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# Journal of the Association of Chartered Physiotherapists in Respiratory Care

VOLUME 37 2005

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Journal of the Association of Chartered Physiotherapists in Respiratory Care

# INSTRUCTIONS TO AUTHORS

Articles should normally be no longer than 2000 words (editorials 1000). They should be submitted on 3.5" disk saved as a Microsoft Word document and accompanied by one hard copy to:

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Articles may take the form of review papers, research reports, case reports, editorials and conference reports.

**TITLE PAGE** *(All submissions)*
The title page should carry:

- Title of the article.
- The names of the authors (with initials or christian names, whichever is preferred).
- Institutional affiliation of each author.
- Full details of each author's current appointment.
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**Summary** *(Not for editorials or conference reports)*

This is typeset 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 and tell them something about the way the review is handled.

**Main introduction**
The main introduction should state the main question that the paper sets out to answer.

**Headings**
Please use plenty of headings. Indicate clearly the 'importance' you attach to each one.

**Conclusions**
Your conclusions should be succinct and logically ordered. Identify gaps in present knowledge and suggest future initiatives.

**Key points** (Excepting conference reports)

Please supply 5-8 key phrases that summarise the major themes of your article. These will appear at the end of the article. An example is shown below.

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Tables and illustrations are a help to readers. It is the author's responsibility to ensure that permission is received from the copyright holder for the reproduction of figures and tables before submission.

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## CONCLUSIONS

The conclusions should be succinct and logically ordered summaries of data you have presented. Identify gaps in present knowledge and suggest future initiatives.

## REFERENCES

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Use the name and year (Harvard) system for references in the text:
As Black and White (1987) have shown…
As already reported (Black and White, 1987)…
For three or more authors print the first author's name followed by et al:
e.g. As Black et al (1987) have shown…
When several references are cited simultaneously, the order should be chronological.

The total number of references should not exceed 20.

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Black B, White W (1963)…
Black B, White W, Green G, Brown B, Tan T (1973)…
Black B, Green G, Tan T (1974)…
Black B, Abel C, Tan T (1975)…

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Smith B, Abel CH (1987) Sexual hypersensitivity. Br J Hosp Med 33: 40-6

The sequence, layout and punctuation for books are:

***Personal author***

Ellis H (1980) Lecture Notes on Psychiatry. 5th edn. Blackwell, Oxford

***Editor***

Scott H, Brown B, eds (1973) Histocompatability Testing. Vol 5. Raven Press, New York: 418-19

***Chapter in Book***

Samuels B (1979) Pulmonary complications of AIDS. In: Rand A, Long B, eds. Management of AIDS. Butterworths, London: 387-95

Papers that have been submitted for publication but not yet accepted are not acceptable as references. They should be cited in the text as 'unpublished observations' (XY Smith, unpublished observations, with or without a date). Similarly, 'personal communication' should be inserted in the text in a parenthesis.

Papers that have been accepted for publication but not yet published may be included in the reference list:
Abel HL (1988) Endometriosis. Br J Hosp Med (in press)

**Abbreviations and units**

Abbreviations should be defined at their first mention. SI units should always be used.

# Introduction

Once again, on behalf of the publications sub group, we welcome you to the Journal of the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) 2005. If you are reading this preface, either as a member or a more occasional reader then we are delighted that you have taken the time to pick up this annual publication. It is always our endeavour to provide a reflection of the association's current activity. We hope you find it useful and should you have any comments or views please do not hesitate to contact us. It is always helpful to receive feedback.

You will note contributions drawn from a range of authors across a number of designations. This has been an increasing feature of more recent years and remains an indicator of work taking place in many situations. Equally, one of the encouraging features of the recent past is the considerable activity and development that is taking place within the ACPRC. This only happens because of the activity and development that is occurring within practice, training and education. Inasmuch, as you review the Journal content for this year, the articles and papers explore professional practice, research, and literature consonant with these matters.

On behalf of the publications subgroup

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# Consultant Physiotherapists in Respiratory Care – a New Way Forward in the Specialty.

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## Summary

*The development of Consultant Physiotherapists is the most exciting change in the clinical career pathway for physiotherapists in the last decade. These posts strengthen professional leadership by retaining clinical maturity and expert practice, which can only improve outcomes for patients. The Consultant Physiotherapist's role is clearly rooted in clinical practice and is focussed on patient care and services provided. As all respiratory physiotherapists know, respiratory care crosses many boundaries from acute and critical care, to chronic disease management and rehabilitation. This is reflected in the current roles of the Consultant Respiratory Physiotherapists in post at the moment. To exemplify this, a brief description of each of the Consultant Physiotherapists' role is outlined at the end of the article. This article hopes to 'de-mystify' the role of the Consultant Physiotherapist with special attention to the specialty of respiratory care illustrating our unique diversity in patient management.*

## Introduction

The NHS has undergone considerable change in recent years. The NHS plan (DOH, 2000) set out to bring the NHS in to the 21st Century. As society changes, different priorities and demands on the service are identified. The basis of the NHS plan was to address these changes and provide services required by society. To achieve this, the NHS has had to respond to these changes, anticipating priorities by proactive re-designing of services, rather than reacting to them as they occur. Modernisation has clearly put the focus on patients and services, which has required new ways of working. Key roles in nursing changed as it was recognised that there was a need to strengthen clinical leadership that facilitated the development of Consultant Nurses (DOH, 1999). As with many new developments for nurses, this has opened up opportunities for Allied Health Professionals (AHPs). This is certainly the case for physiotherapists as they are uniquely placed to influence care through out the whole patient experience. Increasing awareness of what physiotherapists have to offer, and recognition that they currently perform cross-boundary working means that physiotherapists are taking on new challenging roles. Because the scope of their skills is wide, they are able interface the whole spectrum of patient care, from acute, tertiary services to community based care. The evolution of the Consultant Physiotherapist role has extended the clinical career pathway further, from the development of Clinical Specialist roles and Extended Scope Practitioners (ESPs) some years ago. Nurses and AHP's in Consultant posts provide a clinical career pathway in the NHS, retaining clinical maturity and excellence. This strengthens professional leadership by

facilitating the development of extended roles and multi-professional team working. This will not only improve patient care but also aid recruitment and retention of staff. In doing so the Consultant provides a role model for senior staff, developing and promoting the specialty.

## The consultant role

The NHS plan (DOH, 2000) and the Strategy for AHP's 'Meeting the Challenge' (DOH, 2000) set out a commitment to develop Consultant AHPs' by 2004. The first Consultant Physiotherapist was appointed early 2002 with 21 Physiotherapists in post by the end of 2004. It was envisaged that Consultant AHP's would work with senior medical and nursing colleagues across hospital, community and primary care services by drawing on local care and referral protocols. The title 'Consultant' applies to newly developed posts, which are established under the agreement with the Department of Health. It is therefore, the focus of NHS bodies to decide where Consultant posts should be established in the light of service needs, as they are directly related to national initiatives, government priorities and targets. It is clearly stated within the document that the title Consultant must *not* be applied to already established advanced practice posts or to reward specific individuals who currently work innovatively or in extended practice roles. It was recognised that these posts would require individuals to deliver specialised clinical services that exceed the scope of existing roles of current Clinical Specialists and Extended Scope Practitioners. The driving force behind the development of these posts is to improve quality of clinical care at all levels of health care provision and seek quality improvement through clinical governance. This is the main principle of the modernisation programme. Each Consultant post must clearly state that the role is focused on patients and that it is strategic, benefiting patients and services. In all cases there has to be an identified need for the role both clinically and professionally. The scope must be large, taking in the wider picture and must have organisational fit into the modernisation agenda.

It was envisaged that Consultants would be experts in their clinical field bringing clinical leadership and strategic direction in their own area of expertise. In doing so would expand and develop practice, implement clinical governance and deliver improved outcomes for patients. The establishment of Consultant Physiotherapists posts provides an opportunity to renew existing services and develop new areas of care. This creates new opportunities for staff to support the new service model of the modernisation agenda. This will provide benefits to patients, clinical practice and the organisation as a whole locally, nationally and internationally. The Consultant role supports the modernisation agenda, develops the individual and teams by building partnerships and promoting clinical excellence. Through evidence based practice, it enables care to be focused on patients and services which will improve the patient journey from access to discharge, continuing care in the community.

## Clinical specialist: consultant physiotherapist – what is the difference?

The Specialist Physiotherapist is seen as a specialist practitioner within a defined service and may well line-manage physiotherapy staff within the specialty. They will be recognised as a Clinical Specialist locally and regionally, contributing to the strategic direction of the service. They may also be involved in research, audit and evaluation and have awareness of the wider research picture impacting on the clinical services (implementing accordingly). The Consultant has four clear domains of practice within a wide clinical area (outlined below). Consultants have no line management responsibilities and therefore must influence without authority. They work autonomously and lead on strategic service development along side service managers. They should be a recognised expert clinician nationally and internationally, leading on research priorities and development of research strategies to increase local research capacity ensuring that local services reflect best practice.

Because the formation of Consultant posts is a new concept, it is obvious that there are many physiotherapists currently working at Clinical Specialist level who have the necessary experience and skills for the Consultant role. It will take time for more posts to be established so that these professionals can achieve their ambitions, if they wish to do so. Once in post, however it will allow experienced Senior I's to move in to the Clinical Specialist role and commence their advanced clinical career pathway.

## Consultant AHP role domains:

In a previous issue of this Journal, Jane Scullion outlined the role of the Consultant Nurse. The generic role of the consultant AHP has followed the general role format and evolutionary pathway of the Consultant Nurse. All Consultant AHP post job descriptions have four clearly stated domains: *Expert Clinical Practice, Strategic Development, Education and Research* and *Professional Development*. It is envisaged

that as these roles evolve and these areas are explored and developed, Consultants will deliver clinical leadership. These domains are explained below.

**1) Expert Clinical Practice:**
It is expected that Consultants work at the highest degree of professional autonomy demonstrating advanced knowledge, skills and experience within the specific specialist field. They should be a recognised national / international expert within the specialty. The Consultant role is patient focused and must have responsibility for a complex clinical caseload, which the DOH dictates should be about 50% of the role. They should be able to demonstrate advanced assessment, clinical reasoning, knowledge and clinical decision making skills including the provision and management of an expert clinical service. Consultants should promote best practice, based on the best available evidence, with a whole system approach to patient care. Within this it is envisaged that they will create and develop protocols of care, designing patient care pathways, providing best practice guidelines.

**2) Strategic Development:**
For successful strategic development to occur it is important that Consultants will have the ability to manage change and contain conflict so that resolution and positive outcomes are achieved which influence patient care. It is also important to input to the National Quality Agenda influencing and delivering the Clinical Governance programme. Consultants will contribute to strategic planning and lead local implantation of relevant national policy. Key to the Consultant role is to develop high quality cross-disciplinary services, breaking down unhelpful or historical boundaries, delivering a whole system patient focused approach not rooted in a uni-professional perspective. They should contribute to service evaluation, redesign and development and lead on collaborative development and protocol driven services. This will contribute to the local and national planning modernisation agenda.

**3) Education and Research:**
Consultants promote a learning culture enabling others to reach their potential. This is important, particularly with reflective practice so that the service is demonstrably one that continuously improves and develops. Audit is fundamental to this, so that services can be re-designed and outcomes improved. This goes hand in hand with Research and Development (R&D) programmes, as it will help identify gaps in the evidence base. By targeting these areas, research is encouraged within the specialist field and the evidence base enhanced. The research strategy undertaken must be in keeping with nationally developed Government framework, must be relevant, ethical and patient / service focused. The research needs to be of high quality, cost effective and responsive to NHS needs. Also it must add to the evidence base and lead to improvement in the patient experience / access to care. Consultants will therefore facilitate learning opportunities for health professionals and others in the specialist field by establishing links with Higher Education Institutions (HEI) and other professional bodies. It is mandatory that they will provide education of the specialist field of clinical expertise locally, nationally and internationally.

**4) Professional Development:**
Consultants should be working at Masters Level and beyond. They must also be able to demonstrate a commitment to career long learning, experience and education, extending scope of practice. It is important that they facilitate the link between R&D and clinical care, closing the gap between theory and practice. This is achieved by building partnerships between clinicians, professional bodies and academic establishments on a local, national and international level.

## Professional leadership and the AHP consultant role.

Leadership requires specific qualities and Consultants will need to acquire these if they are to be successful leaders. Good leaders communicate well and can motivate and inspire others by leading by example. At the same time they must show tolerance, have humility and integrity. Others must be able to trust them and know that there is no hidden or personal agenda. It is important to have passion, enthusiasm and energy for the speciality that will drive the individual to constantly seek better ways of doing things. In so doing, they can lead and manage change, with a clear wide vision. Through professional leadership, care can be centred on patients by identification of common goals, putting policy into practice and by creating strong relationships between professional groups and management with equal respect. To achieve this it is essential to develop partnerships with teams working across historical and professional boundaries with a shared vision. This will build confidence in others and challenge un-helpful working practice. The Consultant can lead on different levels; individually, by directing a specific team, operationally, leading a network of more than one team and strategically which will contribute to the governance of the organisation

## Consultant physiotherapists.

Currently there are 28 Consultant Physiotherapists in the UK. The government target for 2004 was

250 – so we have a long way to go! The majority (19) are placed in musculo-skeletal work, with respiratory care being the next largest group (5). There are two Consultant Physiotherapists working in Neuro-Rehabilitation, one in Elderly Care, one in Lymphoedema Services.

## Consultant physiotherapists in respiratory care

At the time of going to press there are 5 respiratory Consultant Physiotherapists in post in the UK. Each Consultant is developing high profile services leading on strategy in all areas of respiratory care. The roles are diverse demonstrating that respiratory physiotherapists interface the whole patient journey form acute care to rehabilitation and care in the community. One thing that is agreed upon by the physiotherapists currently in these posts is that the job is considerable with teaching and advising on complex patients being a large part of the role, along with strategic development.

Guy's and St Thomas' NHS Foundation Trust has two Respiratory Consultant Physiotherapists, my self and Sheric Ellum. Working closely with the Nurse Consultant (Critical Care) we are responsible for the strategic lead for physiotherapy within Critical Care outreach services in a team with critical care nurses. The creation of Critical Care outreach services is part of the modernisation programme as outlined in the government report' 'Comprehensive Critical Care' (DOH, 2000). As physiotherapists, working in a multi-professional team we have developed new ways of working. We no longer follow the typical 8.30am to 5.00pm. hours, common to most physiotherapy departments. We work the same 12 hour shift system as our colleagues within the team; hence the need for two Consultants. This role has taken us further than the scope covered by our clinical specialist roles previously. Aspects of our roles include leading on acute lung support, the acute non-invasive ventilation (NIV) service and trachaeostomy care on the general wards. Working closely with the Clinical Specialists we also lead on managing complex respiratory patients in the A&E department. There have been firm links established with King's College, University of London developing respiratory education for the MSc. Physiotherapy course and the Acute Care Skills for Nurses programme. Both Consultants are actively involved with committees and projects with The ACPRC, British Thoracic Society (BTS) and European Respiratory Society (ERS).

Julia Bott is a Consultant Physiotherapist based in North Surrey Primary Care Trust and leads in Pulmonary Rehabilitation (PR). Her role crosses all boundaries by working as a source of clinical expertise for the non –invasive ventilation service and acute respiratory care, to advising those working with patients with Chronic Lung Disease in the community. She is recognised as an international expert in PR and NIV and is secretary to the Physiotherapy Group of the ERS. Julia is also a council member of the British Thoracic Society (BTS).

Mary Dodd is a Consultant Physiotherapist working for an acute care trust in Manchester and is the Physiotherapy lead for adults with Cystic Fibrosis (CF). Much of her role is strategic and develops research and education of the MDT. She oversees Trust policies and guidelines for CF and is resource of expertise regionally and nationally. She is also an internationally recognised expert in the field of CF.

Denise Daly leads on COPD for the Royal Surrey NHS Trust and like Julia works across the boundaries from acute care, rehabilitation and the community. She has set up and leads on the physiotherapy led non-invasive ventilation service. She also has developed Pulmonary Rehabilitation and the rapid discharge scheme form A&E. Interestingly she has developed a training programme for physiotherapists and nurses taking arterial blood gas samples.

## Conclusion

The evolution of Consultant Physiotherapists is an exciting and valuable development. It is clear recognition of the skills and attributes we have as professionals. The formation of Consultant Physiotherapy posts, provide a clinical career pathway in the NHS, retaining clinical maturity and excellence. This strengthens professional leadership that can only enhance the profession in the future. Because they are new posts, there are many physiotherapists currently working at a Specialist level who feel they have the necessary experience and skills for the role, but this will come to fruition as more posts are established. As with all new developments, some individuals are threatened by the prospect of the Consultant AHP, both within the professions and amongst our Medical Colleagues. In my experience these individuals are in the minority and this problem will improve over time. The main driving force, however, underpinning the ethos of the role is for improved patient care that is at the heart of all therapists. The establishment of Consultant Physiotherapists can only be a positive step towards the future of the NHS, patient care and for the profession as a whole.

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– a strategy for Allied Health Professions'. London: DoH

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# Who Should be Forging the Way Forward for Physiotherapists in Respiratory Management?

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## Introduction

Over the past 6 months, I have been asked to talk to physiotherapists around the country about the development of our profession in general, and more specifically about where we stand as specialists in our chosen fields of clinical interest. I am also receiving increasing invitations to represent the profession on multi-agency panels and committees, as are the other Consultant AHPs; the decisions here take forward clinical national health and social policy.

It is apparent that the pace at which the Government are pushing through their reforms in the Health Service makes it difficult to keep up at times. We may be in full agreement with the ethos of a system that deals with health promotion and the maintenance of stability of long-term conditions, minimising the acute episodes, but I sometimes question whether physiotherapists are in a position to stay in the running to permit this?

For those of you who know me, you will know that my clinical specialty is not purely in the respiratory field, although I maintain an interest in this area due to the nature of some of my patients. This article has been written more as a means to stimulate you to question your own practice in the context of today's National Health Service (NHS) and your own area of work.

I strongly believe that you, the reader, are the person who should be forging the way forward for physiotherapists in respiratory management, so I am posing you two questions:

1. How are you proving your worth as a respiratory physiotherapist, i.e. what benefits are you bringing to a person with a respiratory condition and can you prove it?

2. Is it being proven to the people who can help you develop your role and the service you provide?

## An overview of the national context

One of the first things to understand about the 'modern' National Health Service (NHS) is that we can no longer ignore the impact that politics play on our working lives - whether this is with a capital 'P' or not!

Since the publication of '*The NHS Plan: A plan for investment, a plan for reform* (DoH, 2000), *and 'The NHS Improvement Plan: Putting people at the heart of public services'* (DoH, 2004) the Government has expressed its aspiration to develop a service that promotes health rather than constantly dealing with crisis and illness. This includes devolution of financial control from a centralised treasury to the regions and an increase in status of the Primary Care Trusts.

Below is an overview of the more recent national policies and strategies that could have impacted on respiratory physiotherapy, potentially steering the clinical specialty toward a position of strength.

At the turn of the century, the country witnessed acknowledgment from the Government of the worth of the Allied Health Professions (AHP) through the Ministerial signing of the '*Meeting the Challenge: A strategy for the allied health professions'* document (DoH, 2000), a consequence of which meant that the policy had to be incorporated into local strategy giving the professional status more authority than a guidance policy, and '*Shifting the Balance of Power within the NHS Securing Delivery'* (DoH, 2001) document. Both documents addressed reform that focussed on issues affecting patients, empowering them to have a greater say in their care and the development of their local services. More importantly for the AHPs was the reform to

break down the demarcations between different professional groups and organisations. This allowed the redesign of services with a Government commitment to expand AHP roles in health and social care for the benefit of patients. The sting in the tail here is that what goes for the AHPs, also goes for the nurses!

The increased recognition of the AHPs and nurses comes with an increasing onus on the part of the patient to accept some responsibility for their condition themselves. This has been in the form of patient-centred approaches to disease management e.g. *The Expert Patient Programmes* (2001) and, just hot off the press, *'Creating a Patient-led NHS - Delivering the NHS improvement plan'* (DoH, 2005). There is a push for partnership with the patient through publications such as the *'Choosing Health: making healthier choices easier'* (DoH, 2004) and the *'Choice'* agenda, which the government has been advocating through various consultations since 2003. Health, social and voluntary services have been given frameworks upon which to base expansion of services and the impetus to develop the increasing focus on complex and long-term conditions e.g National Service Frameworks (NSF) for Coronary Heart Disease (DoH, 2000), Older People (DoH, 2001), and Long Term Conditions (LTC) (DoH 2005). These have been complemented by clinical guidance through the National Institute for Clinical Excellence with guidelines such as the Chronic Heart Failure (2003), Chronic Obstructive Pulmonary Disease (2004), Lung cancer (2005), although the bias is toward diagnosis and medical treatment, and one can argue that the application of these guidleines to physiotherapy has been thin, to say the least.

## So where does respiratory physiotherapy sit within the national context?

I am glad to report that although the movement of physiotherapy involvement is slow, the direction is definitely forward! This is not just in the nationally recognised centres of excellence, but evident from the reports written in *'Therapy Weekly'* and *'Physiotherapy Frontline'* concerning service developments with non-invasive ventilation and pulmonary rehabilitation with physiotherapists at the heart of the development, or part of pilots and established multi-disciplinary teams.

Anecdotally, the mainstay of respiratory physiotherapists remains on medical and surgical wards (inclusive of ITU and HDU) of Acute Trusts and Foundation Hospitals, although the number of specialised (tertiary) units is increasing, especially out in the community.

With regards to the skill mix across the spectrum of the profession though, unfortunately, we are about 200 short of the 2004 target to have 240 Consultant AHPs in place, and at the time of writing this article, only 5 of these had a respiratory role! There is evidence of an increasing demand for Clinical Specialists when scouring the recruitment pages of the papers and magazines, and more requests through clinical networks about the roles of Technical Instructor (TI) grades in the field – especially in pulmonary rehabilitation.

In connection with published literature, what can I say? The picture is no different to a national picture across most of the specialties, with the well utilised phrase of ….

'the main bodies of research and policy cannot show the benefit of physiotherapy nor refute its efficacy. There is need for further research in this area'….

still being espoused (Cochrane Data Base 2000 – 2005). This does not mean that good evidence is not being produced, but commissioners are still mainly financing through the meta-analysis 'Gold Standard' route, so we have to make a stronger case if we cannot always deliver such research methodology.

## Where do you start?

If you have ever done a management course, you may have come across a 'PEST' analysis. This tool allows you to evaluate the Political, Economic, Social and Technological factors that govern your working environment with a view to making informed decisions and managing change where necessary. Each of the four factors influence or relate to another, and the analysis is a good starting point when evaluating your job, the service you provide and areas you may need to develop further to promote either.

Seeing as the high priority at this time is LTC, a job that deals with the chronic side of a respiratory condition has been explored as an example. If you read the information from the Department of Health about improving chronic disease management, they believe strongly that chronic disease represents a significant and exciting challenge for the NHS. Good management offers real opportunities for improvements in patient care and service quality, and reductions in costs and applies to PCT, NHS Trust and SHA management teams alike

The PEST analysis may look something like Table 1.

