in the ventilator tubing. This washout period has been shown to be as great as two minutes in some studies (Skelley et al 1980, Chulay and Graeber 1988). Pre-oxygenation caused a statistically and clinically significant rise in initial saturation levels from baseline ($p=0.02$). This would suggest that pre-oxygenation for one minute was adequate to optimise the participant's oxygenation.

Although high oxygen saturations were recorded in the study participants, no detrimental effects were witnessed. However, long-term effects of any marked elevation in oxygen saturation have not been well researched and warrant further investigation.

Desaturation

The most vulnerable period for hypoxaemia has been shown to be during and 30 seconds after the suction procedure (Riegel and Forshee 1985, Pierce and Piazza 1987). The most vulnerable period for desaturation in the current study averaged 165 seconds; 210 seconds in the pre-oxygenation group and 120 seconds in the control group. The slower drop in saturations may be explained by several factors: patients not being disconnected from the ventilator, only one suction catheter pass being performed, suction pressures being kept to a minimum and suction duration being limited to 15 seconds. All these techniques are known to reduce suction induced hypoxia (Day et al 2002, Dean 1997, Ozcan et al 2006).

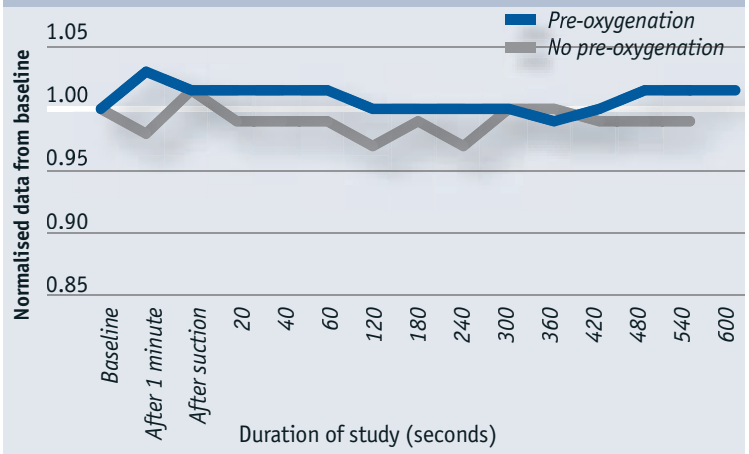
The variability in desaturation between participants may be due to an individual's rate of oxygen absorption, rate of extraction by the tissues and susceptibility to suction-induced small airway closure (Adlkofer and Powaser 1978, Dean and Ross 1992, Oh and Seo 2003). Both groups experienced oxygen desaturation during the procedure but these did not reach statistically significant levels. Interestingly, the rate of fall was greater in the standard intervention group than the pre-oxygenation group. Clinically these findings are important and indicate that pre-oxygenating the patient may provide adequate supplemental oxygen.

Return to Baseline Value

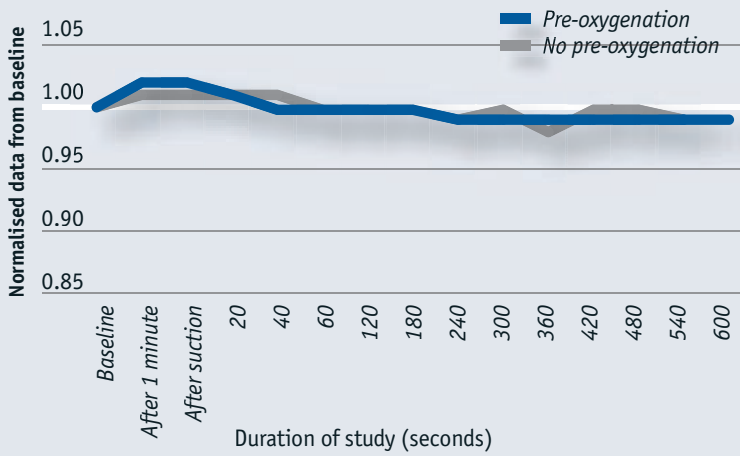
Two subjects in the pre-oxygenation group and one in the standard intervention group failed to return to their baseline saturations during the ten minute study period. These findings are similar to other saline and suctioning studies, however the clinical significance

Fig 2. Normalised date against baseline values

Study 3
Comparison of oxygen saturation levels for baseline normalised date (Baseline = 1)



Study 4
Comparison of oxygen saturation levels for baseline normalised date (Baseline = 1)



of oxygen saturations remaining 1-2% below baseline warrants further investigation. (Ackerman 1993, Ackerman and Mick 1998, Gray et al 1990, Kinloch 1999).

Limitations

Controversy surrounds the most reliable and appropriate method to measure oxygen levels in the blood during and after suctioning. Although a pulse oximeter was used to provide a rapid, non invasive measurement, limitations to the recordings have been identified in critically ill adults with perfusion deficits (Hough 2001).

Using clinicians' subjective opinions on whether secretions were thick enough to warrant saline instillation also leaves this study open to criticism, as does the timing and appropriateness of the saline and suction.

The prevailing problem when reviewing saline and suction studies is the lack of consistency in methods of oxygenation, saline quantity and suction methods. In this study, 5mls of saline was instilled to standardise the quantity used. However in clinical practice, varying amounts of saline are used, depending on the quantity and consistency of the secretions and the experience of the clinician.

In this study, the patients were positioned at 45 degrees. Although this is replicated in many suction and saline studies and so allows for direct comparison, it is a position rarely implemented by clinicians in clinical practice.

Conclusion

As clinicians, we should not be hasty in withdrawing the use of saline in our clinical practice. This pilot study provides preliminary evidence that pre-oxygenation is beneficial when using saline and suction for mechanically ventilated patients. This could have important implications in the clinical setting and necessitates the need for a much larger clinical trial.

Key Points

- Pre-oxygenation caused a statistically and clinically significant rise in saturation levels from baseline
- Both the pre-oxygenation and standard invention group experienced desaturation with saline instillation and suction although these were statistically insignificant
- The pre-oxygenation group took longer to reach their lowest desaturation value compared to the standard intervention group.

REFERENCES

Ackerman MH (1993) The effects of saline lavage prior to suctioning. Am J Crit Care, 2, 326-30

Ackerman MH, Mick DJ (1998) Instillation of normal saline before suctioning in patients with pulmonary infections. Am J Crit Care, 7, 261-66

Ackerman MH, Ecklund MM, Abu-Jumah M (1996) A review of normal saline instillation. Dim Crit Care Nurs, 15, 31-38

Adlkofer RM, Powaser MM (1978) The effects of endotracheal suctioning on arterial blood gases in patients after cardiac surgery. Heart Lung, 7, 1011-14

Anderson KM (1989) The effects of manual bagging versus mechanical ventilation sighing on oxygenation during suctioning. Heart Lung, 18, 301-2

Bostick J, Wendelgass ST (1987) Normal saline instillation as part of the suctioning procedure. Heart Lung, 16, 532-7

Chulay M, Graeber GM (1988) Efficacy of a hyperinflation and hyperoxygenation suctioning intervention. Heart Lung, 17, 15-22

Day T, Farnell S, Wilson-Barnett J (2002) Suctioning: a review of current research. Int Crit Care Nurs, 18, 79-89

Dean B (1997) Evidence-based suction management in accident and emergency. Acc Emerg Nurs, 5, 92-8

Dean E, Ross J (1992) Discordance between cardiopulmonary physiology and physical therapy. Chest 101, 1694-8

Gray JE, MacIntyre NR, Kronenberger WG (1990) The effects of bolus normal-saline instillation in conjunction with endotracheal suctioning. Respir Care, 35, 785-90

Hough A (2001) Physiotherapy in Respiratory Care: an evidence-based approach to respiratory and cardiac management. 3rd Edn. Nelson Thornes, Cheltenham, p. 325

Kinloch D (1999) Instillation of normal saline during endotracheal suctioning. Am J Crit Care, 8, 231-40

Oh H, Seo W (2003) A meta-analysis of the effects of various interventions in preventing endotracheal suction-induced hypoxemia. J Clin Nurs, 12, 912-24

Ozcan MS, Bonett SW, Martin AD, Gabrielli A, Layon AJ, Banner MJ (2006) Abnormally increased power of breathing as a complication of closed endotracheal suction. Respir Care, 51, 423-5

Pierce JB, Piazza DE (1987) Differences in postsuctioning arterial blood oxygen concentration values using two postoxygenation methods. Heart Lung, 16, 34-8

Riegel B, Forshee T (1985) A review and critique of the literature on preoxygenation for endotracheal suctioning. Heart Lung, 14, 507-18

Sasse SA, Chen PA, Mahutte CK (1994) Variability of arterial blood gas values over time in stable medical ICU patients. Chest, 106, 187-93

Schreuder FM, Jones UF (2004) The effect of saline instillation on sputum yield and oxygen saturation. Physiother, 90, 109 (abstract)

Skelley BF, Deeren SM, Powaser MM (1980) The effectiveness of two preoxygenation methods to prevent endotracheal suction-induced hypoxaemia. Heart Lung, 9, 316-23

Sole ML, Byers JF, Ludy JE, Zhang Y, Banta CM, Brummel K (2003) A multisite survey of suctioning techniques and airway management practices. Am J Crit Care, 12, 3, 220-32.

What do respiratory physiotherapists really do? Stage 1 of a consensus project

Rachel Garrod

School of Physiotherapy
St George's Hospital, London SW17 ORE
Tel: 020 8725 0377
rgarrod@hscs.sgul.ac.uk

Penny Bidgood

School of Mathematics, Kingston University

Peter Soan

School of Mathematics, Kingston University

Summary

Much research on respiratory physiotherapy is of poor methodological quality. As stage 1 of the development of consensus- based recommendations, we sought to identify areas of dissent and agreement on current practice. This paper reports on the use of manual techniques in chronic obstructive pulmonary disease, cystic fibrosis, bronchiectasis and asthma, during both acute and stable states. The main findings were that the choice and frequency of technique depended on the disease.

Keywords
manual chest percussion, shaking, respiratory disease, guidelines for practice

Introduction

A recent Cochrane review states that broncho-pulmonary hygiene techniques remain an unproven treatment in the management of bronchiectasis (Jones and Rowe 2000). Similarly, a review of evidence as part of the National Institute for Clinical Excellence (NICE) guidelines process was unable to identify any suitably robust literature to advocate or refute the use of manual chest physiotherapy techniques in Chronic Obstructive Pulmonary Disease (COPD) (National Institute for Clinical Effectiveness 2004). This review highlights the evaluation of physiotherapy techniques as an important area for future research. Other authors have considered the evidence concerning the efficacy of physiotherapeutic treatment techniques in the management of impaired airway clearance and agree that contradictory conclusions are reported (Hess 2001; Thomas, Cook and Brooks 1995). In particular, much of the research concerning the use of manual chest percussion (MCP) and shaking is insufficiently robust to be used confidently in the development of evidence based guidelines and protocols. Additionally, most studies evaluating the use of MCP and shaking have done so in patients with stable disease. However, physiotherapy often takes place when patients are acutely unwell. Thus the use, efficacy and appropriateness of these techniques remains unknown. In the absence of any good evidence on the most effective treatment options for pulmonary diseases, it may be appropriate to develop guidance for the physiotherapy profession based on expert opinion and current practice.

While recognising that a more detailed clinical study would be

preferable, the identification of areas of dissent and agreement in clinical practice represents an important first step in the development of consensus-based recommendations. Using this process to develop guidelines will have application for a number of health professionals where research evidence is not available or methodologically flawed (Balfour-Lynn 2005).

In order to identify more clearly which treatments are commonly used by experienced respiratory physiotherapists, a survey was conducted at an international meeting. The first objective of this evaluation is to determine whether or not the type or state of the disease influenced physiotherapists' frequency of treatment (MCP or shaking). A second aim was to identify the preferences, this being a starting point for further development of consensus.

Methods

This evaluation was performed opportunistically at a closed meeting for members of the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) in Birmingham, UK, in 2004.

Personal Response System (PRS)

PRS is an individualised, electronic voting system that enables instantaneous collation of results and supports anonymity of individuals. Questions were displayed on a screen and the audience was given three minutes to answer each question using the PRS. Two specific treatment methods, MCP and chest wall shaking, were addressed (Jones and Rowe 2003). The questions focussed around the frequency of these treatments in four commonly treated diseases: CF, bronchiectasis, COPD and asthma. Attendees were asked to vote on the frequency of treatment technique in the management of patients in the stable state and during an acute exacerbation.

The following question was asked;

"Assuming an uncomplicated diagnosis and no contraindications to treatment, how often would you use percussion, with Active Cycle Breathing Techniques (ACBT), to treat retained secretions in patients with stable COPD" . The question was repeated, replacing COPD with each of the other diseases in turn, and then again, inserting "acute" for "stable" Finally these 8 questions were repeated but replacing "percussion" with "shaking". Individual responses utilised a 4 point Likert scale:

- Always
- Often
- Rarely
- Never

The statements are polarised, with "Always" and "Often" being closer in response than "Rarely" and "Never". This enabled the responses to be grouped into two categories and described in terms of therapists who would "always or often" use a certain treatment compared with those who would "rarely or never" use a treatment.

