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Introduction

Welcome to the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) journal for 2017. There are a number of firsts for this addition, in fact for the first time this is actually the second journal publication for 2017. The first publication was a supplement with all the accepted abstracts for Conference 2017, we hope that you enjoyed reading them particularly if you did not make it to Conference. This is the first time we have published the journal only as an electronic version. We appreciate that it is nice to have the journal drop through your letterbox but we believe this is the most economical way, in terms of both money and resources, to disseminate the great work that is being carried out by respiratory physiotherapists. For the first time, we have hit double figures for articles published. This is an indication of the increasing number of research studies and service evaluations being carried out and also the commitment of physiotherapists to share their work.

This edition of the journal includes service evaluations and original research across the numerous fields within respiratory physiotherapy. Within undergraduate education Simms et al explored the use of the 'flipped classroom', a relatively new approach to learning, in preparing students for clinical placement. At postgraduate level, Hayward and Kelly carried out a service evaluation of a competency based training programme for lung ultrasound. This is then complemented by a case study on lung ultrasound use in critical care by Hayward and Rudd and a literature review on lung ultrasound by Coxon.

Three articles deal with surgery: A survey on exercise prescription post cardiac surgery by Healy et al; A risk assessment tool for abdominal surgery by Twose and Thornton and the feasibility of prehabilitation for oesophagogastric resection by Weblin et al. In the field of acute care, Bendall and Christley report the views of final year students on on-call working and Biggs and Bazylkiewicz-Cotes review tracheostomy care in their service evaluation. Two further evaluations explore discharge services: Ward et al exploring a home non-invasive ventilation service and Roberts et al a pulmonary rehabilitation service. Pierrepoint and Bendall report on their experimental study investigating the effect of body position on respiratory muscle strength and lung function.

Also within this edition we have a personal viewpoint from Thomas and Mansell on physical assessment in cardio-respiratory physiotherapy, I hope this sparks some good @TheACPRC twitter discussions. We have included two posters from authors that presented at Conference, which we hope completes the Conference dissemination via the members' resources section of the website and the 2017 journal supplement.

We hope that you enjoy this issue of the ACPRC journal and hope that it inspires you to both carry out research and to write it up. We provide members with support through the Research Officer and writing guidelines which are all available on the website www.acprc.org.uk.

We would like to thank all the reviewers who have provided excellent feedback to authors to ensure the high standard of work published in this year's journal.

With best wishes

Una Jones PhD MSc MCSP, and Emma Chaplin BSc MCSP

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Physical assessment in cardio-respiratory physiotherapy: A time for consistency and leadership

Thomas AJ[1] and Mansell SK[2]

The clinical reasoning process in cardiorespiratory physiotherapy begins with the collection of both subjective and objective data (Holdar et al, 2013). The specific approaches or techniques used to collect this data are variously described within the cardiorespiratory physiotherapy literature, including explanations of cardiorespiratory symptoms and signs which may be observed, palpated, percussed or auscultated (Hough, 2001) and examination based on each body system (central nervous system, cardiovascular system, respiratory system, renal and musculoskeletal systems (Harden, 2005; Jones and Moffatt, 2002). Multi-systems assessment and analysis is widely taught within both pre-registration and post-graduate physiotherapy education. It is thus a widely utilised assessment method and is occasionally documented via completion of an assessment checklist (Broad et al, 2012). Despite its prevailing predominance, cardiorespiratory physiotherapy multi-system assessment lacks specific literature evaluating its process, advantages, disadvantages or effectiveness.

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Studies which aim to explore the clinical reasoning and decision making of cardiorespiratory physiotherapists (Holdar et al, 2013; Smith et al, 2008) typically reveal a highly complex, cyclical, evolving and flexible process, where decisions and actions are intertwined and heavily influenced by contextual factors, including the level of practitioners experience (Holdar et al, 2013). The assessment method used by participating therapists in these clinical reasoning studies is never explicitly stated. It is likely (based on the dominance of the multi-systems clinical assessment), that these studies are exploring the reasoning process elicited through multi-systems assessment approaches. The complexity of factors related to the cardiorespiratory clinical reasoning process may contribute to the differences observed between experienced and inexperienced practitioners in clinical practice (Dunford et al, 2011).

An alternative to the multi-systems approach to cardiorespiratory clinical assessment is the systematic (ABCDE) assessment method (Bennett et al, 2016; Thim et al, 2012; Elnour and Shankar-Hari, 2011). The systematic ABCDE assessment approach proposed is that used by resuscitation training programmes, multi-professional first responder training programmes (Resuscitation Council UK, 2010), programmes associated with rapid recognition of abnormal cardio-respiratory physiology (Frost and Wise, 2012; Mulryan, 2011; NICE, 2007) and simulation based education (Gaba, 2010; Gaba et al, 2001). The systematic ABCDE approach was developed in the 1970's when Dr James Styner recommended the process in his advanced traumatic life support courses

following a plane crash involving him and his family (Pasha et al, 2017; Thim et al, 2012). Styner found, from personal experience, that emergency teams were ill prepared to respond to deteriorating patients.

The method uses a logical, systematic approach, in a strict chronological order; starting with examination of the airway "A" and progressing through breathing "B", circulation "C", disability "D" and exposure "E". The ABCDE systematic approach allows findings to be quickly assimilated and enables urgent priorities to be identified and managed, before moving on to the next component. In this sense, it is a valuable technique for managing deteriorating patients in the acute or on-call situation. Clinicians in chronic care may feel the systematic ABCDE approach is less relevant to their practice, but the method is also applicable across the spectrum of clinical presentations in cardio-respiratory health, including chronic stable patients and those patients in the community. The clinician undertaking the assessment determines which component of assessment (A, B, C, D, E) should be specifically emphasised in each clinical setting. Additionally, the systematic nature of the ABCDE approach reduces the likelihood of omission of key clinical considerations during the assessment process (Bennett et al, 2016), which may improve patient safety and facilitate critical thinking (NICE, 2007). Furthermore the approach encourages rapid assessment and required action, and can be employed by experienced clinicians and students alike (Pasha et al, 2017). Indeed the approach is taught to any lay person attending a first aid course (Resuscitation Council UK, 2010).

The ABCDE assessment method is taught throughout nursing and medical undergraduate and postgraduate training (Frost and Wise, 2012; Mulryan, 2011; Resuscitation Council UK, 2010; NICE, 2007). These professions are well versed in the technique and document their assessments accordingly. Documenting physiotherapy assessment findings using this systematic ABCDE order, within the SOAP (subjective, objective, assessment, plan) format (Weed, 1971), may permit standardisation between professional groups, thus enabling clear communication of salient assessment findings. Furthermore, communication and team work during an acute or deteriorating patient scenario are enhanced by clinicians' utilising the same assessment approach (Gaba et al, 2001). Currently cardiorespiratory physiotherapists are using different assessment approaches to our MDT colleagues, making both written and verbal communication of physiotherapy findings and recommendations cumbersome to articulate. Smith, Higgs and Ellis (2008) have suggested that acute cardiorespiratory decision making is a collaborative process involving the integration of information and advice from other health professionals. Using the same approach to the assessment and communication of key findings may support the integral role of collaboration in safe patient care.

Introducing a new assessment approach may seem daunting to educators and experienced clinicians, however the ABCDE approach to assessment is taught to physiotherapy staff as part of their basic life support training, which is mandatory in all areas of clinical practice (Resuscitation Council UK, 2010). Although anecdotally this widely used approach is not routinely included in undergraduate or postgraduate physiotherapy education; it is a technique physiotherapists will be familiar with. The content of a physiotherapy cardiorespiratory assessment would not change, just simply be conducted in a more systematic and user friendly approach. It should therefore be straightforward to adapt the systematic ABCDE approach to cardiorespiratory clinical assessment. Furthermore, within simulation based education SBE the systematic ABCDE approach is consistently taught and encouraged in the management of all acute and non-acute

scenarios. There is a rapidly growing use of SBE within postgraduate physiotherapy education (Gard et al, 2014; Gosling and Murch, 2015; Harlow et al, 2015; Thomas and Gill, 2015), providing a unique opportunity for the education of cardiorespiratory physiotherapists on implementing this method. Anecdotally, as the use of SBE as a component of physiotherapy on call training programmes increases across the UK, use of the systematic ABCDE approach to objective assessment may become more prevalent.

As experienced cardiorespiratory physiotherapy practitioners, the authors propose the introduction of the systematic ABCDE assessment approach as the physiotherapy professions standard method of performing and documenting a cardiorespiratory clinical assessment. The introduction of the systematic ABCDE assessment approach within undergraduate and postgraduate education programmes could improve the quality and consistency of cardiorespiratory physiotherapy practice. Additionally, as individual role models for cardiorespiratory specialist and non-specialist staff, ACPRC (Association of Chartered Physiotherapists in Respiratory Care) members have a responsibility to demonstrate practice which is consistent across multiple settings. ACPRC members have a further opportunity to lead change and to adopt a contemporary integrated documentation method which is standardised within the profession. In order to promote the cardiorespiratory physiotherapy profession, and to ensure safe interdisciplinary working, the documentation of cardiorespiratory physiotherapy clinical assessment must be more recognisable and accessible to other professional groups. From a pragmatic point of view, at the very least, it is important to ensure staff moving across clinical areas, hospitals and trusts, are not confronted with a less than contemporaneous approach (or with multiple approaches) to cardiorespiratory clinical assessment, critical thinking and documentation.

The authors further propose that cardiorespiratory physiotherapy practitioners and members of the ACPRC scrupulously consider this opportunity to lead the profession by demonstrating a consistent approach to clinical assessment, critical thinking and documentation.

Key points

- The systematic ABCDE assessment method is routinely taught and employed in nursing and medical education and practice, yet not universally by cardiorespiratory physiotherapists.
- Use of the same assessment methods across the multi-professional team enhances communication, improves patient safety and increases the profile of the cardiorespiratory physiotherapy profession.
- We propose both undergraduate and postgraduate education programs review the cardiorespiratory assessment methods currently taught and consider the systematic ABCDE approach as a preferential method.

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The effect of a flipped approach to teaching cardiorespiratory physiotherapy on undergraduate student's clinical reasoning and preparedness for placement: An action research project

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Objective

To identify how a flipped approach to cardiorespiratory teaching can help undergraduate Physiotherapy students to contextualise their knowledge and prepare them for clinical placement.

Research design

An action research approach was used, taking mixed methods approach. Novel learning objects and environments were created based around a flipped classroom approach for undergraduate physiotherapy students in year 2 of a 4 year physiotherapy course (n=78). This allowed class time to be spent carrying out clinical reasoning panels and application of skills linked to case studies. The student's performance and feedback in exams was compared to the previous cohort and analysed for trends. A focus group was held to gather student's opinions on the changes to the module and preparedness for placement.

Results

There was increased number of students who passed the coursework component (91% compared to 87.7%), practical exam pass rate remained the same however more students achieved an improved grade. The marker feedback showed that there appears to be improved evidence of clinical reasoning skills across the year group. Themes were identified from the focus group and highlighted a positive attitude regarding the flipped classroom and they felt clinical reasoning panels and case studies better prepared them for the exam and placement.

Students reported that being able to write a set of clinical notes was useful and transferable to other subjects.

Conclusion

Overall a flipped classroom approach improved performance of clinical reasoning in practical exams and was well evaluated by students.

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Introduction

Cardiorespiratory physiotherapy is a speciality where final year students may not feel competent treating patients (Roskell and Cross, 2003). It has been shown there is a lack of interest in specialising with cardiorespiratory amongst final year students in Canada, United Kingdom, Australia and New Zealand (Jansaudis-Ferreira et al, 2016). This is partly attributed to limited clinical experience while at university (Jansaudis-Ferreira et al, 2016; Reeve et al, 2011) Students report being anxious about providing emergency on-call treatment to these patients once qualified (Bendall and Watt, 2015) and senior physiotherapists regard new graduates as inadequately prepared to work with respiratory patients (Roskell and Ross 2000, cited in Roskell and Cross, 2003). This highlights that both students and qualified staff may have concerns regarding how prepared students are for working in respiratory care.