## Political factors

How aware are you about the political arena that affects your role? The main agenda is about the management of long-term

TABLE 1. Pest Analysis

**Political Factors**

The current general political agenda is mainly:

- To limit the number of acute episodes
- To (self) manage the condition within the community
- Provide national standards (e.g. NICE COPD Guidelines, NSF Long term conditions)

For AHP's we need to uphold our professional status

**Economic Factors**

In looking at ways to save / be efficient with money

- Prevent unnecessary hospital admissions
- Look for alternatives to medical support e.g. physiotherapists
- Evaluate the time spent on educational programmes and the long term benefits to the patient
- To devolve financial resources regionally

**Social Factors**

Implications of instituting new services may be:

- An improvement in the public's understanding of what a physiotherapist has to offer
- Public confidence in physiotherapy
- Increase in autonomy to practice
- Better recruitment and retention

**Technological Factors**

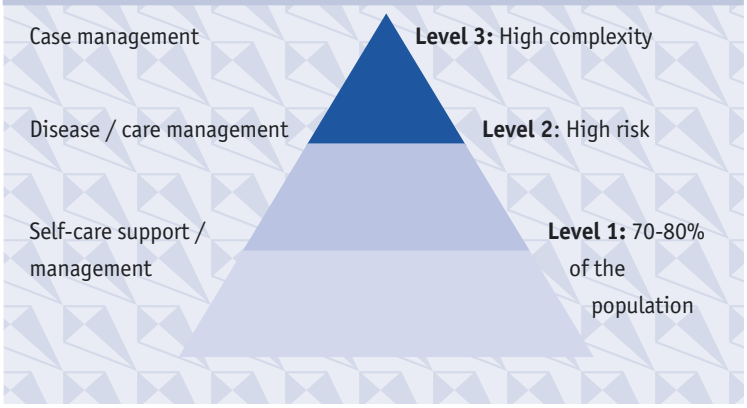
In terms of:

- Equipment, this may include the availability of nebulisers or NIVs in the community
- Manpower, this may be a multi-agency team of specialists
- The skill of the physiotherapist, this could mean the actual evidence base to back up their treatment of choice, their hands on skills and knowledge, clinical leadership etc.

conditions – have you read any of the core publications relating to LTC?

1. *'Working differently'* (AHPF, 2005). This pamphlet details the position of the Allied Health Professions Federation relating to LTC
2. *'Chronic obstructive pulmonary disease: Management of chronic obstructive pulmonary disease in adults in primary and secondary care'* (NICE, 2004)
3. *'Supporting people with long-term conditions: An NHS and Social Care Model to support local innovation and integration'* (DoH, 2005). The Government strategy that is meant to help improve the care and lives of the 17.5 million people in the UK with a LTC
4. *'The National Service Framework for long-term conditions'* (DoH, 2005). Although the bias is toward those with neurological conditions, this NSF clearly states that the 11 quality standards can be applied to *anyone* with a LTC
5. *'Core standards of Physiotherapy Practice'* (CSP 2005). Have you read the revised Core Standards that came out in March to ensure that you are adhering to the Health Professional Council Registration for which you signed yourself as being competent?

TABLE 2. Level of Management




The material you pick up on will depend on whether your bias is towards the clinical or managerial side of the profession.

With regard to long-term conditions, which level of management do your patients or the service you provide fall in?

For the majority of you, the patients being dealt with are in Levels 1 and 2, but **for** those of you in specialised units, it may be Level 3.

## Economic factors

Linked closely to the above factor is also the need to be aware of the regional and local politics i.e. have funding bids gone into the Local Development Plans to provide more specialised respiratory services, and if so, what and where? If it is something you are interested in, who should you be discussing the plans with and what data should you be gathering?

Be realistic about what

support and money will come along with the project. If you review any of the major initiatives that have come out recently, e.g. the Payment by Results scheme, rehabilitation has not been calculated in the payments and very few pilot schemes provide adequate staffing to cover leave.

## Social factors

The main point to make here is that unless a patient has received respiratory physiotherapy, very few understand what is involved. In fact, very few other professionals and agencies outside of the specialty realise that this is part of a physiotherapist's role. One of the major challenges will be to alter the public perception and increase the status of respiratory physiotherapy if you don't want the post to go to a nurse! Are you clear yourself as to the benefits your intervention can make to the patient's well-being and quality of life? If so, have you shown proof to your manager?

## Technological factors

Review what skills and equipment are necessary for the post? This might be in the form of educational materials for those patients in Level 1. Have you got leaflets to help them manage their condition more effectively themselves, or the contact details of a local support group? What articles have you read or courses attended that allow you to make your clinical judgement from and have you evaluated the evidence base for these? What audits have you done recently on the outcome you use to measure your intervention? Without this, how can you prove your efficacy?

## Conclusion

As the population ages, you will see an increase in the pathologies exhibited by patients – respiratory conditions will be one of these. The management of chronic, long-term conditions will become an increasingly significant part of healthcare and the Government is calling for a coordinated approach between health, social care, voluntary and private agencies, and where the patients themselves play a part.

You must be under no illusions that the market and competition for services will increase, and so must be prepared to fight your corner as a respiratory physiotherapist by examining the use of resources and the way in which you need to develop to provide a service that will meet the raised levels of demand.

By proving your efficacy, you will not only ensure the success of the service for the benefit of the patients, but also interest others in the field sufficiently to influence retention and recruitment of staff.

There are examples of innovative and effective management already implemented in the UK that can act as templates. Network with others in the field and share experiences more.

It is you who are responsible for forging the way forward for physiotherapists in respiratory management!!

## Key points

1. Clinical roles for the AHP professions are expanding across the spectrum of health provision
3. Pivotal service development roles start from Senior I posts up to Consultant roles
4. It is for each one of us to take forward the clinical specialty and the profession
5. For this, an ability to provide benefits to the patient's quality of life and well-being must be proven
6. To do this, the service must be evaluated from a wide perspective, including an evaluation of the outcomes used to measure your interventions

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# An Exploration of Emergency Respiratory On-call Service Provision within the United Kingdom

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## Summary

*Provision of emergency on-call respiratory physiotherapy is a challenging service responsibility for the majority of U.K. acute hospitals.*

*It is clear from the limited amount of literature available that there is no national picture of on-call respiratory physiotherapy service provision and that current practice remains unknown. This survey aimed to address part of this by generating a national picture of on-call service provision and building in the detail, which will allow the profession to debate this topic and its future as part of a wider project undertaken by the ACPRC.*

**Key Words:**

**On-call Physiotherapy;**
**Respiratory;**
**Service Delivery;**

## Introduction

Provision of emergency on-call respiratory physiotherapy is a challenging service responsibility for the majority of U.K. acute hospitals.

The Association of Chartered Physiotherapists in Respiratory Care (A.C.P.R.C.) began a major review of on-call working in the year 2000 working with the Chartered Society of Physiotherapy (C.S.P.) (Cross, Harden, Thomas and Ten Hove, 2003). This survey aimed to generate a national picture of on-call service provision and build in the detail, which would allow the profession to debate this topic and its future.

## Literature review

### Service Delivery

Two audits undertaken by Dixon and Reeve (2003) and Brown *et al*, (1997) offered useful, if small, cohort studies demonstrating local respiratory on-call service provision, audited against A.C.P.R.C. Standards (A.C.P.R.C. 1996).

Ntoumenopoulos and Greenwood (1991) found 43% (n=18) of Australian cardiothoracic intensive care units only offered physiotherapy cover during the normal working day. Jones *et al* (1992), found 24-hour access to chest physiotherapy in intensive care units in the U.K., Australia and Hong Kong was available in 97% (U.K.), 49% (Australia) and 0% (Hong Kong). Regular out of hours services (e.g. evening shifts) ran in 16% of U.K., 41% of Australia and 6% of Hong Kong intensive care units. This latest study, however, did exhibit several methodological challenges, including small samples sizes.

Hewitt and Bradley (2002) showed that over a five-week period in a teaching hospital, 180/211 call out episodes were pre-planned by the day physiotherapist (170/180 were deemed appropriate by the attending on-call physiotherapist). The planned call out rate equates to approximately 1.7 planned calls per night.

## Training and support

Parry (2001) surveyed 187 junior physiotherapists, to ascertain their perceptions of on-call working. From the 123 respondents the major concern was a lack of confidence during initial on-call experiences. Of these physiotherapists, 49% had undertaken their first on-call within three months of starting work and 11% within one month.

## Method

Information was collected via a postal questionnaire. The questionnaire was designed to elicit basic physiotherapy respiratory on-call organisational data and opinion, using a mixture of open and closed questions (Oppenheim, 1992). The questionnaire was piloted locally amongst respiratory clinicians, modified and re-drafted to improve clarity and predictive responses. The final questionnaire, with a covering letter explaining the aims of the survey, was distributed to all senior physiotherapists who expressed an interest in the U.K. wide A.C.P.R.C./C.S.P. on-call competency launch conferences during 2002. This was a convenience sample from the target population of physiotherapists involved in managing on-call services.

## Results

In total 235 questionnaires were sent to senior physiotherapists in different physiotherapy services. 204 fully completed questionnaires were returned. Thus a response rate of 87% was achieved.

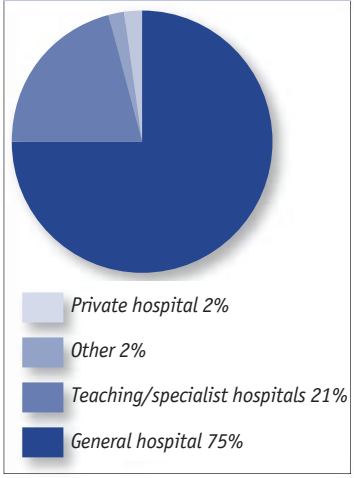
Descriptive statistics were used to analyse the closed data. Open data was analysed using thematic analysis, agreement of meaning was sought from an expert panel of respiratory physiotherapists in order to optimise reliability.

## Demography

**Question 1 – How would you describe your work setting?**

Figure 1 shows the demographic mix of responding physiotherapy services. The 2% 'other' section represented community based or primary care services.

FIGURE 1. Pie chart to show mix of employers represented within the sample




**Question 2 – a. What is the total number of WTE qualified physiotherapists employed by your trust?**
**b. How many WTE physiotherapists do you have on your call rota?**

Table 1 shows that 58% of respondents had over 50% of their staff working as part of the rota.

**Question 3 – Do you run any of the following? If so please explain: Seven-day working; Evening Shifts; Other**

An "evening shift" was offered by 7% of respondents, the organisation of these varied and several were under review regarding their cost efficiency. Four respondents were considering introducing evening shifts in an attempt to try and reduce their on-call workload and assist staff to maintain their clinical skills. No services offered a seven-day service (excluding weekend emergency duty)

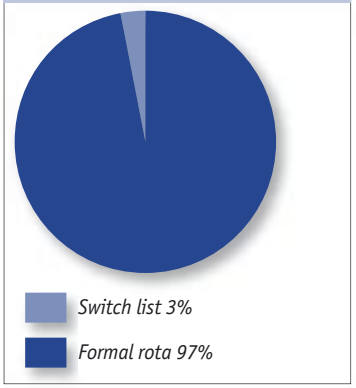
TABLE 1: Table to show the percentage of whole time equivalent staff currently undertaking on call duties at each hospital

| Percentage range | Percentage of staff who work as part of the on call rota |
|---|---|
| 0-25% | 12% |
| 26 – 50% | 30% |
| 51-75% | 45% |
| 76 – 100% | 13% |

**Question 4 –Do you run a formal on-call rota?**

A formal on call rota was run in 97% of respondent services. The remaining 3% (6) of hospitals ran a 'switch list' where switchboard would ring down staff contact numbers to find a willing volunteer.

FIGURE 2 – Pie chart to show percentage of organisations running a formal on call rota




**Question 5 – Do the staff that are not on the respiratory rota, have any other weekend/evening Trust work responsibilities?**

The results are demonstrated in

FIGURE 3. Pie chart to show percentage of staff that, in the absence of agreed suspension of respiratory on call commitments, had other departmental out of hours responsibilities

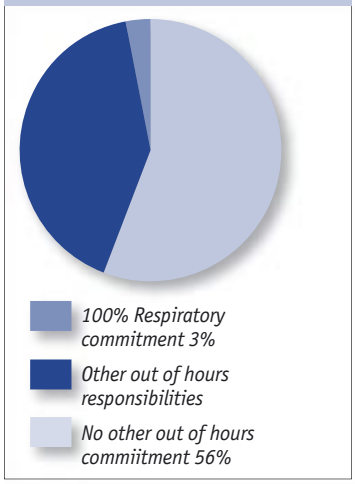



figure 3.

**Question 6 – Which staff groups are not expected to be part of the week/end/on call respiratory rota?Considered which staff groups?**

The only consistent staff group appeared to be Superintendent III (32%).

Reasons given were: -

- Maximum of senior 1 pay for out of hours respiratory on-call commitment.
- Managerial out of hours commitments outside of the physiotherapy department.
- Some met departmental criteria for exemption e.g. carer responsibilities.
- Time and support for training
- Length of time since last regular in-patient work.

**Question 7 – Do you have a respiratory on-call policy? (Please attach a copy: not included here)**

An on-call policy was in place for 79% of respondents. These varied from guidance on calling out a physiotherapist and payment issues to detailed and specific policies. The remainder had no documented policy informing their on-call service.

**Question 8 – a. How many respiratory senior I (i) and superintendent III/clinical specialist (ii) are you budgeted for?**

How many of these posts are currently vacant (i) and (ii)

Table 2 shows the stated departmental cardio respiratory vacancy rates, in the summer 2002.

TABLE 2. to show vacancy rates for senior cardio-respiratory physiotherapy posts (Summer 2002)

| Cardio-respiratory | Vacancies | Available posts | Percentage vacant |
|---|---|---|---|
| Physiotherapists | | | |
| Senior I | 75 | 456.2 | 16% |
| Supt. III | 16.5 | 147.5 | 11% |

## Training and Education:

**Question 9 – What respiratory experience has junior staff had before starting on call?**

None; Student Placement; Respiratory rotation; In-service training; Other?

This question was not answered by 3% (n=6) of respondents reporting that they did not employ newly qualified staff.

In answer 61 (31%) of the remaining sample reported that new junior staff were required to complete a respiratory rotation prior to commencing on-call work. The remaining 69% (135) of services relied upon a combination of student experience and in-service training/induction before respiratory on-call work was undertaken. All respondents reported that either a respiratory rotation and/or induction were undertaken prior to starting on-call working.

**Question 10 – Do you assess in any way that Junior Staff are adequately prepared to start working on call? (please attach any documentation used)**

Of the 97% employing newly qualified staff, 81% (165) stated that new staff grade physiotherapists were assessed prior to commencing on-call working, 32% (53) of these had devised formal competency check lists to help guide staff in the knowledge and skills required. The remainder undertook bedside, informal assessment of clinical reasoning and skills used during induction periods The remaining 16% (33) of new staff grade physiotherapists were not clinically assessed prior to on-call working.

**Question 11 – Do you assess in any way that new starters (other than new juniors) are adequately prepared to start working on-call? (please attach any documentation used:** *not included here)*

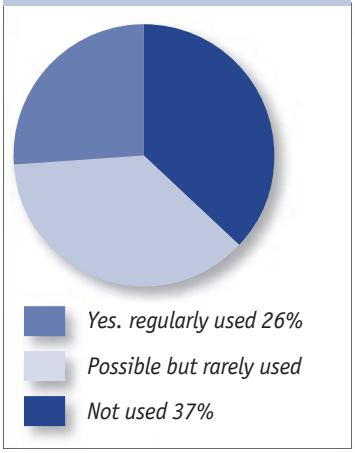
All respondents answered this question stating that new starters (who were not new staff grade physiotherapists) received local induction to on-call working. 77% (177) of hospitals did assess the clinical ability of new staff, only 17% (27) with a competency assessment.

**Question 12 – Do staff shadow an on call before they join the rota? Yes always, yes usually, sometimes, never.**

The opportunity for shadow on-call existed within 26% (53) of services, 37% (75) remarked that it was possible, but rarely undertaken and 37% (76) stated that it was not available within their service.

**Question 13 –Do you have any telephone support mechanisms in place for staff on-call?**

FIGURE 4. Pie chart to show usage of shadow on call episodes to support training




Unofficial phone call, official voluntary rota, official paid rota, nothing.

Informal unpaid telephone support was offered in 72% (147) of services.18% (37) of hospitals offered a planned telephone support to staff on a regular basis again this was unpaid. A paid support system was available in 8% (16), generally in the shape of a buddy system for the first few on-calls to gradually launch new staff or existing staff accommodating to a new environment. 2% (4) of services offered no telephone support out of hours.

**Question 14 –Do you offer training to keep staff updated?**

Training to support on-call working was available in 97% (199) of services, 3% (5) stated that it was not possible to offer training due to staff shortages.

**Question 15 – Do you feel that you have adequate staffing/resources to undertake this training in-house?**

In reply 64% (131) of respondents felt that there was neither the time nor the support available. 36% (73) of respondents stated that there was the time; however 4 respondents qualified this by adding that they did the preparation in their own time and the training was during lunch breaks.

**Questions 16 and 17 – Has your department received any funding for on-call training within your hospital? Has the work force development confederation or similar bodies within your region funded any on-call training?**

Only 12% of respondents had been able to access external training funds to support training for on-call, e.g. local Workforce Development Confederations, the Welsh Assembly etc. Comments described other ways of obtaining this training, for example, hospitals had traded expertise across neighbouring Trusts to achieve skilled specialty training for no cost.

**Question 18 – Have you had any serious recorded clinical incidents/adverse events during on call/weekend working, within the last two years?**

Please describe briefly (this is confidential)

Adverse clinical incidents had been reported in 10% (20) of services. The incidents are confidential, however, respondents revealed that staff or transport not being available could account for only 4 of these. The majority of adverse clinical incidents were relatively minor, one serious, but reversible incident was reported. 2 reports related to other disciplines, untrained in physiotherapy skills, undertaking on-call respiratory physiotherapy.

**Question 19 – Examined the out of hours care of paediatric patient.**
**Do non-paediatric specialist staff treat paediatric patients on call and at weekends?**

68% (136) of respondents answered yes

If you have a neonatal unit, are your staff expected to cover this unit on call and at weekends? 21% (43) of respondents answered yes. Of these services, 3% (4) stated that they were unable to offer any specific paediatric training to staff. The respondents who answered no, either did not offer this service or had no paediatric patients.

**Question 20: What is the general feeling about on-call within your service?**

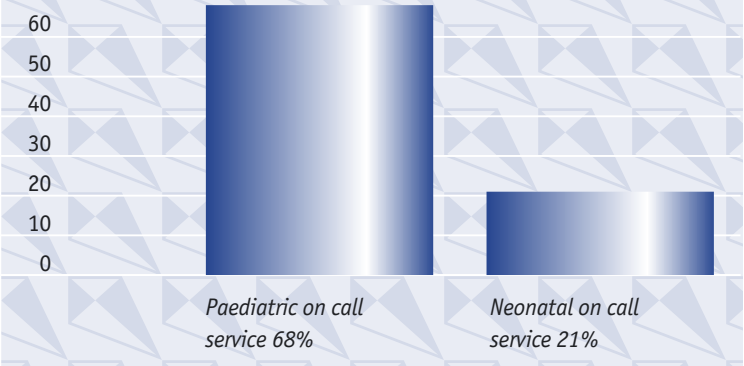
Respondents stated that the following were important factors in successful service delivery

- The development of confident and competent staff, who feel that their contribution is valued.
- The better-supported on-call staff felt, the more harmonious the service appeared.
- On-call needed to be seen as a departmental responsibility.
- The attitude of senior clinicians determined the smooth running of the service.
- Managerial support and involvement in the running of the service was deemed essential.
- Bidding for appropriate on-call funding.

Concern was shared in the following areas: -

- The impact of the appropriate local interpretation of the European Working Time Directive on services.
- Chronic under-funding and the fact that new developments rarely included on-call costs.
- Insufficient time and resources for training.
- Inequitable expectations of staff
- The impact of on call on the

FIGURE 5: Chart to show percentage of organisations offering paediatric on call services




recruitment and retention of all staff groups.
- Availability of suitable student cardio-respiratory placements
- The demands of a variety of out of hours commitments (e.g. weekend orthopaedic working)
- The clinical time needed to maintain confidence and competence.

## Discussion

**Limitations of the work**

The questionnaire design used in the survey offered access to a wide population. It is acknowledged that the method of distribution will have introduced an element of response bias, which may pose a threat to the overall validity of the work. Services that no longer ran on-call would not be represented. It could be argued that hospitals with staffing problems may not have requested details of the conferences. The results showed that there was much representation from services with profound staffing shortages that were looking for help and support. In these instances managers or other clinicians had taken on responsibility for running the service. There were also many hospitals/Trusts represented who ran excellent on-call services.

## Service delivery

The survey suggested that the majority of services had in excess of 50% of their staff working as part of the on call rota. Northern Ireland showed the highest levels of participation. The majority of small hospitals were very reliant upon bank staff to maintain an appropriate frequency of on call working; this raised other issues of how to assure appropriate training, review and support.

The clinical risk issues of 6 services running a 'switch list' was cause for concern. If an appropriate request for physiotherapy is made out of hours and the service is unable to deliver there is a failure in our duty to care for the patient. The second area of risk was from other health care staff untrained in physiotherapy skills undertaking this work out of hours, if these staff are expected to offer this skill out of hours they must be trained and supported to do so safely.

Several variations to a formal nightly rota emerged:

- One service ran a physiotherapy led pre-arranged call out service only, with no provision for emergency care, this was financially driven and under review.
- Due to generally quiet on call, one service ran a weekly on call rota
- Several respondents reported situations where, to support highly specialist or growing services, one individual would unofficially find themselves constantly on call.

All service provision should be supported by an organisational policy (A.C.P.R.C., 1996) the absence of such a policy (21% of responses) was unexpectedly high. This poses a major challenge to the management of these services.

The reporting of clinical incidents appears less meaningful than on first impression. Operational issues and isolated complications were recorded, however potentially inappropriate, inadequate or unsafe treatment cannot be captured.

The majority of respondents highlighted the challenges of maintaining appropriate paediatric and neonatal on call services. The inability of some services to support training in these areas is very concerning.

The Neonatal Physiotherapy Clinical Interest Group have advised the on call working party that out of hours physiotherapy to neonates must only ever be undertaken by staff fully competent and experienced in the treatment of this complex client group. They advise the appropriate competency training and support of nursing staff, in place of on call physiotherapy.

In response to the above findings, specific guidance and examples have been included, where possible, in the CSP information paper (PA57) Emergency Respiratory On Call Working: Guidance for Managers (Chartered Society of Physiotherapy, 2003)

## Staff issues

Open questioning following question 5 revealed that the inequitable expectations of staff to commit to the department's out of hours services was repeatedly highlighted as a major cause of staff dissatisfaction. In the absence of clear policies

regarding who is expected to work out of hours, there is the potential for much inequity to develop. One unit solved this problem by establishing a cross departmental committee, which was responsible for the running of the physiotherapy on call-service.

The increasing complexity of patients and the need to support staff effectively, places a greater responsibility upon senior staff to support staff out of hours. Within the sample, 90% of respondent hospitals had an informal expectation that senior staff would offer unpaid telephone support out of hours. Dixon and Reeve (2003) showed this to be as high as 100%. Parry (2001) showed that 92% of her sample had a means of accessing senior support out of hours and 84% stated that this increased their confidence. The resultant pressure upon senior staff cannot be underestimated; several services reported planned support.

Frustration with managing, supporting and training staff on an on-call rota appeared a major attrition factor in the recruitment and retention of senior cardio-respiratory physiotherapists. The survey showed that for the sample of cardio-respiratory senior physiotherapists, the summer 2002 vacancy rates stood at 11% (Senior I) and 16% (Superintendent III). No specific comparisons could be found. Recruitment for the survey may have skewed response from units with good staffing, as poorly staffed areas may not have had time to be involved, anecdotally this did not appear to be the case.

## Training and support

Training was a common area of concern. Resources and time for appropriate training and support were highlighted as inadequate and becoming more challenging due to increasingly complex patients, junior staff with no clinical respiratory experience, or staff moving to Community/ Primary Care Trust contracts.