Statistical Analysis

As the data are categorical, being counts of the number of therapists selecting the particular options, tests of association are carried out by 2 tests, or Fisher's exact test where expected numbers in too many of the cells are very small. Statistical tests are carried out using the package SAS. Throughout, the null hypothesis is that there is no association between the "variables" which,

FIGURE 1. Bar chart showing counts for manual chest percussion and shaking in stable and acute asthma, bronchiectasis, CF and COPD

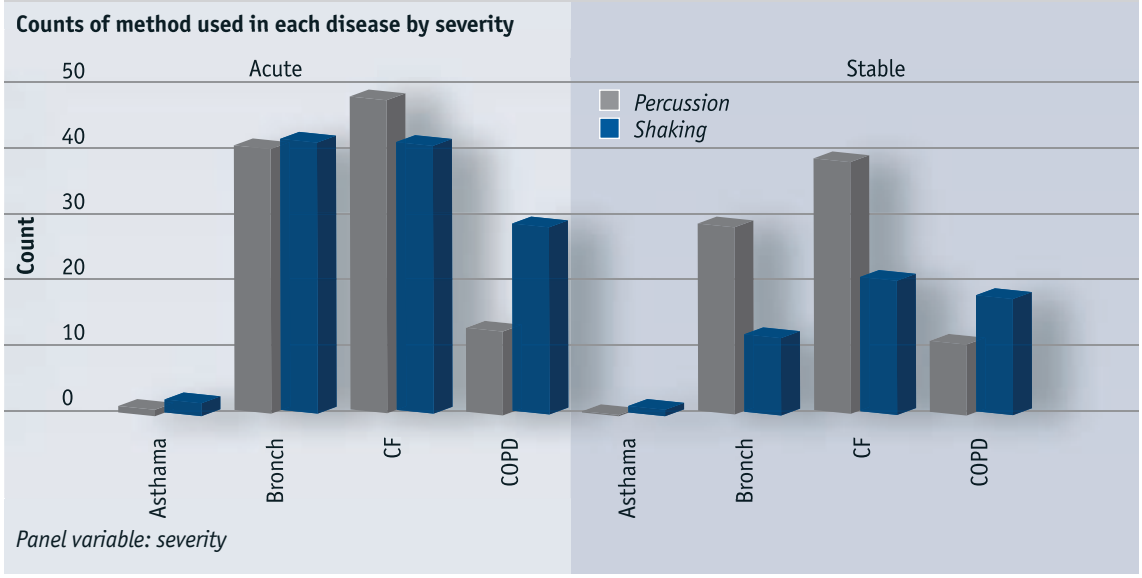


TABLE 1. Frequency of use of manual chest physiotherapy techniques, percussion and shaking, in different conditions.

How often would you use percussion with ACBT to treat retained secretions in patients with:				
	Always (%)	Often (%)	Rarely (%)	Never (%)
Stable COPD	1 (2.1)	11 (22.9)	31 (64.6)	5 (10.4)
Acute COPD	0	15 (31.3)	27 (56.3)	6 (12.5)
Stable CF	5 (10.4)	33 (68.8)	9 (18.7)	1 (2.1)
AcuteCF	16 (33.3)	31 (64.6)	1 (2.1)	0
Stable Bronchiectasis	5 (10.4)	22 (45.8)	19 (39.6)	2 (4.2)
Acute Bronchiectasis	6 (12.5)	36 (75.0)	6 (12.5)	0
Stable Asthma	0	0	19 (40.4)	28 (59.6)
Acute Asthma	0	2 (4.3)	19 (40.4)	26 (55.3)
How often would you use shaking with ACBT to treat retained secretions in patients with:				
	Always (%)	Often (%)	Rarely (%)	Never (%)
Stable COPD	0	17 (35.4)	17 (35.4)	14 (29.2)
AcuteCOPD	0	27 (58.7)	16 (34.8)	3 (6.5)
Stable CF	1 (2.1)	20 (42.6)	22 (46.8)	4 (8.5)
Acute CF	3 (6.4)	40 (85.1)	4 (8.5)	0
Stable Bronchiectasis	1 (2.1)	13 (27.7)	25 (53.2)	8 (17.0)
Acute Bronchiectasis	3 (6.4)	41 (85.4)	3 (6.4)	0
Stable Asthma	0	2 (4.3)	20 (42.6)	25 (53.2)
Acute Asthma	0	4 (8.5)	28 (59.6)	15 (31.9)

in this study are type of disease (asthma, bronchiectasis, cystic fibrosis and COPD), state of disease (acute or stable), method of treatment (percussion or shaking) and frequency of use ("always or often" and "rarely or never"). The null hypothesis is rejected if the resulting p-value is less than 0.05 and in this case the conclusion drawn is that there is some association between the variables.

Results

Forty-eight members of the ACPRC took part. Figure 1 shows clearly the different patterns of use of MCP and shaking in different diseases at different levels of severity. For example both methods are used a great deal in the treatment of bronchiectasis and CF in the acute state, rather less so in the stable state. MCP is preferred to shaking in the stable states for these diseases. There is little difference in the frequency of use of MCP or shaking in the stable state of COPD, although shaking is preferred for the acute state of this disease. Neither method is used much for the treatment of asthma.

Table 1 shows the overall frequencies and percentages for the use of MCP and shaking in the four diseases in the acute and stable states. From the table it can be seen that respiratory physiotherapists infrequently use percussion or shaking in the management of impaired airway clearance in asthma. In contrast, both treatment techniques are used "always or often" a high percentage of the time to manage impaired airway clearance in CF and bronchiectasis, particularly in the acute states.

Is the frequency of use of MCP independent of the disease?

When the frequency of MCP use is investigated for the different diseases irrespective of whether they are acute or stable, Fisher's exact test gives $p < 0.0001$, suggesting that frequency of usage is highly dependent upon the disease being treated. Further investigation of the column percentages shows that 47.9% of physiotherapists use MCP "always or often" (Table 2.1). From this table it can be seen that a much higher proportion of physiotherapists use MCP "always or often" in the management of impaired airway clearance in CF (88.5 %) and bronchiectasis (71.9%)

and a lower proportion in COPD (28.1%) and asthma (2.1%).

Is the frequency of use of shaking independent of the disease?

Similarly, when the frequency of shaking is investigated in the different diseases irrespective of whether they are acute or stable, the 2 test of association gives $p < 0.001$, suggesting that frequency of use is highly dependent upon the disease being treated. Further investigation of the column percentages (Table 2.2) shows that 45.7% of physiotherapists use shaking "always or often", whereas 61.7% use it in treating bronchiectasis and 68.1% in CF.

Is the choice of treatment technique independent of the disease?

Fisher's exact test gives $p = 0.02$, suggesting that frequency of treatment is affected by disease. The association between disease and treatment remains significant after asthma has been removed from the analysis (2 test $p = 0.03$). MCP is used "always or often" by fewer physiotherapists during treatment of COPD (38.0%) than overall (51.6%). In contrast, shaking is used "always or often" by more physiotherapists in COPD than overall (62.0% versus 48.4%). Percentages for CF and bronchiectasis are close to the overall figures (Table 2.3)

Are respiratory physiotherapists influenced in their choice of treatment according to whether disease is stable or acute?

Frequency of use of MCP was not different for stable COPD compared with acute COPD ($p = 0.50$). However, there was a difference in the frequency of use of shaking in the treatment of this disease ($p=0.02$). More physiotherapists chose to use shaking "always or often" during acute COPD (58.7%) compared with stable COPD (35.4%). For CF and Bronchiectasis, the frequency of use of different treatment techniques was clearly influenced by the state of the disease. In each case the p values were much less than 0.05, showing that there were significant associations between the severity of the disease and the frequency of use. More respondents reported using MCP (97.9%) and shaking (91.5%) "always or often" in acute CF, compared with stable CF (79.2% and 44.7% respectively). A similar picture emerged in the management of Bronchiectasis. There is no significant difference in the frequency of the use of MCP or shaking in acute as compared with stable asthma ($p = 0.50$, $p = 0.68$ respectively)

Discussion

Our findings demonstrate three things. Firstly, respiratory physiotherapists' frequency of treatment is different according to disease. Few clinicians

TABLE 2.1 Cross tabulation of frequency of use of MCP in 4 diseases

	COPD	Bronchiectasis	Cystic fibrosis	Asthma	Total Overall
Always or often (Column percent)	27 (28.1)	69 (71.9)	85 (88.5)	2 (2.1)	183 (47.9)
Rarely or never (Column percent)	69 (71.9)	27 (28.1)	11 (11.5)	92 (97.9)	199 (52.1)

TABLE 2.2. Cross tabulation of frequency of use of shaking in 4 diseases

	COPD	Bronchiectasis	Cystic fibrosis	Asthma	Total Overall
Always or often (Column percent)	44 (45.8)	58 (61.7)	64 (68.1)	6 (6.4)	172 (45.7) (((45.7)(475.7)
Rarely or never (Column percent)	50 (54.2)	36 (38.3)	30 (31.9)	88 (93.6)	204 (54.3)

TABLE 2.3 Cross tabulation of using different treatment techniques "always or often" against disease (accumulated acute and stable responses).

	COPD	Bronchiectasis	Cystic fibrosis	Asthma	Total Overall
Reported Percussion (Column percent)	27 (38.0)	69 (54.3)	85 (57.1)	2 (25.0)	183 (51.6)
Reported Shaking (Column percent)	44 (62.0)	58 (45.7)	64 (42.9)	6 (75.0)	172 (48.4)

use manual techniques in the management of impaired airway clearance in asthma and COPD whilst frequency of usage is high for CF and bronchiectasis. Whilst physiotherapists identify appropriate treatments using a "problem based approach", obviously the underlying pathology affects the choice of treatment. The reasons for choice of technique cannot be elucidated from this study. Physiotherapists may be reacting to the different rheological properties of sputum in asthma compared with CF and bronchiectasis, may be reflecting on the different evidence available and, importantly, may have identified negative associations with the use of these techniques in asthma, although one study in acute asthma has shown no detrimental effect of chest physiotherapy on lung function (Asher et al 1990) other authors investigating chronic bronchitis, suggest impaired airflow obstruction after MCP treatment (Campbell, O'Connell and Wilson 1975). Practitioners may be responding to the ambiguity in the literature and choosing to minimise possible risks by avoiding the use of MCP and shaking in asthma.

Secondly, physiotherapists frequently use MCP and shaking in the management of bronchiectasis and CF. Most work concerning the effectiveness of these techniques has been performed in these populations (Mazzocco et al 1985; Pryor, Parker and Webber 1981) and for many decades manual chest techniques have been advocated in the management of impaired airway clearance in CF (Gallon 1991). Our data on practice supports this view and demonstrates that a large proportion of respiratory physiotherapists is regularly using these techniques in CF. There is clear consensus that both MCP and shaking techniques are used in the management of CF and bronchiectasis, especially during acute exacerbations of these diseases. Whilst consensus may be apparent in clinical practice, evidence invites caution. In one randomised controlled trial, MCP was shown to be associated with a fall in oxygen saturation in patients with acute CF (McDonnell, McNicholas and Fitzgerald 1986) and Wollmer and colleagues showed detrimental effects in exacerbation of chronic bronchitis (Wollmer et al 1985). However, it has been argued that if performed in conjunction with the ACBT, this detrimental effect of MCP is negated (Pryor, Webber and Hodson 1990). Clinicians reporting in this data were questioned on their use of MCP and shaking in conjunction with ACBT. The strong consensus toward use of physical therapy may reflect improved clinical practice and implementation of an evidence based approach.

Thirdly, disease state, whether acute or stable, also significantly affects usage of techniques. There appears to be consensus regarding the use of manual techniques for both stable and acute bronchiectasis and CF. However, clinicians' usage of manual treatments in COPD is more varied. MCP is frequently chosen in stable COPD whilst shaking is preferred in acute COPD. Whilst the numbers using shaking during an acute exacerbation are still low, compared with bronchiectasis and CF, the reasons for this treatment choice are unknown. There are no data to support the use of shaking as a treatment intended to assist the clearance of secretions during acute phase.

An important fact to remember when considering data such as these is the reality that what physiotherapists do may not in fact be best practice but merely learned practice. However, the process of evidence based medicine reminds us that recommendations based on expert opinion, whilst achieving a lower methodological grade can still be highly important recommendations. The data were collected at a conference for physiotherapists and provided by members of ACPRC. Whilst members of this association are not necessarily "experts" they are by default interested and experienced in the physiotherapeutic management of patients with respiratory conditions. For the purpose of stage 1 of consensus development a wide range of expertise is required to elicit responses from clinical practitioners who are treating patients regularly.

Implications

Consensus recommendations cannot be formulated without scrutiny of available evidence. In order to improve the validity of this process traditional practice must first be established and an expert panel invited to consider not only the research evidence but also practitioners' opinions. These data have enabled us to identify areas of dissent and agreement in actual practice. This will form the basis of a consensus development conference through which identified experts can review and debate the evidence behind the use of the outlined treatment techniques (Murphy et al 1998). Based on the responses generated by this study the following questions will be discussed at a Stage 2 consensus development conference.

1. Should we recommend the use of MCP and shaking in acute exacerbations of CF and bronchiectasis for the management of impaired airway clearance?

2. What should we recommend concerning the use of MCP and

shaking in COPD?