Healthcare education has been taught in much the same way for the past 100 years and new approaches are needed to modernise this to reflect medical advances and an increasingly complex health care system (Prober & Heath 2012). While with traditional teaching methods students appear to understand respiratory physiotherapy, it has been a long standing complaint that students struggle to problem solve in clinical settings (Hicks et al, 2008). An alternative to traditional teaching methods is the flipped classroom, where students learn topics before class and spend class time applying what they have learned (Roehl et al, 2013). Recent research has shown that flipping the classroom can motivate students to come to class prepared, this allows class time to be spent on the application of knowledge and critical thinking about the topic (Thai et al, 2016; Elsevier, 2014). There is no published research examining the flipped classroom in physiotherapy education. However, it has been shown that the teaching of cardiovascular and respiratory physiology lends itself to a flipped approach and leads to an improvement in graduate student grades (n=27) ($p < 0.05$) (Tune et al, 2013). When teaching qualified medical staff emergency care (n=57) it has been found that that 98% of staff preferred a flipped approach where they were given pre class tasks ahead of a two hour class where knowledge is applied to case studies, compared to traditional lectures (Tan et al, 2015). This is supported by McLaughlin et al (2014) who investigated the learning and engagement of pharmacists (n=150) using a flipped classroom approach, offloading foundational knowledge as pre class activities and allowing class time to assess this knowledge. This demonstrated increased student engagement and participation ($p<0.001$), and a perception that the class activities enhanced learning ($p < 0.001$), there is no mention if this intervention had an effect on student performance in exams. The flipped classroom approach may have a positive impact on students' engagement and learning experience in cardiorespiratory physiology and health education.

Clinical reasoning has been described as a way of thinking and decision making in professional practice which is dependent on the situation, and guides a therapists actions (Hicks et al, 2008). It has been shown that clinical reasoning is not a separate skill to practical knowledge, but instead it develops as a student acquires expertise. Case et al (2000) recommend that physiotherapy education should include experience of practicing on call (emergency respiratory physiotherapy) situations, in order to enhance their clinical reasoning skills. This is supported by Cruz et al (2012) who call for physiotherapy education to include the development of problem solving and self-directed learning to allow the development of clinical reasoning. However it is unclear what benefit the flipped classroom approach has on students' ability to clinically reason.

Aim

To investigate if taking a flipped approach to teaching cardiorespiratory physiotherapy helps students to contextualise their knowledge and prepare them for clinical placement.

Methods

Ethics

Before the commencement of this project, ethical approval was granted by GCU Lead ethics committee.

Study Design

The methodological approach to this study was Action Research. Action Research was chosen as it allows the researcher to identify and solve problems and to facilitate change (Patterson and Chapman, 2016; Norton, 2009). Evaluation was conducted through student performance and focus group.

Subjects

A full cohort of 78 second year undergraduate Physiotherapy students (on a 4 year programme) undertaking the cardiorespiratory module in 2015/16 were included in this study. All student assessment performance data was analysed and a convenience sample of five students participated in the focus group.

Flipped Classroom Method

In order to increase practical skills and clinical reasoning in the classroom, material that was in the lowest comprehensions of learning was removed and learning activities were created on the module website (McLaughlin et al, 2014; Bristol, 2014). The learning activities aimed to break down the information the students needed to learn into manageable chunks, each with their own learning outcomes. A variety of different resources were used; core textbooks, journal articles, relevant external websites and YouTube videos. Having the basic knowledge before coming to class allowed time for the clinical application of what they had learned.

Clinical Reasoning Panels

Clinical reasoning panels were developed where the class was presented with a case study which related to their reading and they were questioned regarding their impression of the patient and to what they felt their problems were. The clinical reasoning panel aimed to test the students' knowledge, help to identify gaps, consolidate and apply their new knowledge and allow for any uncertainties to be clarified with the class tutor.

Data Collection

Evaluation of student performance

The cardiorespiratory module had 2 assessment components; a 2000 word essay on a case study, and a 40 minute practical viva exam where the student carries out a full respiratory assessment and treatment and is asked to justify their reasoning.

Grades

For each component student grades and feedback were compared against the 2014/15 (n=73) to 2015/16 (n=78) cohorts.

Feedback

Written feedback for both assessment components was analysed for themes. Feedback was reviewed as it acknowledged that different year groups would perform differently. For the essay the same case study was used throughout therefore the feedback was reviewed for all students. As a number of different case studies are used for the viva and in order to reduce bias between markers, and to allow for a comparison of treatment selection, one case study was selected for analysis, the same staff member assessed this case study for both cohorts, 2014/15 (n=20) 2015/16 (n=23). The viva feedback showed how the students had performed and if there was evidence of clinical reasoning.

Student Feedback

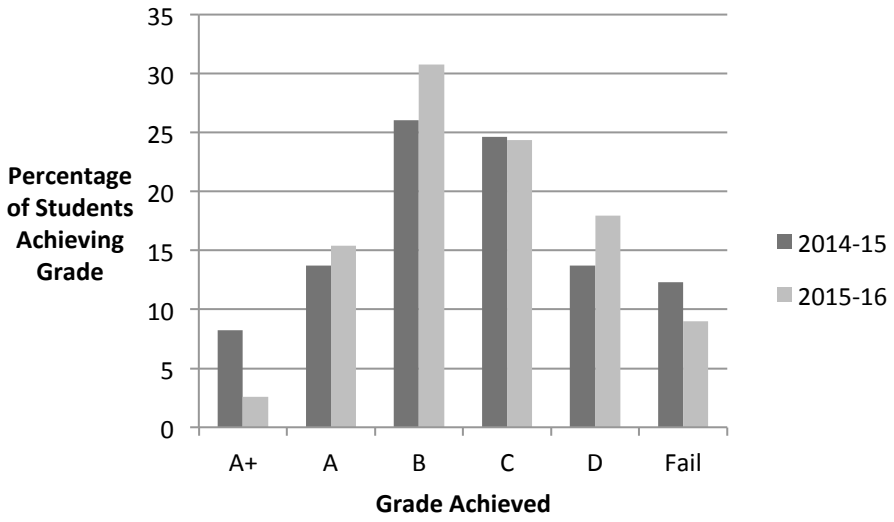
In order to provide insight into how the module was perceived by the students, a focus group was held. All students in the 2015/16 cohort were invited to participate, there were 5 volunteers (n=5).

The framework for discussion in the focus group was developed from whole year group feedback, gathered during usual university feedback mechanisms. The focus group was recorded digitally; transcribed verbatim and analysed using content analysis to give a systematic and objective way of generating a conclusion from verbal data (Bengtsson, 2016).

Results

Student performance: Essay Grades

The essays from 2014/15 (n=73) and 2015/16 (n=78) cohorts were compared. More students passed the essay component in the 2015/16 cohort (91%) compared to the 2014/15 group (87.7%) The spread of grades can be seen in Graph 1:



Graph 1: Spread of grades by percentage

48% of the students in 2015/16 group achieved a B grade or better compared to 40% of the 2014/15.

Student performance: Essay Feedback

Feedback from the essays was analysed and common themes were identified, see Table 1:

Theme	Definition	Example from scripts
Lack of understanding	Did not fully address the essay question, errors or misconceptions relating to cardiorespiratory pathology.	"There are definite omissions and misconceptions in your understanding of atherosclerosis." "you have not fully discussed the pathophysiology in this section, therefore it is not clear you fully understand this process" "there is limited discussion of the psychosocial factors that you need to take into consideration in relation to the case study."
Poor academic practice	Errors in referencing, poor range of sources used, errors in essay structure.	"The first section of your essay requires references so that the reader knows where you got the information from." "This essay would have benefitted from an introduction stating what the aims of the essay are." "make sure you don't rely too heavily on one paper for your information. In the second section you use a number references which are from 1970/1980, you should try and use more up to date research unless the paper is fundamental to the subject area."

Table 1: Common themes from essay feedback and exemplar quotes.

Table 2 shows the comparison in the feedback given to 2014/15 and 2015/16 cohorts, by percentage of students given the feedback.

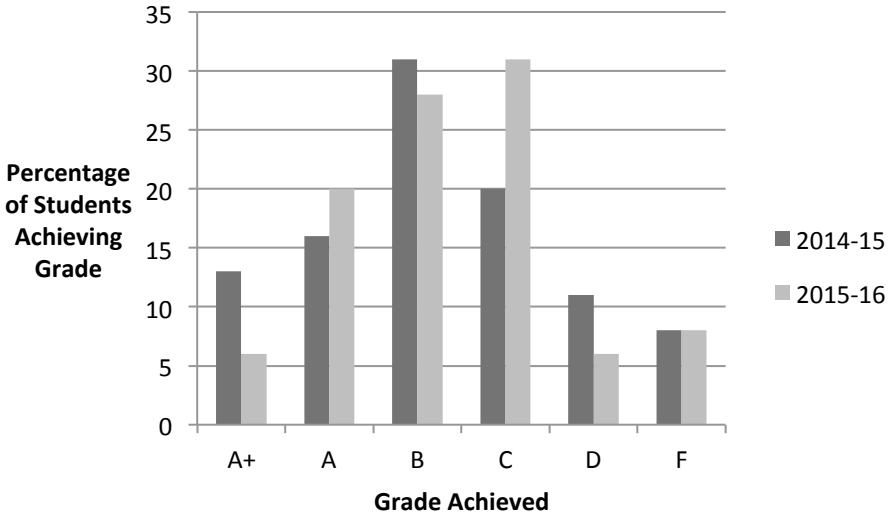
	2014/15	2015/16
Lack of understanding	63%	32%
Poor academic writing	57%	81%

Table 2: Percentage of students receiving comments.

It can be seen from the results from the 2014/15 cohort that 63% of the students had some mention of lack of understanding compared to 32% of the 2015/16 group. There was also a trend that the 2015/16 cohort struggled with academic writing given 80% of students had some reference to their poor academic writing skills compared to 57% the year before.

Student performance: Trimester B Viva

The spread of the grades for the trimester B practical viva can be seen in Graph 2:

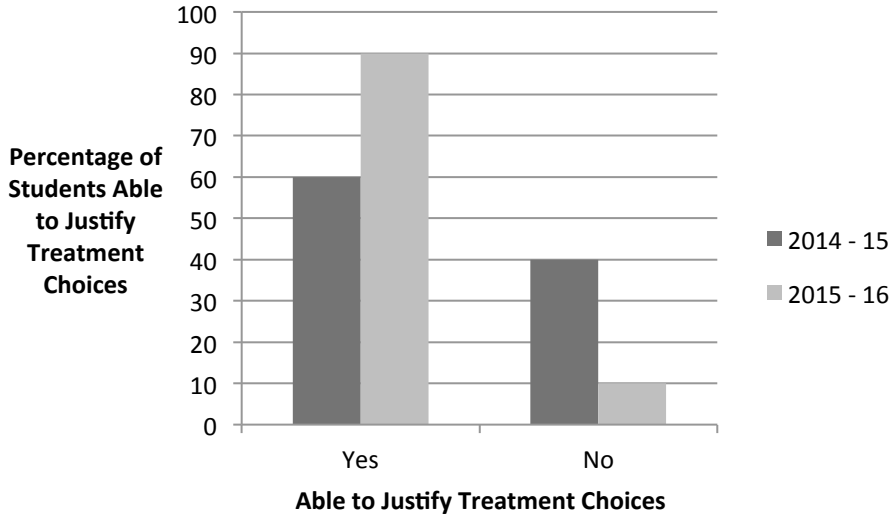


Graph 2: Spread of marks for viva by percentage.

The graph shows an equal number of students passed the viva assessment between the two years. There was an improvement in the number of students achieving a C grade or higher in 2015/16 79% compared to 67% the year before.

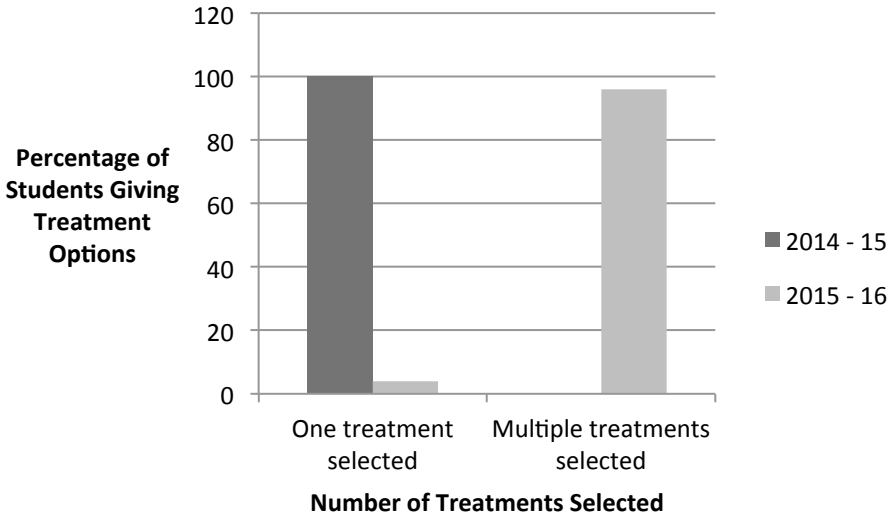
Feedback from Vivas (2014/15 n=20, 2015/16 n = 23)

Graph 3 illustrates students treatment selection for their patient. 96% of students in the 2015/16 cohort selected more than one treatment option, this is compared to the 2014/15 cohort where 100% only selected one treatment option for their patient.