If staff are to meet their responsibilities under Rule 1 of the CSP Rules of Professional Conduct (2001) and the HPC Standards for Physiotherapy Registrants (2003) they will need to be supported to undertake the required training and exposure.

Information paper PA53 (Emergency Respiratory On Call Working: Guidance for Physiotherapists) (C.S.P., 2003) sets the competence level as that of a qualified physiotherapist who has been inducted to the area and appropriately skilled to meet the needs of patients – not an expert. Thomas *et al,* (2003) highlights the importance of domain specific knowledge, which is learned through experience within a particular work environment and implies the need for time in the clinical setting. Open questions repeatedly highlighted respondents' fear of the lack of student placements, high workloads and the need often to expedite involvement in on call due to low staff numbers. Formal assessment of learning needs and ability is the key to cost effective training and appropriate support that supports the stance that staff should undergo some form of documented assessment (C.S.P., 2003) that should then be fed into the Individual Performance Review process to enable staff to access the support and resources required. This will be developed further by the advent of the knowledge and skills framework.

Question 10 showed that 32% of respondents underwent some formal, documented assessment, several respondents who stated that there was no formal process attested to bedside discussions leading to an informal assessment of ability. This was also a reflection, in several cases, of the absence of senior cardio-respiratory staff to support such a process. Dixon and Reeve (2003) showed that 11/18 respondents had agreed standards of practice, with the majority undergoing an informal assessment of "competence". The majority of the competency documentation received alongside the questionnaire took the form of a tick list of skills. Competency checklists alone may not capture the clinical reasoning and ethical decision-making processes as well as the safe application of practical skills that are key issues in determining on call competence (Thomas *et al,* 2003).

It was surprising that other new staff only received formal documented assessment in 17% of cases. Comments suggested that staff were not keen to challenge new staff on their ability, for fear of them refusing to take part in the rota, or out of respect for their expertise in another area. Staff may view such assessment as a threat, although PA53 (CSP 2003) suggests that assessment should be constructively focused on learning needs to identify training and support required.

The results suggested that 16% of newly qualified staff and 23% of established staff did not undertake any form of assessment prior to working on call. This poses significant clinical governance concerns for the employers.

The opportunity to shadow on call appeared frequently in open questioning as a means of supporting staff. Many respondents commented that, although offered, the opportunity was rarely used. Parry (2001) showed that 24% (30/123) of her sample had shadowed at least one on call episode. PA57 (CSP 2003) emphasises the shared responsibility of staff, clinicians and managers in supporting staff to work on call. Thus it is the responsibility of all three parties to make the option available and appropriately remunerated, but also to take up the offer and to ensure the process is a valuable

learning experience.

Open questioning suggested that the fear of on-call is often the result of early, unsupported feelings of fear or inability to help. Thomson (2003) showed, that 6/14 (43%) of staff grade physiotherapists admitted to feeling frightened on the occasion of their first on call. She added that with undergraduate training in cardio-respiratory care often just a distant memory – the result showed a wide variation in the preparation of staff for on call working. Care of the critically ill patient has been cited as a key stress factor for newly qualified physiotherapists (Mottram and Flynn, 1998).

Ongoing training was available to staff in 97% of the sample. The 3% unable to offer training cited staff shortages to undertake the training as the barrier. Respondents cited many of the barriers to training of staff e.g. learning/teaching time being reduced by pressure of work. Parry (2001) showed that 110/123 (89%) of her sample had received training.

There were many examples of highly innovative practice leading to the creation of training posts, excellent university links and the development of pooled training and support either across Trusts or with critical care outreach teams. Some areas have accessed local funding very successfully. Some areas of Wales appeared to have been particularly successful in securing funding from the Welsh Assembly.

The questionnaire did not examine the documentation and monitoring of on call services, as the purpose of the study was to determine a baseline of organisational data.

## CONCLUSION

The survey has provided useful data to inform the ongoing work of the ACPRC. and offers a valuable snapshot of the reality of the UK's on call service provision The survey has, however, identified a number of problems encountered in managing, training and supporting an on-call physiotherapy service. The concerns raised in the study have been addressed as part of the CSP information papers PA53 (C.S.P., 2003) and PA57 (C.S.P., 2003). Innovative management is required to modernise services, take advantage of developments and funding opportunities and to work collaboratively with local healthcare (including the private sector) and university partners.

## Acknowledgements

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# Reliability of Vibrations and Shaking as a Respiratory Technique

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## Summary

*Vibrations and shaking are techniques used as an airway clearance technique for almost 50 years with little evidence of effectiveness. The technique is dependent upon therapists' interpretation of compliance of the chest wall and applying appropriate forces. This study aimed to assess consistency of forces used during vibrations and shaking incorporating a method measuring forces via a force platform.*

**Key words:**

**Vibrations,**
**Shaking,**
**Consistency,**
**Forces**

## Introduction

Vibrations and shaking are techniques used within physiotherapy in the management of patients with respiratory problems. These techniques are characterised as rapid oscillating movements performed by the physiotherapist's hands over the chest wall. Kohlrausch first described them in 1953 (cited Doering *et al*, 1999), which noted an increase in the clearance of lung secretions that occurred during the treatment of patients with this technique. McCarren *et al* (2003) highlighted the technique is frequently used by physiotherapists, yet the evidence base is weak. Bott (1997), describes the techniques as being difficult to study as therapists have a different method of performing them. The hand position and frequency and amplitude of the oscillations can vary tremendously with the actual determination of the amount of compressive force applied, being left to the therapists' discretion (Pryor, 1992). Forces applied to the chest wall by physiotherapists differ in accordance with its compliance. This can be reduced when the mobility of the chest wall is impaired by several conditions, including ankylosing spondylitis, obesity, the skeletal changes, which accompany ageing, including the ribs, and the state of ossification of the costal cartilages (Nunn, 1993).

As each patient is different in terms of chest wall compliance as well as their underlying pathology, a physiotherapist will alter techniques accordingly. However, questions that arise are whether a physiotherapist will use the same force

consistently with the same patient and also whether different physiotherapists will use similar forces with the same patient. An extension of this line of inquiry is whether experience affects consistency of technique.

Studying the reliability of vibrations and shaking may answer these questions. Reliability refers to the reproducibility and consistency of a measurement and can be used to examine homogeneity and the degree of random error (Bowling, 1997). The concept of reliability can be applied to any technique that generates quantitative data, whether it is a measurement tool or not (Bruton et al, 2000). Thus, the theory of reliability can be adapted for this study to examine the consistency of force produced during vibrations and shaking.

Reliability is generally measured using a correlation coefficient (Polgar & Thomas, 1998). Correlation coefficients are concerned with expressing quantitatively the degree and direction of the relationship between variables. Rankin and Stokes (1998) carried out a statistical analysis of reliability studies, assessing the advantages and disadvantages of Intra-class Correlation Coefficients (ICC's), the coefficient of variance and the Bland -Altman Tests. Although each test has advantages and disadvantages, Rankin and Stoke (1998) recommend that for a study of inter- and intra-tester reliability an ICC is by far the best test to use.

The aim of this study was to assess intra-rater and inter-rater reliability of shaking and vibrations of student and qualified physiotherapists.

## Method

**Study Design:**
A within day reliability study was undertaken.

**Consent:**
The University of Wales College of Medicine Undergraduate Research and Ethics Sub-Committee approved the study and informed consent was obtained from each subject prior to the study. A risk assessment was carried out, which classified the procedures in this study as trivial.

FIGURE 1. Position of Tester and Subject

**Subjects:**
Two senior II physiotherapists and two 3rd year physiotherapy students performed the techniques on 14 subjects. The subjects were chosen as a convenience sample, the qualified physiotherapists from a local hospital, the students from the Department of Physiotherapy Education, University of Wales, College of Medicine. The 14 subjects were randomly selected from the student population from the above department.

**Instrumentation:**
A Kistler Type 5233A piezoelectric force plate was used to measure the amount of force transmitted through the subjects' thorax during a vibration shaking. Signals from the force plate were measured at 100Hz and digitally relayed to VICON 512 Work Station – a computerised data acquisition and analysis station. According to the manufacturer's specifications the components of the force vector being measured can be determined with an error of less than 2%. Schmiedmayer and Kastner (1999) note that although errors of up to ±30mm have been reported when determining the point of application with this type of force plate due to the potential bending at the surface of the active force-plate, these can be avoided by keeping the point of force application as central as possible within the plate, as long as the platform is set up correctly.

**Procedure:**
The two physiotherapists and two students were to represent the four testers and were named as follows: Student A, Student B, Physiotherapist A and Physiotherapist B, with each subject being attended to in this order. All four testers were given a pre-written scenario to ensure that they all treat the subject with what they interpret as an appropriate amount of force. The scenario read as follows:

*This patient is 48 hours post-surgery, with a horizontal trans-abdominal incision. He/she has no previous respiratory complication, however, due to pain from the abdominal incision, is unable to independently clear secretions. As a result, you can hear fine crackles bi-basally on auscultation.*

Each subject was required to remove their upper-garments so a T-shirt covered their upper

body only. The subject was asked to lie on a mat with their rib cage central over the force platform, see Figure 1. The force reading was set to zero. The subject was instructed to take a deep breath in and on exhalation a vibration was performed. This was repeated twice and the whole procedure was repeated for shaking.

Each tester repeated this complete procedure for all fourteen subjects.

**Data Collected:**
For each set of three vibrations and three shakings carried out by the four testers, VICON 512 recorded the forces picked up by the force-plate during each tester's three vibrations in form of a graph. Each graph was subsequently processed using MatLab 10, which interpreted the forces, organising the data into three peak force readings in Newtons that could be tabulated for further analysis.

**Analysis of data:**
Inter-tester and intra-tester reliability for vibrations and shaking was analysed statistically using the intra-class correlation coefficient. The descriptors are based on Landis and Koch (1977) see Table 1 below:

## Discussion

The results of this study indicate that intra-tester reliability is higher than inter-tester reliability for both vibrations and shaking. In real terms this indicates that a patient will receive more consistent treatment from a single physiotherapist than if they are treated by a number of physiotherapists within the same day. Intra-tester reliability for shakings was similar between qualified and student physiotherapists, yet was notably lower when students performed vibrations. This could be due to vibrations being possibly a 'higher level' skill to shaking and therefore students were less consistent in their technique.

The results for inter-tester reliability seem to confer with Pryor (1992) that performance of the technique is left to therapists' discretion. Doering et al, (1999) state that the technique may differ in force, frequency and direction in qualified therapists, so the differences would be presumed to be higher in students. In fact, the inter-tester reliability was higher than that of the senior physiotherapists. The low inter-tester reliability of senior physiotherapists may be due to the fact that tester 4 (qualified) had shoulder problems during the testing. This may have resulted in differences in the forces applied. Although this was not ideal for a research study it does mirror real life, as the shoulder problems were not sufficient for the therapist to be off work.

The forces measured were those that reached the force platform and does not take into consideration those that were dissipated through the chest wall. However, for each patient the dissipation should be similar as the chest wall compliance would be unchanged. An observation made by the therapists during the procedure was the effect of chest wall compliance on forces produce. What the therapists perceived as a less compliant or "stiff" chest tended to have considerably higher peak force reading than those with more compliant chests. This was thought to be due to the way the structures of the thorax absorb forces applied by the therapist, the more compliant chests with greater pliability at the joints absorbing a greater proportion of vibrational energy from the therapist's hands and therefore less energy being transmitted to the force plate. The study could have been improved by allowing a "practice" vibration to get a feel for the compliance of the chest before the three readings were taken. In a true clinical setting the therapist would carry out vibrations more than three times on a patient, therefore they would be able to establish a feel for the compliance of that patient's chest and perhaps be able to improve the consistency of force they used throughout the treatment session.

Other factors that may have affected the results were the position of the subject and the therapist. Lying on the floor is obviously not the position a patient would be treated in and the therapists had to assume

TABLE 1. Interpretation of intra-class correlation coefficients (ICC)

| ICC | Interpretation |
|---|---|
| 0.00-.02 | Slight reliability |
| 0.21-.04 | Fair reliability |
| 0.41-0.6 | Moderate reliability |
| 0.61-0.8 | Substantial reliability |
| 0.81-1.0 | Excellent reliability |

## Results

TABLE 3. Intra-class correlation co-efficient for Intra-tester reliability

| | Overall | Qualified | Student |
|---|---|---|---|
| Vibrations | 0.82 excellent | 0.83 excellent | 0.49 moderate |
| Shaking | 0.84 excellent | 0.77 excellent | 0.90 excellent |

TABLE 2. Intra-class correlation co-efficient for Inter-tester reliability

| | Overall | Qualified | Student |
|---|---|---|---|
| Vibrations | 0.082 slight | 0.09 slight | 0.37 fair |
| Shaking | 0.05 slight | 0.18 slight | 0.32 fair |

unnatural positions to carry out the techniques. This reduces the external validity of this study.

Although this study does assess effectiveness of treatment, consistency of treatment is a component of its effectiveness. Further research could incorporate assessment of reliability of frequency of vibrations and shakings. Van der Schans (1999) reports that mucociliary clearance is dependent upon frequency of the manual technique, with frequencies of 10-15 being most effective. Research may then be further refined to assess effectiveness of treatment in patients.

## Conclusions

This study highlighted the inconsistency in vibrations and shakings when carried out by qualified and student physiotherapists. Although intra-tester reliability was moderate to excellent – inter-tester reliability was slight to fair. These inconsistencies may be due to real differences in technique or procedural effects such as positioning of the subject and therapist. Further studies into between day reliability may give further insight into this area incorporating a preliminary number of vibrations to assess chest wall compliance. If consistency is low between therapists this could be improved by further training using a force plate as a measuring tool. If interventions are consistent – studies into efficacy of treatment may be more conclusive. Further research may incorporate measurement of frequency of techniques enabling analysis of multiple components of the techniques.

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# Can the Interrupter Technique be used as an Outcome Measure for Autogenic Drainage in Bronchiectatic Patients? A Pilot Study.

**Completed as part of MSc Cardiorespirtory Physiotherapy, University College London, August 2000.**

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## SUMMARY

*Valid outcome measures in respiratory physiotherapy are lacking. The interrupter technique may be a potential tool in measuring airway calibre pre-and post chest physiotherapy. The following article will discuss current literature surrounding the technique. If validated, the interrupter technique might provide a viable alternative to spirometry, an effort dependent technique that can be tiring and potentially provoke bronchospasm.*

## Introduction

Clinical effectiveness is difficult to establish in the respiratory outpatient setting for patients with adult bronchiectasis. Outcome measures that have been previously used in studies and commonly used in practice, such as sputum weight, sputum volume and spirometry, are seriously flawed (Prasad & Main, 1998). A potential alternative is a measure of airway resistance using the interrupter technique via a portable device called the MicroRint (MicroMedical).

The MicroRint calculates interrupter resistance (Rint), a measurement of airway resistance based on pressure difference and flow following a brief period of interruption during the inspiratory and expiratory phases of the respiratory cycle. Airway resistance is the pressure difference between the alveoli and the mouth divided by flow rate (Lumb 2000, p77). The interruption technique works on the principle that when the airway is suddenly occluded, alveolar pressure (Palv) will equilibrate with pressure at the mouth (Pmo). Rint can then be calculated as the ratio of post- occlusion pressure change at the mouth to the flow rate immediately prior to occlusion (Bates et al, 1987a; Bates et al, 1988a; Phagoo et al, 1993).

The interruption technique is beneficial over other techniques in that it requires minimal co-operation, can be performed during quiet breathing, does not tire the patient, has not been found to cause bronchoconstriction (Bridge et al, 1999) and interruption

devices, such as the MicroRint, are portable.

The sensitivity of Rint has varied in comparison to current methods of measuring airway resistance (Chowienczyk et al, 1991; Morrison et al, 2003; Phagoo et al, 1993). However, it is not known whether the technique can be used in adult bronchiectatic patients. If measuring Rint in patients before and after physiotherapy can show a reduction in airway resistance, physiotherapists could compare sputum clearance techniques in individual patients, use Rint as an outcome measure for research and ultimately promote clinical effectiveness.

## Aims

This pilot study aims to investigate the feasibility of the measurement of airways resistance by the interrupter technique in adult bronchiectatic patients and whether changes in airway calibre following sputum clearance can be detected using the technique.

## Hypothesis

- Sputum clearance will reduce airway resistance and this will be detected by a reduction in Rint.

## Null hypotheses

- Sputum clearance may reduce airways resistance, but this will not be detected by a reduction in Rint.
- Sputum clearance will not reduce airways resistance.

## Study design

The study design was quasi-experimental using a single subject repeated measures design (Polit & Hungler, 1999 p183, p222). This approach was structured by means of the randomised controlled trial using quantitative data collection methods (Bowling, 1997 p109-110).

TABLE: 1 Sample Demographics

| ID No | Sex | Age | Height | FEV1/ FVC % pred | Previous Surgery | Smoking History |
|---|---|---|---|---|---|---|
| 1 | F | 52 | 164 | - | No | None |
| 2 | M | 76 | 168 | 51 | No | None |
| 3 | F | 58 | 164 | 68 | No | None |
| 4 | M | 59 | 161 | 57 | Left Lower Lobectomy | None |
| 5 | M | 64 | 180 | - | No | 20 per day |
| 6 | M | 67 | 176 | 70 | No | None |
| 7 | M | 84 | 170 | 65 | No | None |
| 8 | F | 58 | 146 | 88 | No | None |
| 9 exc | F | 40 | 162 | 82 | No | 1 per day |
| 10 | M | 63 | 167 | 94 | Left Lingula Lobectomy | None |
| 11 | M | 63 | 169 | 54 | No | None |
| 12 | F | 70 | 159 | - | No | None |
| 13 | F | 73 | 147 | 82 | No | None |

Exc = Excluded F = Female M = Male pred = Predicted

## Ethical approval

The Doncaster Local Research and Ethics Committee (LREC) approved the study. Informed consent was obtained from each patient prior to his or her inclusion in the trial and the patient was allowed to withdraw at any time (Polit & Hungler, 1999 p136-137).

## Sample

A convenience sample of 13 consecutive patients referred for outpatient physiotherapy over a period of six months at the Northern General at Sheffield was used. Table 2 describes the inclusion and exclusion criteria for the study.

Patients were randomly assigned by sealed envelope to Group 1 treatment followed by control or Group 2 control followed by treatment (Polit & Hungler, 1999 p221).

## Apparatus

The interrupter device used for this study, the MicroRint (MicroMedical Ltd, UK), has been calibrated and validated in previous published and unpublished studies (Kannisto et al, 1999; Jones et al, 1999) and a preliminary study by the author. The MX200 (My Weigh Pocket Scales Ltd, UK), with a sensitivity of 0.1grams (g), was used to weigh sputum.

## Method

**The Interrupter technique**
Rint measurements were taken in the upright sitting position with the elbows supported during quiet tidal breathing. A valve inside the machine occluded when peak tidal flow was reached. A maximum of 10 readings were taken during expiration and then during

TABLE 2: Inclusion and Exclusion Criteria

| Inclusion Criteria | Exclusion Criteria |
|---|---|
| Adult, bronchiectatic patients under the care of consultants at the Northern General Hospital in Sheffield. | Acute respiratory illness. |
| In a stable condition. | Unfamiliar with the autogenic drainage technique. |
| Competent in autogenic drainage and using the autogenic drainage technique as part of their sputum clearance regimen. | Unable to give informed consent |
| Copious producer of sputum (greater than 30 mls per day) | Used bronchodilator, steroids or cromolyn within 1 hour of assessment. |
| | Patients unable to complete a 30-minute session of autogenic drainage during the assessment. |

inspiration. Closure of the valve should not be felt, although a click can be heard. A test measure of Rint was taken in order to demonstrate the technique and familiarise the patient with the machine. The patients' cheeks and pharynx were supported and nose clips were worn.

**Sputum Weight**
Cumulative weight of sputum was then measured at each Rint measurement. Patients were requested not to swallow their sputum.

**Treatment group**
A set of Rint measurements were taken (t=0) and repeated after 30 seconds to establish repeatability (Bridge et al, 1999). Autogenic drainage, as described by Schoni (1989), commenced in a relaxed sitting position for 30 minutes. Rest intervals were provided as necessary if the patient wished. A set of Rint measurements were taken immediately following autogenic drainage (t=30), 15 minutes post treatment (t=45) and 30 minutes post-treatment (t=60). Cumulative sputum weight was calculated at the time of Rint measurements.

**Control group**
Method as above, but patients sat in a relaxed position for 30 minutes instead of receiving autogenic drainage.

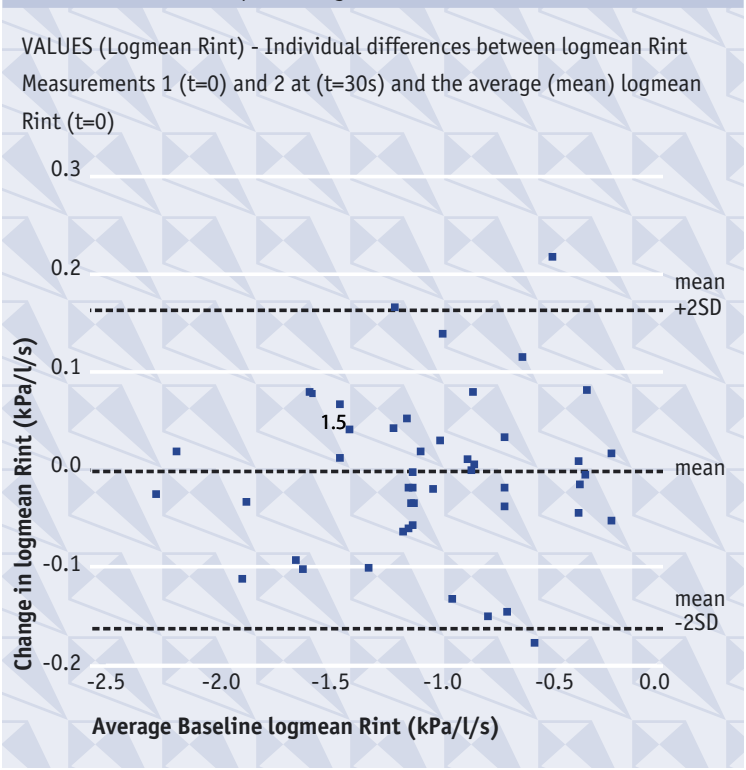
## Data analysis

**Statistical Tests**
Exploratory analysis was conducted using SPSS package version 11.0 The Univariate ANOVA was used in order to analyse response to treatment. Where data was skewed (Altman, 1991 p36-38), natural logarithms of the data were calculated in order to allow analysis (Altman, 1991 p61, p143). Normality of distribution was established by conducting normal plots of the data (Altman, 1991 p133) and using the Kolmogorov- Smirnov single sample test.

Repeatability was assessed using the repeatability co-efficient (twice the standard deviations of differences between the first and second sets of Rint measurements 30 seconds apart at baseline) (Bland and Altman, 1986). Bland Altman plots were constructed as this allowed easier interpretation of the repeatability co-efficient (Bland and Altman, 1986). Correlations were explored using the Pearson's product moment (r) test (Altman, 1991, p293).

**Statistical Significance**
P values of less or equal to 0.05 ($p \leq 0.05$) will be considered as a guideline of statistical

FIGURE 2: Bland Altman plot for logarithms of mean Rint



significance, but the value of P is given in order to allow individual interpretation (Bowling, 1997 p150-151; Altman, 1991p 169).

**Results**

One patient failed to attend for the treatment session due to illness and was therefore excluded from analysis.

Logarithms of data were used for analysis following assessment of normality of distribution. Repeatability co-efficient was 13.5%. Repeatability is displayed in Figure 2.