3. Should we recommend that physiotherapists abstain from using MCP and shaking in asthma (stable and / or acute)?

REFERENCES

Asher MI, Douglas C, Airy M, Andrews D, Trenholme A (1990) Effects of chest physical therapy on lung function in children recovering from acute severe asthma. Paed Pulmonol, 9, 3, 146-51

Balfour-Lynn IM (2005) Some consensus but little evidence: guidelines on management of pleural infection in children. Thorax, 60, 2, 94-6

Campbell AH, O'Connell JM, Wilson F (1975) The effect of chest physiotherapy upon the FEV1 in chronic bronchitis. Med J Austr, 1, 2, 33-5

Gallon A (1991) Evaluation of chest percussion in the treatment of patients with copious sputum production. Respir Med, 85, 1, 45-51

Jones AP, Rowe BH (2003) Bronchopulmonary hygiene physical therapy for COPD and bronchiectasis (Cochrane Review). Cochrane Library no. 4

Hess DR (2001) The evidence for secretion clearance techniques. Respir Care, 46, 11, 1276-93

Jones A, Rowe BH (2000) Bronchopulmonary hygiene physical therapy in bronchiectasis and COPD: a systematic review. Heart Lung, 29, 2, 125-35

Mazzocco MC, Owens GR, Kirilloff LH, Rogers RM (1985) Chest percussion and postural drainage in patients with bronchiectasis. Chest, 88, 3, 360-3

McDonnell T, McNicholas WT, Fitzgerald MX (1986) Hypoxaemia during chest physiotherapy in patients with cystic fibrosis. Irish J Med Sci, 155, 10, 345-48

Murphy MK, Black NA, Lamping DL, McKee CM, Sanderson CF, Askham J, Marteau T (1998). Consensus development methods, and their use in clinical guideline development. Health Technology Assessment, 2, 3, i-88

National Institute for Clinical Effectiveness (2004) The national collaborating centre for chronic disease: guidelines for the management of COPD. Thorax, 59, S1, 1-232

Pryor JA, Parker RA, Webber BA (1981) A comparison of mechanical and manual percussion as adjuncts to postural drainage in the treatment of cystic fibrosis. Physiother, 67, 5, 140-1

Pryor JA, Webber BA, Hodson ME (1990) Effect of chest physiotherapy on oxygen saturation in patients with cystic fibrosis. Thorax, 45, 1, 77

Thomas J, Cook DJ, Brooks D (1995) Chest physical therapy management of patients with cystic fibrosis. A meta-analysis. Am J Respir Crit Care Med, 151, 3 pt 1, 846-50

Wollmer P, Ursing K, Midgren B, Eriksson L (1985) Inefficiency of chest percussion in the physical therapy of chronic bronchitis. Euro J Respir Dis, 66, 4, 233-9

Pre-operative risk assessment to predict post-operative pulmonary complications in upper abdominal surgery: a literature review

Maria Blanchard

Physiotherapy Dept, Central Middlesex Hospital, London NW10 7NS
e-mail: bxtnm@aol.com

Completed as part of an MSc in Cardiorespiratory Physiotherapy, University College, London, August 2004.

Summary

Upper abdominal surgery is often followed by significant pulmonary complications such as atelectasis and pneumonia. Identifying those patients most at risk may enable these complications to be reduced. The literature identifies a variety of risk factors and models for identifying these complications, the most important of which are ageing, smoking, poor cognitive function, obesity, location of incision.

Key Words

Post-operative, physiotherapy, complications, pre-operative risk

Introduction

Post-operative pulmonary complications (PPC's) are a significant factor impeding the recovery of patients after upper abdominal surgery (UAS). These complications are the largest cause of morbidity and mortality amongst this patient group (Brooks-Brunn 1995). Contributions to PPC's include anaesthesia, surgical procedures, the reason for surgery, post-operative recovery, drug management, post-operative mobility and pre/peri-operative morbidity (Kehlet and Douglas, 2002). Patients undergoing UAS have a higher risk of developing PPC's than cardiothoracic, lower abdominal or peripheral surgery (Ali et al 1974).

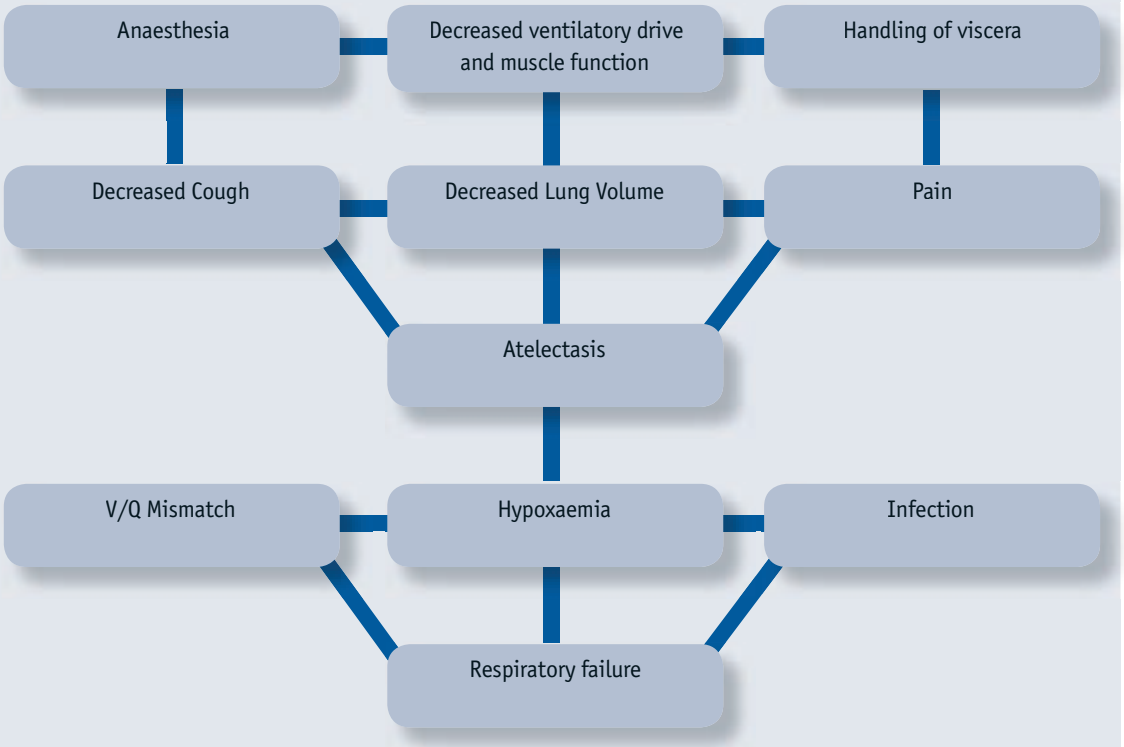
This high respiratory complication rate affects patient morbidity, possible mortality, hospital length of stay, expense and patient experience. Identifying patients who are at high risk of developing PPC's prior to surgery could minimise risk by medical optimisation prior to surgery, pre-operative advice, alternative procedures offered, post-operative management and location considerations (Derrington and Smith, 1987).

This paper will explore the issues and literature surrounding PPC's in patients undergoing UAS. It will investigate the reasons for PPC's, look into the risk factors associated with PPC's and the impact on resources, and discuss predictive models which attempt to identify patients likely to develop PPC's.

Pathophysiology of post-operative pulmonary complications

A reliable definition of PPC's is essential. This is the first problem that arises when reviewing the literature. Very little commonality exists in the definition of PPC's in UAS, giving rise the agreed incidence of PPC's ranging from 20 to 70% (Bourn and Jenkins 1992, Brooks-Brunn 1995, Stiller and Munday 1992). Importantly, a PPC requires clinical significance, as opposed to clinical interest alone. This is supported by Marini (1984) who explains that atelectasis without superimposed

FIGURE 1 . Pathophysiologic mechanisms leading to post-operative pulmonary complications after abdominal surgery



From: 'Perioperative respiratory care of the patient undergoing upper abdominal surgery' Celli,B.C. Clinics in Chest Medicine, 14, 2, 253-261

infection is not inflammatory or destructive. This concept has been incorporated in the following definition of PPC: 'any pulmonary abnormality that produces identifiable disease or dysfunction that is clinically significant and adversely affects the clinical course of the patient' (O'Honohue 1992). Oft-cited PPC's are pneumonia, atelectasis, fever, prolonged mechanical ventilation and respiratory failure (Doyle 1999).

The interplay of the pathophysiological mechanisms that create PPC's is demonstrated in Figure 1. The causes of atelectasis and pneumonia will specifically be investigated in this paper.

Anaesthesia

Major abdominal surgery requires a general anaesthetic. Once anaesthetised, respiratory suppression is caused by pharmacologically-induced paralysis, opiates for analgesia and inhalation gases for coma; therefore mechanical ventilation is required. It has been said that the reduction in Functional Residual Capacity (FRC) is the most important factor in developing PPC's (Craig 1981), and although the FRC falls immediately upon induction of anaesthesia, it is how long that drop is maintained that is important. Length of anaesthesia will be discussed later.

In a study on anaesthetised humans, 20-25% of lung tissue showed atelectasis on CT scan in dependent lung regions (Rothern et al 1995). Why? In any supine adult, a loss in FRC of about 1 litre is seen due to the cephalad movement of the diaphragm secondary to abdominal content movement (Barnas et al 1993, West, 2000). Anaesthesia causes the FRC to fall a further 450mls due to relaxation of the muscles of the chest wall, further cephalad movement of the diaphragm and possible increase in thoracic blood volume (Hedenstierna et al 1985; Nunn 1990, Warner et al, 1995). This brings about compression atelectasis in the dependent regions, which, together with possible blockages of the small bronchioles with secretions, leads to reabsorption of gas distally, and further collapse.

Loss of surfactant in atelectatic areas may also play a part in developing this restrictive pattern (Hedenstierna 1990, Magnusson and Spahn 2003). Atelectasis, anaesthesia and mechanical ventilation combine to produce an abnormal pattern of ventilation which is directed to the non-dependent regions, i.e. the now more compliant part of the lung (Froese and Bryan 1974, West 2000). Loss of the cough reflex and sigh mechanism, and poor muco-cilliary transport from dry irritating gases during general anaesthesia also contribute to this picture (Brooks-Brunn 1995a

Magnusson and Spahn 2003). Although mechanical ventilation can restore these lung volumes (Wahba 1996), it cannot regain normal ventilatory distribution.

After extubation, the after-effects of anaesthesia, patient position, pain and opiates continue this process of ventilation/perfusion mismatch and atelectasis (Craig 1981). Any connection between atelectasis and the development of pneumonia has not been proven (Brooks-Brunn 1995b)

Post-operative breathing patterns and lung volumes

Once extubated, the breathing pattern of patients following UAS is shallow and rapid (Simmonneau et al 1983). Patients continue to show a restrictive pattern, with reduced inspiratory capacity by over 60% (Simmonneau et al 1983) and a further reduction in FRC. This process deteriorates before it improves, being at the lowest point 1-2 days post-operatively. Recovery occurs over 7 – 10 days, the FRC being the slowest to return to normal (Craig 1981, Meyers et al, 1975).

Respiratory control

Hangover effects of anaesthetic gases reduce the body's sensitivity to hypoxaemia, acidosis and carbon dioxide (Warner et al 1995; Warner and Warner 1995) so that in the presence of post-operative hypoxia, the normal response of increased ventilation may not occur. Post-operative narcotics also produce respiratory suppression and loss of the sigh mechanism, resulting in further possible atelectasis.

Diaphragmatic dysfunction

Diaphragmatic dysfunction after UAS was identified in the early 1980's (Ayoub et al 2001, Ford et al 1983, Ford et al 1993, Simmonneau et al 1983). Despite adequate analgesia, the diaphragm does not appear to contract sufficiently for up to 7 days. Indeed there can be paradoxical movement of the diaphragm during tidal ventilation (TV), and rib cage movement contributes more to TV than the diaphragm (van der Leur et al 2003), encouraging dependent atelectasis. The theory that dominates is inhibition of the phrenic nerve by abdominal disturbance and associated sensory output (Easton et al 1989, Ford et al 1988, Prabhaker et al 1985).

Pain

Incisional and visceral pain, and paralytic ileus, can inhibit the ability to breathe deeply and recover pulmonary function. There is evidence that even in the presence of good analgesia, FRC is still poor (Craig 1981), implying that there is another mechanism for lung volume reduction.

Opiates can depress the ventilatory drive and should be used under observation otherwise the loss of sigh and poor alveolar ventilation may result in atelectasis (Platell and Hall 1997). The emergence of epidural analgesia has reduced the risk of developing PPC's due to lack of influence over the respiratory centre and suppression of the stress response (Kehlet 1989, Platell and Hall 1997).

Post-operative immobility

The majority of UAS patients spend the first 24 hours on bed rest due to the lasting effects of anaesthesia. Usual practice is to start encouraging mobility from day 1, with sitting out of bed and walking, then progressing until pre-morbid mobility is achieved. This can be hampered by pain, drips, drains, nausea, motor blocks from epidurals, catheters, stoma bags, psychological issues and other post-operative complications. The assistance required may be limited by staffing levels and time available, although it has been found that an increase in the FRC by 17% can be achieved by just sitting the patient out of bed on Day 1 (Meyers et al 1975).

Fast-tracking uncomplicated surgical procedures by adjustments in pre and peri-operative care has shown reduced length of stay from 8-11 to 2-3 days, accelerated rehabilitation, reduced morbidity and increased patient satisfaction (Kehlet and Douglas 2002).

Risk factors associated with post-operative pulmonary complications

Functional ASA status and emergency procedures

The American Society of Anaesthesiologists (ASA) has produced a physical status scale that categorises surgical patients into a class of risk. Groups I – V take into account the patients' pre-operative morbidity and physical status. Further considerations supplement the ASA scoring, e.g. high to low risk surgery (Pasternak 2002), and whether it is elective or an emergency (Derrington and Smith 1987).

Site of incision and type of surgery

Transverse as opposed to the popular midline incision has been shown to reduce the risk in patients (Lindgren et al 2001) particularly those with chronic obstructive pulmonary disease (COPD) (Becquemin et al 1985). The length of anaesthesia also relates to the development of PPC's, with times of more than

3 hours (Celli 1993, Garibaldi et al 1981) or 4 hours (Doyle 1999) being quoted.