Graph 3: Number of treatments selected by the students by percentage.

The students were also asked to justify their choice of treatment choice(s). The graph below shows if they were able to justify their treatment choice(s).



Graph 4: Percentage of students justifying their treatment choice(s).

There is a marked difference between the 2 cohorts. 40% of the 2014/15 group struggled to justify the treatment they had chosen, with many listing age or that it was easier to teach rather than linking to the patients' signs and symptoms. Whereas, 90% of the 2015/16 group were able to justify their treatments and link to the patients presentation.

Student Feedback

Five students volunteered to participate in the focus group. The results of this are presented in the discussion framework in Table 3.

Framework Theme	Positive Exemplar Quotes	Negative Exemplar Quote
Flipped Classroom	[P1] (the reading) "was really good… but there was a lot of it" [P2] "it is a good way to encourage students to take own learning seriously. I know that we sit through a lecture you might think oh you know I went to that lecture, maybe you wouldn't actually learned it, compared to the reading"	[P3]"the volume of reading… some people don't feel that the get anything from the books" [P1] Reading doesn't suit everyone learning style would be better if we had more mediums"
Clinical Reasoning Panel	[P4] "initially it was difficult to understand why they were being done, whereas now I'm like that makes sense…I think people should be put on the spot more, in groups people can hide. No one likes being put on the spot but we do it for the exam, so we need to get used to it"	[P2] "they were too long, people struggled to focus towards the end"

Framework Theme	Positive Exemplar Quotes	Negative Exemplar Quote
Note Writing	[P5] "I really liked practicing writing notes with the case studies, it is impossible to practice without them. It was a really nice way of summing up the lesson" [P3] " I feel more comfortable (with notes) than any other module" [P1] "has helped in other areas, like neuro and stuff like that"	
Prepared for placement	[P1] "It makes me wish I had a respiratory placement first" [P4] "Definitely more confident if I had a respiratory placement2	[P3] "In class it is very systematic, you do this, then this, whereas on placement you will do a mix of everything and I need to get in to that mind set"

Table 3. Focus Group Framework and exemplar quotes.

Flipped classroom

The students in general were positive regarding the flipped classroom; they found the learning activities appropriate; however they acknowledged that this was not a unanimous view as it did not fit every students learning style.

Clinical Reasoning Panel

The students all agreed that they saw the relevance of the clinical reasoning panels by the end of the term, however at the start they found this process daunting. Students reported that being put on the spot was beneficial as it replicated the exam and placement.

Note writing and problem lists

Students reported feeling more comfortable with note-writing following this module. They felt in the case study sessions that the notes helped them summarise what they had learned. Students felt that they understood what was expected of them when writing treatment plans and problem.

Prepared for placement

The students who participated in the focus group agreed that they felt prepared if they had to undertake a cardiorespiratory placement.

Discussion and Conclusion

The aim of this study was to investigate if taking a flipped classroom approach to teaching cardiorespiratory physiotherapy helped students to contextualise their knowledge and prepare them for clinical placement. The results indicate that for this cohort of students, they were better able to demonstrate clinical reasoning in exams and felt well prepared for a respiratory placement following the completion of the module.

While overall there has been no change in pass rates, there was some positive change with an increase in the number of students achieving a B grade or higher in their essays and a C grade or higher in their viva, this supports Tune et al (2013). When assessment feedback is analysed there is evidence of improved evidence of clinical reasoning illustrated by less feedback relating to their knowledge and understanding of cardiorespiratory and being able to justify their treatment selection in a practical exam. The students reported they felt prepared for a respiratory placement and that they liked the flipped approach to teaching, this supports the work of Tan et al (2015) and McLaughlin et al (2014).

There are a number of limitations to this study. Ideally it would have been preferable to have spoken to the 2014/15 cohort and see what their perceptions were at the same point of the year. However, due to the timing of this project that was not possible. It would also have been beneficial to speak to respiratory clinical educators to see if they noticed a difference in the students' performance.

The flipped classroom approach to teaching cardiorespiratory physiotherapy has worked for this cohort and will be continued in future years with continued development of resources based on student feedback.

Key Points:

A flipped approach to cardiorespiratory physiotherapy:

- Allows more time for consolidation of knowledge.
- Improves clinical reasoning.
- Students feel better prepared for clinical placement.

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Respiratory on-call working post-qualification: reporting the views of final-year physiotherapy students

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Background

The emergency respiratory on-call service is a key area of concern across the profession. Literature highlights a need for on-call training and preparation to begin at undergraduate level. Limited research using qualitative methods to explore final-year physiotherapy students' views of respiratory on-call work has been undertaken.

Research question

What views do final-year BSc (Hons) physiotherapy students have in relation to respiratory on-call working?

Methodology

Face-to-face, semi-structured interviews with four participants from one final-year BSc (Hons) University cohort, selected using purposive sampling. The interview guide was developed from a literature review. Verbatim transcription and thematic analysis was employed alongside triangulation and reflexivity.

Results

Three themes were identified: (1) preparation and support; (2) personal anxieties and (3) professional identity; further multiple sub-themes were presented. Quotations were used to corroborate the themes.

Discussion

The expectation that formal training and rotational experience would be provided post-qualification to support respiratory on-call working was identified, alongside the presence of personal anxieties and that on-call working would likely involve emotional contexts. The awareness of professional identity and the accountability and responsibility of the role was clear; alongside a perceived sense of importance attributed to working on-call.

Conclusion

This study provides insight from one University. Further consideration for best preparation and support for undergraduates during transition to on-call working is required to promote opportunities for on-call workforce development.

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Introduction

The on-call service provides emergency respiratory physiotherapy for the management of critically ill patients (Gosselink et al, 2008). Making clinical decisions independently, and often rapidly, is a vital component of physiotherapists working on-call (Thackray and Roberts, 2017). It may not be surprising therefore that novice physiotherapists feel less confident about on-call working and require more support than expert physiotherapists (Dunford et al, 2011).

The knowledge, skills and behaviours required to support the transition of newly qualified physiotherapists (NQPs) to respiratory on-call working are expected to have been attained through pre-registration courses. However, due to the shortfall of clinical placements nationally, not all universities are able to provide a respiratory placement (Roskell, 2013). For those students that do have a respiratory placement, gaining experience of the types of situations faced during on-call working is not always possible. Therefore, other opportunities in preparing students for on-call working are required.

Students are recognising opportunities to broaden respiratory knowledge and skills, to support on-call working, on other clinical placements (Bennett and Hartberg, 2007; Bendall and Watt, 2015). Alongside this, opportunities for students to 'shadow' the on-call process are being provided (Bendall and Watt, 2015) and this practice is seen as a cost effective way for graded exposure (Parry 2001; CSP 2004). This may also be of benefit in allaying concerns, as on-call has been recognised as a key stressor for both novice and NQPs (Dunford et al, 2011; Parry, 2001; Thomson, 2000; Mottram and Flin, 1988). Real time learning and teaching practices which incorporate opportunities for reflective practice have been recognised by students to be of value (Bendall and Watt, 2015). Therefore, discursive practices related to empathy, coping and interpersonal communications (Roskell, 2013) that can support delivery of patient care in on-call contexts, where acute illness and end-of-life issues are common place (Roskell, 2006, cited in Roskell, 2013, p. 133) is advocated. The use of respiratory on-call simulation to prepare students for clinical practice has also been found to be of benefit (Gough et al, 2016; Stiger et al, 2016).

The study aim is an exploration of the views of final-year physiotherapy students in relation to respiratory on-call working post-qualification. The use of qualitative methods in exploration of this topic area is limited in the literature and is therefore worthwhile to enable the views held by students to be reported. These findings may further aid universities and practice educators in ensuring that undergraduate students are appropriately informed about the nature and requirements of respiratory on-call working to support transition to on-call working post-qualification.

The research question for the study therefore was:

What views do final-year BSc (Hons) physiotherapy students have in relation to respiratory on-call working?

Method

An interpretive approach was employed; data was collected from face-to-face, semi-structured interviews, which followed an interview guide formulated from available literature. Interviews were selected instead of a focus group to promote opportunities for greater context to be understood by developing a relationship between researcher and participant (Hansen, 2006).

Ethical approval for the study was gained from the Cardiff University School of Healthcare Sciences Research Ethics Committee in June 2014. The study used a purposive sampling technique,

and the selection criteria were physiotherapy students who were in their final year of study. All eligible students were e-mailed details of the project using university accounts and invited to volunteer. Students that had completed a shadow on-call during clinical placement were excluded from the study as this experience would have provided differing views. Four students volunteered and met the sampling criteria. A subject information sheet depicting the main features of the research design, possible risks and benefits to participation, and of their right to withdraw at any point was e-mailed over 24-hours before planned study participation to provide opportunity to consider involvement.

All participants signed a consent form prior to data collection. Anonymity was ensured from the start of the data collection process to protect the participant's identity, with participants choosing a pseudonym (Hammell et al, 2000). Participants were advised to avoid identifying place names and people during the course of the interview and were assured that any identifiable information would be removed during transcription to protect confidentiality.

The interviews were audio recorded using a Dictaphone and notes were made by the researcher to record any notable factors that may enhance understanding of the verbal context within data analysis. A reflexive journal was used throughout for the researcher to acknowledge their subjectivity and how their own experiences could affect the research process. This enabled identification of any potential bias or influence on the results to be deliberated accordingly (Moule and Hek, 2011).

A pilot study was conducted with one of the four participants to gauge the amount of data that would be obtained from one interview and test the flow and responses through using the interview guide. The pilot study yielded rich and plentiful data and as it was considered to have been carried out with similar and sufficient rigour as the main study, there was appropriate justification for the pilot data to be included in the main study; therefore, data from four interviews was used.

Data collection and analysis occurred concurrently. Audio files were transcribed verbatim. Respondent validation was completed to maximise data credibility by gaining confirmation that the researcher has correctly interpreted the participant's words (Bryman, 2012). All four participants felt that the transcripts were a representation of their ideas and no changes were made.

Data was analysed thematically by initial coding to identify patterns in the data and then these were grouped into themes and sub-themes, using the approach described by Braun and Clarke (2006). Confirmability was improved by employing researcher triangulation with the study supervisor, alongside data triangulation by using multiple data quotes from multiple participants to corroborate themes (Miles et al, 2014).

The participants

Jessica, Hugo, Emma and Elizabeth were the pseudonyms chosen by the four participants and all were aged 20 or 21 years. Each interview lasted between 45-60 minutes. During the course of the interview it became evident that all participants had completed a named respiratory placement within an acute hospital environment.

Findings and Discussion

Three themes emerged from the analysis:

Theme 1: 'Preparation and support' describes the understanding of the procedural components to working on-call (including the referral criteria), expectations for training provision, alongside the support provided from senior staff.

Theme 2: 'Personal anxieties' explored the perceived disruption; emotional impact in relation to on-call; perceptions of preparedness to undertake the role in the context of experience and need for clinical reasoning abilities.

Theme 3: 'Professional identity' explores the importance of professional responsibility and accountability alongside the physiotherapist's role within the multidisciplinary team.

Theme 1: Formal Preparation and Support

Understanding of the on-call process

Respiratory on-call physiotherapy was defined by participants using a similar description to that provided by Gough and Doherty (2007) thereby showing a good understanding of the remit of on-call working and basic criteria for patient referral.

> *"I understand it to mean the responsibility we'll have every month, or so, and the hospital will have our number, so the nurses will know if there's a respiratory emergency…..we are called out….we'll go out and help as part of the team to treat the patient" [Emma].*

Despite participants having an overview of on-call, awareness of national guidelines or being able to articulate confidently the requirements and processes that are commonly involved, were not provided.