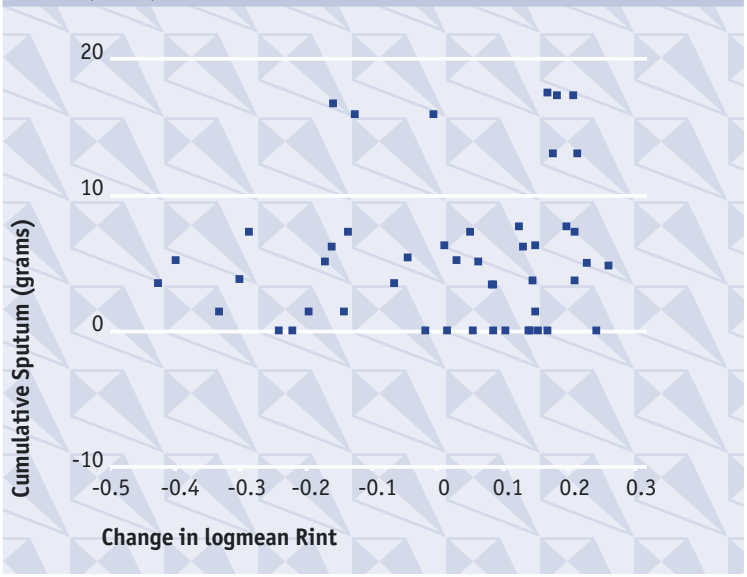
**Response to treatment**

No significant difference was found between control and treatment for session and time point (p=5.33 and p=5.35 respectively). Rint values for each time point are displayed in Figure 3.

**Sputum**

Significantly more sputum was produced during the treatment session (mean 9.4grams (g) compared to the control (mean 1.7g) (p=0.000). Significantly more sputum was expectorated at 30 minutes (p=0.000) than at 45 (p=0.308) and 60 minutes (p=0.359). No correlation was found between cumulative sputum and logmean Rint values at 60 minutes (p=0.989) or change in Rint from baseline (t=0) to the end of the session (t=60) and cumulative sputum production at 60 minutes (p=0.387), (Figure 4).

FIGURE 4: Scatter diagram for change in logmean Rint and cumulative sputum (grams)




## Discussion

**Normal Distribution**

The skew of data before logarithms were conducted and Kolmogorov-Smirnov tests for single samples suggest that a larger sample number was necessary (Altman, 1991 p157).

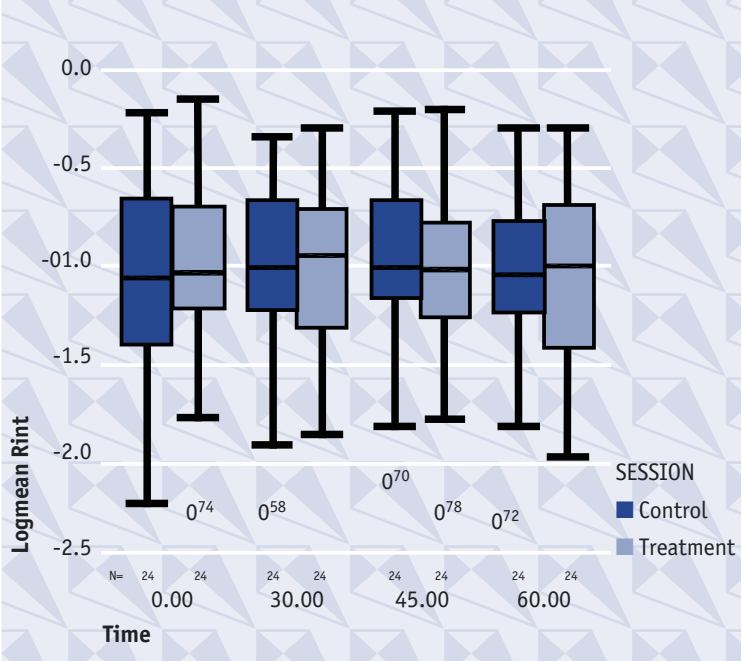
**Repeatability**

It can be seen from the Bland Altman Plot Figure 2 that most of the changes in Rint values are within 2 standard deviations of the mean (45/48, 94%). Repeatability co-efficients compare well to other studies involving subjects with lung disease (Kannisto et al, 1999; Bridge & McKenzie, 2001).

**Effects of Physiotherapy Intervention**

No changes in overall changes in Rint were found following physiotherapy treatment compared to the control (Figure 3), which is in contrast to other studies investigating the effects of physiotherapy on lung function (Cochrane et al, 1977; Savci et al, 2000). The absence of a significant change in Rint post-treatment may be because Rint is not sensitive enough to detect changes in the airways of adult bronchiectatics or in contrast to the findings of other studies (Cochrane et al, 1977; Van der Giessan et al, 2004; Savci et al, 2000), quite simply that no change occurred. Therefore Rint, as measured in this study, cannot be considered a sensitive outcome measure to be used pre and post physiotherapy in bronchiectatic

FIGURE 3. boxplot for logarithms of mean Rint values (Logmean Rint) at each timepoint



patients.

No correlation was found between cumulative sputum yield and change in Rint values from those measured at baseline to those measured at 60 minutes, a time when one might have expected bronchospasm to subside. Since Rint values were not significantly different post-treatment, it is not surprising that a correlation was not found. However, in contrast Van der Giessan et al, (2004), Cochrane et al, (1977), found no correlation between sputum production and SGaw, even in the presence of an improvement in airway calibre.

**Factors Affecting the Sensitivity of Rint**

It is possible that the interrupter technique is not sensitive enough to detect change in adult bronchiectatic patients. Research involving the use of the interrupter technique in adults has varied (Chowienczyk et al, 1991; Phagoo et al, 1993) whereas the Rint has been validated consistently in children (Bridge et al, 1999; Morrison et al, 2003; Van der Giessan et al, 2004). This may be due to the smaller airway size in children (Lumb, 2000 p60-61). Other studies have, however, found the technique to be sensitive in adults with reversible airway disease (Eiser et al, 2001; Chowienczyk et al, 1991). Therefore further investigation into the sensitivity of the technique with adult patients is warranted.

The lack of significant changes in Rint measurements following physiotherapy treatment may, however, be attributed a number of other factors:

- Severity of bronchiectasis
- Bronchospasm
- Inadequate equilibration between mouth and alveolar pressure
- Muscle activity during equilibration
- Treatment technique
- Bronchodilator use
- Timing of outcome measures
- Poor technique using the MicroRint
- Variations in the interruption technique between studies.
- Criteria in Selecting data
- Limitations of the study design

The study could be improved in a number of ways addressing the factors above. Establishing whether a change in airway calibre occurs by comparable measures of airway resistance in a manner that do not effect treatment or Rint measurements was not possible in this study, but might be possible in a longer term design. A longer duration would also allow realistic changes in airway calibre to occur as a result of reduced inflammation and the inclusion of qualitative measures.

## Conclusion

This study found no significant differences in Rint following physiotherapy and the null hypothesis (section 2.4) is accepted, however, this may be because of type II errors, limitations of the study design and uncontrolled variables. It cannot be established whether the absence in significant findings is because there is a difference in airway resistance that the interrupter technique is not sensitive enough to measure or because there is no change in airway resistance following AD as described in this study. It therefore suggested that the interrupter technique should not be used as an outcome measure with adult bronchiectatic patients until further investigation establishes its validity with this population.

The research question itself, however, is narrow and generates little knowledge regarding the relevance of treatment to individual patients. If validated in the future, the interrupter technique could be used to highlight physical response to physiotherapy to patients and clinicians, so that a program of care can be devised and the patient is empowered to make informed choices regarding their treatment.

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# The Physiotherapy Management of the Coronary Artery Bypass Graft Patient

## A survey of current practice throughout the United Kingdom.

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## Summary

*This study investigated the current physiotherapy management of the patient undergoing routine coronary artery bypass graft. A postal questionnaire was sent to the senior physiotherapists in all (n=52) cardiothoracic units in the United Kingdom. Respondents were asked to identify assessment and treatment programmes in both the preoperative and postoperative management of these patients and the basis on which these programmes were implemented. An indication of current research awareness was also ascertained. A response rate of 80% (n = 40) was obtained.*

## Introduction

Coronary artery bypass grafting (CABG) was first performed in 1967. It has subsequently become a widely accepted treatment for severe coronary artery disease due to alleviation of symptoms and improved life expectancy. The United Kingdom Cardiac Surgical register showed the number of CABGs in 1999/2000 to be 24,728. Cost efficient use of physiotherapy resources in the management of this increasing patient group is clearly vital.

Chest physiotherapy has been regularly utilised since the 1960's in the prevention and amelioration of postoperative pulmonary complications (PPCs) following CABG (Dull & Dull, 1983; Oikkonen et al, 1991; Jenkins & Moxham, 1991; Tucker et al, 1996). Abnormal radiological and auscultatory findings, reductions in lung volumes and hypoxaemia, are commonly reported findings after CABG but despite these changes less than 10% of patients go on to develop chest infection (Jenkins et al, 1989a; Stiller et al, 1994a; Stiller et al, 1994b; Stiller et al, 1995). O'Donoghue (1992) states pulmonary dysfunction postoperatively to be inevitable and that changes need to be clearly defined as being those that will recover spontaneously and those which will go on to become clinically significant, producing identifiable dysfunction and adversely affecting the postoperative recovery. He states clinically significant atelectasis is *usually* that which is persistent or progressive, associated with significant hypoxaemia, increased work of breathing or other identifiable distress to the patient. However, the criteria used to diagnose PPCs vary widely throughout the literature and lend confusion to the arguments of when pulmonary changes become *clinically* significant. To date, there is little consensus as to

TABLE 1. Content of the questionnaire

| Section and subject | Questions | Topics covered |
|---|---|---|
| 1. General information | 1 – 5 | Qualification details, length of practice, length in CTU, accredited courses, experience overseas |
| 2. Service provision | 6 – 13 | Hospital type, no. of CABG per week, usual LOS, type of conduit, no. of CTU beds, PT staffing levels, normal PT hours, on call provision |
| 3. Pre operative physiotherapy | 14 – 22 | Patients seen?, rationale for pre op interventions, assessment procedures & by whom, Rx undertaken, risk factor i/d, |
| 4. Immediate post op physiotherapy | 23 – 28 | Patients seen?, protocols, rationale for immediate post op practice, Rx procedures used |
| 5. Post operative physiotherapy | 29 – 41 | Patients seen?, aims of Rx, Rx criteria, Rx procedures, length of PT input, no. of daily visits by PT, Rx progression & staff involved, rationale for (non) intervention |
| 6. Relevant literature | 42 – 43 | Indication of literature read, affect of research on practice |

KEY TO TABLE 1. CTU – cardiothoracic unit,CABG – coronary artery bypass graft, LOS – length of stay, PT - physiotherapy, Rx – treatment, no. – number

what differentiates a clinically significant PPC from a self-limiting, transient dysfunction (Brookes-Brunn, 1995; Stiller & Munday, 1992; Stiller et al, 1994a). Nonetheless, following extensive investigation throughout the late 1980's and 1990's the efficacy of chest physiotherapy in the prevention of PPCs in the routine CABG patient has been questioned (Bourne & Jenkins, 1992; Crowe and Bradley, 1997; Eales, Barker & Cubberley, 1995; Jenkins et al, 1989a; Jenkins et al, 1990; Jenkins, Akinkubge, Corry & Johnson, 1994; Stiller et al, 1994a; Stiller et al, 1994b; Stiller et al, 1995; Patman, Sanderson & Blackmore, 2001). These studies have demonstrated prophylactic chest physiotherapy has little influence in the prevention of PPCs in the routine CABG patient. Furthermore, the additions of modalities, such as adjuncts to treatment, appear to confer no further benefit to a regimen of early mobilisation and cough. The benefit of chest physiotherapy in higher risk patients and in those patients with clinically significant problems remains unclear to date.

Literature investigating early extubation protocols, rapid recovery guidelines and fast track regimes have reported no further increase in the incidence of postoperative complications (Dunstan & Riddle, 1997; Reyes et al, 1997; Stafford, Ho & Jenkins, 1997). Similarly literature focussing on the incidence of musculo-skeletal complications following surgery and the role of physiotherapy in their prevention (El-Ansary, 1995; El-Ansary, Adams & Ghandi, 2000a; El-Ansary, Adams, Toms & Elkins, 2000b; Stiller, McInnes, Huff & Hall, 1997) has demonstrated no difference in the incidence of musculoskeletal problems between control groups and treatment groups receiving active range of motion exercises (of the upper limb and trunk) in the early postoperative period.

Tucker et al (1996) conducted a postal questionnaire in cardiothoracic units throughout Australia and New Zealand that examined the current pre and postoperative physiotherapy management of patients undergoing CABG. Results showed 94% of respondents carried out routine preoperative physiotherapy with 89% treating all patients in the postoperative period. The authors concluded physiotherapists were reluctant to change practice based on research findings. Practice was mainly based on personal preference and the study recommended a survey of practice overseas to serve as a comparison. Wattie (1998) conducted a postal survey establishing the use of incentive spirometry in CABG patients in the UK. Despite no evidence supporting the use of incentive spirometry in these patients this study highlighted continuing extensive use of the device by physiotherapists. The study demonstrated physiotherapists' reluctance to change practice but did not specifically ascertain respondents' awareness of the relevant literature.

In the light of the above and given the evidence to date, the aims of this study were to determine:

- Specific interventions that physiotherapists currently use in the management of the routine CABG patient
- Factors that influence the

TABLE 2. Demographic data

| **Place of qualification** | **Frequency** | **Length of time since qualification** | **Frequency** |
|---|---|---|---|
| UK | 36(90) | Over 10 years | 20 (50) |
| Australia | 2 (5) | 7 – 10 years | 6 (15) |
| India | 1 (2.5) | 4 – 6 years | 11 (27.5) |
| Ireland | 1 (2.5) | Under 4 years | 3 (7.5) |
| | | | |
| **Length of time working in CTU** | **Frequency** | **No of patients undergoing CABG per week** | **Frequency** |
| Under 1 year | 4 (10) | Under 10 | 8 (20) |
| 1 – 3 years | 13 (32.5) | 10 – 20 | 14 (35) |
| 4 – 7 years | 10 (25) | 21 – 30 | 15 (37.5) |
| Over 7 years | 12 (30) | Over 30 | 3 (7.5) |
| **Physiotherapy staffing levels in UK CTUs** | **Frequency (min – max)** | | |
| Clinical specialist | 1 (1-1) | | |
| Superintendent | 17 (.5 – 5) | | |
| Senior I | 33 (1 – 3.5) | | |
| Senior II | 27 (1 – 4) | | |
| Staff physiotherapist | 25 (.5 – 5) | | |
| Physiotherapy assistant | 7 (.1 – 1) | | |

KEY TO TABLE 2. CTU – cardiothoracic unit ( percentages in parentheses except where otherwise stated)

provision of physiotherapy to routine CABG patients
- Physiotherapists awareness of the available evidence in the physiotherapy management of the routine CABG patient
- Whether an awareness of the evidence influenced the provision of care

## Method

A postal survey using a questionnaire based on the structure of the questionnaire developed by Tucker et al (1996) was utilised. The structure was extended and adapted by the authors for use in the UK and undertaken during late1999/early 2000. Piloting was performed in two cardiothoracic units (CTUs) using four Senior II physiotherapists (a grade below the targeted respondents). Comments were invited which highlighted ambiguities in question design and flow/ filtering issues. The results from these questionnaires were not included in the final study. Following amendment the questionnaire was sent to 'the senior physiotherapist' in all UK CTUs. This included a cover letter explaining the purpose of the study (and ensuring confidentiality), a workable response date and a pre-paid return envelope. Coding of the questionnaire allowed for follow up of non-responders. The questionnaire was comprised of six sections and included both open and closed questions. Open questions were coded using a system agreed by both authors. These questions were subsequently analysed independently by both authors. In the event of any dispute in coding a third person was used. The questionnaire sections and examples of the questions used can be seen in Table 1.

Sheffield Hallam University's Masters programme approval panel granted ethical permission for the study. NHS multi regional ethics committee approval was not deemed necessary.

## Results

Questionnaires were sent to a total of 52 CTUs throughout the UK. Two questionnaires were returned stating that their units had amalgamated with another hospital (a joint response was returned). Two other hospitals no longer conducted cardiac surgery. This gave a total of 48. A response rate of 83.3% was obtained (n = 40). Questionnaire

results were analysed using the Statistical Package for the Social Sciences (SPSS) for windows version 8.

## Background data and service provision

Demographic data can be seen in Table 2. Of note was the high level of senior staffing in these units implying the necessity for experienced physiotherapy input. The majority of respondents (63.2%) qualified over ten years had spent over seven years working in the CTU.

19 (47.5%) respondents had undertaken some form of accredited training in the cardiovascular /respiratory field with ten (25%) having staff that had undergone accredited courses also.

39 (97.5%) units offered 24 hour 'on call' physiotherapy, three (7.5%) respondents utilised an extended hours service (8 am to 8 pm) in addition. One (2.5%) unit offered no 24-hour cover.

One third of respondents worked in private hospitals. This may affect service provision and physiotherapy care e.g. length of stay, number of visits, level of post operative care. Respondents from private hospitals highlighted this with comments such as:

*We tend to be lucky enough to have time to see patients / We feel lucky that we can indulge our patients – they certainly appreciate this / Working in a private hospital there are not the financial considerations of the health service however, practice is still governed by evidence – experiential and literature / Patients in private care expect a full range of services.*

Most centres used a combination of internal mammary arteries and saphenous vein grafts for grafting. The use of the internal mammary artery has been documented to increase pain and further reduce respiratory function (Jenkins et al, 1989b).

## Preoperative physiotherapy practice

23 (57.5%) respondents saw (face to face contact) all patients on a preoperative basis and 14 (35%) saw only some patients. Only 7.5% did not see any patients prior to operation (n = 3). Main reasons for seeing all patients can be seen in Table 3. Of those patients seen preoperatively 33 (82.5%) conducted a baseline respiratory assessment and 30 (75%) taught respiratory manoeuvres. Of those respondents seeing only some patients preoperatively the main reason for selection of these patients was risk assessment (n = 8).

Of those patients not seen by physiotherapists preoperatively, most patients were indirectly assessed via medical and nursing notes (n=13) or advice and education were administered by other means such as video (n=2), written (n=10) or group contact (n=3). In two instances cardiac support nurses rather than physiotherapists discussed postoperative respiratory care with patients.

A number of respiratory assessment procedures routinely carried out by physiotherapists were also assessed by other disciplines. The only assessment that was unique to physiotherapy was the assessment of range of movement of the shoulders, cervical and thoracic spine. All other assessment was reproduced by at least one other member of the multidisciplinary team. Some assessment procedures were reproduced up to four times by other team members.

In order to ascertain what factors influence the provision of physiotherapy preoperatively, respondents were asked what basis their preoperative practice was based upon. These are highlighted in Table 4.

TABLE 3. Main reasons for seeing ALL patients preoperatively ( percentages in parentheses)

| Pre op purpose | Frequency |
|---|---|
| Teaching purposes | 20 (50) |
| Chest assessment | 10 (25) |
| Risk assessment | 8 (20) |
| Reduction in anxiety/reassurance | 4 (10) |
| Introduction of physiotherapist to patient | 4 (10) |
| Improve patient co operation | 3 (7.5) |
| Pre operative treatment | 2 (5) |
| Give incentive spirometer | 2 (5) |

## Immediate postoperative practice

The majority of respondents (80% n = 32) did not visit patients postoperatively whilst routinely intubated during the immediate postoperative period. Of those respondents that did see patients (n = 8) during this period, reasons for doing so included assessment, prophylactic treatment and advice to carers. Those that advocated seeing patients during this period indicated their reasons for doing so as being personal experience (n= 7), literature recommendations (n=6) and established practice (n= 6). 29 (72.5%) units had no specific physiotherapy protocols for this period.

TABLE 4. Basis for pre & post operative physiotherapy practice ( percentages in parentheses)

| Basis for physiotherapy practice | Pre op | Post op |
|---|---|---|
| Personal experience | 33 (82.5) | 30 (75) |
| Literature | 28 (70) | 18 (45) |
| Established practice | 22 (55) | 27 (67.5) |
| Resource considerations | 11 (27.5) | 2 (5) |
| Anaesthetist /surgeon recommendations | 9 (22.5) | 24 (60) |
| Contractual obligation | 0 | 7 (17.5) |
| Peer pressure | 0 | 6 (15) |
| Other | 5 (12.5) | 3 (7.5) |

## Postoperative physiotherapy

38 (95%) respondents saw (face to face contact) all patients postoperatively. The factors on which physiotherapists based their postoperative practice can be seen in Table 4.
Only one respondent did not see all patients. All other respondents conducted an assessment on all patients postoperatively and 22 (55%) also applied treatment interventions to all patients. Ten of the 22 respondents who treated all patients postoperatively stated their practice was based on literature recommendations.

Respondents were asked to indicate their main aims in seeing all patients postoperatively. These included assessment and monitoring of postoperative progress (n = 25), early mobility and exercise (n = 23), prevention and treatment of PPC's (n = 20), education and advice (n = 7) and maintain clear chest (n = 3).

Where treatment was instigated Figure 1 shows which treatments were normally incorporated. Additional responses to this question included shoulder girdle and neck exercises, limb and circulatory exercises and stair climbing.

Nursing staff were widely utilised in the mobilisation of patients with 15 (37.5%) respondents indicating that both physiotherapists and nursing staff were involved in progressing patient mobility. Other areas of overlap of treatment programmes included home education and advice and cardiac rehabilitation programmes (both exercise and advice).

34 (85%) respondents administered physiotherapy home education and advice, 21 (57.5%) using a physiotherapy specific discharge booklet. Nursing staff also administered discharge booklets in 19 units and it is possible that some of these booklets incorporated physiotherapy discharge advice also, however this was not directly ascertained.