Obesity

This is an area of debate. Patients with a high body mass index (BMI) or weight over 250lbs (Garibaldi et al 1981) have been linked with the development of PPC's in older review papers (Luce 1984, Tisi 1979). Obesity presents with a restrictive lung defect; UAS exaggerates this so that these patients have significantly lower lung volumes than non-obese patients (von Ungern-Sternberg et al 2004). However, this does not automatically mean that they develop PPC's, especially with the emergence of specific UAS procedure for obese patients, e.g. gastroplasty (Pelosi et al 1998).

Recent review papers state that obesity is not a clearly significant risk factor for PPC's (Brooks-Brunn,1995, Smetana 1999).

Smoking

Smoking has been widely investigated (Pearce and Jones1984, Tobin et al 1984). Increased mucus production, higher CV, poor mucocilliary clearance, bronchial hyperreactivity, increased carboxyhaemoglobin levels and the development of COPD all increase the risk of developing PPC's up to 2-4 times, and up to 5 times in heavy smokers (Brooks-Brunn 1995, Tobin et al 1984) It has been shown that giving up 8 weeks prior to surgery leads to a lower risk of PPC's in cardiac surgery (Warner et al 1989), but only 4 weeks are needed in pulmonary surgery (Nakagawa et al 2001). This has not been investigated specifically in UAS, but it is thought that at least a 20 year smoking history is significant (Brooks-Brunn 1995b).

Respiratory pathology – COPD and Asthma

COPD increases the risk of developing PPC's, predominantly because the effects of surgery and anaesthesia compound the pathological manifestations of the disease. These patients are medically optimised prior to surgery, using bronchodilator therapy, possible steroids and antibiotic prescription (Smetana 1999). The severity of COPD, as classified by lung function, appears not to have a significant correlation with PPC's.

A small study on people with asthma undergoing a variety of surgical procedures, did not show any significant PPC's (Warner et al 1996), and it is thought that controlled asthma is not considered a significant risk factor (Smetana 1999).

Age

Older age is often quoted as a high risk associated with PPC's (Luce 1984, Tisi 1979), which is related to deterioration of lung function and the effect of a higher CV (West 2000). When combined with UAS, these effects are exacerbated. However, the literature indicates that postoperative morbidity is associated with conditions of old age like pneumonia, myocardial infarction, or poor physical status, rather than specifically with age itself (Luce 1984). Some authors conclude that age is not an independently significant risk factor (Smetana 1999), although the older the person, the more likely they are to develop PPC's due to the existence of co-morbidities.

Poor nutritional status

It has been suggested that patients with less than 70% of ideal body weight are more at risk due to their weaker respiratory muscle strength (Arora and Rochester 1982). A study in patients undergoing UAS showed that protein depletion caused a higher rate of PPC's, possibly due to weaker respiratory muscles (Windsor and Hill 1988). In combination with other co-morbidities, poor nutrition may contribute to developing PPC's (Brooks-Brunn 1995b).

Post-operative analgesia

The type of post-operative analgesia may have an effect on PPC's (Kehlet and Douglas 2002, Platell and Hall 1997). The neuroendocrine stress response to surgery is directly related to the degree of surgical trauma, and may cause a wide range of adverse responses in many of the body's systems (Wu and Caldwell 2002). These responses may be inhibited by epidural anaesthesia, which blocks afferent and efferent stimuli via the spinal cord. Also diaphragmatic dysfunction may be reduced by alleviating phrenic nerve inhibition.

Opiates provide good pain control but do not appear to improve lung function dramatically, as the loss of lung volume is not purely pain-related. However opioids suppress the respiratory drive and reduce gastrointestinal motility, contributing to respiratory failure and ileus formation (Roenquist and Rosenberg 2003). This may put the patient at higher risk of developing PPC's than if an epidural was used.

Lung Function Tests (LFT's)

Respiratory function tested by spirometry does not appear to be conclusive. LFT's are relevant for thoracic surgery, but less so in UAS (Jürgen 2001). It is recommended that spirometry is used in conjunction with physical examination and

history taking (Lawrence et al 1989, Zollinger et al 2001, Kocabas et al 1996).

Predictive models for the development of post-operative pulmonary complications

Once there is understanding of how and why PPC's develop following UAS, the goal is to predict which individual would develop these complications. In that way, changes in pre-operative management, alternative procedures, post-operative care and possible elective mechanical ventilation can be considered.

There have been several attempts at creating a predictive model for use in UAS. There are already some generic models used for determining risk:

- ASA model (Lafferty and Rennie 1988)
- Goldman Scale for cardiac risk in non-cardiac surgery (Goldman et al 1977)
- Duke's Activity Status Index (Eagle et al 2002) which also covers cardiac risk to patients presenting for non-cardiac surgery.

Predicting pulmonary risk by a specific model in UAS has not achieved as much success, possibly because of the wide range of risk factors which may be inter-related, but research has not identified which may be independent.

This paper will only review the attempts made at PPC predictor models for UAS which are used prospectively and demonstrate accuracy. They may require calculations, be weighted to allow for inter-relationships between risk factors, and may incorporate exercise testing – something that has not been fully explored in the the medical papers. To be fair, many of the predictive models arose from analysing what constituted significant risk factors in studies, and attempted to create a possible tool via methods such as logistic regression analysis.

Studies incorporating predictive models

A prospective controlled study in North America looked at respiratory therapy for UAS and gynaecological surgery patients (Torrington and Henderson 1993). They used a pre-operative model that allocated patients a score based on physical examination, history, lung functions tests, type of surgery, age and weight. Patients were divided into high, moderate or low risk, and allocated a predetermined 'package' of therapy. PPC included fever, abnormal CXR and signs of pulmonary disease, which had good correlation with the predictive scores, therefore the model demonstrated accuracy.

In another paper, stair climbing was investigated for predicting risk in cardiothoracic and abdominal surgery (Girish et al 2001). It would be reasonable to expect that physical activity would relate to the majority of risk factors already identified in this paper. This was a blinded, prospective study, comparing the ability to climb stairs pre-operatively with the incidence of PPC's. Patients who could manage 7 flights did not develop PPC's, compared to patients unable to climb 1 flight, 89% of whom developed PPC's. They calculated that there was a positive predictive value of 82%, associated with the inability to climb 2 flights of stairs (36 steps). A larger study would be useful to look at this patient group as well as assessing the use of a single step, which would have even greater utility.

Exercise testing by bicycle was used to test patients over 65 years old undergoing UAS and thoracic surgery (Gerson et al 1990). Supine bicycle exercise was assessed pre-operatively and PPC's collated. Inability to perform 2 minutes of exercise, raising the heart rate to above 99 beats/minute, was highly significant for predicting PPC's and cardiac complications. In patients unable to perform this test, 42% developed pulmonary or cardiac complications.

Brooks-Brunn also developed a predictive model using a split sample method – a model development set, and a validation set (Brooks-Brunn 1997). The first part of the study identified independent risk factors, and the next part of the study examined whether the predictive model was accurate. Initially 23 risk factors were identified, which narrowed down to 14 significant ones, with ultimately only 6 proving to be independently significant. They were:

- age > 60 years
- smokers within 8 weeks
- cancer
- upper or upper and lower incision
- BMI > 27
- poor cognitive function.

However, upon validation, this model did not provide accurate predictions and an alternative model has not yet been validated (Brooks-Brunn 1998).

Impact on resources

Much of the published data on the cost of UAS comes from outside the UK, possibly because costings and insurance schemes have a higher profile. It has been estimated that 30% of admissions in the USA account for elective or semi-elective surgery, which all require hospitalisation post-operatively. Their usual length of stay for UAS is 8-11 days, and the cost implications for this patient group are high.

Scrutiny is being applied

to modifying the peri/post-operative care, while laproscopic surgery and fast track systems will reduce the anticipated length of stay and incidence of PPC's (Kehlet and Douglas 2002). However, internationally an increasing elderly population creates a surgical population that carries greater risk (Chalfin and Nasraway 1994).

The implication on physiotherapy is not well known. Most papers concentrate on specific interventions rather than service delivery, although one influences the other. Whether physiotherapy post and / or pre-operatively affect the incidence of PPC's is not the remit of this paper. However, the involvement of physiotherapy is recognised (Platell and Hall 1997, Stiller and Munday 1992).

To use an example of service delivery, a well known paper (or maybe not!) about breathing exercises in cardiac bypass surgery patients demonstrated no benefit in breathing exercises to reduce PPC's in uncomplicated cases (Jenkins et al 1989). However, routine breathing exercises are still utilising staff and patient time inappropriately (Tucker et al 1996). Although not related to UAS, the implications are probably the same.

An attempt at demonstrating the effect of UAS on the physiotherapy weekend service was carried out by Ball (1999). Although there were only small numbers, by employing a risk score to predict PPC's and limiting the referral criteria to high risk patients, there was a reduction of more than 60% in the cost of the service.
As highlighted before, the PORT programme (Torrington and Henderson 1993) produced significant cost savings on low risk patients. Respiratory therapy is provided routinely for surgical patients in the USA, and this paper highlighted that therapy could be targeted at high risk patients which cuts down on insurance costs. This is not the case in the UK, but provision of unnecessary therapy cannot be supported.

Conclusion

Patients and health staff need to be aware of the risks of UAS. The most common PPC's are atelectasis and pneumonia, but there is non-uniformity in the definition of PPC's, creating misleading findings in the literature. It must be remembered that PPC's need to show that they adversely affect the patient's condition. Understanding how these complications occur helps to structure pre/peri/post-operative care.
The most significant risk factors are:

- site of incision
- length of anaesthetic
- high ASA scores
- emergency surgery
- smoking
- COPD

The individual role of the following risk factors is less clear:

- age
- weight
- LFT's
- pain
- cancer
- cognitive function
- nasogastric tubes
- immobility
- ABG's
- stress
- blood chemistry
- sputum production
- history of aspiration.

Co-morbidities confuse the picture.

Pre-operative exercise testing appears to identify high risk patients and shows a higher degree of accuracy than risk scoring systems.

Prophylactic, routine interventions are a thing of the past. Targeting high risk patients and administering evidence-based care ensures optimal patient outcomes and appropriate use of resources.

REFERENCES

Ali J, Weisel RD, Layug AB, Kripke BJ, Hechtman HB (1974) Consequences of postoperative alterations in respiratory mechanics. Am J Surg, 128, 376-82

Arora NS, Rochester DF (1982) Respiratory muscle strength and maximal voluntary ventilation in undernourished patients. Am Rev Respir Dis, 126, 5-8

Ayoub J, Cohendy R, Prioux J, Ahmaidi S, Bourgeouis JM, Dauzat M, Ramonatxo M, Prefaut C (2001) Diaphragm movement before and after cholecystectomy. Anesth Analg, 92, 3, 755-61

Ball V (1999) The provision of weekend respiratory physiotherapy to surgical patients. Journal ACPRC, 32, 9-11

Barnas GM, Green MD, Mackenzie CF, Fletcher SJ, Campbel N, Runcie C, Broderick GE (1993) Effect of posture on lung and regional chest wall mechanics, Anesthesiol, 78, 2, 251-9

Becquemin JP, Piquet J, Becquemin MH, Melliere D, Harf A (1985) Pulmonary function after transverse or midline incision in patients with obstructive pulmonary disease. Int Care Med, 11, 247-51

Bourn J, Jenkins S (1992) Post-operative respiratory physiotherapy. Physiother, 78, 2, 80-3

Brooks-Brunn JA (1995) Postoperative atelectasis and pneumonia. Heart Lung, 24, 94-115

Brooks-Brunn JA (1995) Postoperative atelectasis and

pneumonia. Am J Crit Care, 4, 5, 340-9

Brooks-Brunn JA (1997) Predictors of postoperative pulmonary complications following abdominal surgery. Chest, 111, 564-71

Brloks-Brunn JA (1998) Validation of a predictive model for postoperative pulmonary complications. Heart Lung, 27, 3, 151-8

Celli BR (1993) Perioperative respiratory care of the patient undergoing upper abdominal surgery. Clin Chest Med, 13, 253-61

Chalfin DB, Nasraway SA (1994) Preoperative evaluation and postoperative care of the elderly patient undergoing major surgery. Clin Geriatr Med, 10, 1, 51-70

Craig DB (1981) Postoperative recovery of pulmonary function. Anesthesia and Analgesia, 60, 1, 46-52

Derrington MC, Smith G (1987) A review of studies of anaesthetic risk, morbidity and mortality. Brit J Anaesth, 59, 815-33

Doyle RL (1999) Assessing and modifying the risk of postoperative pulmonary complications. Chest, 115, 5 Suppl, 77S-81S

Eagle KA, Berger PB, Calkins H, Chaitman BR, Ewy GA, Fleischmann KE (2002). ACC/ AHA Guideline update for perioperative cardiovascular evaluation for noncardiac surgery. Circulation, 105, 1257-67

Easton PA, Fitting J-W, Arnoux R, Guerraty A, Grassino AE (1989) Recovery of diaphragm function after laparotomy and chronic sonomicrometer implantation. J Appl Physiol, 66, 2, 613-21

Ford GT, Grant DA, Rideout KS, Davison JS, Whitelaw WA (1988) Inhibition of breathing associated with gall bladder stimulation in dogs. J Appl Physiol, 65, 1, 72-9

Ford GT, Rosenal TW, Clerque F, Whitelaw WA. (1993) Respiratory physiology in upper abdominal surgery.Clin Chest Med, 14, 2, 237-52