It was felt by participants that the university had taught respiratory and clinical reasoning skills that could be applied to the on-call setting. Clinical placement had also prepared them well by providing the opportunity to practice skills, however the need for "*context*" and "*more experience*" in respiratory care in order to feel ready to commence on-call working were regularly used words. The authors acknowledge that context and more experience may be achieved through other methods of preparation at undergraduate level, for example simulated-based education (Gough et al, 2016; Stiger et al, 2016), that was not provided at the university at the time the study took place.

Opportunities for support and development

In obtaining the "*context*" and "*experience*" for on-call working, the expectation that training would be provided post-qualification was evident alongside the view that on-call working would only commence after completion of a respiratory rotation. The ability for services to meet this expectation may be challenged by financial pressures on healthcare delivery, which may impact on-call training provision (Bott et al, 2009). This is attributed to the current financial and staffing situation within the National Health Service (NHS) where managers need to allocate staff to on-call rotas without waiting for individuals to complete their first respiratory rotation. An increase is therefore anticipated in the percentage of NQPs that start on-call working within one month of employment in comparison to the 11% reported by Parry in 2001.

It may be of comfort to students that in a more recent study, 99% of physiotherapy departments surveyed did provide some form of in-service on-call training (Gough et al, 2013) and therefore views held by participants in relation to training, to some degree, are likely to be met by employers. This may be as a result of the resources and publications from the 2001 'The National On-call Project' (Harden et al, 2005) being used within the delivery of the undergraduate curriculum in the university in which the study was conducted.

Participants also held the view that further training was necessary post-qualification, as on-call working specifically had not been an opportunity provided on clinical placement:

> *"……we don't do it as a student, so it's gonna be something completely new, whereas with every other sort of physio I think the University have prepared us well for it 'cos we're pretty much working as Band 5's at the moment considering we're third years…whereas on-call is just something completely different, something completely new as we don't get to practice this and build up our experience on placement" [Elizabeth].*

Value was attached by participants to undertaking a shadow on-call as a student in order to gain further experience:

> *"I would have liked to have shadowed an on-call physio, I know some placements do allow that" [Elizabeth].*

Opportunities for students to 'shadow' the on-call process whilst on clinical placement are being provided, with Bendall and Watt (2015) reporting that 29% of students from one university cohort had this experience. As this practice has been recommended by both NQPs (Parry, 2001) and the professional body (CSP, 2004) as a cost effective way for graded exposure, these real time methods may help to provide the "context" and "more experience" that students felt they required.

Senior support

The view that senior support would be available when completing on-call as a qualified physiotherapist was evident:

> *"I think if I was really in a situation where I felt uneasy about doing something, then I wouldn't hesitate…….to call up a senior just for a bit of advice" [Hugo].*

In the context of these findings, it is reassuring for participants that only 2% of the on-call physiotherapy services surveyed by Harden et al (2005) did not offer telephone support for their staff and only 8% of the hospitals surveyed by Gough and Doherty (2007) did not provide out-of-hours support of some description for NQPs. These studies, although not surveys completed in recent years, demonstrate that the support is likely to be available when commencing on-call working.

Theme 2: Personal anxieties

Disruption to personal lives

The perceived disruptive impact that being on-call has on a physiotherapist's life was identified, with examples of feelings of being "*on edge*" and "*aware that your phone might go off*" [Elizabeth]. Alongside this, recognition that there may be times when there is no requirement for an on-call physiotherapist to attend and this may be:

> *"….a bit boring just waiting for the phone to ring" [Hugo].*

The perceived disruption was also articulated in context of the financial reimbursement:

> *"…..the pay doesn't seem too great for the amount of hours and the amount of disruption it happens to their life….."[Elizabeth].*

As expected by the nature of on-call working, Hugo discussed the effect it would have on his sleep:

> *"I know I'm going to be woken up at some point by my phone……I never sleep well…when I'm expecting to be woken up".*

Despite the recognition that on-call may impact on sleep, the prospect of feeling tired as something they may experience was not reported. Instead the view was expressed that the emergency nature of on-call situations would prevent tiredness:

> *"…..the adrenaline would wake you up anyway" [Hugo].*

The lack of consideration of tiredness as a factor during on-call working corresponds with the findings of Bendall and Watt (2015) where none of the respondents named 'lack of sleep' as an area of on-call working that caused worry.

It is interesting that in this study, those at the very start of their careers, are voicing concerns over on-call working in relation to pay, sleep and perceived disruption to life. There was no physiotherapy literature identified that has explored the impact of on-call working on work/life balance. However, a recent publication conducted with first-year social sciences students shows that being on-call has a negative effect on perceived sleep quality, particularly when the process of on-call induces stress (Ziebertz et al, 2017). This may be an interesting aspect for further study in physiotherapy, especially in consideration of respiratory workforce development and retention.

Emotional impact

Concerns surrounding on-call working post-qualification were identified with the word "*stress*" used within descriptions, alongside other words of "*worry*", "*concern*", "*anxiety*" and the prospect of on-call being "*scary*".

The range of patients expected to be seen, and the possibility of coming across a patient whose pathology was not recognised or understood, was a cause for concern. This is reflective of novice physiotherapists with less experience having lower confidence and higher stress levels than experts (Dunford et al, 2011).

> *"a multitude of different patients, you just don't know what could come up…….so yeah at the moment I'm relatively sort of anxious I guess until I get out there and have the proper training" [Hugo].*

There was also recognition that on-call working may bring with it some challenges when working with patients at the end-of-life:

> *"…….emotionally it might be quite tough…on-call respiratory is one area that I would expect mortality to happen…….it's not very nice to see, but there again I don't really mind how it makes me feel as long as you make the patient feel a little bit better, make them more comfortable as they are nearing end-of-life" [Elizabeth].*

As participants have recognised that end-of–life care may be commonly encountered in respiratory on-call working, this adds justification for inclusion of this topic within undergraduate curricula to support development. This may also provide further evidence of the need for on-call teaching post-qualification to promote staff development of strategies and abilities to cope with the psychosocial aspects of this role.

Preparedness

Mirrored in previous literature (Roskell and Cross, 2003), the view of a lack of preparedness was evident, attributed to inexperience, lack of exposure in on-call working and a lack of confidence in respiratory skills:

> *"..the amount of times I've had to make clinical decisions on a patient like that is very limited…..the kind of clinical decisions you're making are going to have a bigger impact on that patient compared to patient in rehabilitation settings for example…"[Hugo].*

It is not surprising that clinical reasoning was identified as causing anxiety. This would seem reasonable as a lack of "context" for on-call working had already been identified, and as clinical reasoning is contextual (Doody and McAteer, 2002; Case et al, 2000). The main aspect of on-call clinical reasoning that led to a feeling of under preparation was in participants deciding on "*appropriate call-outs*" and emotions were attributed with this:

> *"….if you're a physio on-call and you're the only physio on-call then it's ALL your responsibility to provide effective treatment that's not going to make them worse…..you've got to make decision all by yourself……" [Elizabeth].*

Further exploration of the experiences of students in relation to clinical reasoning and on-call working is recommended.

Theme 3: Professional Identity

Professional Responsibility and Accountability

Professional identity, specifically in relation to on-call, is not a key theme reported in the literature to date, although Roskell (2013) investigated the professional identity embedded within the cardiorespiratory physiotherapy curricula of higher education institutions around the UK, finding that it is well represented. This study identified that on-call working would provide a sense of professional identity and a "*responsibility*" [Elizabeth] to provide adequate care when on-call (CSP 2002) and that undertaking on-call working would "*provide a sense of pride*" [Hugo].

> *" ……you've got that professional identity of being a physio, of having those tools in your toolbox that are unique to you as a physiotherapist…" [Jessica].*

Professional identity can be assumed once an individual understands the skills and values of their profession (Davies et al, 2011); it is reassuring that final-year physiotherapists approaching qualification have identified their professional identity in relation to on-call working. This is particularly positive for the future physiotherapy on-call workforce and warrants further exploration.

Physiotherapists role within the multidisciplinary team (MDT)

The importance of the on-call physiotherapist's role in the MDT as a valued team member was evident among participants:

"…..if they've called you out, they obviously think you're important" [Elizabeth].

MDT perceptions of physiotherapists is an under-explored topic in the UK. Using a questionnaire survey, Vincent-Onabajo et al (2014) found that 90% of medical students agree physiotherapists are a vital part of the MDT, but have a low level of awareness of their professional role. This may mean that NQPs are exposed to a difference of professional opinion across other disciplines, borne out of a lack of awareness of the physiotherapy role, which has the potential to create challenging situations when working on-call.

The prospect of on-call working was considered to be "*exciting*" [Hugo] in regard to being able to contribute new ideas and skills to add to the care of the patient with Jessica reporting:

"…….you can actually make a really big difference which I think would be really rewarding in that situation".

Study limitations

Whilst a reflexive approach, triangulation and a clear audit trail enhance the trustworthiness of this work, recruitment of students from one university limits the transferability of findings. Alongside this, the limited age range of participants may not be representative of final-year physiotherapy students. The individuals recruited to the study had completed a respiratory placement in an acute hospital environment, and therefore different findings may have been found if participants had not had this experience and this aspect warrants further exploration.

Conclusion

Little qualitative research has been undertaken on the topic of respiratory on-call working with most current literature being quantitative in the form of questionnaires. Therefore, the use of qualitative methods to report the views of final-year students in this study adds to a limited literature base.

Some of the issues identified in this study relate to the need for organisational support from both the NHS and university in providing undergraduates with the opportunities for "*context*" and "*more experience*" during transition to on-call working.

These findings are useful in informing undergraduate teaching within the university in which the study took place and may be of use to other institutions with similar student and programme characteristics. This study also identifies amongst students nearing qualification, the condition specific challenges to working on-call, including emotional aspects. Further consideration as to the best methods for preparing and supporting undergraduates for all aspects of their role as they transition to post-qualification work is required, as the need to get this right may influence recruitment and retention to the specialist field of cardiorespiratory physiotherapy.

Alongside the areas identified for further research, it is recommended that wider discussions continue in order to clarify the current scope, correct timing for, and implementation of on-call preparation at both undergraduate and post-graduate levels. This would enable individuals to be supported in developing the necessary knowledge, skills and behaviours to successfully transition to on-call working post-qualification.

Key points

- Undergraduates have an expectation that formal training and support will be provided post-qualification to support transition to on-call working.

- The prospect of undertaking on-call working post qualification does cause concern to undergraduates, attributable to a variety of factors.
- Professional identity and being an integral member of the multidisciplinary team are views held by undergraduates in relation to on-call working.

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Can physiotherapists utilise lung ultrasound to enhance management of critical care patients? A case report demonstrating this novel diagnostic strategy.

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Introduction

The profile of lung ultrasound (LUS) in the critical care setting is growing amongst the medical profession. Historically, physiotherapists have relied on the use of auscultation and portable chest radiography (CXR) interpretation for the assessment of pulmonary pathology and to ultimately guide treatment options. Research into the use of LUS by physiotherapists as an assessment adjunct is still in its infancy. The purpose of this report is to contribute to a proof of concept by demonstrating the potential impact of LUS as part of the physiotherapy clinical examination in the critical care setting.

Case presentation

The clinical examination of a 74 year old caucasian male following cardiothoracic surgery who deteriorated post-operatively and required reintubation. The initial assessment using CXR review and auscultation suggested bibasal consolidation. Physiotherapy treatment was initiated which included manual hyperinflation (MHI) for secretion clearance; however, no improvement was demonstrated. The physiotherapists decided to use LUS to investigate. This showed unexpected large bilateral basal pleural effusions. A decision was made for the medical team to insert bilateral chest drains with 2480mls and 1580mls drained. Clinical improvement was seen over the following 24 hours, enabling extubation, radiological improvement on CXR and weaning of fraction of inspired oxygen to room air within two days.

Conclusion

Multidisciplinary assessment of the patient led to a working diagnosis of post-operative pneumonia following the interpretation of the available investigations. The addition of physiotherapy initiated LUS added a differential diagnosis of large pleural effusions adding to this patient's respiratory deterioration. Following a review of the medical management plan, the patient made significant clinical improvement. This case report demonstrates that the physiotherapeutic management of a deteriorating patient in a critical care setting can be guided by the use of point of care LUS.

Introduction

Lung ultrasound (LUS) is a novel diagnostic technique amongst critical care physiotherapists. It has yet to show its efficacy on patient outcomes in the hands of physiotherapists as the current body of evidence is in its infancy. So far only a handful of papers have been published on this topic which have only consisted of case studies and literature reviews (Le Neindre et al, 2016; Leech et al, 2015; Leech et al, 2014).