Figures 2 & 3 show the usual number of days physiotherapists saw their patients postoperatively and

FIGURE 1. Post operative physiotherapy treatment modalities

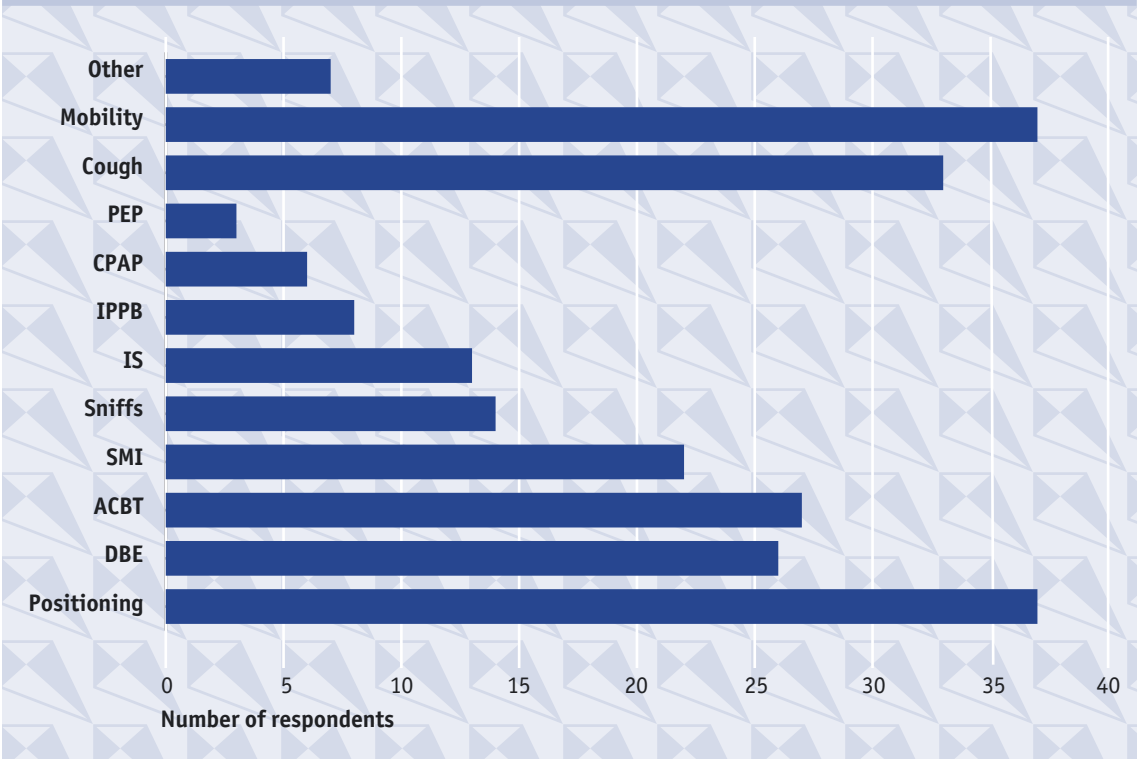
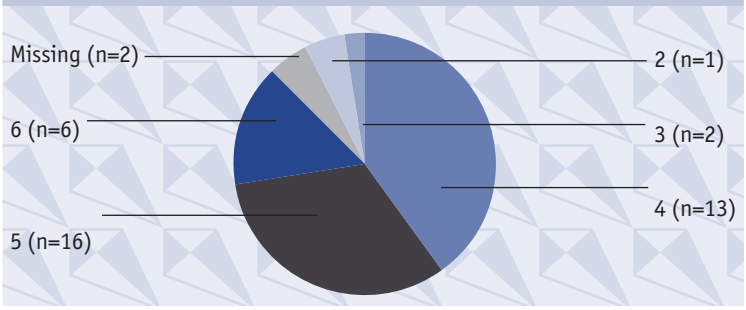


FIGURE 2. Usual number of post op days seen by physiotherapist.




the number of physiotherapy visits daily respectively. 23 (57.5%) respondents continued to see their patients for 5 days or more. As most patients were discharged between 4 – 6 days postoperatively this data would indicate that many patients continue to be seen by physiotherapists up to discharge. It also showed that in the first two postoperative days the majority of patients receive visits twice daily. Eight (20%) respondents continued to see patients on Days 6 & 7, six (15%) of these being private hospitals.

The only respondent who reported not routinely seeing all patients postoperatively based this decision on recommendations from the literature and personal experience. Those patients not seen by the physiotherapist postoperatively were given DBE, cough instruction and mobilised by nursing staff on Day 1 as per current literature recommendations.

## Research awareness

An awareness of the literature was ascertained by a simple closed question asking respondents to highlight which of a list of 7 KEY physiotherapy papers in this area they had read (Dull and Dull, 1983; Jenkins *et al,* 1989; Jenkins *et al*, 1990; Jenkins, Akinkubge, Corry & Johnson, 1994; Oikkenen *et al,* 1991; Stiller *et al,* 1994; Stiller *et al*, 1995). Memory recall and the possibility of prestige bias may have affected the reliability of this question but these papers were chosen based on their quality and the level of evidence provided. 36 (90%) indicated having read one or more of the articles, seven (17.5%) having read all the articles and three (7.5%) clearly indicating they had read none of the literature. Two respondents failed to answer this question.

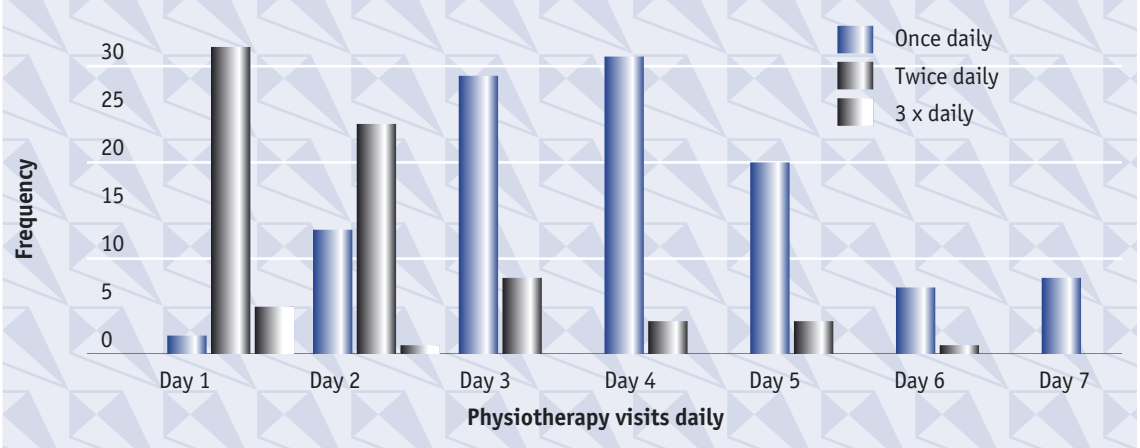
26 (65%) respondents indicated that reading the papers had affected their practice with seven (17.5%) indicating it had not. However, of those indicating their practice to be affected by the evidence, 25 respondents continued to see all patients. All continued to assess all patients and 13 of these continued to treat all patients.

16 (64%) respondents who said an awareness of the evidence had affected practice continued to incorporate DBE into their programmes despite evidence that the addition of these confers no additional benefit in the prevention of PPCs.

Respondents were asked an open question about how reading the literature had affected their practice**.** Responses included:

*"No longer treat all CABGs routinely, assess and teach ACBT only / I now place much more emphasis on early mobilisation than 4 –5 years ago / Do not spend time teaching and using breathing exercises as a treatment technique on patients with clear chests but for effective auscultation they are briefly taught lateral costal expansion if they are not doing this automatically / Articles show the importance of early mobilisation of the patients & have questioned effectiveness of breathing exercises for postop (sic) patients / Much less emphasis on DBE and more on positioning, early mobility and effective cough / The IS papers did make me look at my practice, but patients loved them and did feel they practiced more regularly as it was in front*

Figure 3. Usual number of physiotherapy visits daily



*of them to remind them. Our consultants like them so we have continued to use them / Made us think a lot about our reasoning but we decided to remain the same due to our patients response"*

Many statements seemed to indicate a trend towards reducing the emphasis on DBE and an increasing emphasis on early mobility and positioning.

## Discussion

This survey investigated current physiotherapy practice in CTUs throughout the UK in an attempt to ascertain the factors which physiotherapists state influence their practice. The demand for evidence based practice in healthcare poses a challenge for physiotherapists working within cardiac surgery where there is a necessity to rationalise and validate their interventions by utilising existing evidence and by conducting new research. It has been suggested that physiotherapists disregard research findings, instead placing more emphasis on personal experience (Jenkins, 1998). A study by Turner and Whitfield (1997) demonstrated research literature ranked poorly as a basis for choosing a physiotherapy intervention approach. The findings of Tucker et al (1996) would seem to corroborate this in the area under investigation and our study has supported these findings further.

## Preoperative physiotherapy

Preoperative education has long been considered a routine and important aspect of care (Brookes-Brunn, 1995). The importance of preoperative education on postoperative recovery and pulmonary function is documented throughout nursing and medical literature yet there is no data to support the effectiveness of physiotherapeutic interventions preoperatively in the clinical situation.

Our findings show the majority of units have some form of physiotherapeutic intervention with patients preoperatively, most of these being face to face contact. 70% of physiotherapists surveyed indicated knowledge of the literature (in addition to personal experience and established practice) had affected their preoperative practice despite a current lack of evidence supporting preoperative physiotherapy for this patient group. Face to face contact with all patients appears to be unnecessary, as does the duplication of some preoperative assessment procedures that have been established in this group.

Preoperative assessment is believed to decrease anxiety and increase motivation and thus co-operation postoperatively, helping contribute to an improved outcome (Hough, 1998, Frownfelter, 1987). Studies have used varying outcome measures but none have demonstrated changes in analgesia requirements, mood scores, physical activity and length of stay. The rationale for preoperative intervention remains tenuous, but recognition of high-risk patients is a role advocated by many authors and this was found to be the main factor where physiotherapists were selective of patients to be seen preoperatively.

Further research to establish the effectiveness of preoperative interventions needs to be undertaken. This should consider what information by what means, how, when, to whom and by whom this information should be delivered. It should evaluate the effectiveness at both the time of delivery and on postoperative outcome and should include not only physical outcome but quality of care, subjective and patient satisfaction outcome measures also.

## Immediate postoperative period

Recent evidence (Patman, Sanderson & Blackmore, 2001) clearly demonstrates physiotherapy during the intubation period in uncomplicated cardiac surgical patient does not influence outcome. This study demonstrates the practice of the majority of physiotherapists in the UK to be in line with these findings. Few UK units have an established protocol for physiotherapy during this period in contrast the findings of Tucker et al (1996) in Australia and New Zealand where 63% of hospitals had an established protocol.

The minority of UK units that continue to undertake prophylactic treatment during this period should now consider basing their practice on more recent findings (Patman, Sanderson & Blackmore, 2001).

## Postoperative physiotherapy

That prophylactic chest physiotherapy has little influence in the prevention of PPCs following routine CABG surgery is now well established (Crowe and Bradley, 1997; Jenkins et al, 1989a; Jenkins et al, 1990; Johnson et al, 1996; Stiller et al, 1994a; Stiller et al, 1994b; Stiller et al, 1995). Despite this, physiotherapists throughout the UK continue to routinely assess patients and implement treatment programmes often for up to 5 days postoperatively.

The high numbers of senior physiotherapists in the units clearly indicate this area of work to be regarded as requiring specialist staff. This implies the complexity and specialisation of the work involved. Given this, an awareness of the relevant literature in the area may be expected yet the basis for postoperative physiotherapy practice remains governed by personal preference or

established practice. That the preference of surgical and anaesthetic colleagues ranked more highly than literature findings is of concern. Most respondents indicated that an awareness of recent research influenced their practice, however, in only a minority of cases did a withdrawal of assessment and / or treatment result. This is despite compelling recent evidence that suggests its value to be limited in the patient group under investigation here. This literature should provide physiotherapists with the evidence necessary to modify or discontinue treatments found to be ineffective but our study would suggest this not to be the case. Our study extends Watties' (1998) work and, as recommended, specifically requests information on research awareness and its influence on practice. Furthermore it confirms concerns and echoes practice recently surveyed in New Zealand and Australia (Tucker et al, 1996). Open comments seemed to indicate a trend towards a reducing emphasis on prophylactic chest physiotherapy (including deep breathing exercises and incentive spirometry) and an increasing emphasis on assessment, early mobility and positioning.

Clinicians must share a commitment to reduce inappropriate variations in practice and ensure value for money whilst achieving the greatest health benefit for the population for whom they have responsibility. Clinical effectiveness is, therefore, achieved by using interventions that are known to work and embedding these within an environment and systems that are of the highest quality (Bury and Mead, 1999). Awareness of the evidence should provide physiotherapists with the tools necessary to modify or even discontinue treatments found to be ineffective but our study would suggest this not to be the case. Reasons for respondents' reluctance to change are likely to be complex and are worthy of future investigation. Personal, environmental and behavioral factors, as well as the nature of the intervention requiring change will all influence the change process (Bandura, 1986) but appropriate diffusion and dissemination of information is necessary. Means of effective dissemination of research results need to be considered further. Publishing information alone is rarely sufficient to change practice and people require many things when going through the change process, including recognition, advancement, interest and overall security (Bury & Mead, 1999).

The discontinuance of a treatment programme has many potential consequences including staffing loss or redeployment implications and an effect on working culture. Many physiotherapists have a 'hands on' approach and the focus on minimal (or no) intervention may be difficult to initiate. However, evidence to date would seem to suggest that physiotherapists should be focusing their attention on those patients who develop PPCs or other postoperative complications and devolve less specialist skills such as promotion of early mobility and stair climbing to others. Recent evidence (Cockram, Jenkins & Clugston, 1999) has demonstrated ambulation and stair climbing to be safe when appropriate clinical criteria were met yet currently this is undertaken by 90% of physiotherapists with only one unit devolving this responsibility to nursing staff. The devolvement of these duties would seem appropriate in uncomplicated cases.

Repetition or overlap of assessment, treatment, advice and education between nursing staff, physiotherapists and other health professionals was common both pre and postoperatively. This may be beneficial to patient care, reinforcing information and promoting recovery but should be closely scrutinised to ensure both necessity and consistency.

Much of the current physiotherapy literature focuses on the prevention of PPCs rather than on the effects of early rehabilitation following CABG, or on the treatment of PPCs where these have developed. Both of the latter situations warrant much further investigation. The effects of early rehabilitation on recovery, both physically and emotionally may be profound and warrant much extensive investigation. This study has focused only upon the prevention of PPCs but recognises the multifaceted role of the physiotherapist in the postoperative period. Physiotherapists' knowledge and skills in the physical and emotional rehabilitation from major surgery are extensive and unique. This involves, amongst others, their in-depth knowledge of applied anatomy, exercise physiology and response to injury. Health promotion, affecting lifestyle alterations and promoting physical and mental well being are important aspects of the physiotherapist's role following cardiac surgery. An emphasis on these aspects may be a more effective utilisation of specialist skills than the continuance of roles, which under normal circumstances might be more efficiently performed by other members of the multidisciplinary team.

Many responses reflected a focus on quality of care issues in addition to physical outcomes. These quality issues include reduction in levels of anxiety, reassurance, advice and education. If physiotherapists believe these to be important aspects of their interventions then tools to measure these must be devised, validated and studied. Utilised appropriately as a measure of quality of patient care and linked to clinical

effectiveness, these subjective perceptions of patients may be important additions to quality initiatives.

## Study Limitations

**Questionnaire construction**

Difficulties in the definition of terms within chest physiotherapy have been alluded to in this study and this may have affected the reliability of some of the responses. Other sources of ambiguity included use of the terms *'accredited', 'routine', 'normal', 'usual', 'commonly', 'seen'* and some of these were anticipated prior to administration but acceptable alternatives were unable to be found. Throughout the study it became clear that there remain current discrepancies and differences in both understanding and use of terms within chest physiotherapy. Tucker et al (1996) found similar problems and called for these to be clarified. These discrepancies remain and may have affected the content validity of the questionnaire.

There was no attempt to test – retest reliability (mainly due to time constraints) of the questionnaire but in some areas reliability of responses was increased by the use of multi-item indicators, rechecking responses by different wording and careful coding of open questions. Patterns of responses can help understanding the meaning of responses and this was considered during analysis. The veracity of responses is unknown. It is possible that respondents answered according to what they believed to be acceptable rather than honestly. In this survey, question 42 ("which of the following research papers have you read") is the most likely to have elicited this response. This question's reliability may have been improved by offering an 'unsure' option in addition to "read" or "not read".

The concepts underpinning this study are multidimensional and not all of these can be measured by a postal questionnaire. Those concepts measuring causal factors, attitudes and beliefs would be best measured using other survey methods such as follow up interviews and further work is recommended. Our study therefore gives us a preliminary picture of practice only and thus further investigation should to be undertaken to establish why physiotherapists continue to use established practice and personal experience in preference to research findings.

**Sample selection**

Other limitations included the use of only one respondent per unit. More than this would have been repetitious of data but may have served as a possible test of inter observer reliability. It was anticipated that the senior physiotherapist of the unit would have a better overview of practice, any historical, economical and political factors and would most likely have influenced practice.

## Conclusion

Our study has highlighted that physiotherapy practice on CTUs throughout the UK varies. The provision of physiotherapy to patients undergoing uncomplicated CABG is extensive and commonly involves assessment, early mobility, positioning and cough. Over half of respondents continued to use deep breathing exercises and the active cycle of breathing techniques despite recent literature indicating this to be unnecessary. A variety of factors influenced the provision of physiotherapy that were mainly based on personal experience or established practice. Our study has shown that the majority of respondents are aware of (at least) some of the available evidence but that many are reluctant to change practice on the basis of this evidence. Further work should be undertaken to investigate reasons for this phenomenon.

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# Shared learning – How students' assignments could be incorporated into Evidence Based Practice

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## Introduction

The term 'Evidence-based medicine' has been used since 1991 when it began to appear in the literature (Guyatt, 1991). Despite the recognition that many professions allied to health and social care have adopted an evidence approach to care, the term medicine still often remains in published work. With this in mind delegates at the 2nd International Conference of Evidence-Based Health Care Teachers and Developers held in Sicily in 2003 raised concerns related to the use of this terminology. As a result, the Sicily statement on evidence-based practice by Dawes et al (2005) was published and it indicated that chartered physiotherapists are as concerned as our medical colleagues in working towards care that is evidence based.

Providing evidence based health care is a key skill for health care workers (Culham, 1998). In 1995, Rosenberg and Donald suggested that medical students, having carried out critical appraisals to learn evidence based medicine, could share this knowledge with their teams and colleagues. Bennett (2003) agrees and suggests that one way forward for physiotherapists is for students to have opportunities to share their personal knowledge with clinical staff during their clinical placements.

When physiotherapy students are set written assignments they are expected to provide information that is relevant, up to date and reveals some critical analysis of research evidence (the depth of analysis increasing as the student progresses through their programme). This knowledge, combined with the clinical expertise of clinical educators / physiotherapy staff could improve ways in which, when questioned, the physiotherapist can justify their role for self, clients and other professional groups.

The following is a part example of work submitted by a student for an optional module in critical care and is a critical appraisal of literature. The assignment was set with the aim of providing research evidence to support clinical decision-making.

## Physiotherapy and the role it plays in the multidisciplinary management of critically ill clients with severe head injuries

Patient management in an intensive care unit (ITU) requires a team of medical, nursing and allied health staff with specialised training and expertise (Jones, Hutchinson & Oh 1992). Physiotherapists with their holistic training and as experts regarding the cardio-respiratory system, play a major role in the acute respiratory management of the critically ill head injured patient (Semlyen *et al*, 1998) and are seen as an integral part of the ITU team. However, within published literature there is a somewhat negative portrayal of chest physiotherapy and its efficacy, which Ciesla (1996) argues stems from its common use without regard to the patient population or condition for which it is prescribed.

Intensive care of the critically ill, ventilated patient with raised intracranial pressure (ICP), requires optimal respiratory management including the integration of chest physiotherapy as part of treatment (Paratz & Burns, 1993), and patients with severe

head injuries frequently require aggressive respiratory care in addition to the maintenance of mechanical hyperventilation, as pulmonary infection is second only to intracranial hypertension as the leading cause of death in this patient population (Rudy *et al,* 1991). Aspiration pneumonia, adult respiratory distress syndrome, pulmonary contusion and neurogenic pulmonary oedema have all been shown to complicate recovery from head trauma (Borel *et al,* 1990; Ciesla 1996).

In 1990, Prasad & Tasker published an overview of the literature and stated that optimal respiratory management of any ventilated patient necessitates the consideration of physiotherapy as an integral part of treatment. This outcome was earlier shown when in 1985, MacKenzie & Shin demonstrated significant improvements in total lung compliance and cardiorespiratory function after multi-modality chest physiotherapy in mechanically ventilated patients, with the benefits gained lasting for up to two hours.

However, it is important to explore evidence in relationship to specific conditions. The physiotherapist, working in ITU with patients with severe head injuries requires a thorough knowledge of how physiotherapeutic interventions may affect the condition and there is much debate in the literature surrounding the effect of interventions on a patient's ICP. Secondary brain injury is more likely to occur if high intracranial pressures are sustained after interventions and therefore it is crucial to try and control it (Miller 1985).

Intensive care management of severe head injuries is primarily concerned with the prevention of secondary ischaemic / hypoxic cerebral insults and minimising brain shifts. Respiratory physiotherapy techniques including positioning, percussion, manual hyperinflation and suction have all been shown to have the potential to alter intracranial pressure (Paratz & Burns, 1993) and other physiological measures, so, as a way of examining this, they carried out a small study of 20 ventilated patients, each acting as their own control and found that percussion did not cause ICP to rise, but actually found that ICP decreased after 5 minutes of percussion treatment, though it should be noted that this decrease was not statistically significant. Their findings support previous work by Imle *et al* (1988) & Garradd & Bullock (1986) who demonstrated that percussion is not deleterious to a neurosurgical patient.

Clearance of retained secretions is as essential for patients with severe head injury as it is for those with other critical illnesses (Borel *et al,* 1990). However, the way in which this is performed is open to questioning. It has been empirically demonstrated that endotracheal suctioning (ETS) head injured patients results in rises in ICP (Brucia & Rudy, 1996; Imle *et al,* 1988 & Ersson *et al,* 1990). Parsons & Shogan (1984) reported that a stepped increase in ICP occurred with each pass of the catheter. Nevertheless, this conclusion is called into question due to the limitations of the study namely being manual recording of ICP and different nurses collecting the data. The findings are further questioned as Crosby & Parsons (1992) revised and repeated the study with a larger sample (n=49 head injury patients) and were able to control the stepped rise in ICP associated with multiple passes of the catheter by giving the patient at least 2 minutes of undisturbed rest before any other activity and at least 60 seconds of manual hyperinflation (MH) between each ETS.

In 1991, Rudy *et al,* concluded that ETS causes a significant increase in ICP in adults with severe head injuries regardless of the volume used for hyper-oxygenation (100 or 135%) and also argue that ICP rises regardless of whether subjects received medication prior to suctioning. However, the study is in some ways flawed, as the conclusions drawn did not consider the level of sedation objectively. There was no statistical proof that the rise in ICP reported was purely as a result of ETS. Despite these conclusions, others still stress the importance of physiotherapists asking for a bolus of sedation prior to suctioning to lower ICP (Brucia & Rudy 1996 and Kerr *et al,* 1996).

What the weight of evidence does suggest is that repeated suctioning produces an increased risk of extending cerebral tissue damage in the adult with severe head injury. However, it should be viewed as a necessary procedure if indicated but also as a potentially detrimental procedure if correct care and diligence is not taken (Watson 2001).

Cumulative increases in ICP have been reported when care activities are performed one after another (Mitchell *et al,* 1981; Shalit &Umansky 1977) and therefore the literature suggests that multi-disciplinary pre-planning is needed to avoid a cumulative rise in ICP. It is important that professionals coordinate their input in order to prevent duplicated or conflicting goals (Powell *et al,* 1994), therefore the efficiency of the multidisciplinary team (MDT) is paramount. Unfortunately, the evidence is inconclusive about whether it is best to do everything at once and then let the patient settle or to spread out physiotherapy from other professions' interventions (Chudley 1994, Wainwright & Gould 1996).

The majority of studies have concluded similar findings and trends being that ICP rises on suctioning, positioning and many multi professional interventions (Parsons &

Shogan, 1984; Garradd & Bullock, 1986; Imle *et al,* 1988; Chudley, 1994), but a major limitation is the small number of subjects in each study (Paratz & Burns, 1993; Brucia &Rudy, 1996**;** Horouchi *et al*, 1997) and for the evidence to be more conclusive and reliable future studies need to involve much larger sample groups. The studies to date have also been limited by the fact that the studies are difficult to control, with subjects varying in age, the severity of the head injury and with only a small number of studies including subjects with a baseline mean ICP of above 20 mmHg (Brimoulle *et al,* 1997).

It must be appreciated that the randomised double blind placebo controlled trial that many clinicians view as a seal for a high quality trial and evidence cannot ethically be conducted in the Critical Care arena (Watson, 2001). Consequently, observational studies and case studies are needed to supplement the limited existing evidence to inform practice. The effect of interventions, be they medical, nursing or those highlighted from physiotherapy, on ICP and CPP remains a vital area of concern amongst practitioners and more research is needed if practice is to be evidence based (Chudley, 1994).