Ford GT, Whitelaw WA, Rosenal TW, Cruse PJ, Guenter CA (1983) Diaphragm function after upper abdominal surgery. Am Rev Respi Dis, 127, 431-6

Froese AB, Bryan AC (1974) Effects of anaesthesia and paralysis on diaphragmatic mechanics. Anesthesiol, 41, 242-55

Garibaldi RA, Britt MR, Coleman ML, Reading JC, Pace NL (1981) Risk factors for postoperative pneumonia. Am J Med, 70, 677-80

Gerson MC, Hurst JM, Hetzberg VS, Baughman R, Rouan GW, Elis K (1990). Prediction of cardiac and pulmonary complications related to elective abdominal and noncardiac thoracic surgery in geriatric patients Am J Med, 88, 101-7

Girish M, Trayner E, Dammann O, Pinto-Plata V, Celi B (2001) Symptom-limited stair climbing as a predictor of postoperative cardiopulmonary complications after high-risk surgery. Chest, 120, 4, 1147-51

Goldman L, Caldera DL, Nussbaum SR, Southwick FS, Krogstad D, Murray B (1977) Multifactoral index of cardiac risk in noncardiac surgical procedures. New Eng J Med, 297, 16, 845-50

Hedenstierna G (1990) Gas exchange during anaesthesia. Acta Anaesthesiol Scand, 34, Suppl 94, 27-31

Hedenstierna G, Strandberg A, Brismar B, Lundquist H, Svensson L, Tokics L. (1985) Functional residual capacity, thoracoabdominal dimensions, and central blood volume during general anesthesia. Anesthesiol, 62, 247-54

Jenkins SC, Soutar SA, Loukota JM, Johnson LC, Moxham J (1989) Physiotherapy after coronary artery surgery - are breathing exercises necessary? Thorax, 44, 634-39

Jürgen B (2001) Optimizing preoperative lung function. Curr Opin Anaesthesiol, 14, 1, 65-9

Kehlet H (1989) The stress response to surgery. Acta Chir Scand, 550, Suppl, 22-8

Kehlet H, Douglas WW (2002) Multimodal strategies to improve surgical outcome, Am J Surg, 183, 630-41

Kocabas A, Kara K, Ozgur G, Sonmez H Burgut R (1996) Value of preoperative spirometry to predict postoperative pulmonary complications Respir Med, 90, 1, 25-33

Lafferty K, Rennie J (1988) Surgery: the basics, in: Concise Surgery, Lafferty K, Rennie J (ed), Arnold, London, p.1

Lawrence VA, Page CP, Harris GD (1989) Preoperative spirometry before abdominal operations. Arch Int Med, 149, 280, 85

Lindgren PG, Nordgren SR, Oresland T, Hulten L (2001) Midline or transverse abdominal incision for right-sided colon cancer. Colorectal Dis, 3, 1, 46-50

Luce JM (1984) Clinical risk factors for postoperative

pulmonary complications', Respir Care, 29, 5, 484-91

Magnusson L, Spahn DR (2003) New concepts of atelectasis during general anaesthesia. Brit J Anaesth, 91, 1, 61-72

Marini JJ (1984) Postoperative atelectasis. Respir Care, 29, 5, 516-22

Meyers JR, Lembeck L, O'Kane H, Baue AE (1975) Changes in functional residual capacity of the lung after operation. Arch Surg, 110, 576-83

Nakagawa M, Tanaka H, Tsukuma H, Kishi Y (2001) Relationship between the duration of the preoperative smoke-free period and incidence of postoperative pulmonary complications after pulmonary surgery. Chest, 120, 3, 705-10

Nunn JF (1990) Effects of anaesthesia on respiration. Brit J Anaesth, 65, 54-62

O'Honohue WJ (1992) Post operative pulmonary complications. Postgrad Med, 91, 167-75

Pasternak RL (2002) ASA practice guidelines for pre-anesthetic assessment, Internat Anesthesiol Clin, 40, 2, 31-46

Pearce AC, Jones RM (1984) Smoking and anesthesia. Anesthesiol, 61, 576-84

Pelosi P, Croci M, Ravagnan I, Tredici S, Pedoto A, Lissoni A (1998) The effects of body mass index on lung volumes, respioratory mechanics, and gas exchange during general anesthesia. Anesth Anal, 87, 3, 654-60

Platell C, Hall JC (1997) Atelectasis after abdominal surgery. J Am Col Surg, 185, 6, 584-92

Prabhaker NR, Marek W, Loeschke HH. (1985) Altered breathing pattern elicited bt stimulation of abdominal visceral afferents. J Appl Physiol, 58, 1755-60

Roenquist RW, Rosenberg J (2003) Postoperative pain guidelines. Regional Anesth Pain Med, 28, 4, 279-88

Rothern HU, Sporre B, Engberg G, Wegenius G, Reber A, Hedenstierna G (1995). Prevention of atelectasis during general anaesthesia. Lancet, 345, 1387-91

Simmonneau G, Vivien A, Sartene R, Kunstlinger F, Samii K, Noviant Y (1983) Diaphragm dysfunction induced by upper abdominal surgery. Am Rev Respi Dis, 128, 899-903

Smetana GW (1999) Current concepts: preoperative pulmonary evaluation. New Eng J Med, 340, 12, 937-44

Stiller KR, Munday RM (1992) Chest physiotherapy for the surgical patient. Br J Surg, 79, 8, 745-9

Tisi GM (1979) Preoperative evaluation of pulmonary function. Am Rev Respir Dis, 119, 293-307

Tobin MJ, Suffredini AF, Grevnik A (1984) Short-term effects of smoking cessation. Respir Care, 29, 6, 641-9

Torrington KG, Henderson CJ (1993) Perioperative respiratory therapy. Chest, 93, 5, 946-51

Tucker B, Jenkins S, Davies K, McGann R, Waddell J, King V (1996) The physiotherapy management of patients undergoing coronary artery surgery. Austr J Physiother, 42, 129-37

van der Leur JP, Smit AA, Broekema AA, van der Mark TW, van der Schans CP (2003) Are clinical observations of breathing and pulmonary function related in patients after abdominal surgery. Physiother Theory Pract, 19, 45-52

von Ungern-Sternberg BS, Regli A, Scheidner MC, Kunz F, Reber A. (2004) Effect of obesity and site of surgery on perioperative lung volumes. Br J Anaesth, 92, 2, 202-7

Wahba RM (1996) Airway closure and intraoperative hypoxaemia. Can J Anaesth, 43, 11, 1144-9

Warner DO, Warner MA (1995) Human chest wall function while awake and during halothane anesthesia. ii. carbon dioxide rebreathing. Anesthesiol, 82, 1, 20-31

Warner DO, Warner MA, Ritman EL (1995) Human chest wall function while awake and during halothane anesthesia. i. quiet breathing. Anesthesiol, 82, 1, 6-19

Warner MA, Offord KP, Warner ME, Lennon RL, Conover MA, Jansson-Schumacher U (1989) Role of preoperative cessation of smoking and other factors in postoperative pulmonary complications. Mayo Clin Proc, 64, 609-16

West JB (2000) Mechanics of breathing, In: Respiratory Physiology. The Essentials, West JB (ed) Lippincott Williams & Wilkins San Diego, p 79

Windsor JA, Hill GL (1988) Risk factors for postoperative pneumonia. Ann Surgery, 208, 2, 209-14

Wu CL, Caldwell MD (2002) Effect of post-operative analgesia on patient morbidity', Best Pract Res Clin Anaesthesiol, 16, 4, 549-63

Zollinger A, Hofer C, Pasch T (2001) Preoperative pulmonary evaluation. Curr Opin Anaesthesiol, 14, 1, 59-63

Appendix

Variety of risk factors quoted in the literature

Lung Function Tests
Age
Weight
BMI
Arterial blood gases
Smoking history
Respiratory disease
Functional ASA status
Type of anaesthesia
Post-operative analgesia
Stress and patient education
Abnormal boichemistry
Cancer
Emergency surgery
Length of anaesthetic
Length of incision
Nutritional status
Site of incision
Cognitive ability
Sputum production
History of aspiration
Nasogastric tubes
Mobility status

Normal saline instillation as an adjunct to endotracheal suctioning – a review of the literature

Victoria L C Jackson

Physiotherapy Dept, University Hospital, Lewisham
Victoria.Jackson@UHL.nhs.uk.

Completed as part of an MSc in Cardiorespiratory Physiotherapy, University College, London.

Summary

Instillation of normal saline (0.9% NaCl) prior to suctioning has been proposed as a beneficial technique in enhancing secretion removal (Gray et al, 1990). Although a procedure undertaken routinely by many clinicians, it has been suggested that it is theoretically unsubstantiated, influenced primarily by departmental culture and anecdotal experience (Ackerman and Mick, 1998). Due to the controversy surrounding normal saline instillation (NSI), it has been highlighted by the CSP (2002) as a priority for cardiorespiratory research.

Key Words

airway clearance, broncho-alveolar lavage, critical care, normal saline instillation, pre-oxygenation, suction, mechanical ventilation.

Introduction

Management of the artificial airway is one of the key aspects defining critical care (Chartered Society of Physiotherapy (CSP) 2002). Endotracheal suctioning (ETS) is an essential component of this, allowing the mechanical aspiration of pulmonary secretions (American Association of Respiratory Care (AARC) 1993).

For intubated patients, particularly in the presence of pre-existing pulmonary disease, infection or dehydration, respiratory secretions become increasingly tenacious, making aspiration more difficult (Isea et al 1993). Excess pulmonary secretions reduce airway radius, directly increasing airway resistance and compromising respiratory status (O'Neal et al 2001). The resultant secretion retention predisposes to airway obstruction by inspissation of mucus, facilitating infection (Nakagawa et al 2000). This has led to the controversial practice of normal saline instillation prior to ETS.

Instillation of normal saline (0.9%NaCl) prior to ETS is a traditional but unsubstantiated intervention (Ackerman and Mick 1995). Although not clearly stated in the literature, Ridling et al (2003) proposed that the practice of NSI be introduced prior to humidification of ventilator circuitry.

A number of suggestions have been proposed to support NSI as beneficial in secretion removal, including dilution and mobilisation of secretions, lubrication of ETT and cough stimulation (Gray et al 1990, Ackerman et al 1996, Blackwood 1999).

Proposed adverse effects of NSI include increased incidence of nosocomial pneumonia, decreased SaO_2 and increased intracranial pressure (ICP) (Ackerman 1993). Other consequences may include

unnecessary cost to the NHS (CSP 2002).

Guidelines for the practice of NSI are inconsistent. This review of the literature examines evidence surrounding NSI.

Cardiovascular Physiological Parameters

Gray et al (1990) used a repeated measures design involving 15 patients. Each subject was suctioned once with NSI and once without NSI in a randomised order. Immediately following ETS a statistically significant increase was noted in heart rate and blood pressure, but this was independent of NSI and did not appear clinically important in the haemodynamically stable population.

Ackerman and Mick (1995) examined the effect of NSI on haemodynamic variables in 29 mechanically ventilated patients with pulmonary infection. Subjects were randomised into an experimental group who underwent ETS with NSI and a control group who did not have NSI. No significant differences were found. The authors confirmed NSI as a source of stress for patients, but to reach this conclusion from the data presented was unfounded and possibly biased by the authors' preconceived beliefs.

A further study examining the effect of NSI found that patients undergoing suctioning with saline exhibited significant increases in heart rate (HR), whereas no increases were detected in cardiovascular parameters following ETS without NSI (Akgul and Akyolcu 2002).

Volume of secretions

Demers and Saklad (1973) stated that mucus and water are immiscible and saline cannot therefore be effective in thinning secretions. Although this paper is commonly cited, the scientific basis upon which this conclusion was formulated was not adequately documented (Raymond 1995). It has since been suggested that mucus and water need not occupy the same phase, but that ETS will still remove a mucus-water suspension more easily (Glickman 1986). However, it has been proposed that attempts to suspend secretions in solute do not generate an increase in actual sputum aspirated but only increase the volume of solution yielded (Bostick and Wendlegass 1987).

Limited research has examined actual distribution and clearance of saline instillations. Hanley et al (1978) undertook serial imaging of radio-labelled normal saline following instillation. All saline instilled remained in the trachea and main-stem bronchi. The authors concluded that NSI has no effect on secretions beyond the main-stem bronchi. However, caution is required when interpreting these results as the study population was based on only five canine and two human subjects.

Bostick and Wendelgass (1987) examined the effect of different volumes of saline in 45 patients who had undergone open-heart surgery. Subjects were randomly assigned to one of three groups:

- Group 1 (control), in whom no saline was administered
- Group 2, in whom 5mL of saline was instilled
- Group 3, who received 10mL of 0.9%NaCl.

A significant difference was found between the volume of secretions aspirated ($P<0.05$), with the smallest weight recorded in the control group and highest weight in Group 2. Similar findings were reported by Gray et al (1990). Suctioning with NSI (5mL) resulted in a significantly greater amount of material aspirated when compared to suctioning alone ($P<0.05$), although no analysis was undertaken to determine material content. The authors proposed that this may have been secondary to an enhanced cough elicited by NSI. However, to date no study has assessed the relationship between NSI and force of cough, and ETS alone can be an effective technique for cough stimulation. Ackerman and Gugerty (1990) also reported a statistically significant increase in sputum weight following ETS with NSI. It has been suggested that, although reported increases in volume aspirated reached statistical significance, this has little clinical significance as the sputum weight increases were small (Bostick and Wendelgass 1987, Ackerman and Gugerty 1990).