Historically, physiotherapists have relied on the use of auscultation and portable chest radiography (CXR) interpretation to supplement their assessment of pulmonary pathology and ultimately to guide treatment options. Leech et al (2014) discuss the accuracy and reliability of auscultation, CXR and LUS when compared to computed tomography (CT) in their narrative review. Their review highlights the superior sensitivity and specificity of LUS to detect pulmonary pathology.

The evidence base for the use of LUS as a diagnostic modality continues to develop outside the physiotherapy profession. The medical profession have published systematic reviews that have demonstrated consistently high accuracy in the detection of pleural effusion (Grimberg et al, 2010) and pneumonia (Chavaz et al, 2014). Under supervised training we have initiated the use of LUS in our hospital by our critical care physiotherapists as a way to enhance their diagnostic assessment and accuracy.

Our case report presents a post-operative patient following cardiac surgery who deteriorated requiring him to be readmitted to critical care. We detail how the patient was treated and the impact physiotherapy initiated LUS had on his outcome. The aim of this report is to further highlight the potential impact of the use of LUS by physiotherapists in the critical care setting. We also wish to show how LUS can influence and ultimately enhance the management of intubated patients through enabling more focused and individualised intervention and in doing so strengthen the case for continued research in this field.

Case Presentation

A 74-year old caucasian male was acutely admitted to hospital following a myocardial infarction. Angiogram showed 80% stenosis in the left main coronary artery, occlusion of the proximal right circumflex artery as well as occlusion of the non-dominant circumflex. The patient had a past medical history of asthma, hypercholesterolaemia and was an ex-smoker. The patient was accepted under care of a cardiothoracic surgeon and underwent urgent off-pump coronary artery bypass grafting (CABG). As per routine post-operative care he was transferred to the cardiac intensive care unit (CITU).

Early Post-Operative Phase

Initial physiotherapy contact was routine and the patient was reviewed the morning after surgery. Objective assessment revealed fine crackles bibasally on auscultation with CXR showing some right middle zone infiltrates and a small left apical pneumothorax. Arterial blood gases (ABGs) were satisfactory on minimal fractioned inspired oxygen ($Fi0_2$), Physiotherapy treatment consisted of mobilising to sit in a chair, incentive spirometry and supported wound cough. Inotropic support and pain limited further mobilisation.

On the second day following surgery, the patient's ABG results deteriorated. $Fi0_2$ increased to 0.50 via nasal high flow and continuous positive airway pressure (CPAP) was initiated. The patient's white cell count (WCC) also increased to 16.3 10^3/L with purulent sputum. Blood cultures were taken and antibiotics commenced. CXR demonstrated increased bibasal opacities.

Physiotherapy treatment over the subsequent two days consisted of mobilising to the chair, intermittent positive pressure breathing (IPPB) and Active Cycle Breathing Technique (ACBT). The patient fatigued quickly during physiotherapy treatment, limiting active participation in treatment.

Clinical improvement was seen by post-operative day 4, $Fi0_2$ had reduced and therefore could be delivered by nasal cannulae but ongoing inotropic support was required. Auscultation and CXR demonstrated significant improvement with some remaining left basal opacity. Infection markers also improved. Physiotherapy treatment continued with daily IPPB, ACBT and mobility. The patient remained fatigued but co-operated with treatment showing persistent improvement in $Fi0_2$.

Despite clinical improvement, the patient continued with persistently raised WCC, opacity on CXR and acute kidney injury therefore a CT thorax, abdomen and pelvis was arranged.

The CT demonstrated moderate bilateral pleural effusions with ground glass opacities suggesting active inflammation. Bilateral chest drains were inserted draining more than 3 Litres in total. CXR and urine output improved but WCC remained persistently high >20 10^3/L.

The patient was transferred to the ward on post-operative day 11, mobilising short distances with physiotherapists on 2L/min oxygen via nasal cannulae.

Late Post-Operative Phase

The patient was readmitted to CITU due to worsening kidney function on post-operative day 18. White cell count had remained persistently high with increasing bibasal opacity on CXR.

On readmission to CITU, a transoesophageal echocardiography (TOE) was performed revealing poor left ventricular function, no pericardial collections and small bilateral pleural effusions.

Within 48 hours of readmission to CITU the patient acutely deteriorated with respiratory distress, increased $Fi0_2$ and deteriorating ABGs resulting in sedation and ventilation.

CXR showed increased bibasal opacities suggestive of consolidation (Figure 1).

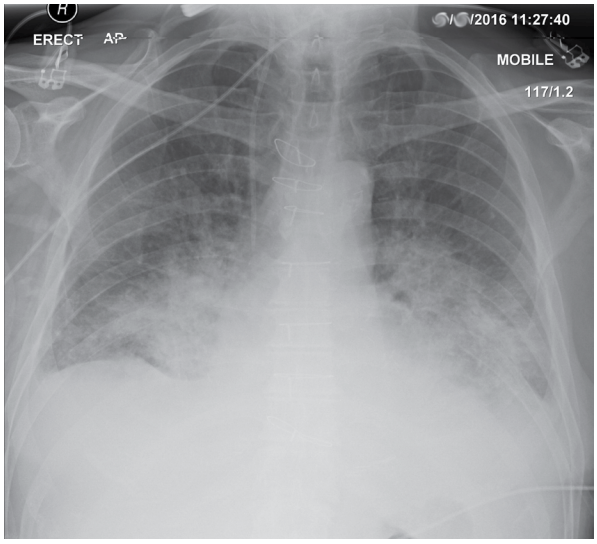

Figure 1: CITU re-admission CXR.

Auscultation revealed reduced air entry bibasally. Minimal secretions were removed with endotracheal suctioning. Manual Hyperinflation (MHI) demonstrated good equal thoracic expansion with no increase in sputum yield. Re-auscultation remained unchanged with no clinical improvement.

The decision was made to perform LUS by the physiotherapist under the supervision of a consultant anaesthetist. Images (Figures 2 & 3) revealed extremely large bilateral basal pleural effusions which were not present on the TOE two days previously.

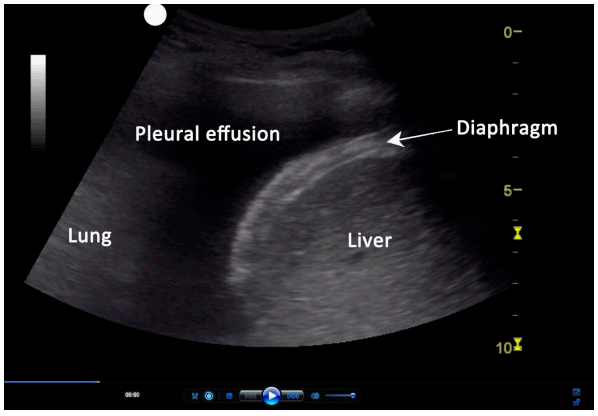

Figure 2: Right hemi-diaphragm with pleural effusion.

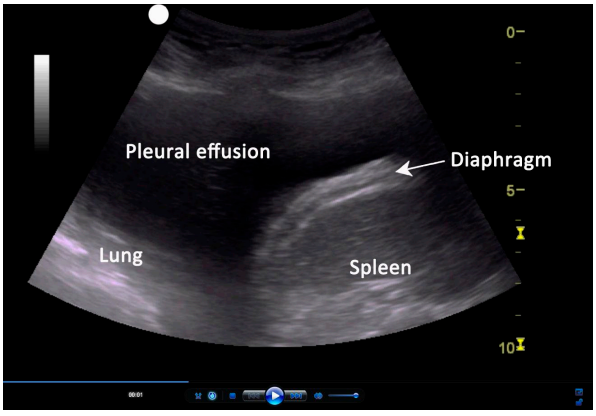

Figure 3: Left hemi-diaphragm with pleural effusion.

Bilateral chest drains were inserted which elicited 1580mls from the right chest and 2480mls from the left chest within a 24 hour period. Follow-up CXR demonstrated radiological improvement (Fig. 4).

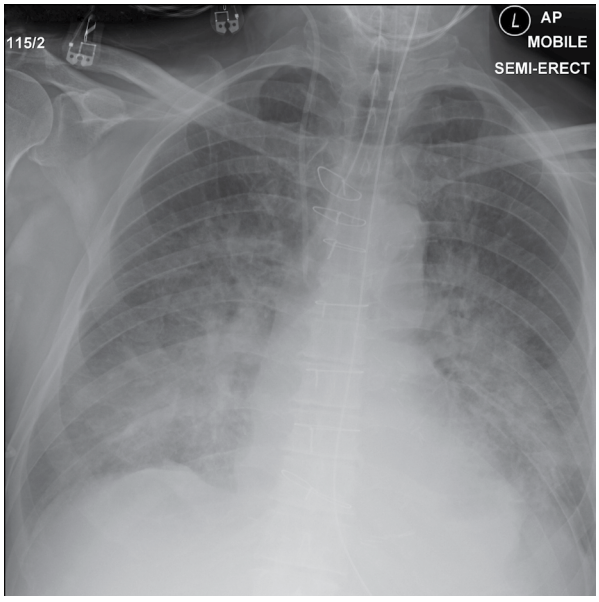

Figure 4: Post drain removal CXR demonstrating radiological improvement.

The patient was extubated the following morning (post-operative day 22) and continued to improve. Within two days he required no oxygen therapy. Physiotherapy treatment progressed to focusing upon increasing mobility/physical function. White cell count reduced and care was taken over by a heart failure consultant to optimise the patient's clinical status.

Discussion

In this case report a multidisciplinary team (MDT) assessment of the patient following reintubation led to a working diagnosis of post-operative pneumonia after reviewing the available investigations. Reasons for this included the continued high WCC and small pleural effusions being found on TOE two days prior to the physiotherapist's LUS scan. The addition of physiotherapy initiated LUS added a differential diagnosis of large pleural effusions adding to this patient's respiratory deterioration. A review of the medical management plan and pleural drainage was undertaken within the hour of the LUS. This timely intervention facilitated a considerable clinical improvement within a short period of time and contributed to the patient being liberated from mechanical ventilation.

This report contributes to the proof of concept initiated by Leech et al (2015) in their case report. The cause for the respiratory deterioration in their patient was also reported as a result of a large pleural effusion. Indeed, Le Neindre et al (2016) discuss in their narrative review that "LUS is an excellent tool" to identify pleural effusions (p106). They go on to say that it "seems reasonable" to address the pleural effusion first and then implement physiotherapy management if required (p106). This is further supported by a systematic review (Grimberg et al, 2010) which showed LUS had consistently high sensitivity, specificity and accuracy in detecting pleural effusions. However, at the time of this literature search, only four studies met their inclusion criteria. According to Hew and Tay (2016) there is a strong body of evidence for the use of lung ultrasound in the diagnosis of pleural effusions that supports its use. Further research is still required to demonstrate the efficacy of physiotherapy-initiated LUS within critical care on both short-term and long-term patient outcomes.

The limitations of a case study mean it would not be appropriate to use this example to generalise to the wider critical care population. The strengths of this case study lie within its contribution to the proof of concept for the addition of this potentially powerful diagnostic skill in the hands of another member of the critical care team. Hopefully this case study along with that of Leech et al (2015) will allow other physiotherapists to generate and test further hypotheses that can explore the efficacy of physiotherapy initiated LUS.

Conclusions

This case study demonstrates that the physiotherapeutic management of a deteriorating patient in a critical care setting can be guided by the use of point of care LUS. More importantly, the operator of the diagnostic ultrasound machine can be a physiotherapist thus strengthening that individual's diagnostic and therapeutic decision making in real-time at the bedside.

Key points

This case report illustrates how:

- Lung ultrasound can be performed by Physiotherapists.
- Lung ultrasound can potentially enhance decision making and patient health outcomes.
- Further evidence is required to explore the efficacy of physiotherapy initiated LUS.

Acknowledgements

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References

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Grimberg A., Shigueoka D., Atallah A., Ajzen S. & Iared W. 2010 Diagnostic accuracy of sonography for pleural effusion: systematic review. Sao Paulo Medical Journal 128(2): pp90-95.

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Leech M., Bissett B., Kot M. & Ntoumenopoulos G. 2015 Physiotherapist-initiated lung ultrasound to improve intensive care management of a deteriorating patient and prevent intubation: a case report. Physiotherapy Theory Practice 31(5): pp372-376.

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Chest X-Ray and Lung Ultrasound: A literature review of the current primary imaging tool, does it provide best practice?