Despite physiotherapy being seen as an integral part of the MDT in most Intensive Therapy Units and in the wider scope of Critical Care, there is limited evidence demonstrating the effectiveness of physiotherapy in these arenas (Stiller, 2000). As many conclude (Bott, 2000; Stiller, 2000; Ciesla, 1996) the role of physiotherapy in ITU will continue to be questioned until it has been shown to have a favourable impact on broader outcomes for ITU patients. Evaluation of the successes of physiotherapy is notoriously difficult because literature is scarce and often ambiguous, 'chest physiotherapy' is poorly defined and variables such as simultaneous medical input and the placebo effect influences results of the studies that are presented within the literature. There is an urgent need for further research to be conducted to justify the role of physiotherapy and for the recommendations of 'The Role of Healthcare Professions in Critical Care Services' (2000) to be followed.

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# Critical Review of Positioning for Ventilation/Perfusion ($V_A$/Q) Matching.

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## SUMMARY

*Positioning is in essence 'gravity management'. The premise of therapeutic positioning is to reduce the deleterious effects of gravity and promote those effects thought to be of benefit. 'Good lung down' positioning is frequently used clinically as a means to optimising ventilation and perfusion in the dependent lung of patients with unilateral lung pathologies. This article reviews the rationale supporting good lung down positioning for VA/Q optimisation and investigates how alveolar-closing volumes can influence the effectiveness of this strategy.*

## Introduction

Positioning is in essence 'gravity management'. Body position has profound acute affects on cardiovascular and cardiopulmonary function (Dean, 2002 pp. 143). The premise of therapeutic positioning is to reduce the deleterious effects of gravity and promote those effects thought to be of benefit. As the body is never beyond the influence of gravity, positioning should be integral to respiratory care (Hough, 2001 pp. 149).

Clinically 'good lung down' positioning is frequently used as a means to optimising ventilation and perfusion in the dependent lung of patients with unilateral lung pathologies. This article aims to review the rationale supporting lateral positioning for $V_A$/Q in such patients and aims with the use of research evidence to investigate why there are exceptions to this rule.

## Ventilation and Perfusion Distribution

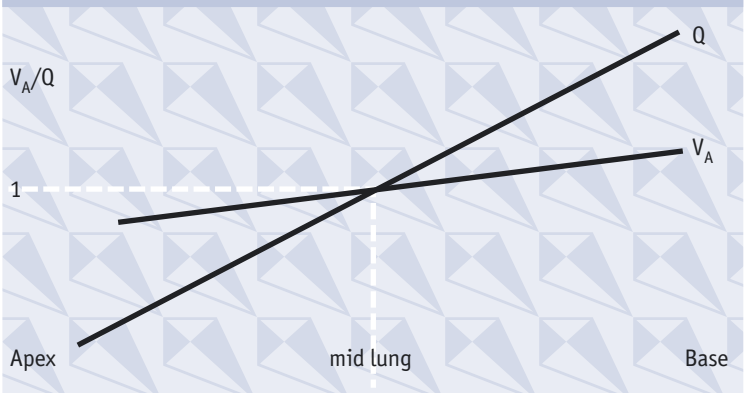
VA/Q ratios describe the relationship between ventilation and perfusion in the lungs and are therefore the most important variable controlling gaseous exchange. In a healthy individual regional differences in both ventilation and perfusion exist within the upright lungs. These are predominantly due to the effects of gravity and regional changes in lung compliance, (figure 4 and 5).

The literature reviewed presents a general consensus supporting the positioning of the unaffected lung in the dependent position for $V_A$/Q matching in unilateral lung disease (Ciesla, 1996; Tucker & Jenkins, 1996 and Stiller 2000). Where unilateral atelectasis is present this positioning strategy is further endorsed as Fourrier *et al,* (1994) and Stiller *et al,* (1996) present results showing atelectasis is positively influenced when the affected lung is positioned uppermost. Each of the authors stop short of recommending global application of this positioning strategy, stating $V_A$/Q benefits for 'some' patients (Stiller, 2000). Holland *et al,* (1968) provide an indication of why all patients may not respond in the same way.

## Closing Volumes

Holland et al, (1968), observed a reversal in the normal ventilation distribution pattern in 5 out of 6 elderly subjects studied. The subjects were aged between 65-75 yrs and were tested in the upright position. The study found the apices were preferentially ventilated in these subjects at low lung volumes and during resting tidal volume. As lung volumes increased to 65% of TLC, proportional distribution to the lower zones increased. The results were attributed to airway closure in the dependant

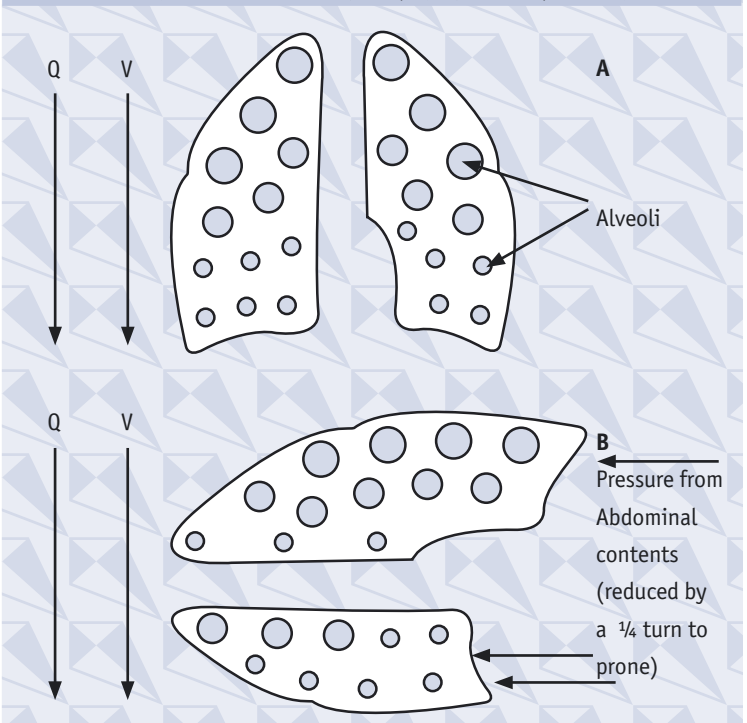
FIGURE 4. Distribution of ventilation and Perfusion




- The bases are preferentially perfused and ventilated. The bases have an excess of perfusion, $V_A/Q$ = <1
- At the apices ventilation and perfusion are at their lowest with ventilation exceeding perfusion, $V_A/Q$ = >1
- At mid lung regions VA and Q are matched, $V_A/Q$ = 1

The $V_A/Q$ ratio for the whole lung is close to 1 in healthy subjects

FIGURE 5. A diagrammatic representation of the effect of gravity on ventilation and perfusion in the lung in A) upright and B) lateral positions.




*Reproduced from Hough (2001) pp 9*

airways. Hough (2001 pp 18) illustrates this effect in figure 6 where closing volume can be seen to encroach on normal tidal volume.

This effect has been documented in lateral body positions by Seaton *et al,* (1979), Badr & Grossman (1990) and Chang *et al,* (1993). Each of the three studies compared $V_A/Q$ via alveolar – arterial $PO_2$ difference ($AaPO_2$) in 'good lung down' and 'bad lung down' positions in patients with unilateral lung disease. Chang *et al, (1993)* found that 16 out of 35 patients studied had lower $AaPO_2$ values (better gas exchange) when positioned with the affected lung dependent while Seaton *et a l, (1979)* found similar results for 2 of the12 post-thoracotomy patients. They conclude airway closure during normal tidal volume was the most likely reason for these results but propose no causative factors e.g. age, smoking.

Choe *et al,* (2000) tested this hypothesis, i.e. is oxygenation in lateral recumbent positions influenced by an increase in closing volume? The full study protocol was conducted on 16 hospitalised patients aged between 16-83 years (SD 49.9 +/- 18.7). In addition to calculating $AaPO_2$ the patients underwent ventilation lung scanning, measured by radionuclide $^{133}Xe$ and closing volume measurements, using the single breath nitrogen test method. Analysis of the results leads the authors to suggest:

The lower the CV in the normal lung in the dependent position

The greater the fractional ventilation of the normal lung in the dependent position

The better the oxygenation of the normal lung in the dependant position

The greater the CV in the normal lung in the dependent position

The lower the fractional ventilation of the normal lung in the dependent position

The worse the oxygenation of the normal lung in the dependent position

The authors hypothesise that a high CV produces not only a reversal in the distribution pattern of ventilation but also a consequent redistribution of perfusion resultant of hypoxic vasoconstriction in the

dependent lung. Unfortunately, the authors do not extrapolate their data to ascertain the existence of common themes that could be used to identify those patients with higher closing volumes e.g. age or smoking status. Nor do they investigate their clinical effects.

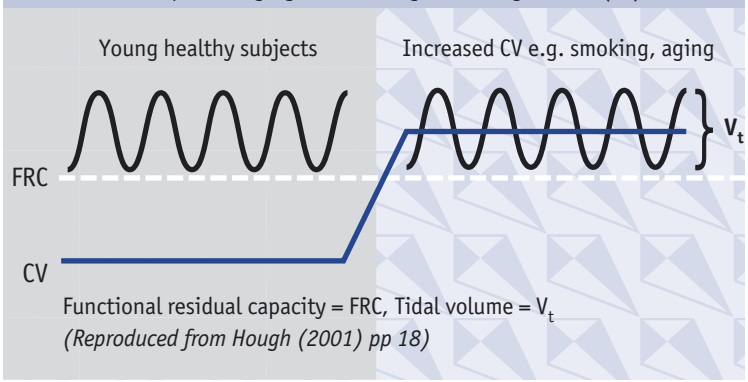
## Implications for clinical practice

Does the evidence go as far as to suggest a place for 'bad lung down' in the treatment of adult unilateral lung disease? This is a difficult question to answer and one based on clinical reasoning rather than evidence. If bad lung down is providing the best $SaO_2$ / $PaO_2$ values for a patient then by definition and according to the evidence, there must be some degree of small airway closure in the dependent lung together with hypoxic vasoconstriction redirecting perfusion from the dependent lung. Therefore, a more appropriate question might be; is this acceptable? The answer must be no. Putting the diseased lung (or the normal lung) into a postural position which compromises both ventilation and perfusion could easily lead to longer term consequences of the type physiotherapy tries to avoid, e.g. further atelectasis, sputum retention, infection, increased work of breathing.

Figure 7 enables the visualisation of the adverse consequences of high closing volumes when positioning for VA/Q a patient with bi-basal consolidation and unilateral atelectasis in the right lung.

**7A+B** represent the clinical ideal, positioning the unaffected lung in the dependent position optimises $V_A/Q$. **7C+D** represent the same scenario but with the existence of high closing volumes, here the left dependent lung experiences small airway collapse, ventilation and perfusion are redistributed to the compromised right lung

FIGURE 6. The impact of aging and smoking on closing volume (CV)




therefore gas exchange potential is reduced.

**7E** illustrates how reverse positioning ie 'good lung up' despite delivering improvements in overall $V_A/Q$ could severely compromise the status of the diseased lung in the dependent position.

In the event that 'good lung down' positioning as seen in fig **7C+D** leads to a deterioration of the patient's $PaO_2$ / $SaO_2$ then high closing volumes can be assumed and lateral positioning as a treatment strategy should be abandoned. The next clinical course of action should be to address the airway closure by utilising techniques to increase functional residual capacity (FRC). Positive pressure ventilation CPAP or BiPAP may be indicated dependent on the patient's $PaO_2$ and $PaCO_2$. Alternatively, if the patient is less symptomatic and able to comply with treatment TEE's and incentive spirometry may be effective. IPPB provides a useful adjunct if fatigue or breathlessness limits a patient's participation in treatment when non invasive ventilation is not yet indicated.

## Conclusion

The evidence available does not provide specific information enabling the clinical identification of those patients with reversed ventilation distribution patterns or high closing volumes; nor does it guide clinicians as to a course of action in treating these patients for $V_A/Q$ mismatch. The evidence does however provide much food for thought.

## Key Points

- 'Good lung down' is not a panacea to VA/Q matching in unilateral lung disease.
- The subjective assessment should be used to identify patients likely to have reversed ventilation distribution patterns (elderly +/- chronic smokers).
- Monitoring effects of positioning is essential.
- Recognising and responding when positioning techniques aren't producing the desired improvements in Sa02/Pa02 is critical.

The conclusions drawn are based on the information available and clinical interpretation. Further research that would aid this process would be a large demographic study aimed at identifying high closing volume patient characteristics and diagnostic tests. Also further research exploring how high closing volumes are tolerated and to what extent non-positive pressure techniques can be effective in reversing small airway closure in patients with high closing volumes.

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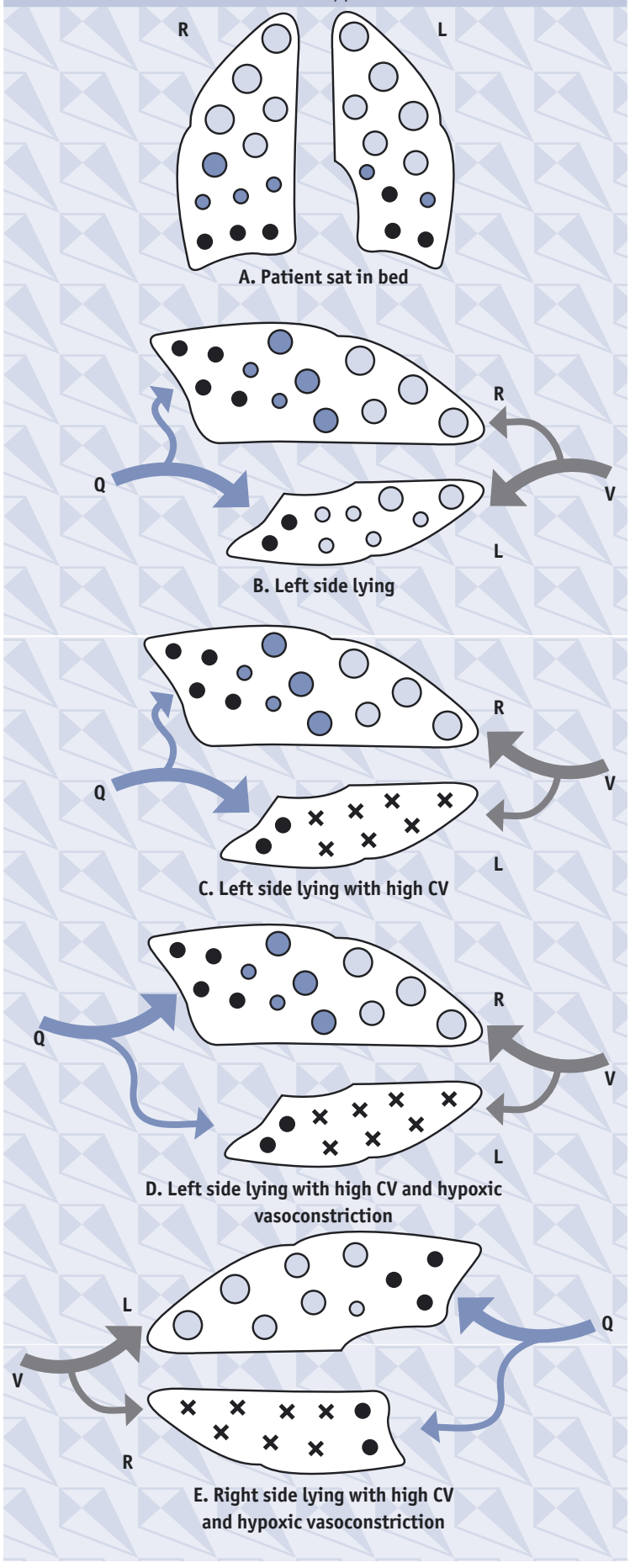
FIGURE 7. R = right lung, L = left lung, V = ventilation, Q = perfusion.
○ Ventilated alveoli, ◍ atelectasis, ● consolidation, **X** small airway collapse
Arrows denote distribution of ventilation/perfusion

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# Can the Interrupter Technique be used as an outcome measure for sputum clearance techniques?

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## Summary

*Valid outcome measures in respiratory physiotherapy are lacking. The interrupter technique may be a potential tool in measuring airway calibre pre-and post chest physiotherapy. The following article will discuss current literature surrounding the technique. If validated, the interrupter technique might provide a viable alternative to spirometry, an effort dependent technique that can be tiring and potentially provoke bronchospasm.*

## Introduction

Clinical effectiveness is difficult to establish in the respiratory outpatient setting for patients with adult bronchiectasis. Outcome measures that have been previously used in studies and commonly used in practice, such as sputum weight, sputum volume and spirometry, are seriously flawed (Prasad and Main, 1998). A viable alternative to methods currently used in practice pre and post treatment is necessary. One potential alternative that warrants further investigation is a measure of airway resistance using the interrupter technique via a portable device called the MicroRint (MicroMedical).

The MicroRint calculates interrupter resistance (Rint), a measurement of airway resistance based on pressure difference and flow following a brief period of interruption during the inspiratory and expiratory phases of the respiratory cycle. Airway resistance is the pressure difference between the alveoli and the mouth divided by flow rate (Lumb, 2000 p77). The interruption technique works on the principle that, when the airway is suddenly occluded, alveolar pressure (Palv) will equilibrate with pressure at the mouth (Pmo). Rint can then be calculated as the ratio of post- occlusion pressure change at the mouth to the flow rate immediately prior to occlusion (Bates *et al*, 1987a; Bates *et al*, 1988a; Phagoo *et al*, 1993).

The interruption technique is beneficial over other techniques in that it requires minimal co-operation, can be performed during quiet breathing, does not tire the patient, has not been found to cause bronchoconstriction (Bridge *et al*, 1999) and interruption devices, such as the MicroRint, are portable. However, it is not known whether the technique can be used in adult bronchiectatic patients or whether the technique could be a short term or long term outcome measure. If measuring Rint in patients before and after physiotherapy can show a reduction in airway resistance, physiotherapists could compare sputum clearance techniques in individual patients, use Rint as an outcome measure for research and ultimately promote clinical effectiveness.

### Aim

This article aims to discuss current literature surrounding the potential use of the interrupter technique as a physiotherapy outcome measure

of sputum clearance techniques with a particular focus on bronchiectasis.

## Literature review

The literature review was conducted using Cinahl, Medline, Swetswise, Science Direct, Cochrane Library and Web of Science in order to investigate what advantages there might be for using Rint as an outcome measure for sputum clearance. The key search words were: **bronchiectasis, Rint, the interrupter technique, physiotherapy, sputum clearance, airway resistance** and **bronchospasm**.

The interrupter technique is most commonly used in practice with asthmatic children regarding reversibility testing and the majority of research using the technique has concerned this population. However, more recent studies have also investigated the use of the interrupter technique in children with Cystic Fibrosis (CF). MicroRint values improved following a course of antibiotics in 78 children with CF and significantly correlated with standard spirometry (Morrison *et al*, 2003). This may suggest a role for the interrupter technique in longer term studies of sputum clearance. In a small, unpublished study of children with CF, Rint was found to be a feasible method of evaluating a single chest physiotherapy session and Rint values were positively correlated to sputum production (Van der Giessan *et al*, 2004). However, specific details are unavailable for critical analysis of the study. Research concerning the use of the interrupter technique with asthmatic children may not be necessarily be comparable to that with adults because respiratory resistance is affected in terms of lung volume, compliance and closing volume, which change with age (Lumb, 2000 p 64,65).

## Could the technique be used in adults?

There have been a number of published studies involving adult subjects, however none have investigated the interrupter technique as a physiotherapy outcome measure.

It has been shown that although the airway is larger in adults, the interrupter technique may still be sensitive enough to detect change (Eiser *et al*, 2001; Chowienczyk *et al*, 1991). Eiser *et al* (2001) found that Rint measurements decreased significantly in adult COPD patients on bronchodilation ($p=0.003$) in accordance with improvements in spirometry and the six-minute walking test. However, the sample size was small and the procedure of the technique poorly described. In another study involving bronchodilator response in adults with reversible airflow obstruction, the sensitivity of Rint using a portable device was compared to airway resistance as measured by body plethysmography (Raw) (Chowienczyk *et al*, 1991). Changes in Rint and Raw were significant and closely correlated suggesting that their device should be useful in detecting changes in airways resistance following therapeutic intervention. Again, however, the sample size was small and demographic data is lacking making results difficult to interpret.

Rint was not shown to be a sensitive technique as a measure of bronchial challenge in normal adults (Phagoo *et al*, 1993). When Raw was doubled and airway resistance increased by 7-10 standard deviations, for many individuals the overall change in Rint was less than 2 standard deviations. The lack of sensitivity of Rint in this study could again possibly be attributed to the small sample size in the study. However, Raw may be more sensitive in normal subjects than in obstructive conditions because measuring Raw by body plethysmography has been found to be inaccurate and underestimated in patients with lung obstruction depending on the degree of airway obstruction and the compliance of the extrathoracic airway (Stanescu *et al*, 1982). Phagoo *et al* (1993) highlight that in cases of obstruction, there is a loss in pressure across the obstruction, however this may also potentially occur during Rint measurements.

## Could the technique be used in bronchiectasis?

The main reason why the interrupter technique is not more widely used has been the uncertainty regarding its validity in patients with airflow obstruction. The theory of the interrupter technique is based on a single compartment model (Bates *et al*, 1988a). However, the lung also consists of parallel compartments (Bates *et al*, 1988a). The time-constants of individual lung units in diseased lungs may differ, which leads to some compartments filling or emptying faster than others (Lumb, 2000 p45, p165-169), the faster compartment achieving a lower pressure than the slower one as expiration progresses (Bates *et al*, 1988a). The relative pressure difference, however, becomes greater during expiration than during constant flow inflation (Bates *et al*, 1988a) and will be exaggerated by bronchospasm leading to an underestimation of airway resistance (Chowienczyk *et al*, 1991). Airflow obstruction may delay the equilibration of alveolar pressure and mouth pressure where there is compliance of the extrathoracic airways (Bates *et al*, 1987a; Listro *et al*, 1989). An increase of up to 10 times the airway resistance can still be calculated as long as upper airway compliance is not excessively

high (Bates *et al*, 1987a). A valid estimate of airways resistance can be assumed as long as upper airway compliance is minimised by supporting the cheeks and pharynx (Bates *et al*, 1987a; Bates *et al*, 1988a; Listro *et al*, 1989). A more accurate reading may be given if the machine calculates Rint during inspiration as opposed to expiration, the more commonly used method, so that airways obstruction is minimised (Chowienczyk *et al*, 1991). An additional factor, which may aid the accuracy of the interrupter technique, has been the advancement in the apparatus, for example with the improvement of the closing speed of the shutter (Listro *et al*, 1989). Therefore in theory the interrupter technique should be able to detect changes in airway resistance in patients with airflow obstruction. Although airflow obstruction is the most common finding in bronchiectasis, there are other factors, such as fibrosis and parenchymal scarring which reduce compliance and have a restrictive influence on measurement of airway resistance (Nicotra *et al*, 1995; Lumb, 2000 p48; Roberts *et al*, 2000). Reduced compliance may influence Rint measurements not only in terms of reduced lung volume (Lumb, 2000 p 64,65), but also because it has been postulated that Rint may actually be a measure of lung tissue resistance as well as airway resistance, however, back extrapolating the measurement has been found to reduce this error (Jackson *et al*, 1974). Therefore the validity of the interrupter technique in the presence of airflow obstruction may have improved, however, it is not known whether the interrupter technique can detect changes in airway calibre post sputum clearance.