Each of the above studies cited utilised a similar, non-validated, technique for secretion measurement. Original sputum trap weight was subtracted from the final trap weight, inclusive of material aspirated, to provide sputum weight. This technique fails to account for the weight of saline aspirated.

Reynolds et al (1990) attempted to account for the saline content of aspirated material by subtracting the volume of saline instilled from the total material weight yielded. However, this assumes that all of the saline instilled is retrieved. A significant increase in sputum following NSI was reported and the authors concluded that NSI may increase secretion volume.

Caution is required when interpreting the results of these studies due to the common methodological flaw of inaccurate secretion measurement. In all of the studies cited, it is probable that the material aspirated contained some proportion of the initial saline solution instilled. Future work should therefore concentrate on formulating a

suitable validated technique of secretion analysis.

Respiratory Mechanics

Stimulation of tracheal mucosa has been reported to cause various reflex responses. It has been suggested that NSI may elicit such responses, evoking changes in pulmonary mechanics (Beeram and Dhanireddy 1992).

In a small preliminary trial, small aliquots of distilled water or saline were randomly injected into the ETTs of anaesthetised patients (Nishino et al 1988). Vigorous respiratory responses such as apnoea and altered respiratory pattern were elicited following administration of distilled water. No responses were noted following NSI.

Airway resistance is directly affected by radius of the airway, as expressed by Poiseuille's law (Lumb 2000). Secretions or normal saline in the ETT decrease the radius of the artificial airway and may lead to increased airway resistance (Vasbinder-Dillon 1988, O'Neal et al 2001). However, it could also be hypothesised that successful airway clearance may elicit a decrease in respiratory resistance below baseline values (Guglielminotti et al 1998).

Gray et al (1990) examined the effect of NSI on minute ventilation, peak inspiratory pressure (PIP) and forced vital capacity, but found no significant changes in any of these outcome measures following ETS with or without NSI. Reynolds et al (1990) reported significant changes in PIP following ETS with NSI, but this also occurred after ETS alone. To date this study is presented in abstract format only, and the direction of the change in PIP was not recorded.

Fernandez et al (1995) investigated the instillation of a mucolytic agent in patients with acute respiratory failure and used NSI as a control. Saline instillation had no significant effect on pulmonary compliance or airway resistance.

Although NSI has not been found to have a beneficial effect on pulmonary mechanics, it also does not appear to have any deleterious effect. Further investigation is required.

Oxygenation

Bostick and Wendelgass (1987) examined the effect of NSI in 45 patients following cardiac surgery. No significant difference occurred in PaO_2 20 minutes post ETS, but a possible trend linking lower levels of PaO_2 with increasing volumes of saline instilled was suggested. Despite having acknowledged the previous work of Hanley et al (1978) regarding saline distribution, the authors hypothesised that saline may possibly impede alveolar-capillary oxygen exchange.

Gray et al (1990) examined the effect of NSI on oxygenation. No significant difference in SaO_2 occurred following ETS with or without NSI, but PaO_2 was found to decline immediately after both techniques.

Although the above studies failed to demonstrate a link between NSI and oxygenation, other authors have reported findings which suggest that NSI does have an adverse effect on oxygenation.

Ackerman and Gugerty (1990) reported that suctioning with and without NSI caused an immediate, but non-significant, fall in SaO_2, but NSI caused a significantly greater reduction in SaO_2 after 45 seconds and continued until five minutes post ETS. Similar findings were reported by Ackerman (1993), who found that NSI had a statistically significant negative effect on oxygenation, which increased over a five-minute period. Although these two studies report statistical significance, it only amounted to a mean reduction in SaO_2 of 1%. Ackerman and Mick (1998) also demonstrated that NSI had an adverse effect on oxygenation, which worsened over time.

The previous three studies share a common principal investigator and it is possible that pre-conceived expectations influenced findings. An additional weakness is the use of a single measure of oxygenation. Although SaO_2 is a valid measure of oxygenation, pulse oximetry cannot always be reliable in critically ill patients due to altered peripheral perfusion. The findings of these studies would undoubtedly have been strengthened with the use of an additional measure of oxygenation.

Kinloch (1999) investigated the effect of NSI on mixed venous saturation (SvO_2), a clinically significant measure which rapidly reflects the balance between oxygen supply and demand, in patients who had undergone cardiac surgery. Patients were either suctioned with or without NSI, the decision for which was determined solely by the care-providers' personal preferences. Mean SvO_2 decreased to below safe levels (60%) in both groups, with the lowest mean SvO_2 being significantly lower following NSI. SvO_2 levels also took longer to return to baseline in patients following NSI. Several study limitations were acknowledged, including lack of randomisation, multiple care-providers, and potential instrumentation error. However, this study may reflect clinical practice and the results should not be dismissed.

In their article summary and conclusion, Akgul and Akyolcu (2002) report decreases in PaO_2 and SaO_2, which did not reach statistical significance, following suction with and without NSI. However, the discussion refers

to a "clear decrease in PaO_2 five minutes after the procedure, a finding that was statistically significant." Therefore it is difficult to establish the actual findings of this study due to lack of clarity.

The results of these studies add to the scientific framework of literature surrounding NSI and oxygenation, but the conflicting results and methodological flaws contribute to the difficulty in reaching an evidence-based conclusion.

Infection

NSI may be a potential source of lower airway contamination and infection (Pollard 2001).

Nosocomial pneumonia is an endogenous process, primarily arising from aspiration of upper airway and gastric contents. To reduce this, it has been suggested that airway manipulation should be minimised (Carroll 1994), indicating that NSI may contribute to the risk of nosocomial pneumonia.

To evaluate the potential risk of infection associated with NSI, Hagler and Traver (1994) examined whether the instillation process caused bacteria to be dislodged from the internal lumen of ETTs. Ten ETTs, which had been removed from critically ill patients intubated for more than 48 hours, were examined. A five mL aliquot of saline was run through the ETT and the dislodged materials cultured. Saline lavage dislodged 310,000 viable bacterial colonies in comparison to 60,000 dislodged by passage of catheter alone. The authors concluded that NSI undoubtedly increases the risk of infection.

Rutala et al (1984) cultured saline vials that had been routinely opened by nursing staff and found that 23% were contaminated with a variety of organisms.

Patient comfort

Odell (1993) suggested that NSI may cause a sensation of drowning in patients. Gray et al (1990) assessed subject-rated discomfort and found no difference when saline was instilled compared to suctioning alone, although the non-validated measurement scale may have lacked sensitivity.

Dyspnoea, the subjective sensation of breathlessness, may be associated with a reduction in artificial airway radius secondary to secretion presence (O'Neal et al 2001). Based on the concept that NSI would further decrease airway radius, O'Neal et al (2001) assessed perception of breathlessness but found no significant difference between ETS with and without NSI.

Conclusion

Endotracheal suctioning is an essential component of airway management (AARC, 1993), but policies on suctioning and airway management vary widely and do not always reflect research recommendations.

A number of plausible suggestions in support of instillation of normal saline prior to ETS have been proposed but, to date, there appears to be lack of empirical evidence, and decisions regarding instillation appear to be influenced by departmental tradition (Schwenker et al 1998).

It is essential that health professionals are familiar with current research and appropriate evidence-based recommendations are formulated to guide practice. Clinical research often lacks internal validity due to difficulty in controlling variables (Wainright and Gould 1996), while varying designs and lack of sample homogeneity make meaningful comparisons impossible. Such methodological limitations make it difficult to draw conclusions from current research.

Although progress in research on ETS with NSI has been achieved, further research studies are required. More importantly, increased methodological rigour is required, with the appropriate choice of patient populations and validated outcome measures, in order to ascertain the benefits and adverse effects of normal saline instillation with endotracheal suctioning.

Key Points

- Instillation of normal saline prior to ETS is common practice. Guidelines for the practice of NSI are inconsistent, and there appears to be a lack of definitive evidence to support it.
- It is difficult to reach an evidence-based conclusion on the relationship between NSI and oxygenation because of methodological flaws and conflicting results.
- Instillation of normal saline has been highlighted by the CSP (2002) as a priority for cardiorespiratory research.

REFERENCE LIST

AARC (1993) AARC Clinical Practice Guideline: endotracheal suctioning of mechanically ventilated adults and children with artificial airways. Respir Care, 38, 5, 500-504.

Ackerman MH (1985) The use of bolus normal saline instillations in artificial airways: Is it useful or necessary? Heart Lung, 14, 5, 505-506.

Ackerman MH (1993) The effect of saline lavage prior to suctioning. Am J Cri Care, 2, 4, 326-30.

Ackerman MH, Ecklund MM, Abu-Jamah M (1996) A review of normal saline instillation. Dimensions Crit Care Nurs, 15, 1, 31-8.

Ackerman MH, Gugerty B (1990) The effect of normal saline bolus instillation in artificial airways. ORL: Head Neck Nurs, Spring, 14-17.

Ackerman MH, Mick DJ (1995) Instillation of normal saline before suctioning. Am J Crit Care, 7, 4, 261-6.

Akgul, S and Akyolcu, N (2002) Effects of normal saline on endotracheal suctioning. J Clin Nurs, 11, 826-30.

Beeram MR, Dhanireddy R (1992) Effects of saline instillation during tracheal suction on lung mechanics in newborn infants. J Perinatol, 12, 2, 120-3.

Blackwood B (1999) Normal saline instillation with endotracheal suctioning. J Adv Nurs, 29, 4, 928-34.

Bostick J, Wendelgass ST (1987) Normal saline instillation as part of the suctioning procedure. Heart Lung, 16, 5, 532-7.

Carroll P (1994) Saline and suction. Singapore Nurs J, 26, 3, 17.

Demers RS, Saklad M (1973) Minimising the harmful effects of mechanical aspiration. Heart & Lung, 2, 542-6.

Fernandez R, Sole J, Blanch L, Artigas A (1995) The effect of short-term instillation of a mucolytic agent on airway resistance. Chest , 107, 4, 1101-1106.

Glickman J (1986) Letters to the editors. Heart Lung, 15, 3, 320.

Gray JE, Macintyre NR, Kronenberger WG (1990) The effects of bolus normal-saline instillation in conjunction with endotracheal suctioning. Respir Care, 35, 8, 85-790.

Guglielminotti J, Desmonts J-M, Dureuil B (1998) Effects of tracheal suctioning on respiratory resistances in mechanically ventilated patients. Chest, 113, 5, 1335-8.

Hagler DA, Traver GA (1994) Endotracheal saline and suction catheters: sources of lower airway contamination. Am J Crit Care, 3, 6, 444-7.

Hanley MV, Rudd T, Butler J (1978) What happens to intratracheal instillations? Am Rev Respir Dis, 117,124-8.

Isea JO, Poyant D, O'Donnell C, Faling LJ, Karlinsky J, Celli BR (1993) Controlled trial of a continuous irrigation suction catheter vs conventional intermittent suction catheter. Chest, 103, 4, 1227-30.

Kinloch D (1999) Instillation of normal saline during endotracheal suctioning. Am J Crit Care, 8, 4, 231-40.

Landa JF, Kwoka MA, Chapman GA, Brito M, Sackner MA (1980) Effects of suctioning on mucociliary transport. Chest, 77, 2, 202-7.

Levine SA, Niederman MS (1991) The impact of tracheal intubation on host defences and risks for nosocomial pneumonia. Clin Chest Med, 12, 3, 523-43.

Lewis RM (2002) Airway clearance techniques for the patient with an artificial airway. Respir Care, 47, 7, 808-817.

Lumb A (2000) Nunn's Applied Respiratory Physiology, Butterworth Heinemann: Philadelphia: 58 – 61.

Nakagawa NK, Macchione M, Petreolino HMS, Guimaraes ET, King M, Saldiva PHN, Lorenzi-Filho G (2000) Effects of a heat and moisture exchanger and a heated humidifier on respiratory mucus. Crit Care Med, 28, 2, 312-17.

Nishino T, Hiraga K, Mizuguchi T, Honda Y (1988) Respiratory reflex responses to stimulation of tracheal mucosa. J Appi Physiol, 65, 3, 1069-74.

Odell A, Allder A, Bayne R, Everett C, Scott S, Still B,West S (1993) Endotracheal suction for adult, non-head-injured, patients. Int Crit Care Nurs, 9, 274-8.

O'Neal PV, Grap MJ, Thompson C, Dudley W (2001) Level of dyspnoea experienced in mechanically ventilated adults with and without saline instillation. Int Critl Care Nurs, 17, 356-63.

Pollard C (2001) Endotracheal suction in the infant with an artificial airway. Nurs Crit Care, 6, 2, 76-82.

Raymond SJ (1995) Normal saline instillation before suctioning? Am J Crit Care, 4, 4, 267-71.

Reynolds P, Hoffman R, Schlichtig R, Davies PA, Zullo TG (1990) Effects of normal saline instillation on secretion volume, dynamic compliance and oxygen saturation (abstract). Am Rev Respir Dis, A574, 141.

Ridling DA, Martin LD, Bratton SL (2003) Endotracheal suctioning with or without instillation of isotonic sodium chloride in critically ill children. Am J Crit Care, 12, 3, 212-19.

Rutala WA, Stiegel,MM, Sarubbi FA (1984) A potential infection hazard associated with the use of disposable saline vials. Inf Control, 5, 2, 170-172.

Schwenker D, Ferrin, M, Gift,G (1998) A survey of endotracheal suctioning with instillation of normal saline. Am Jf Crit Care, 7, 4, 255-60.