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Introduction

Chest X-ray (CXR), although criticised for its lack of precision, is still regarded as the current primary imaging tool for a range of respiratory pathology. Lung Ultrasound (LUS), a novel imaging device, has been demonstrated to show high levels of accuracy in the diagnosis of the same conditions. However, it is still not recognised as a primary point-of-care diagnostic tool in the UK. Misdiagnosis from the use of inaccurate investigations can lead to poor patient-centred care and consequently a poor application of resources.

This paper aims to compare the effectiveness and efficacy of CXR and LUS in diagnosing respiratory pathology.

A literature search was performed across six medical, nursing and allied health professional databases. Key words related to LUS, CXR and pulmonary and cardiac pathology, were combined using Boolean operators. Of a total of 671 abstracts retrieved, 40 studies satisfied the inclusion criteria. On subsequent analysis, 27 out of the 40 studies were excluded leaving 13 papers for review. This data was then assessed using Critical Appraisal Skills Programme (CASP) tools.

The literature found demonstrated the need for further research. LUS was compared to CXR in the diagnosis of the following pathology; pneumonia, pneumothorax, and pulmonary oedema associated with left-ventricular failure. Since the completion of this literature review a guideline for one of the respiratory pathologies reviewed has been produced, recommending LUS as a front line tool. Further research in LUS is required to allow a more accurate comparison with CXR and to further examine its diagnostic capability across a wider range of respiratory pathology.

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Keywords

Lung Ultrasound,
Chest X-Ray,
Pneumonia,
Pneumothorax,
Left-Ventricular Failure.

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Introduction

The research question was developed in order to determine the most effective point-of-care diagnostic tool for respiratory pathology. Computed Tomography (CT) is suggested as the gold standard diagnostic tool for respiratory pathology, being the most sensitive and specific (Mundada et al, 2014; Syrjälä et al, 1998). Therefore CT scanning produces reliable true positive results and true negative results respectively. Although CT is the most accurate method of chest imagery, due to its high cost, levels of exposure, length of time to use, and difficulty to access,

it has failed to surpass Chest X-ray (CXR) as the primary imaging test across respiratory conditions (Lim et al, 2009; Syrjälä et al, 1998). Meanwhile misdiagnoses from CXR use have been present in numerous studies (Self et al, 2013; Nagarsheth and Kurek, 2011). Lung Ultrasound (LUS), a novel diagnostic tool, is seen to be much more practical and less expensive than CT (Dhawan, 2011), whilst possessing greater precision than CXR (Caiulo et al 2013). However, its use is still not recommended as the primary imaging tool by current guidelines (National Institute of Clinical Excellence [NICE], 2014a; NICE, 2014b).

Methods

In January 2015 a literature search was conducted across six databases; Cinahl Plus, ProQuest Hospital Collection, Medline, Biomed Central, Science Direct, and Pubmed. The Databases were searched using key words related to LUS, CXR, pulmonary and cardiac pathology, selected from 'Mesh databases', and combined using Boolean operators (FIGURE 1). This resulted in 671 abstracts retrieved, of which 40 met the inclusion criteria. After further analysis an additional 27 were excluded, resulting in a final number of 13 studies for review (FIGURE 2). These 13 studies have been numbered in accordance with their appearance in this review (FIGURE 3).

Search terms	Database	Hits
"Pneumonia" OR "Pneumonitis" OR "Pulmonary Consolidation" OR "Bronchopneumonia" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	45
	Medline	20
	Pubmed	20
	Cinahl Plus	37
	Biomed Central	15
	Science Direct	27
"Pneumothorax" OR "Collapsed Lung" OR "Pneumothoraces" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	21
	Medline	13
	Pubmed	8
	Cinahl Plus	31
	Biomed Central	21
	Science Direct	44

Search terms	Database	Hits
"Haemothorax" OR "Hemothorax" OR "Haemorrhagic Pleural Effusion" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	2
	Medline	1
	Pubmed	1
	Cinahl Plus	3
	Biomed Central	15
	Science Direct	12
"Atelectasis" OR "Partial Lung Collapse" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	11
	Medline	5
	Pubmed	4
	Cinahl Plus	22
	Biomed Central	19
	Science Direct	12
"Chronic Obstructive Pulmonary Disease" OR "COPD" OR "Chronic Obstructive Airway Disease" OR "Bronchitis" OR "Chronic Obstructive Lung Disease" OR "Emphysema" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	6
	Medline	1
	Pubmed	2
	Cinahl Plus	5
	Biomed Central	16
	Science Direct	10

Search terms	Database	Hits
"Pleural Effusion" OR "Pleural Fluid" OR "Fluid on the Lung" OR "Chylothorax" OR "Hemothorax" OR "Hydrothorax" OR "Pyothorax" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	6
	Medline	0
	Pubmed	2
	Cinahl Plus	5
	Biomed Central	20
	Science Direct	7
"Pulmonary Oedema" OR "Pulmonary Edema" OR "Lung Congestion" OR "Pulmonary Congestion" OR "Lung Water" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	5
	Medline	3
	Pubmed	4
	Cinahl Plus	8
	Biomed Central	19
	Science Direct	3
"Respiratory Problems" OR "Respiratory Failure" OR " Respiratory Pathology" OR "Lung Failure" OR "Pulmonary Failure" OR "Pulmonary Pathology" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" Or "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	28
	Medline	4
	Pubmed	13
	Cinahl Plus	16
	Biomed Central	16
	Science Direct	10

Search terms	Database	Hits
"Cardiac Problems" OR "Cardiac Failure" OR " Cardiac Pathology" OR "Left Ventricular Failure" OR "Heart Failure" OR "Myocardial Failure" OR "Myocardial Pathology" AND "Lung Ultrasound" OR "Lung Ultrasounds" OR "Lung Ultrasonography" OR "Lung Sonogram" OR "Lung Sonography" OR "LUS" OR "Thoracic Ultrasound" OR "Thoracic Ultrasounds" OR "Thoracic Ultrasonography" OR "Thoracic Sonogram" OR "Thoracic Sonography" OR "Chest Ultrasound" OR "Chest Ultrasounds" OR "Chest Ultrasonography" OR "Chest Sonogram" OR "Chest Sonography" OR " Chest X-Ray" OR "Chest Radiography" OR "CXR" OR "Thoracic X-Ray" OR "Thoracic Radiography" OR "Lung X-Ray" OR "Lung Radiography"	Proquest	4
	Medline	9
	Pubmed	0
	Cinahl Plus	15
	Biomed Central	16
	Science Direct	9

Figure 1: Search terms and the Results.

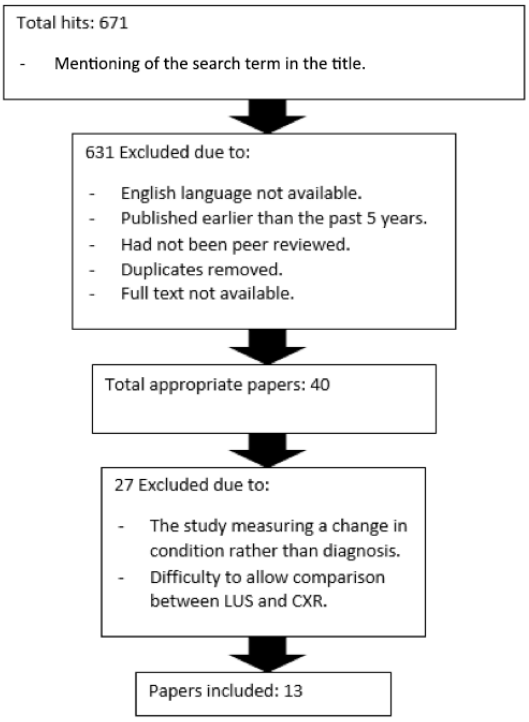

Figure 2: Inclusion and exclusion criteria of the research papers.

No.	Paper	Author	Year	Country of Research	Type of Study	Findings
1.	Performance of lung ultrasonography in children with community-acquired pneumonia	Esposito S., Papa S. S., Pinzani R., Principi N., Borzani I., Giannitto C., & Consonni D.	2014	Italy	Prospective observational study	103 paediatric ICU patients over a four month period. Patients assessed with CXR and LUS by a paediatrician who was blinded to the CXR results. The CXR was used as the gold-standard and found that LUS had 97.9% sensitivity, 94% PPV, 94.5% specificity, and 98.1% NPV.
2.	Lung ultrasound in the diagnosis and follow-up of community-acquired pneumonia: a prospective, multicentre, diagnostic accuracy study	Reissig A., Kroegel C., Neumann R., Hoyer H., Copetti R., Mathis G., et al.	2012	Germany	Prospective, multicentre, diagnostic accuracy study	362 patients with suspected pneumonia assessed with LUS against CXR (or CT if CXR was inconclusive or contradicted by LUS). The findings for LUS: 93.4% sensitivity and 97.7% specificity. The findings for CXR were 92% sensitivity, and 100% specificity.
3.	High discordance of chest x-ray and computed tomography for detection of pulmonary opacities in ED patients: implications for diagnosing pneumonia.	Self W. H., Courtney D. M., McNaughton C. D., Wunderink R. G., & Kline J. A.	2013	USA	Multi-centre, observational cross-sectional study.	3,423 patients assessed with suspected pneumonia across 12 emergency departments over a 39-month period. This allowed a comparison between CT and CXR. The results showed CXR had a 43.25% sensitivity with 108 false negatives, 83 true positives, and a 26.9% PPV. CXR did however provide 3006 true negatives, with 22 false positives.
4.	Lung ultrasound characteristics of community-acquired pneumonia in hospitalized children	Caiulo V. A., Moramarco F., Gargani L., Picano E., Caiulo S., Fisicaro A., et al.	2013	Italy	Prospective control trial	102 patients with clinical suggestions of Pneumonia assessed with a CXR and LUS on the same day. The gold-standard comparison being the final diagnosis after a combination of clinical presentation, CXR and clinical course. The findings showed that LUS had 98.8% sensitivity whilst CXR had 91% sensitivity.

No.	Paper	Author	Year	Country of Research	Type of Study	Findings
5.	Lung ultrasound is an accurate diagnostic tool for the diagnosis of pneumonia in the emergency department	Cortellaro F., Colombo S., Coen D., & Duca P. G.	2012	Italy	A prospective clinical study	120 patients with suspected pneumonia in an emergency department. CXR and LUS were performed on all patients and in any cases with a questionable diagnosis a CT scan was ordered. The results showed a 99% sensitivity, 95% specificity, 19.3 PLR, and 0.01 NLR for LUS. Whereas the CXR displayed 67% sensitivity, 85% specificity, 4.3 PLR, and 0.39 NLR.
6.	Performance comparison of lung ultrasound and chest x-ray for the diagnosis of pneumonia in the ED	Bourcier J., Paquet J.,Seinger M., Gallard E., Redonnet J., Cheddadi F., et al.	2014	France	A prospective, observational, single-centre study	144 patients were analysed with LUS and CXR. The primary end point was the diagnosis on hospital discharge. LUS showed a 95% sensitivity, 93% PPV, 57% specificity, and 67% NPV. Whereas the CXR provided 60% sensitivity, 96% PPV, 76% specificity, and 25% NPV.
7.	Anteroposterior chest radiograph vs. chest CT scan in early detection of pneumothorax in trauma patients	Omar H. R., Mangar D., Kolla J., Camporesi E. M., Khetarpal S., Shapiro D. H., et al.	2011	USA	Three Case Reports	A combination of three case reports in the emergency room where CT was used, in conjunction with CXR, to confirm the diagnosis. The CXR managed to produce one true positive result out of the three, the other two were false negatives.
8.	Lung ultrasound in post procedural pneumothorax.	Elia F., Ferrari G., Molino P., & Aprà F.	2010	Italy	Case report	A single case report on an 84 year old man who underwent Thoracentesis. Post-procedure the patient complained of dyspnea and had oxygen saturation levels of 85%, a CXR was performed and displayed no pneumothorax. However, LUS was available and was performed to produce a true positive finding of pneumothorax.
9.	Use of ultrasound to diagnose pneumothorax after video assisted thoracic surgery: do we need to acquire a new skill?	Mundada S., Gosavi K., & Kondvilkar B.	2014	India	Case Report	Single case report of a patient post-surgery with a rapid drop in oxygen saturation and increase in heart rate. CXR was ordered but delayed, therefore LUS was used. The LUS showed a pneumothorax, the delayed CXR similarly detected pneumothorax.