## Could the interrupter technique be used as a short term outcome measure?

If the physical presence of sputum significantly compromises lung function by blocking the airway then one would expect a change as soon as treatment fatigue and bronchospasm had resolved (Lumb, 2000 p71-73). Immediate changes in airway calibre have been found post-treatment in studies of the effects of physiotherapy sputum clearance techniques on airway resistance measured by body plethysmography and spirometry (Cochrane *et al*, 1977; Pfleger *et al*, 1992). Cochrane *et al* (1977) found that a significant percentage of airways obstruction was caused by bronchial secretions and this obstruction was relieved by physiotherapy in a study in which 47% of patients were bronchiectatic. Hence there is a potential for Rint to detect this change. However, changes in airway calibre following physiotherapy in bronchiectatic patients have not previously been investigated using the interrupter technique.

Methods of measuring airway calibre comparable to the interrupter technique have detected changes in airway calibre following physiotherapy. Specific airway conductance (SGaw) and spirometry have been found to improve following single physiotherapy sessions in adult patients with CF, Bronchiectasis and chronic bronchitis (Cochrane *et al*, 1977; Pfleger *et al*, 1992). The reciprocal of Rint, interrupter conductance (SGint), has been found to be comparable to SGaw, in patients with severe obstructive disease when the cheeks and the floor of the mouth are supported (Listro *et al*, 1989). However, Rint is affected by lung volume, which may render it less sensitive than SGaw to changes in airway calibre. The interrupter technique has been found to be comparable to spirometry in published and unpublished trials (Bridge *et al*, 1996; Jones *et al*, 1999), however, spirometry itself may be flawed (Prasad and Main, 1998). Therefore the interrupter technique might be a potential measure of airway calibre following physiotherapy, but its sensitivity has not been established.

In our own research, we investigated in a randomised controlled trial whether the interrupter technique could be used to assess airway calibre pre- and post autogenic drainage in 12 bronchiectatic patients. Rint measurements were repeatable in adult bronchiectatic patients, but changes in airway calibre post physiotherapy were not established. However the small sample size and lack of valid comparative outcome measures were recognised as limitations. Further research involving larger sample numbers and a comparative measure that would not influence Rint measurements or treatment is warranted.

## Could the interrupter technique be used as a long term outcome measure?

Investigating the use of the interrupter technique as a long term measure of assessing the effects of physiotherapy on airway calibre may be more beneficial as realistic changes in lung function may occur as a result of reduced inflammation (Cole, 1986). In addition, assessing long term outcome measures allows quantitative and qualitative approaches to be used in conjunction so that adherence, change in health status, quality of life and lung function to be addressed.

## Conclusions

- The sensitivity of Rint has varied in comparison to

current methods of measuring airway resistance.
- These methods are, however, inherently flawed in their own right.
- The interrupter technique has a number of advantages over current methods in adult patients with airflow obstruction
- Clearance of sputum, as an obstruction, can have immediate effects on pulmonary function and hence there is a potential for Rint to detect this change.
- Methods of measuring airway calibre comparable to the interrupter technique have detected changes in airway calibre following a single physiotherapy session.
- It is not known whether Rint is a sensitive measure of airway calibre in bronchiectatic patients.
- Research concerning the use of the interrupter technique as a physiotherapy outcome measure is currently unpublished, involving small samples and had varied outcomes.
- Further research in this area is warranted involving larger sample sizes, short term and long-term time scales.

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# Acupuncture and Respiratory Problems

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## What is acupuncture?

Today, non-invasive methods (acupressure, laser, electrical stimulation) are found to be just as effective as needling (Vickers, 1986). Body and ear acupuncture can be used on their own, together, or with other treatment modality.

## Does acupuncture work?

It is evidence-based on research, clinical guidelines and care pathways; there has been improvement in FEV1 & PEFR following needle acupuncture. Respiratory conditions are recognised as being treatable with acupuncture by the WHO (Hopwood, 1993). It has been found to be safe and potentially effective for bronchial asthma and COPD (Jobst, 1995).

## How does acupuncture work?

Palpating an acupuncture point (acupt) stimulates Ab fibres, needling stimulates Ad fibres. Both work by inhibiting pain via gating descending inhibitory pathways. Acupuncture releases endorphins and serotonin that have been shown to have effects on cell growth and healing. (Kishi, 1996 & Pakala, 1998). Stimulation of certain acupts activates cortical areas of the brain that have controlling effects on symptoms being treated (Zhang, 1996). Traditionally energy flows within the meridians and acupts are chosen to balance this flow. Acupts and meridians have a high concentration of gap junctions (Mashansky, 1983) facilitating intercellular communication and thereby mediating the effects of acupuncture.

## What is acupuncture used for?

To relieve acute and chronic pain, help to control disabling breathlessness (Linde, 1986), exercise induced asthma (Kam Pui Fung, 1986) and improve lung function and quality of life in COPD (Neumeister, 1999). It can control panic attacks and stress. Used pre-operatively, it can reduce post-operative pain, the risk of infection and improve recovery rate. How do we find and treat Acupts ? Active points that require treatment for an individual patient are detectable by skin resistance measurement and palpation for tenderness. Needles can be left in situ for a period of time or moved around while in situ. An electrical current can be applied to them or moxibustion techniques used for those patient who are unresponsive to ordinary needling. However, needling is the biggest cause of adverse effects in acupuncture (Halvorsen, 1995), therefore non-invasive methods are becoming more prevalent, especially for respiratory patients, who are often contra-indicated for needling. These include acupressure, which can also be used by the patient as a home treatment, laser and electrical stimulation.

## Auriculotherapy (ear acupuncture)

This is safer than body acupuncture, is quicker and access is easier e.g. in ITU situations. Patients contra-indicated to body acupuncture, e.g. those with heart conditions, can be safely treated via the ear non-invasively. It can also be used as prevention and diagnostically (Lichstein, 1974). Used appropriately, as part of a team approach, acupuncture can help to improve quality of life in respiratory diseases, reduce potential side effects from drug therapy and help in some way where the conventional approach has failed.

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# National Institute for Clinical Effectiveness: Guidelines for the management of Chronic Obstructive Pulmonary Disease.

*In February 2004, the National Centre for Clinical Excellence (NICE) produced new guidelines for the management of Chronic Obstructive Pulmonary Disease (COPD) (National Institute for Clinical Effectiveness, 2004).*

## Why the need for new guidelines on COPD?

After all, three well know guidelines were already published (British Thoracic Society, 1997; Pauwels *et al*, 2001 & Pearson 2001). Well, unlike other guidelines the NICE framework is the first to consider cost effectiveness in the evaluation of management, NICE has a transparent and wide approach to the development of guidelines. But, perhaps most importantly, NICE is a government funded institution meaning it has more to gain or lose from the implementation of its guidance. The wide approach of NICE has had significant benefits for physiotherapists. NICE is a well-recognised organisation of some considerable importance in the medical and health sector, whether you agree with their guidance or not there will be expectations that you comply. In fact NICE clearly states that whilst guidance is advisory there are expectations that guidelines will be taken into account by clinicians, and that includes physiotherapists. In fact we feature prominently in the COPD guidelines. It is, to me, reassuring and welcoming that physiotherapy was considered so highly at the meetings. Another important aim of NICE guidance is to improve communication between patients and clinicians. I believe physiotherapists, along with nurses and other members of the allied health professions, play a crucial role in facilitating learning for patients; we do have the time (comparatively) to listen to patients, to explain a procedure, treatment or advice and to ensure that patients understand. We are trained to do this. Undergraduate students often complain about the amount of learning that they are required to do around communication. That's because it is vitally important that we get it right, it isn't easy, but it is important.

As a physiotherapist on the guideline panel I was heartened by the amount of support our profession warranted, but I was also dismayed, at times, by the lack of recognition we receive concerning our role in critical areas such as during exacerbation.

## What can we do about it?

I think there's a lot we can do, firstly let's be seen to be promoting the guidelines, let's be seen and heard as key members in the team. Let's evaluate our role in light of the guidance, what can we deliver better? What are we not delivering enough? Let's look at the guidance and see how we fit in.

Out of 188 recommendations arising from the guideline, the panel identified 6 key recommendations. The requirements were that the key recommendations would make a large difference and that they would benefit a large number of people. We have a role in all of the key recommendations. The first one concerns the early diagnosis and treatment of COPD:

*"COPD should be considered in smokers over the age of 35 with exertional breathlessness and cough"*

(National Institute for Clinical Effectiveness 2004).

This is not new but is based on a growing body of evidence to support the need for early intervention (Calverley, 2000). What is new is that nurses are increasingly being recognised as those with initial diagnostic skills. Practice care nurses, in particular, are well placed to support the initial diagnosis of COPD, are we in the same position? The document points out that:

*"opportunistic case finding in primary care is a relatively cost effective strategy"*
[a]National Institute for Clinical Effectiveness 2004)

...based on a smoker or ex smoker presenting with cough and / or breathlessness, could we raise awareness in our musculoskeletal outpatient clinics? Are physiotherapists routinely asking about smoking history? Are smokers given the opportunity to access spirometry testing if they wish? Similarly, the second key recommendation concerns smoking cessation. Firstly we must diagnose COPD early; secondly we must help smokers stop. Hence we as professionals must ask about smoking habits and then give people the opportunity to try. Information, promotion of clinics, referral to specialist clinics, prescription rights, all these will help us play an effective role in assisting people to stop smoking.

The third key recommendation concerns effective inhaler therapy. Long acting bronchodilators should be used in patients who remain symptomatic on short acting bronchodilators. Symptomatic is defined as breathless on exertion and reduced exercise capacity. We see patients in the community, in rehabilitation and on the wards. Physiotherapists assess and ask about daily activity and exercise ability consistently. We are in the prime position to pick up patients for whom medication may need reviewing or whose condition has changed since the last review. Referral to the general practitioner, to the chest consultant or to a health practitioner with prescribing rights will be relevant. In particular, patients should be using inhaled steroids at an earlier stage than was once perhaps felt. There is evidence to support the role of steroids in reducing exacerbation, particularly in patients with an FEV1 of < 50% and in those having more than 2 exacerbations a year (Burge et al, 2000). Physiotherapists know these patients; let's ensure our patients know how important inhaled steroids are. To facilitate patient education around these issues the fabulously comprehensive and readable COPD Guidelines patient document is available from the NICE website . *(http://www.nice.org.uk/page.aspx?o=104441)* Put a copy up in your chest clinic, highlight the availability of the document to your patients in pulmonary rehabilitation, and make sure they have access to these documents.

The next key recommendation is fundamental to us and is recognised as such. We play a crucial part in pulmonary rehabilitation. So let's continue to be the main players, develop the services in the community, evaluate and promote our results, increase resources, improve effectiveness. Does your medical director receive bi-annual reports on the results of pulmonary rehabilitation? Do patients all know about the service? Could you run more classes? Could you have different types of classes, shorter more active classes for less severe patients with larger numbers, longer less intensive classes for more severe patients with smaller patient numbers? The guidelines state that we need to provide:

*"Pulmonary rehabilitation for all who need it"*

...and that really is all those who wish to attend, we need to increase our delivery whilst maintaining the high standards already being reached.

The next two key recommendations really concern the management of acute exacerbation from non-invasive ventilation treatment in hypercapnic respiratory failure. Both of these areas I consider physiotherapists to be actively involved in, sadly, the NICE guideline panel were less convinced. I believe it is time to take a good hard look at our role in the management of acute exacerbation, why are we not seen as key players? Could we be promoting the role more? I think things will change with the advent of Consultant therapists, with prescribing rights and with extended skills such as blood gas analysis. I believe we should jump at these posts and really try to make our voice heard in this important area of care. Do we have physiotherapists in A& E evaluating patients and supporting early discharge schemes? Managing exacerbation cost effectively is an important therapeutic target for trusts. We have a role in "hospital at home programmes" (Gravil *et al,* 1998), in supportive managed discharge (Killen & Ellis, 2000) and in oxygen assessment and referral. Importantly, NICE guidance recognise the role of the allied health professionals with recommendation number 139 clearly stating that:

*"hospital at home schemes should include allied health professionals with experience in the management of COPD and may include Physiotherapists, Occupational Therapists ..."*
(National Institute for Clinical Effectiveness 2004)

There are a number of recommendations specific to physiotherapy and for that we have to be thankful to an increasingly robust evidence base, which whilst still small, is rapidly emerging. Based on methodologically sound evidence showing that diaphragmatic breathing in combination with positive expiratory pressure mask treatment resulted in less cough and fewer exacerbation in stable COPD compared with a control group recommendation number 102 was formulated (Christensen, Nedergaard, & Dahl 1990).

R 102 states, "if patients have excessive sputum they should be taught;

- The use of positive expiratory pressure masks [in combination with diaphragmatic breathing]
- Active cycle of breathing techniques (National Institute for Clinical Effectiveness, 2004).

The first recommendation received a grade B, indicating that it is directly based on category ii evidence (well designed controlled study) or extrapolated from category i evidence (randomised controlled trial). The second recommendation received a grade D indicating that is based on consensus evidence and really reflects the remarkable work in the past by the likes of Jennifer Pryor and Barbara Webber. Whilst their trials may not stand up to today's rigour they represent a body of evidence that has influenced physiotherapy practice as we know it today (Partridge, Pryor, & Webber 1989; Pryor & Webber 1979; Webber *et al,* 1998)

The final key recommendation focuses on multidisciplinary working:

*"COPD care should be delivered by a multidisciplinary team"* (National Institute for Clinical Effectiveness 2004)

I believe this reflects more than simply lip service to the "Cinderella professions" but in fact represents a true recognition of the complex nature of COPD needs that can only be met by a truly holistic approach. I think the medical profession as a whole has recognised that it cannot do it all and indeed should not do it all. Our values and those of our nursing and occupational therapy colleagues are respected and as such we should promote and endeavour to fulfil the recommendations within the NICE guidelines.

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# Audit of Oxygen Therapy Prescription, Application and Monitoring

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## Introduction

Oxygen is widely used throughout the acute hospital setting. It is defined as a drug and if administered in an inappropriate concentration may have serious or even lethal effects (BNF, 2003).

Oxygen should therefore be prescribed, applied and monitored by health care professionals with appropriate qualifications and training.

## Aim

To audit the prescription, application and monitoring of oxygen therapy on four wards in an acute hospital setting.

## Standards

- The prescription of oxygen should include flow rate, concentration, delivery device, duration, method for monitoring (Bateman & Leach, 1998)
- Routine observation recordings should include pulse oximetry, oxygen saturation level ($SpO_2$)
- $SpO_2$ should be recorded with fraction of inspired oxygen ($FiO_2$) and/or flow rate (litres/minute)
- There should be no discrepancy between oxygen applied and oxygen prescribed

## Method

Data was collected from all patients on four wards (thoracic/general surgery, medical, respiratory medicine and elderly care) over a one-hour period. Observation of the patient plus review of the patients' TPR and drug prescription charts to record the following for each patient:

- presence / absence of oxygen therapy
- flow rate or $FiO_2$ applied
- oxygen therapy device used
- presence of recent (within 12hours) $SpO_2$ level
- recording of $SpO_2$ with $FiO_2$ / flow rate
- presence / absence of oxygen prescription
- prescription of $FiO_2$ / flow rate
- prescription of an oxygen therapy delivery device
- any discrepancy between oxygen prescribed and oxygen applied in terms of duration / date of prescription, flow rate / $FiO_2$, delivery device

## Results

Data was recorded in each category for each patient on the four wards. Unknown results were due to the absence of the patient (e.g. in theatre), or the unavailability of the patient's TPR or drug prescription charts.

## Discussion of results

The greatest percentage of patients receiving oxygen was on the elderly care ward (31%). This indicates a need for widespread training in the effective prescription, application and monitoring of oxygen therapy across the acute inpatient setting, and not solely in areas with a respiratory bias.

Pulse oximetry oxygen saturation level is a gold standard outcome measure of oxygen therapy (Dodd, 2001). These levels were recorded most effectively on the respiratory medicine ward where a separate oxygen saturation monitoring chart was already in place; 95% of patients had $SpO_2$ recorded with $FiO_2$ / flow rate.

The mean percentage of drug charts available was 87% (range 77-92%).

The prescription of oxygen was generally poor. The mean percentage of patients on each ward prescribed oxygen was 17.25% (range 0-32%); of those prescribed oxygen 72% were not prescribed a flow rate / $FiO_2$ and 79.75% were not prescribed a delivery device.

The introduction of an oxygen prescription chart increases the prescription of oxygen (Dodd et al, 2000). Accuracy of prescription also increases; the most common omission being flow rate. A specific prescription chart for oxygen therefore improves clinical practice.

A discrepancy occurred on all four wards between the percentage of patients receiving oxygen and the percentage who had oxygen prescribed; discrepancy ranged from 8-18%. This may have resulted

FIGURE 1. Patients Receiving $O_2$

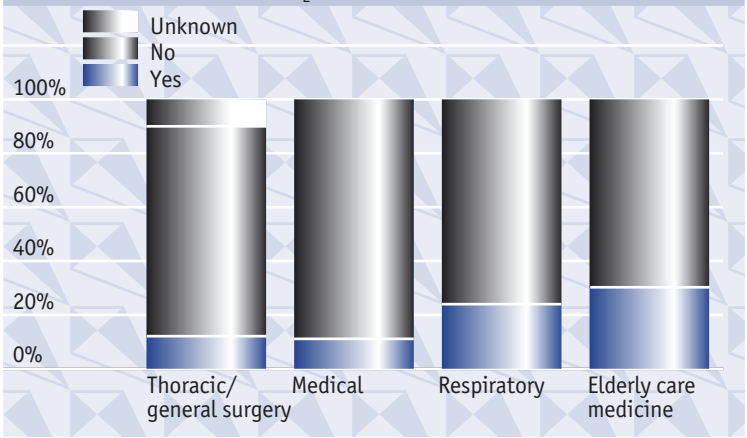



FIGURE 2. $O_2$ Sats recorded

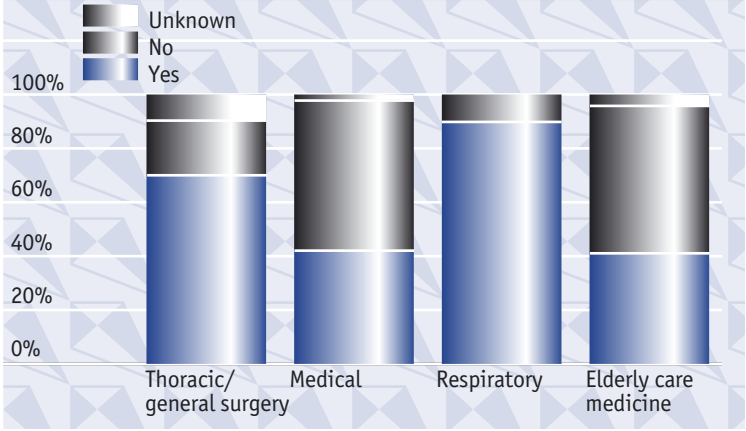



FIGURE 3. $O_2$ Sats recorded with $O_2$ level

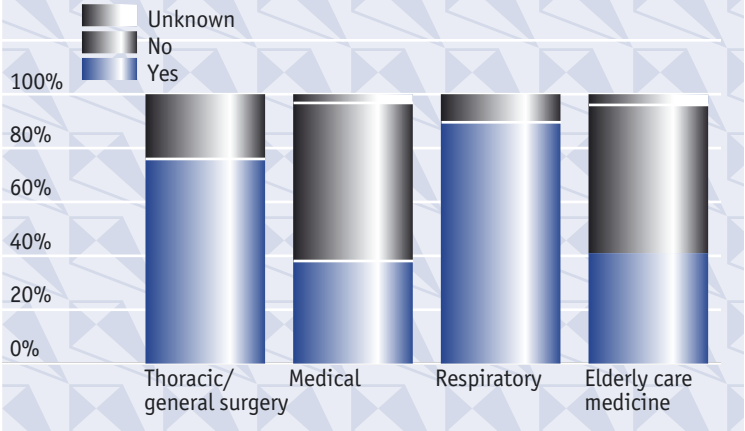
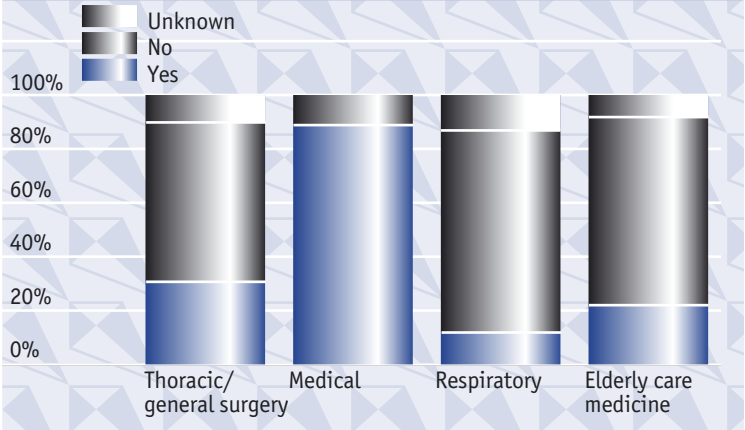



FIGURE 4. Oxygen Prescribed




from inaccurate application of prescribed oxygen, weaning of oxygen without discontinuation of oxygen prescription, absence / outdated oxygen prescription where oxygen was being applied or the removal the oxygen therapy device by the patient / staff.

## Recommendations

- All patients to have Sp02 levels recorded with routine observations
- All patients to have Sp02 levels recorded with Fi02 (e.g. on air, on 40%, Fi02 0.35)
- Utilise a specific Sp02 monitoring chart to improve monitoring of patients
- Utilise a specific oxygen prescription chart as recommended by Dodd et al (2000) to increase prescription of oxygen including delivery device and flow rate / Fi02
- Staff education to facilitate the effective prescription, application and monitoring of oxygen therapy and encourage regular review of each patient's oxygen therapy
- Re-audit to include data analysis of flow rate, concentration, delivery device, duration and monitoring method as recommended by Bateman and Leach (1998)

## Conclusions

Oxygen therapy is widely used throughout the acute hospital setting, however despite the serious consequences of misuse, its prescription, application and monitoring remains inaccurate. Further education of staff and introduction of specific prescription and monitoring charts would improve standards of oxygen therapy prescription, application and monitoring.