Chartered Society of Physiotherapy (2002) Priorities for physiotherapy research in the UK.

Vasbinder-Dillon D (1988) Understanding mechanical ventilation. Crit Care Nurse, 8, 42-43 & 46-58.

Wainright SP, Gould D (1996) Endotracheal suctioning: an example of the problems of relevance and rigour in clinical research. J Clin Nurs, 5, 6, 389-398.

Silver Jubilee Conference 2005

The 25th anniversary of the founding of the ACPRC was marked by a special conference held in Oxford last year.

Abstracts

Guest Lecture

The Use of Heliox for Breathlessness

Paul Downie

Centre for Anaesthesia, University College Hospitals
email: p.downie@nhs.net

Despite having been discovered over 100 years ago helium has yet to establish itself as a mainstream therapeutic agent. This lecture will provide a basic primer of the physical properties that make helium an attractive gas to use in a variety of clinical situations. We will then look at some technical problems that are presented by these different physical properties.
The clinical use of helium was documented in the Second World War for upper airway obstruction but advances in the 2 agonists meant that helium was sidelined for many years. In recent years researchers have begun to look at this gas and its oxygen mix – heliox- and have produced an increasing amount of data to suggest that it may well have a role both inside and outside the intensive care unit. The current data suggests that it may be of benefit in asthma, COPD and using invasive and non-invasive ventilation. There are also data to suggest that it may improve the delivery of nebulised drugs. Despite these encouraging data there has yet to be any studies that have demonstrated clinical outcome benefit, and a recent meta-analysis could not support its use in asthma. It remains to be seen if larger, better conducted trails will translate the obvious acute physiological benefits into clinical outcomes.

Glossopharyngeal Breathing

Barbara Webber

Former Head of Physiotherapy, Royal Brompton Hospital
e-mail: bwebber@gotadsl.co.uk

Glossopharyngeal breathing (GPB) is a technique first used by patients with poliomyelitis in the 1950s. Although papers have reported its benefits for people with spinal cord injuries, Duchenne muscular dystrophy and other neuromuscular conditions where there is respiratory muscle paralysis or partial paralysis, it is regrettably rarely taught. The possible reasons for this will be discussed.
GPB is a form of positive pressure ventilation produced by the patient's voluntary muscles, where gulps of air are forced into the lungs – hence the colloquial name 'Frog breathing'. To breathe in, a series of pumping strokes is produced by action of the lips, tongue, soft palate, pharynx and larynx. Air is held in the lungs by the larynx, which acts as a valve when the mouth is opened for the next gulp. Expiration occurs by normal elastic recoil of the lungs and rib cage. The stages of teaching the technique will be described and illustrated, starting with the individual movements required and progressing to maximising the volume of air per gulp and finally putting it into practice.
GPB is very useful in patients who are able to breathe spontaneously but whose power to cough and clear secretions is inadequate. The technique also enables these patients to make their voice more audible and to help maintain or improve lung and chest wall compliance. Paralysed patients dependent on a mechanical ventilator may be able to use GPB continuously, other than during sleep, to substitute for the mechanical ventilation.
For patients dependent on a ventilator, either non-invasively or via a tracheostomy, GPB is a safeguard in times of ventilator or power failure, and can increase the feeling of independence. Some people learn GPB quickly, others take longer, but commitment to teaching the technique can lead to greatly improved quality of life for many people.

Neuromuscular Techniques for Respiratory Patients

Ann Thomson

Director of Physiotherapy Studies, University College London
email: rmgyaat@ucl.ac.uk

The main learning outcome of this session is for cardiorespiratory physiotherapists to revise and develop a protocol for examining and treating patients whose dysfunction or pain may arise within the neuro-musculoskeletal (NMSK)

system. Case histories of NMSK dysfunction mimicking cardiorespiratory dysfunction will be presented. Participants will be invited to add from their experience of any 'masqueraders' or interesting patient presentations. The effects of improving NMSK function and posture on cardiorespiratory function will be explored. Participants will practice examining skills including palpation and develop confidence in applying some manual treatment techniques to add to their management of patients.

Keynote Lecture

The Child is the Father of the Man

Andrew Bush

Royal Brompton Hospital
email: a.bush@imperial.ac.uk

Many adult diseases have their roots in infancy and even prenatally. If events that initiate these diseases, as opposed to those that propagate the disease state, are to be understood, then the difficult area of how ethically to research problems in infancy must be tackled. Furthermore, the predisposition to archetypal 'pure' adult problems such as COPD may lie antenatally, with the effects being masked until the lung starts to age. An additional factor is that the success of paediatricians, for example in ensuring the survival of extremely premature, low birth-weight infants leads to adult survivors with potentially a whole new morbidity.

The first prerequisite to making progress is a sound understanding of the development of the normal lung, and how adverse environmental and maternal influences, such as exposure to environmental tobacco smoke and maternal atopy, may affect growth. This presentation will focus in particular on three key areas: the implications of different pre-school wheezing phenotypes for adult disease, the importance of very early life events in cystic fibrosis, and the long term consequences of chronic lung disease of prematurity. Finally, I discuss the ethical principles that must underlie future research in children, and the means that we might use to further our understanding of underlying early disease processes.

Prescribing for AHP's

Mark Borthwick

Lead Pharmacist, Adult Intensive Care, John Radcliffe Hospital, Oxford
email: mark.borthwick@orh.nhs.uk

There has long been recognition that non medical practitioners roles have extended to the point that prescribing becomes the next logical route of development for such practitioners. Coupled with an ever increasing workload on the NHS and European legislation that is reducing the numbers of hours that doctors work, the situation in the health service is reaching the point where there simply will not be enough prescribers to take care of the prescribing needs of health service users. Nurses have been prescribing for several years, but it is only recently that the skills of allied health professionals have begun to be harnessed in this respect.
Supplementary prescribing status was initially open to nurses and pharmacists, but new professional groups including physiotherapy, have been added to the list of professions that can prescribe. These personnel must pass an accredited course and become registered with their professional body in order to practice as a supplementary prescriber.
Central to the concept of supplementary prescribing is the Clinical Management Plan. This is a patient specific and individualised care plan that sets out the condition being treated, responsibilities and agreements made between the parties involved in the plan (patient, independent prescriber, and supplementary prescriber) as well as any guidelines used, the range of agents that may be prescribed under the plan and the boundaries that the supplementary prescriber must work within.
Further models of prescribing are being explored with a consultation on the extent and range of independent prescribing recently being completed for both nurses and pharmacists. Other allied health professionals may also be considered in future, indeed, chiropodists, podiatrists, optometrists and specialist physiotherapists were recommended for independent prescriber status in the final Crown report.
These developments allow the allied health professional new access to an old tool, medicines. Using this tool in a responsible and effective manner for the benefit of patients is a challenge that allied health professionals must meet if the health needs of the population are to be met in the future.

Rehabilitation in Critical Care

Amanda Thomas

King George Hospital, Essex
email - midaz_europe@hotmail.com

The typical experience of an individual requiring critical or intensive care involves a variable period of enforced

immobility or limited activity. This period can involve pharmacological manipulations including paralysis, sedation and pain relief. In addition, trauma may inhibit active movement or necessitate prolonged immobilisation. The physiological consequences of reduced activity in young healthy adults are rapid and dramatic, and it is anticipated that these effects are more profound for the elderly person with acute illness.

Individuals with chronic respiratory and cardiac disease may be more susceptible to these negative adaptations because of the musculo-skeletal consequences of their diseases. With the exception of the critical illness neuropathies, the physiological consequences of prolonged bed rest in a critically ill population is poorly defined , or extrapolated from studies in healthy young adults. Literature highlights the prolonged dependency of those who survive an intensive care admission and the lack of physical rehabilitation programs after intensive care. However, there is a paucity of literature that examines the role of physical rehabilitation during an intensive care admission, or even clearly defines what rehabilitation in this environment entails. Evidence for the use and prescription of exercise in the critically ill does not exist.

The focus of this presentation is therefore to highlight the dramatic physiological consequences of bed rest that may potentiate the disabling consequences of chronic cardiorespiratory disease. In addition, literature that may present strategies to minimise these changes in the critically ill population are reviewed. Models for rehabilitation strategies are identified, and evaluation of these strategies are proposed. Reviews of this nature may provide ongoing justification for physiotherapy in the critical care environment and highlight the need for research in this area.

ABC of Paediatric Assessment

Paul Ritson

Royal Liverpool Childrens Hospital
email - aediatricsLead@acprc.org

Paediatric respiratory physiotherapy is an area with which all respiratory physiotherapists will come into contact at some point in their career. For most, it is not a challenge that they relish! This presentation aims to de-mistify paediatric respiratory care and provide delegates with a sound anatomical and physiological basis for a methodical respiratory assessment.

The session covers the anatomy and physiology of the paediatric age group and relates these to the signs and symptoms shown by babies and children who are experiencing respiratory difficulties. We also examine the signs of respiratory distress seen in children and use these signs to evaluate the child's condition. A methodical approach to paediatric respiratory assessment is vital if the clinician is to identify the patient's respiratory problems.

The final part of the presentation takes delegates through this process, from the subjective assessment, objective assessment, clinical reasoning, problem identification and treatment options.

Muscles, Mechanics & Weaning

Nick Hart

Lane Fox Respiratory Unit, St Thomas's Hospital, London
email - Nicholas.Hart@gstt.nhs.uk

Patients with acute respiratory failure may require intensive care for invasive mechanical ventilatory support. Although non-invasive ventilation is useful in avoiding intubation and facilitating weaning in selected groups of patients, such as those with chronic obstructive airways disease, between 5-10% of invasive mechanical ventilated patients are slow to wean and are defined as having weaning failure. This small group of difficult-to-wean patients are a huge resource burden and provide a challenge to all members of the multidisciplinary team involved in their care. This problem has prompted the American and European Respiratory and Intensive Care Societies to produce an International Consensus Statement, which will be published shortly. Although over the last 10 to 15 years our understanding of the epidemiology, pathophysiology and strategies to optimise weaning success have improved, many problems still face physicians managing these patients. With the pressure on intensive care beds, especially in the UK, regional weaning centres are slowly becoming more established. In the US, as these long-term weaning institutions offer the insurance companies an attractive financial alternative to conventional intensive care units, the explosion of these units is occurring at an almost alarming rate raising concerns about levels of staffing and expertise. However, when

adequately staffed and managed such centres offer a specialist multidisciplinary approach to liberating patients from invasive mechanical ventilation in a less intense environment with the ability to then provide long-term ventilatory support for those patients with complete or partial ventilatory dependency.

The Benefits of a Late Shift Respiratory Physiotherapy Service

Brown C, Rowley C, Johnson C, Sharpe, C.

City General Hospital, Stoke on Trent
email: elizabeth.brown@uhns.nhs.uk

Background

The physiotherapy department at UHNS provided a reactive on-call respiratory service responding to emergencies rather than pre-empting the deterioration of patients. Previous audit data identified that on-call activity had increased and this correlated with a rise in sickness across the team.

Method

The on-call arrangements were reviewed and a late shift service proposed. A senior and junior respiratory physiotherapist work from 1.30 in their speciality team, then from 4.30pm to 9.30pm on a late shift covering the wards across the trust. Alongside offering this service, additional treatments can be given to patients who have the potential to deteriorate overnight. This ensures greater access to physiotherapy for patients and training for on-call rotas.

Results

Since the introduction of the late shift, the number of overnight on-calls has decreased by two-thirds. On average, 65% of patients requiring overnight interventions are new patients. Prior to the late shift, only 35% of patients referred to the service were new patients. Audit reflects that feedback from service users has been positive in that it allows more flexibility and equity in service provision and extended links across the MDT. Staff feedback highlighted benefits including a break before going on-call at 9.30, less pressure to fit caseloads into 9-5 work patterns, improvements in work-life balance, and decreased stress and sickness (N=70 80% reply rate) levels. The service has led to better communication across the MDT, particularly with the outreach team and advanced nurse practitioners.

Conclusion

The change in service delivery has enhanced quality of care and raised the profile of respiratory physiotherapy. Raising the profile of the late shift may further decrease overnight on-calls as new patients could be referred to the late shift service.

Oxygen Therapy – A Patient's Perspective

Grant L, Marshall H, Rush, N, Vyse H, Thomas S

University of the West of England.
email: Ratkiduk@hotmail.com or sandythomas@uwe.ac.uk

Background

Oxygen therapy (OT) has important physiological and psychological advantages for patients with COPD and may prove beneficial when combined with exercise. However, some patients who may benefit are not receiving OT and others may be receiving it unnecessarily. At present, prescriptions do not appear adequately individualised and patients' perceptions are frequently overlooked.

Aim

To investigate patients' perspectives of using OT for COPD in relation to exercise and activities of daily living.

Method

Seven volunteers receiving OT from Frenchay Hospital Lung Exercise and Education Programme took part in qualitative semi-structured interviews. Analysis occurred through a grounded theory approach.

Results

Patients' perspective conveyed variable attitudes and feelings to OT. It was found that adherence to OT may be affected by user difficulties and lack of knowledge of its effects. Individuals' control over the use of OT increased independence initially, but dependency on the knowledge that oxygen is available often becomes an issue and ultimately limits this independence. There were inconsistencies regarding oxygen use during activities: while all patients used oxygen during pulmonary rehabilitation sessions, many did not use oxygen for similar activity outside this programme, perhaps reducing the long-term benefits.

Conclusion

Physiotherapists should recognise that OT is a unique experience for each individual, some reporting increased exercise tolerance whilst others gained relief from their response to exertion. For this reason, care should be taken to individualise OT prescription and alter physiotherapy treatment accordingly, in order to gain optimal benefits. Physiotherapists should consider patients' perspectives in order to optimise the effects of OT during activity, with the aim of improving patient quality of life through a user-centred approach.