No.	Paper	Author	Year	Country of Research	Type of Study	Findings
10.	Ultrasound detection of pneumothorax compared with chest x-ray and computed tomography scan	Nagarsheth K., & Kurek S.	2011	USA	Prospective single blinded study	79 patients in a level one trauma centre over a 24 month period. Patients received a CXR and LUS which were read by radiographers and sonographers that were blind to the previous results, finally both were compared with a CT scan. The results indicated LUS had a sensitivity of 81%, a PPV of 100%, a specificity of 100%, and an NPV of 93.4%. Whereas the CXR has a sensitivity of 31.8%, a PPV of 100%, a specificity of 100%, and a NPV of 79.2%.
11.	Accuracy of chest radiography for evaluating significantly abnormal pulmonary vascularity in children with congenital heart disease	Tumkosit M., Yingyong N., Mahayosnond A., Choo K. S., & Goo H. W.	2012	Korea	Retrospective (controlled) trial	120 paediatric patients with congenital heart disease. Compared with cardiac catheterisation for levels of pulmonary vascularity CXR showed 84-94% sensitivity to increased pulmonary vascularity, 26-68% sensitivity to reduced pulmonary vascularity, an overall 71-94% PPV, a 61-69% specificity, and a 71-98% NPV.
12.	Echocardiographic and lung ultrasound characteristics in ambulatory patients with dyspnea or prior heart failure	Platz E., Hempel D., Pivetta E., Rivero J., & Solomon S. D.	2014	USA	Prospective single blinded study	A study on 81 ambulatory patients found that the detection of pulmonary oedema correlated well with the detection of heart failure using an echocardiograph.
13	Prehospital lung ultrasound in the distinction between pulmonary oedema and exacerbation of chronic obstructive pulmonary disease	Zechner P. M., Aichinger G., Rigaud M., Wildner G., & Prause G.	2010	Austria	Case Report	In two separate cases LUS gave a true positive, aiding to distinguish between COPD and Pulmonary Oedema associated with LVF.

Figure 3: Summary of the included studies numbered in order of appearance.

The 13 studies included 9 controlled trials and 4 case studies. Case studies were included to provide an additional retrospective viewpoint (Vandenbrouke, 2001) as well as insight into the reasoning behind the usage and choice of either tool.

Respiratory pathology examined across 13 studies included the diagnosis of pneumonia, pneumothorax and pulmonary oedema. Thematic analysis was completed and the level of quality was assessed using CASP tools (CASP, 2014a; CASP, 2014b; CASP, 2014c) by the primary author with review and grading from both secondary authors. The clinical trials were deemed to be of a moderate to high level of quality with the discovered flaws highlighted throughout the main body.

Pneumonia

Six controlled trials reviewed a combined total of 4,254 patients with suspected pneumonia. The general consensus from these studies favoured the use of LUS, however, two methodologically similar studies did conclude otherwise. In Esposito et al (2014)[1] and Reissig et al's (2012)[2] prospective observational studies, 465 patients were analysed in total and although they both were statistically sound, their methodology was flawed. LUS was being compared in both situations against CXR, which is not the gold standard assessment tool. Sonography did demonstrate a mid-to-high ninety percent in sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) over both studies. The CXR similarly scored well, especially in the specificity category as this tool failed to give a false positive, particularly evident in Reissig et al's (2012)[2] study. This suggests an advantage to the use of CXR, however due to the CXR's use as the 'gold standard' in these studies the results could be attributed to flaws in methodology. Versi, (1992) defines the 'gold standard' as the most specific and sensitive tool that is available, and as stated earlier, this should be the CT scan. CXR was used as the gold standard in these studies, this could allow flaws in the validity of results to be misconstrued as failings of the tool being assessed. Reissig et al (2012)[2] reported fourteen and Esposito et al (2014)[1] reported three false positives produced by LUS. Due to the poor methodology however, it is uncertain if this is due to a flaw in CXR rather than LUS. Self et al (2013)[3] in their much larger, observational study across twelve emergency departments indicates it may be caused by the radiograph. They found when they compared CXR with CT it had a low sensitivity and PPV. This suggests that in fact it may not have been LUS that had produced false positives, but the CXR that produced false negatives in Esposito et al's (2014)[1] and Reissig et al's (2012)[2] studies. This not only theoretically underestimates the specificity of LUS but also results in possible misdiagnoses from the use of CXR.

Two of the controlled trials comparing CXR and LUS within this review found a technical superiority in LUS. These robust studies reported greater sensitivity, specificity, PPV, NPV, positive likelihood ratio (PLR), and negative likelihood ratio (NLR) in LUS (Caiulo et al, 2013[4]; Cortellaro et al, 2012[5]). In both of these studies, ultrasonography was performed by an expert with years of clinical experience, increasing the likelihood of accurate findings. In Bourcier et al's (2014)[6] study they obtained similar results regarding the sensitivity, yet finding a 20% greater specificity. Unlike in Caiulo et al's (2013)[4] and Cortellaro et al's (2014)[5] studies the sonographer in Bourcier et al's (2014)[6] study was one of five emergency physicians who received a total of two days training. This lack of training is also found in Esposito et al's (2014)[1] study. It is recommended by the American College of Emergency Physicians (2009) that before a qualified individual becomes competent in LUS, at least 150 supervised examinations should have been performed. As neither Esposito et al's (2014)[1] nor Bourcier et al's (2014)[6] study mentioned that the sonographers had

achieved this their competence could be questioned. Consequently, the analytical results of the LUS could be underestimated from the less effective application of the tool.

These studies show the strength of both tools in assessing for pneumonia. Although the more robust studies hinted at a greater performance by LUS, there is not enough evidence demonstrated to prove this notion.

Pneumothorax

In the condition of pneumothorax, four studies were found: one controlled trial, and three case reports. In two of the case reports CXR provided false negatives (Omar et al, 2011[7]; Elia et al, 2010[8]). The other case report stated that both tools detected the presence of a pneumothorax (Mundada et al, 2014)[9]. However, in this emergency situation LUS provided a more rapid, effective diagnostic tool in comparison with portable CXR, resulting in more timely patient management (Mundada et al, 2014)[9]. These results display the usage of both diagnostic tools in a practical situation. Although the low-strength case reports make it difficult to draw definitive conclusions, they do provide evidence for clinical effectiveness with a novel diagnostic tool (Gagnier et al, 2013), justifying their inclusion in this review.

The final piece of evidence on pneumothorax, produced by Nagarsheth and Kurek (2011)[10], found both diagnostic tools to have an equal 100% specificity. However, the sensitivity was 81% to 31.8% for LUS and CXR respectively. Although this shows a great advantage to LUS, the exclusion criteria prevents a true reflection of the wider population. Patients were excluded if they had large amounts of subcutaneous emphysema, a chest tube or pleural adhesions. These all effect LUS' ability to detect pneumothoraces (Dente et al, 2007; Gooman et al, 1999) and their inclusion may have altered the tool's high level of sensitivity.

Nagarsheth and Kurek (2011)[10] measured 79 patients with CXR and LUS against CT. Unlike in the case studies the reviewers of each test result were blinded from the results of the other findings, demonstrating reduced situational bias (Kopec and Esdaile, 1990). Although this study was rated highly methodologically and statistically, the results are not generalizable to the wider population as a power analysis was not performed. This study, and the case studies, propose a greater effectiveness of LUS in diagnosis of pneumothorax. However, this evidence is not strong enough to make any resounding conclusions regarding the research question.

Pulmonary Oedema caused by Left-Ventricular failure

The literature discovered regarding respiratory problems due to left-ventricular failure (LVF) included one involving CXR measured against heart catheterisation, one measuring LUS against echocardiogram, and a case report on the use of LUS to differentiate between LVF and chronic obstructive pulmonary disease (COPD). Tumkosit et al (2012)[11] aimed to find CXR's ability to detect pulmonary vascularity related to heart failure. Although this is one of the larger studies in this literature review their inclusion criteria for participants was poor. They only included individuals with a very high, or very low blood flow in the experimental groups. This is not representative of the whole data set, as those with more intermediate blood flow levels were not included. They did however find that CXR was highly sensitive to increased pulmonary vascularity (over 1.5 Qp:Qs [ratio of pulmonary to systemic blood flow]), yet had low sensitivity to reduced pulmonary vascularity (under 0.8 Qp:Qs) (Tumkosit et al, 2012)[11]. Reduced pulmonary vascularity can be caused by LVF and is highly likely to result in pulmonary oedema (Gehlbach and Geppert, 2004). Increased pulmonary vascularity however, is indicative of COPD (Sakao et

al, 2014). This suggests that CXR performs well when identifying COPD, whilst less effective at detecting LVF and associated pulmonary oedema.

LUS is seen to be effective at detecting extravascular lung water, yet still has some obvious flaws. Platz et al (2014)[12] produced a statistically and methodologically sound study on 81 patients either with dyspnoea or prior heart failure. They found LUS had an excellent ability to detect pulmonary oedema and it correlated well with LVF, when monitored by ECG (Platz et al, 2014)[12]. However, the oedema may not only be due LVF. It could potentially be an indication of acute respiratory distress syndrome (ARDS) (Volpicelli et al, 2013), two conditions which require differing management plans (Matthay and Zemans 2011; Gradman and Alfayoumi 2006). LUS cannot differentiate between the possible aetiology of the extravascular lung water (Volpicelli et al, 2006). Therefore it would not be best practice to rely on the sole use of this tool.

Finally, the case report by Zechner et al (2010)[13] presents two patients suggestive of either an exacerbation of COPD, or LVF; two conditions that are treated very differently (Zechner et al, 2010)[13]. However, LUS provided an accurate diagnosis in a time when there was uncertainty regarding the suspected condition (Zechner et al, 2010)[13]. This small case study suggests that LUS performs well when differentiating between COPD and LVF.

The evidence found regarding LVF and similar presenting conditions suggest both tools hold a relevance in practice. However, the tools are not accurate enough, nor is this evidence strong enough, to suggest that they should be used solely to diagnose a patient. Therefore their use needs to be in conjunction with other diagnostic tools and subjective and objective information.

Discussion

To discuss these two tools fully involves deciding not only which is the most efficacious but also the most effective including safety, costs, and practicality issues (Pittler and White, 1999). LUS costs less and does not have the health risks of radiation exposure of CXR or CT (Dhawan, 2011). Also, Zhang et al (2006) found that LUS is over three times quicker than CXR at providing a diagnosis, supported by Mundada et al (2014). With these factors in mind there is a strong argument for funding further research in diagnostic LUS.

There are some limitations to this study, preventing a definitive answer to the research question. Firstly, although all of the studies in this review showed few statistical flaws in what they applied, their sample sizes and lack of power analyses, prevent the data from being generalizable. Therefore, it would be incorrect to present one answer as conclusive across the population suffering from the analysed pathology.

Another limitation is the fact that only pneumonia, pneumothorax and pulmonary oedema caused by LVF were analysed. To obtain a definitive result regarding the comparison of both of these tools a greater variety of pathology assessed is required. However, as there is currently a lack of literature allowing contrast between the two diagnostic tools, only a superficial conclusion could be produced.

All of the studies are set in an acute setting, suggesting patients are in a relatively unstable condition. This creates challenges with implementation of controlled trials within this field, mainly due to a difficulty obtaining consent (Edwards et al, 1998). In order to ensure the best outcomes for the patient, clinical judgement and patient safety takes priority over producing research. Therefore, although CT is the gold standard respiratory imaging tool, its application

cannot be used for routine patients due to its high cost, radiation exposure levels and reduced availability (Brenner and Hall, 2007). The issue of time constraints and the application of excessive, high-levels of radiation exposure when applying the CT along-side another diagnostic tool adds preventable risks to the patients (Picano, 2004).

Finally, this review was undertaken with a limited time frame as part of an undergraduate degree in May 2015. Therefore with more time it may have been possible to conduct a wider search in more databases, potentially accessing further literature. However, the databases searched are credible enough to ensure some recommendation can be made from the research found. The author also concedes there is now NICE guidance for the diagnosis of Pneumothoraces in patients admitted after major trauma which include the use of LUS as one of their primary imaging tools (NICE, 2016). This demonstrates the developments already taking place however this review reiterates the need for more.