FIGURE 5. Flow rate prescribed

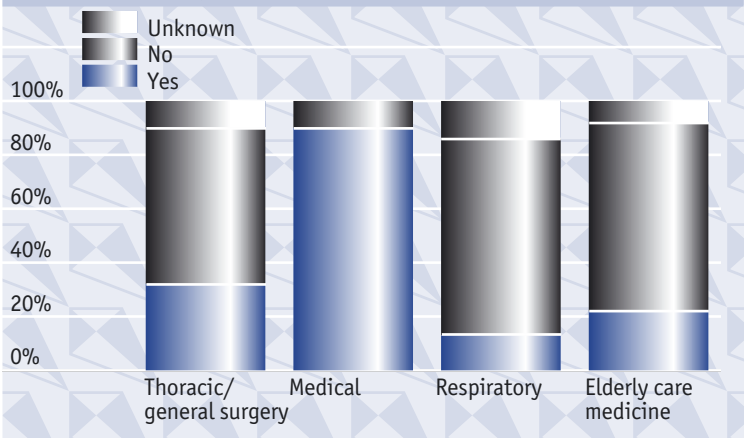



FIGURE 6. Delivery device prescribed

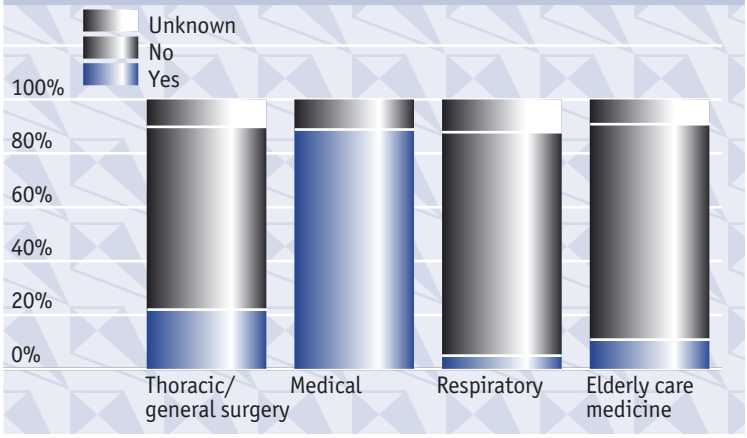
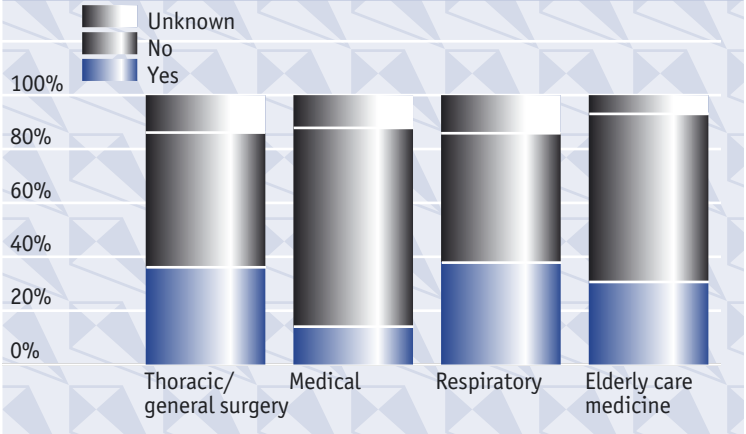



FIGURE 7. Discrepancy

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# Respiratory Muscle Training (RMT)

## Principles and Considerations for Clinical Applications

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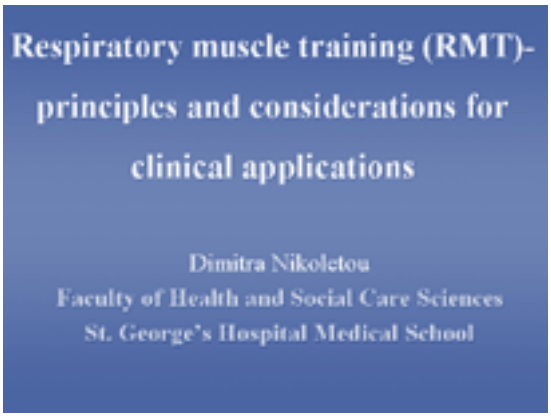


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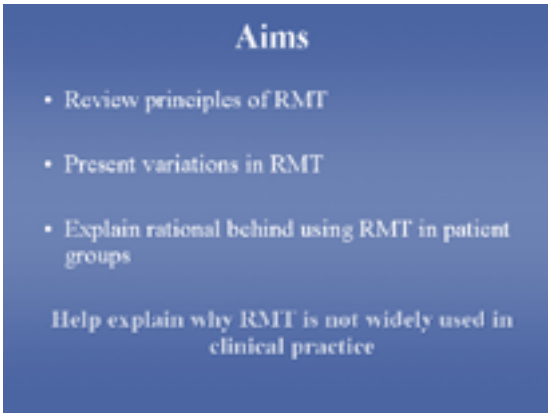


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## Principles of training

- **Specificity**- Response to training is specific to the stimulus
- **Intensity** - intensity must be relatively great to elicit a response
- **Reversibility** - effects of training will be reduced once training ceases

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## Variations in RMT

Types of RMT

Training regimes
- Duration
- Load
- Frequency

Outcome measures

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## Types of inspiratory muscle training

- **Normocapnic hyperpnoea**
- **Inspiratory resistive breathing**
- **Inspiratory threshold loading**

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## Normocapnic Hyperpnoea

**Advantages**
- Trains both Inspiratory and expiratory muscles
- Load similar to that applied during exercise

**Disadvantages**
- Flow dependent-Visual feedback required
- Complicated equipment
- Unsuitable for home use

Scherer A. et al (2000) Am J Resp Crit Care Med; 162(5):1709-1714.

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## Normocapnic Hyperpnoea principle

- Increase in slow-twitch, high-oxidative muscle fibers in diaphragm
- **Changes similar to other skeletal muscles after endurance-training stimulus**

Grassino A. Eur Respir J. (1989), 2, Suppl. 7, 581-586s

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## Inspiratory resistive loading

**Advantages**
- Provides combination of strength and endurance training
- Suitable for home use

**Disadvantages**
- Flow dependent
- Until recently complicated devices

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## Resistive training principle

- Responses similar to both strength and endurance training

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## Resistive device TRAINAIR (based on TIRE principle)

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## Inspiratory threshold loading

Advantages

- Flow independent
- Ideal for home-use
- Relatively cheap and portable devices

Disadvantages

- Built-up of negative pressure before flow occurs

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## Inspiratory threshold loading principle

- Isometric contraction until threshold pressure reached
- Promotes more efficient breathing pattern
- Increases velocity of inspiratory muscle contraction

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## Inspiratory threshold loading principle

- Isometric contraction until threshold pressure reached
- Increases velocity of inspiratory muscle contraction

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## Threshold devices


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## Types of Inspiratory muscle training

- **Normocapnic hyperpnoea**
- **Inspiratory resistive breathing**
- **Inspiratory threshold loading**

Different training effects? - No evidence so far

Different practical considerations

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## Training regimes

- **Duration** - min 3weeks, max 3months
- **Load** - > 30%PImax
- **Frequency**- varies

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## Outcome measures

Assessment of:

Strength
Endurance
Exercise capacity – 6MWD or SWT
Quality of Life questionnaires
LFT
Diaphragm muscle fibres

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## RMT has been used for :

- Athletes
- COPD patients
- MND patients
- Weaning from ventilators

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## Athletes

**Rational:** Utilise respiratory muscle reserve to improve performance in sports

**Study findings:**

↑ Time to exhaustion to *fixed-rate submaximal loads*

**Effect of RMT in exercise performance limited in highly trained athletes**

Sheel W. A. (2002) Sports Med; 32(9):567-581

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## RMT in COPD

**Rational:** Train the respiratory muscles for strength and endurance to reduce dyspnoea

**Study findings:** 1) PImax increases

2) Increased mitochondrial capacity and efficiency in the inspiratory muscles- endurance like effect

Demoule A. et al (2001) Am J Resp Crit Care Med;163: A46

Ribera F. et al (2003) Am J Respir Crit Care Med;167: 873-879.

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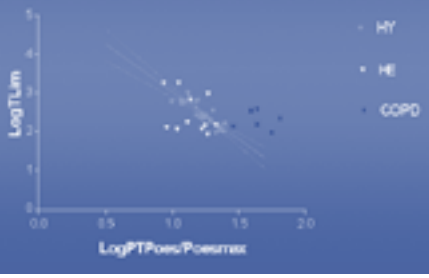
## Endurance in COPD- comparison with healthy young and elderly subjects

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## RMT in COPD

- Structural adaptations in ext. intercostals post RMT
- Supervised training
- Control of training load
- Selection of COPD patients

Ramirez-Sarmiento A. et al.(2002) Am J Resp Crit Care Med, 166:1491-1497

Lotters F. et al (2002) Eur Respir J; 20:570-576

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## RMT in MND

**Rational:** *Expiratory muscle* training for augmentation of cough

**Study findings:** 1) Increased PEmax

2) Increased cough expiratory flow rate

**? Effects on mortality and frequency of exacerbations**

Suleman M. et al (2003)Thorax; 58(Suppl. III): iii77

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## RMT for Weaning from mechanical ventilators

**Rational:** To improve RM strength and endurance and reduce ventilation time

**Study findings:** Small sample sizes

No controlled trial yet

Successful weaning of difficult-to-wean patients

Martin AD et al (2002) Chest;122(1):192-196

Gutierrez CJ et al (2003) J Rehabil Res Dev.; 40(5 Suppl 2):99-110

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## Summary of Main Points

- RMT is based on theory of strength and endurance reserve
- Wide variations in training regimes, types of RMT and outcome measures
- Certain patient groups might benefit more than others

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## Conclusion

RMT is not a well established rehabilitation option because a number of questions remain unanswered

# Respiratory muscle training in tetraplegia - a single case study

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## Introduction

The vulnerability of tetraplegic individuals to respiratory problems stems from three main issues: the lack of inspiratory muscle strength (Hopman *et al,* 1997), the altered respiratory dynamics (Brownlee & Williams, 1987) and the lack of expiratory muscle strength. In a prospective trial, it was found that 67 % of acutely injured patients suffered from respiratory complications such as atelectasis (36 %) and pneumonia (31%). Repeated chest infections can lead to hospital admission and poor quality of life for the tetraplegic individual. Although statistics for the number of patients suffering respiratory complications in the post-acute phase is not known the higher the level of lesion the more likely the patient is to have respiratory complications. Experience at the Princess Royal Spinal Injuries Unit suggests these patients tend to be elderly with previous chest conditions or history of smoking. Younger patients who wean from ventilation but have poor respiratory reserve are also prone to problems.

Respiratory muscle training (RMT) has been much researched in the last 20 years. Some studies have focused specifically on spinal cord injured patients. (Hopman *et al,* 1997; Rutchik et al, 1998; Gross *et al,* 1980 & Uijl et al, 1999). Stiller and Huff reviewed articles in their paper in 1999. At the time of the study RMT was not being used in the spinal injuries units in the UK.

## Aim

The aim of the study was to assess the effect of RMT on the tetraplegic patient. The study was a single case experimental design, chosen in order to assess the efficacy of the treatment in a controlled manner with a single patient who had a stable condition. Permission to complete the study was granted by the Sheffield Teaching Hospitals ethics committee.

## Background

### Mechanisms of respiration

The mechanics of ventilation are well documented, in normal quiet inspiration the diaphragm (innervation C3, 4 & 5) descends and the ribs lift up and out. The diaphragm performs about 70 – 80 % of the work of breathing (Reid & Dechman 1995).

Less well known is the role that the abdominal muscles play in inspiration. Their resting tone opposes the descent of the diaphragm and causes abdominal contents to be compressed laterally and the lower rib cage to expand. (Reid & Dechman 1995). The role of the abdominal musculature is demonstrated by any patient with a spinal cord injury above T 8. Inspiration is not as efficient (Zupan et al, 1997) and forced expiration relies solely on the elastic recoil of the lung leaving cough effectiveness vastly reduced. Loss of the abdominal muscles will reduce cough strength (Wang *et al,* 1997) and secretion retention (Stiller & Huff 1999). Objectively Wang et al, (1997) found a direct relationship between motor level and cough strength. Power is proportional to the volume inspired as well as the power of the muscles of forced expiration. The action of the internal intercostals remains controversial; it is thought that they also play a small role in expiration (Reid & Dechman 1995). In this context it is worth noting that the respiratory muscles work continually, contracting 12 to 20 times a minute, and have no opportunity to rest. These muscles fatigue if overloaded for a prolonged period of time (Reid & Dechman 1995).

An injury to the cervical spinal cord will cause loss of innervation to the muscles below the level of the lesion. Altered mechanics and loss of innervation will cause vital capacity to be severely reduced. With fewer muscles able to take the inspiratory load the muscles will be at risk of tiring. With intercostal paralysis there is no tone to oppose the caudal pull of the diaphragm, negative intrathoracic pressure causes depression of the chest wall and paradoxical breathing will occur at rest. As a tetraplegic patient is unable to achieve full lung inflation or sigh, there is a predisposition to hypoventilation and subsequent microatelectasis (Stiller & Huff 1999).

The factors outlined above lead respiratory complications in tetraplegia to be the most common causes of morbidity and mortality. (Stiller & Huff, 1999; Liaw M-Y et al, 2000 and Silver & Gibson 1968).

## Respiratory muscle training

As the muscles of respiration are skeletal muscles it would follow that the well researched training theories would also apply to the respiratory muscles. Faulkner (1985) described the principles of skeletal muscle training as:

**1. Overload**
The training should be of sufficient intensity to overload the muscle in order to strengthen it. He states that this should be a minimum of 20 – 40 % of the maximum power of that muscle. The prolonged ventilation will weaken respiratory muscles that many of these patients experience, and also by lack of innervated motor units, thus making training to increase strength an important factor.

**2. Specificity**
The training should be devised according to the desired results. For endurance training there should be high intensity with a low load. For strength there should be low intensity with a high load. It is important that as well as increasing strength these patients undergo endurance training, enabling them to breathe effectively against the altered respiratory mechanics, and at times of increased load.

Faulkner also stated that the effects of training are reversible – and will be completely reversed within 6 weeks of discontinuation. Which leads to the question of maintenance exercises. This is beyond the scope of this study but remains a topic for further investigation.

Chattam *et al*, (1995) suggested that training should control the variables of inspiratory time, flow rate, respiratory rate and resistance. This established theory is exactly what physiotherapists do if trying to strengthen other muscles. The Devillbiss machine chosen for this study answered all these points.

Investigators have commentated that although strength and endurance are closely related the respiratory muscles will respond to the specificity of exercises (Samsa et al, 2002; Bach & Alba 1990). For strength training it has been found that improvements in inspiratory capacity occur when inspiratory muscles are trained near to the total lung capacity. (Rutchik et al, 1998) this should then be a factor in training regimes, again the machine chosen encourages a pattern of breathing that takes the patient to 80 % of maximum capacity.

On the basis of this evidence it can be concluded that any training should fulfil the principles of specificity and load and be continuously evaluated in order to maintain overload. Training needs to be on going in order to maintain training effect and the utmost care given to prevent fatigue. The Devillbiss RT2 re-evaluates the patient prior to each training session, with a maximum effort breath, thus ensuring continued overload (although obviously this is reliant on patient co-operation and maximal effort). If the patient fails at any level the exercise session is halted, thereby preventing overtraining and fatigue.

## Method

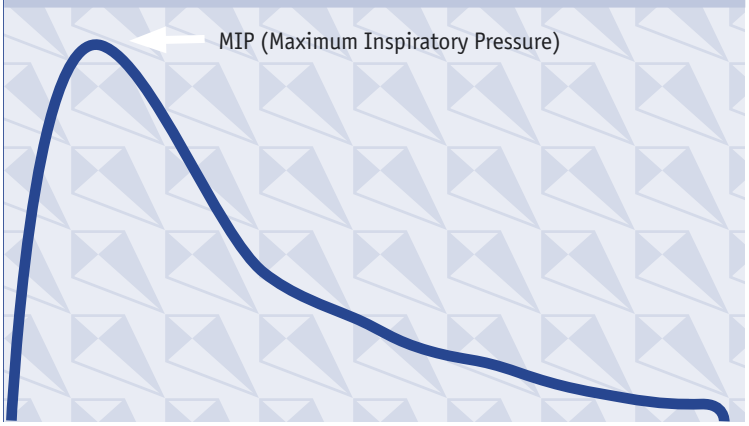
The subject of the study was year old was a 35-year-old female who had been admitted to hospital and ventilated with a diagnosis of transverse myelitis. Transverse myelitis is an inflammatory process affecting a focal area of the spinal cord. Damage develops over hours or days to give paralysis below the level of the lesion. One third of patients gain no recovery. The patient in the study was affected at the level of C4 / 5 having no sensation below the upper chest, weak elbow flexors, and no movement below this level of the body. The patient can thus be described as tetraplegic. With this level of lesion the patient is unlikely to have full innervation to the diaphragm. Training took place three months after successful weaning. At the time the patient was on no mechanical support, and had been decannulated, she was given two litres of oxygen at night. The patient was assessed for a period of two weeks to check for stability and then undertook a period of eight weeks exercise. Assessment was in the form of base line, midway and end of intervention measurements. Approximately half of the study was conducted following discharge.

## Intervention

The Devilbiss RT2 respiratory muscle trainer allows the patient to set their best effort. It is most important to these patients that they can work at a level appropriate, as their base line strength is much lower than the population as a whole. The machine also includes the aspects that Chatam considered important in exercise, the variables of inspiratory time and flow rate are determined by the patient, (set against their best effort), and respiratory rate and resistance are kept constant by the machine. A 2mm bore gives fixed resistance.

Exercise was performed 3 times a week, with 48 hours rest between training sessions. Prior to beginning the exercise on each occasion the patient performs three test breaths and the best of these is taken as a baseline from which 80 % of the maximum effort is calculated to use as an exercise template. The exercise session is incremental in design, six breaths on six levels

FIGURE 1 . Inspiratory trace such as created by the Devilbiss RT2




– each breath is of the same inspiratory time and flow rate with the rest periods decreasing from 60 seconds to 5 seconds between breaths on each set.

## Outcome measures

Much thought was given to the choice of outcome measures; above all it was thought necessary that they were clinically relevant to the patient. A high tetraplegic patient cannot perform a shuttle test so other measures needed to be considered. Objective measures of pulmonary function, arterial blood gases; MIP (Maximum Inspiratory Pressure) and MEP (Maximum Expiratory Pressure) were taken. Regarding functional outcomes, a quality of life questionnaire and voice volume were measured (the thought being that with an increased expiratory flow rate a larger voice volume would be possible). This is an important functional measure for the patient allowing them to use voice activated equipment, hands free telephones and to shout for help if it was needed. An attempt was made to measure diaphragm thickness by ultrasound in order to look for muscular hypertrophy. The results were inconclusive; the radiologist acknowledging the impossibility of ensuring the same point was measured on each occasion. The quality of life questionnaire was affected by the patient being discharged home halfway through treatment and therefore was not used as an outcome measure.

## Results

Objective measurements were taken at base line, midway and end of training. The midway measurements showed no improvement in any of the variables, this was not entirely unexpected as it was considered that more than four weeks training would be needed before an improvement could be measured.

In terms of lung volumes the improvement in FVC was 30 %, TLC 7.7 % and reserve volume decreased by 8.9 %. (See **Table 1**) This indicates improved lung expansion and should decrease atelectasis and reduce the risk of respiratory infections. The decrease in reserve volume indicates better uptake of previously closed alveoli. In terms of respiratory muscle power the increased lung volumes were gained by an MIP increase of only 8.8 %.

The results for expiratory measures were interesting as we were purely exercising the inspiratory muscles. $FEV_1$ increased by 29 % and there was an increase in PEFR of 34 %. and MEP by 20 %. This would indicate that the increased expiratory volumes flow rate and MEP was gained by increased elastic recoil, and a larger inspiratory volume.

## Arterial blood gases

Blood gases taken at the beginning of the training showed a raised $CO_2$ with metabolic compensation. The $pO_2$ was lower than would be expected in an individual of this age who had no previous history of respiratory problems.

Post training results showed a change towards normalisation of the gases, however clinically this was not great enough to prevent the need for overnight oxygen.

Voice volume was shown to have increased but the measurement remains crude. Using a monitor used by speech therapists to assess voice volume we measured the volume of voice projected from a distance of 10 meters. Although the only measure available at the time the method of recording the volume was by a series of lights and three different sensitivities, improvement was gained but results with this tool at best remain subjective.

## Discussion

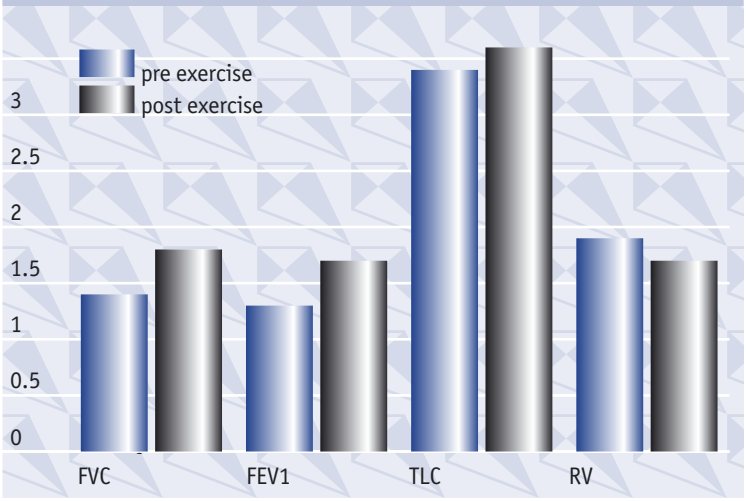
### Tetraplegic individuals and exercise

Gross et al, (1980) found that in tetraplegia patients the Pm Max (the maximum mouth pressure

TABLE 1. Results

| Value | Pre-exercise | Post-exercise | Percentage Change |
|---|---|---|---|
| pH | 7.39 | 7.40 | |
| pCO2 | 6.56 | 5.92 | 9.7 decrease |
| pO2 | 9.26 | 10.55 | 13.9 increase |
| HCO3- | 29.2 | 27.5 | 5.8 decrease |
| BE | 3.4 | 2.5 | 26 decrease |

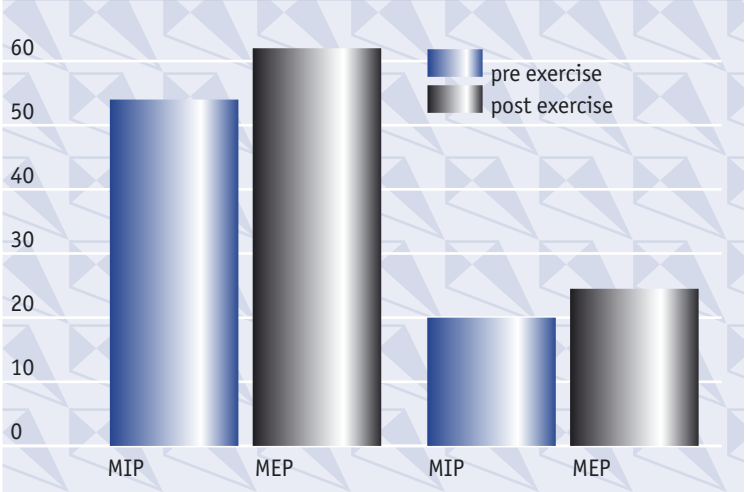
FIGURE 1: Pulmonary Function Tests, Pre and Post Exercise




(MIP)) was 2/3 that of normal subjects and that the muscles fatigued at much lower loads. Fatigue has been described as the loss of power that will reverse with rest and weakness as the lack of power in a rested muscle (Reid & Dechman 1995).

With an increase in work of breathing patients are more likely to fatigue not only because of decreased power but also because they have no alternative muscles of respiration (Brownlee & Williams 1987). Clinically it can be observed that a small increase in work of breathing can tip the balance and cause diaphragmatic fatigue. Individuals who have undergone long periods of mechanical ventilation, as many high tetraplegics do, will have weakened respiratory muscle pump; this was confirmed by Brunton et al, (2002).

FIGURE 2: Muscle strength – MIP and MEP Pre and Post exercise




Tetraplegic individuals have little potential to exercise. Practice at the time of the study relied on the strengthening of the respiratory muscles during any other cardiovascular exercise that the patients could undertake. With little physical assistance these patients can use respiratory muscle trainers. Difficulties are found in trying to set a range of outcome measures particularly ones with significance to the patient, showing outcome is a good motivator for the patient and as such an important consideration.

Bringing together the evidence, these patients already have limited muscle power that might be further weakened by long periods of rest on mechanical ventilation, coupled with a predisposition to early fatigue. It is logical to conclude that as physiotherapists we should be proactive in our approach in strengthening the muscles of respiration.

## Conclusion

This study did demonstrate that in this patient respiratory muscle training improved muscle strength allowing inspiration of larger volumes. The changes also brought about an improvement in the expiratory capacity of the patient. What we do not know is how this improvement will be effected by Faulkner's assertion that training effect will be lost within 6 weeks.

With regard to clinical significance, at the end of the trial, the patient felt that her ability to project her voice was enhanced and cough strength was improved.

It would be unwise to extrapolate from this very limited study to the wider tetraplegic population or even to other patients who have undergone long periods of ventilation. However, the study does give interesting results that suggest the benefit of further study using a larger population. The author is currently working on setting up a multi-centre trial.

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