Acapella versus 'usual airway clearance' during acute exacerbation in bronchiectasis

Patterson JE, Hewitt O, Bradbury I, Elborn JS, Bradley JM

University of Ulster, Belfast City Hospital, Queen's University Belfast
email: JM.Bradley@ulster.ac.uk

Background

It has been proposed that adherence to self-managed airway clearance during exacerbations of bronchiectasis is improved with user-friendly devices. No clinical trials have investigated the efficacy of the Acapella for airway clearance during these exacerbations.

Methods

The study was approved by the local ethics committee and written informed consent was obtained. Twenty patients with bronchiectasis and an acute exacerbation requiring oral antibiotic therapy were allocated to one of two groups determined by concealed computer-generated randomisation. Group 1 (n=10) performed airway clearance using the Acapella at home twice daily during oral antibiotic therapy. Group 2 (n=10) used their 'usual' airway clearance at home during oral antibiotic therapy. Patients recorded the during of each treatment session and volume of sputum produced. An independent assessor performed outcome measures of spirometry, cough counts, pulse oximetry and breathlessness at the beginning and end of the study period.

Statistical Analysis

T-test for independent samples and analysis of covariance were used. A p-value of <0.05 was considered statistically significant.

Results

The mean volume of sputum expectorated during Acapella sessions was significantly greater than that expectorated during usual airway clearance sessions [mean difference 3.70ml (95% Cl 0.13 to 7.26) p=0.04]. There were no significant differences between the groups in duration of each session or in changes in lung function, cough counts, breathlessness or SaO_2 between the beginning and end of the study period.

Conclusion

This study demonstrates that the Acapella may offer an acceptable, user-friendly method of airway clearance in patients with bronchiectasis.

Case study

Mr AB, aged 80 and living with COPD, was visited at home after referral for increasing exhaustion due to difficulty in clearing his chest.

Social history

- Smoked 10/day from age 20 till 1986.
- Lives with wife; has 3 supportive children and 5 grandchildren.
- Independent in personal care but finds it tiring.
- Lives on steep slope.
- Drives.
- Has oxygen 'p.r.n'.

Relevant medical history

- OA – L hip > R, knees, elbow, neck.
- HH.
- Chronic sinusitis.

Drugs

- Lots.

Subjective

- Phlegm stuck in gullet.
- Dry throat from mask oxygen.
- Sleep:
  - sometimes I have to stay up all night trying to clear my chest
  - cough++ if I sleep on my right, so I sleep on my left
  - sometimes get panic attacks
- Exercise:
  - short walk daily if the weather is OK
  - if I can get to the beach, I walk but only with the tide coming in, to avoid pollutants
  - limiting factor is breathlessness
- Fluid intake: 12 cups of tea, 1 pint of water.
- Appetite good.
- Diet varied, with adequate fruit and veg.
- Dairy intake: 1 pint full-cream milk a day, natural yogurt regularly.
- Chest clearance regime: salbutamol nebuliser, inhaled steam, percussion from my wife, cup of tea, 'massage' upwards as I shave my neck.

Objective

- Breathing pattern irregular, with breath-holds.
- Able to talk rapidly without stopping.
- SOB after short walk.
- Breath sounds fair, R = L.
- Scattered coarse crackles.
- Distended abdomen: the patient feels this is due to steroids; objectively, percussion indicates solid rather than air or liquid.
- Sputum thick.

Analysis

- Patient tends to rush at things and then get exhausted.
- Wife's arthritis limits her ability to do effective percussion, but patient finds it helpful, albeit curtailed.
- Husband and wife are anxious about each other, very supportive of each other, both well motivated.

Problems

- Sputum retention.
- Breathlessness à limited exercise tolerance.

Goals

- Optimise chest clearance programme to minimise fatigue and maximise efficacy.
- Enable easier ADL.

Plan

- Observe wife's percussion, modify as required.
- Try alternative chest clearance techniques.
- Pacing à exercise training.
- Energy conservation with ADL.
- Teach brief relaxation technique and incorporate into lifestyle.
- Discuss oxygen use + try nasal specs.
- Obtain oxygen prescription and lung function tests; ponder lack of correlation between ability to speak without stopping and limited exercise tolerance.
- Liaise with consultant about distended abdomen.
- Beg, borrow or steal a pulse oximeter.
- Refer to pulmonary rehab programme.

Treatment

- Identify patient's knowledge.
- Identify patient's goals.
- Education (with wife):
  - discuss breathlessness; desensitise
  - explain pacing
  - use and misuse of exercise; concept of 'breathless but not speechless'
  - discuss panic attacks; identify coping strategies
  - discuss sleep; identify coping strategies
  - discuss fluid intake
  - leaflets on ACBT (homemade) and exercise (BLF)
  - joint protection advice.
- Re-educate breathing pattern, including elimination of breath-holds.
- Teach ACBT.
- Quads exercises – to be done

when TV ads come on.
- Put pacing into practice, adapted to ADL.

Progression

- ACBT corrected and refined.
- Flutter tried, then other devices; Cornet accepted.
- 'Palm cups' (Henleys) loaned, then vibrator (Tesco!) for wife's percussion.
- Patient's vibrating chair utilised in different positions.
- One month's reduced dairy intake advised (ensuring substitutes are calcium-enriched).
- Exercise outside house observed, pacing reinforced.
- Breathing co-ordinated with exercise.
- Exercises taught (feasible with watching TV, to avoid adding more to daily regime) - quads, shoulder, neck and trunk mobility, exercises for OA joints.
- Exercise diary with tick boxes.
- Sleeping positions + sleep hygiene advice, including short chest clearance regime before going to bed.

Outcomes

- Wife and patient found the 'palm cups' beneficial and avoided causing pain to wife's wrists.
- Patient achieved appropriate fluid intake by using a water filter ('because Eastbourne water is disgusting').
- Patient achieved effective pacing by using rating scales
- Sputum became looser and easier to clear.
- Less fatigue, ACBT requiring less force, now able to enjoy daily 20 minute walk.
- No further panic attacks.
- Now able to sleep on left hand side; sleep better but still sometimes disturbed by coughing.

Still to come

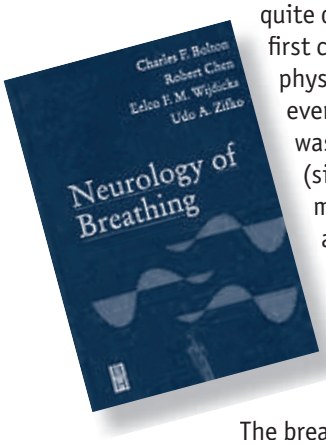
- Patient will try dairy-free month 'when I'm geared up for it'.
- Still awaiting oxygen prescription and lung function test results…..

Alex Hough

Book reviews

Neurology of Breathing

by CF Bolton, R Chen, EFM Wijdicks and UA Zifko. (2004)
Butterworth-Heinemann. £50.99.



I eyed this daunting tome warily, but actually found it quite digestible. After the first chapters on anatomy, physiology and assessment, every relevant disorder was covered, from hiccups (singultus to you and me) to anything that affects breathing and the nervous system, with a useful chapter on respiratory failure caused by acute neurological disease. The breathlessness sections were also particularly relevant to respiratory physios, covering the mechanism and sensation of this complicated symptom.

Sadly, there was not a whisper about hyperventilation syndrome. There were, however, enough references about breathing in general to comfortably weigh down your bedside table.

For most of us, the book is for selective reading only, but MSc candidates and other keen types would find it useful if this is your area of special interest. Neither the contents nor the price are aimed at physios, but if you can persuade your respiratory medicine department to get a copy, it would be a handy reference in your odd moments (oh yes?) of leisure.

Intensive Care Aftercare

RD Griffiths & C Jones (2002)
Butterworth-Heinemann

This book isn't whizzingly recent, but post-ICU clinics are catching on only slowly, so I couldn't resist spreading the word. If you're not already putting rehab at the forefront of your physiotherapy management of intensive care patients, you will after reading this, which identifies the sorry state of patients discharged from ICU.

Page one highlights the anomaly between the attention given to the functional outcome of neonatal 'graduates', and that given to their adult counterparts. Understanding the aetiology of this enables the physio to contribute to its management accurately and early. And for those who are sceptical about passive movements, rationale is provided.

Seamless management of patients after transfer to the ward is also emphasised, with respiratory physiotherapy at the forefront. Assessment teams and pulmonary rehabilitation are also recommended.

The book emerged from the experience of ICU follow-up clinics, where patients were often unable to recall their ICU stay. The authors put to rest the mistaken idea that it is best for patients to forget their time on the unit, as shown by the benefit of replacing delusional memories with factual ones. Interdependence of physical and psychological wellbeing is emphasised, assisted by diaries and discharge booklets.

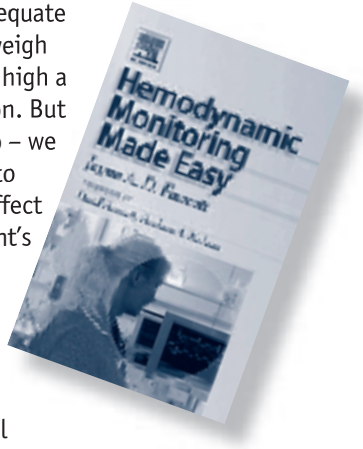
The style is chatty and readable. There is some overlap between chapters, but overall this handy little book needs to be read by all intensive care physios and their teams.

Hemodynamic Monitoring Made Easy

by JAD Fawcett (2005)
Butterworth-Heinemann. £19.99

Aimed at nursing staff, with a nod to medical staff (but physios…who are they?), this emphasises the new, less invasive monitoring systems. It covers cardiovascular anatomy and physiology, a cardiodynamic view of oxygen delivery/demand/consumption, and the fundamentals of haemodynamic interpretation.

Oxygen therapy is covered in only a paragraph. It was pleasing to be told that the risks of inadequate oxygen outweigh those of too high a concentration. But then – oh no – we are advised to assess the effect by the patient's colour and breathing pattern (where did the physiological rationale go there?)



Adequately-referenced, the book provides enough depth for senior respiratory physios. Peppered with terminology boxes, objectives boxes, quizzes and clinical scenarios, it also makes for easy reading. The pocket size (for a big pocket) means you can peek into it while waiting for your handover.

Alex Hough

Journal of the Association of Chartered Physiotherapists in Respiratory Care

INSTRUCTIONS FOR AUTHORS

Articles should be no longer than 2000 words (editorials 1000). They should be emailed to info@alexhough.com with the files named as follows

- Main document- Author,date submission,title of paper e.g. Bradley020906Bronchiectasis
- Tables Author,datesub mission,titlefigue e.g. Bradley020906Table1
- Figures- Author,datesu bmission,titlefigue e.g. Bradley020906Figure1

Submissions may take the form of review papers, research reports, audit reports, case studies, editorials, conference reports, equipment reports and reviews of books, CDs or DVDs. Student contributions are welcome.

Please double-space throughout, with no headers or footers (other than page numbers), and without footnotes unless these are absolutely necessary.

Write succinctly and concisely. If you wish to go above the word-count, please contact the editor.

If you are willing, include a photo of yourself. Photos and other illustrations for your piece are also welcome.

TITLE PAGE

The title page should carry:

- Title of the article.
- Names of the authors and details of each author's current appointment.
- Name and e-mail address of the author responsible for correspondence (please send contact telephone number with covering letter).

SUMMARY

(not for brief reports)

This is in bold at the beginning of the article and should be between 50 and 60 words in length. It is designed to develop the readers' interest in the article.

INTRODUCTION

The introduction should state

the main question that the paper sets out to answer or the main message of the article.

CONCLUSION
Conclusions should be short and logical. Identify gaps in present knowledge and suggest future initiatives.

KEY POINTS
(not for brief reports)
Please supply 3-6 phrases that summarise the major themes.

HEADINGS
Please use plenty of headings. Indicate which are headings, subheadings, and if necessary subsubheadings, by (a), (b) and (c) respectively.

ABBREVIATIONS AND UNITS
Abbreviations should be defined at their first mention. SI units should be used.

TABLES AND ILLUSTRATIONS
Tables and illustrations should be sent in separate files, together with any source data in Excell format. In the text, please insert:

****Table 1 near here****
or

****Figure 2 near here****

separated by two line spaces from the main text.

If previously published, acknowledge the original source. It is the author's responsibility to obtain permission from the copyright holder for the reproduction of figures and tables before submission (search for 'permissions' on the publisher's website).

References, explanatory matter and definitions of abbreviations should be in the footnotes.

Ensure that each table and figure are cited in the text.

REFERENCES
The total number of references should not exceed 20.

Papers that have been submitted for publication but not yet accepted should be cited in the text as 'unpublished observations' (Smith AB, unpublished observations, date) with no mention in the reference list.

Papers that have been accepted for publication but not yet published may be included in the reference list: Abel HL (2007) Endometriosis. *Br J Hosp Med* (in press).

The Harvard system for references should be used. See: http://libweb.anglia.ac.uk/guides/new_harvard.php

This is modified for our journal, e.g. less punctuation and no 'p.p' before page numbers. See this issue of the journal for examples.

PHOTOGRAPHS AND IMAGES
Ensure that all photographs, drawings etc that are embedded in your Word document are also supplied as separate files in JPEG, TIFF, GIF, or PNG format. Supply images at highest resolution obtainable from source. Do not reduce the file size.

Thanks!