Conclusions

The findings from this study suggest that there is a need for further research directly comparing both tools. LUS has been seen to have a greater level of sensitivity, NPV, PPV, PLR, and NLR regarding the detection of pneumonia and pneumothorax in the majority of the cases presented, whilst CXR has been suggested to have superior specificity. LUS is also proposed to be beneficial to identifying pulmonary oedema, yet unable to correctly distinguish between aetiology. CXR however has difficulty to detecting LVF, yet performs well when recognising COPD. Incorrect diagnoses are not only costly to the patient but also to the healthcare provider (Batemen et al, 2010). This can be prevented through the application of a more precise diagnostic tool and is something that must be considered when questioning whether to fund further research.

In review of effectiveness the findings of this study suggest time, cost, and decreased health risks are attached to LUS when compared with CXR. This should provide greater encouragement to fund LUS, further research, and provide associated training with the use of the tool.

LUS is proposed as a useful diagnostic tool with numerous benefits. Its application will be used in conjunction with subjective, objective and other diagnostic findings in a clinical practice, further increasing the accuracy of the assessment (Reissig et al, 2012). Although there still is a requirement for CXR, further investigations and comparisons should be performed on LUS to suggest its use as the new primary imaging tool. Sound and generalizable studies are not frequent within LUS research. Further robust comparisons between LUS and CXR in a wider range of respiratory pathology is required. This will then provide a definitive answer to the research question.

Key Points

- Lung ultrasound provides an alternative imaging tool to the currently recommended Chest X-ray.
- Research suggests lung ultrasound has a superiority over Chest X-rays in their effectiveness and efficacy regarding diagnosis of pneumonia, pneumothorax and pulmonary oedema caused by left-ventricular failure.
- Further research is required to achieve best practice, provide improved patient outcomes and increase cost effectiveness.

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Respiratory physiotherapy and lung ultrasound: A service evaluation of a competency based training programme

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Purpose

Lung ultrasound (LUS) has the potential to enhance a respiratory physiotherapist's clinical examination and inform physiotherapy treatments. However there are very limited formal training opportunities for physiotherapists within the United Kingdom. This paper evaluates a training programme initiated on a general and a cardiothoracic adult intensive care unit.

Method

Six physiotherapists ("trainees") commenced a four phase competency based LUS training programme. The training programme was modified from the Intensive Care Societies (ICS) Core Ultrasound Intensive Care (CUSIC) syllabus under the guidance of a CUSIC approved mentor. The training included an introductory course, supervised scan sessions, completion of scan report logbook and finally a triggered assessment. The first one hundred scan reports were collected and analysed and each trainee was involved in a peer discussion about their experiences during the training programme.

Results

Mentor feedback from the first 100 scan reports include advice about optimal scanning depth, artefact identification, avoiding rib shadows, orientation within the thorax/abdomen and lung sliding. Information from the peer discussions around barriers to training and indications for scanning are also reported. At the time of writing three of the six trainees had successfully completed the triggered assessment and deemed competent to perform LUS independently.

Conclusion

There are a number of potential barriers to completing a LUS training programme that need to be addressed. It is essential that sufficient time is allocated to complete the full competency training and attendance on an in-depth introductory course is advised. Finally it is essential to be under the supervision of an experienced mentor throughout the training process for regular guidance and feedback.

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Introduction

Lung ultrasound (LUS) as part of point of care ultrasound (POCUS) is gaining popularity amongst critical care physiotherapists as an adjunct to portable chest radiograph (CXR) and clinical examination to aid pulmonary pathology diagnosis and inform physiotherapeutic treatment options. Leech et al (2015b) report on the use of physiotherapy initiated LUS to aid the management of a deteriorating patient. Two narrative reviews around the use of LUS by physiotherapists have previously been published. Leech et al (2015a) focused on the diagnostic performance of LUS when compared to auscultation and CXR and found that LUS increases diagnostic accuracy when identifying acute pulmonary pathology. They also highlight that LUS is not routinely used by physiotherapists and report a lack of training standards for physiotherapists. Le Neindre et al (2016) focused on the basics of LUS, its semiology and how to apply this in practice. They report that LUS performs better than CXR and auscultation and physiotherapists should consider it as an outcome measure and to inform clinical decision making. For practitioners to become proficient in LUS, competency based training is required in image acquisition and interpretation (see Figure 1) (Cholley et al, 2011). The level of training and timeframe for respiratory physiotherapists to gain competency is currently unclear. As such, an established training pathway should be utilised to attain the skills necessary for competent use of LUS. See et al (2016) report on a LUS training programme however this involved respiratory therapists and was located within the healthcare system of Singapore. Currently, within the United Kingdom (UK), there are no formal training, competency or accreditation courses aimed at physiotherapists. The Intensive Care Society (ICS) offer the Core Ultrasound Intensive Care (CUSIC) training pathway which includes theoretical, practical and competency based assessments in lung, vascular and abdominal ultrasound. The CUSIC training is predominantly aimed at intensive care medicine trainees and incorporates the unified approach advised by an international expert panel (Volpicelli et al, 2012). The aim of this service evaluation was to evaluate the training programme of six physiotherapists in LUS by closely following the CUSIC training pathway (omitting the vascular and abdominal components).

- Theoretical training: 10 hours of lectures, case studies and web-based self-study
- No “set” number of scans
- Competence determined by an experienced supervisor
- Exposure to a variety of pathologies (Case studies or real patient)
- Use of normal volunteers is acceptable
- Supervised bedside scanning
- Complete written reports for each scan to be verified by the supervisor
- Maintain a log book of scanning activity
- Dedicated ultrasound machine at each training location
- **No formal certification/accreditation is required – Competency based training**
- Each individuals duty of care to achieve required skills and experience

Cholley et al, 2011

Figure 1: Summary of expert statement on ultrasound training standards.

Method

Following research and development approval, permission was gained from the NHS trusts divisional governance teams to commence the training programme.

The LUS training programme took place over a nine month period in 2016 across an eight bed general intensive care unit (ICU), a six bed general high dependency unit (HDU) and a twenty bed cardiothoracic ICU. Six physiotherapists (the "trainees", see Table 1) embarked on a competency based training programme adapted from the CUSIC accreditation pack offered by the ICS in the United Kingdom. In order to complete the CUSIC module it is necessary to have an ICS registered CUSIC mentor with sufficient experience to oversee the training. The mentor for this training programme is a consultant in anaesthetics and critical care medicine with over ten years' experience in whole-body critical care ultrasound and a registered CUSIC mentor.

In order to closely match the CUSIC training we adopted their four-phase pathway. Phase 1 was theoretical training and introductory practice. This took the form of locally delivered training involving a two hour lecture covering the theory and knowledge based aspects of the CUSIC syllabus. Then followed by a two hour supervised practical session where LUS was practiced on other trainees and phantoms. Phase 2 involved each individual trainee completing directly supervised scans. It was the trainee's responsibility to book these supervised scans and were dependent on the mentor's availability. Phase 3 involved individual independent practice and completion of a log book. With independent practice, each subsequent scan was recorded on a reporting form along with saved video files (see Appendix 1). These were then reviewed by the mentor who gave feedback to each trainee. Phase 4 was the assessment of competence. Once the mentor had confirmed each aspect of the core skills had been demonstrated and competence had been shown, a "triggered assessment" was completed. This took the form of a directly supervised LUS scan exam.

This service evaluation will evaluate the LUS training programme by reporting:

- The number of physiotherapists who gained competency within nine months.
- How many scans were required to consistently identify common artifacts/pathologies.
- How many logged scans were needed prior to the triggered assessment.
- Common mentor feedback from scan reports.
- Themes from informal peer discussions with the trainees.

The first one hundred scan reports were collected and analysed for common feedback comments and themes. In addition, each trainee was involved in an informal one to one peer discussion about the training programme. This took the format of an unstructured discussion where open questions were asked about their experiences while learning and using LUS in practice. Common themes were collated and described.

Results

At nine months four out of six trainees had submitted reports for review by the mentor. At the time of writing, three of the group had successfully completed a triggered assessment and were deemed competent by the mentor to perform LUS independently (Table 1).

According to the feedback forms all four trainees were correctly and consistently identifying artefacts/pathologies after a mean number of 10 scans.

The number of logged scans required prior to successfully passing the triggered assessment ranged from twenty eight to thirty nine (Table 1).

Mentor feedback

Listed below are seven common pieces of mentor feedback from the 100 scan reports. Each of these feedback comments were present on every trainee's reports at some point during their training.

1. Ineffective or incorrect use of depth while scanning. This would lead to too much depth for superficial structures or too little depth for deeper structures. The advice given was to adjust scan depth to 2 cm below the desired target structure to acquire the best possible image.
2. Confusion over the presence or absence of B-lines. All were advised to consider the definition of B-lines by the supervisor.
3. Rib shadows obscuring target structures which needed advice on probe handling.
4. Disorientated within the anatomy of the thorax and abdomen. The advice was to revisit the anatomy and to use anatomical landmarks to ascertain scanning location.
5. The presence of lung sliding under a pleural effusion. Advice was that even a small effusion will separate the two pleura therefore abolishing lung sliding.
6. Closer attention to the definition of A-lines was advised as some A-lines were incorrectly identified or missed completely.
7. Trainees are advised to submit no more than 5 scan reports at once to allow sufficient feedback prior to further scanning and allow timely correction of mistakes.

Peer discussion feedback

Following review, the peer discussion feedback could be grouped into three themes; barriers to LUS use, indications for LUS use and mentor support.

Barriers to LUS use

For trainees who held both clinical and managerial responsibilities the time available for scanning practice appeared very limited due to their managerial responsibilities taking them away from critical care.

For clinical trainees the barriers highlighted were as follows;

1. A lack of access to the diagnostic ultrasound machines due to being in use by other multidisciplinary team members.
2. Some physiotherapists had roles that required them to move between critical care settings and the wards. Again this would limit their time on critical care.

On some occasions when a significant LUS finding had been encountered by a physiotherapist trainee and handed over to a senior member of the medical team, it was found that the medical team member wasn't familiar with LUS and therefore didn't understand what they were being shown or how to proceed with this new information.

Indications for LUS use

Initially trainees would scan patients to build up scanning experience and refine their image acquisition and interpretation. As experience grew the focus shifted to clinical questions that other clinical examination skills could not answer. As a result, a number of physiotherapy specific themes arose regarding indications to performing a LUS scan.

They included:

- Ambiguous portable CXR
- Worsening CXR
- Acute respiratory deterioration
- Failing ventilator wean
- Failing to achieve respiratory milestones
- Absent breath sounds on auscultation
- Ability to track responses to treatment with serial scanning

This is not an exhaustive list but highlights some of the numerous ways in which LUS can support clinical reasoning.

It was noted by one trainee that early on in a patient's admission a higher proportion of ultrasound scanning was performed by the medical team. Once the treatment plan had been established the trainee was more likely to perform scans to monitor progress or reassess the patient following a decline in respiratory status or a period of no improvement.

Mentor Support

Trainees commented on the benefit of arranging 1:1 supervised scanning sessions with the mentor and the value of receiving immediate feedback. It was the opinion of some trainees that they should have taken more advantage of the 1:1 supervised sessions earlier in their training to build confidence.

Trainee	Role	Full-time or part-time (FT/PT)	Critical care experience (Years)	Time to triggered assessment (Months)	No. scans prior to triggered assessment
A	Clinical	FT	5	4	39
B	Clinical	FT	12	5	31
C	Clinical	PT	5½	9	28
D	Clinical	FT	6½	N/A	(16)*
E	Clinical & Managerial	FT	5	N/A	N/A
F	Clinical & Managerial	FT	5	N/A	N/A

* Number of scans reported but trainee has not completed the triggered assessment.

Table 1: Trainee demographics and progress.

Discussion

We have found that ultrasound naïve physiotherapists can gain competency in LUS having undergone a structured training programme under the guidance of an experienced mentor.

Feedback from the mentor was most effective when given more frequently and in 1:1 sessions. It is advised that no more than five scans should be completed before the reports were handed in for review. This allowed any feedback points to be integrated into practice earlier on during training to improve image acquisition and interpretation.

Problems arose around some trainees not having enough time to complete any scans, scan reports or a scan log. At the time of writing this evaluation only four of the six trainees had submitted scan reports for feedback. Of those four, all were clinical and didn't have any formal managerial responsibilities. It would appear that any responsibilities away from clinical work will limit a trainee's ability to learn LUS. It therefore seems sensible to allocate protected time to learn LUS or to commence training at a relatively less time-pressured period.

Three trainees completed the triggered assessment and passed. The timeframe for half the trainees to complete this LUS training programme through to competency was between four and nine months. The number of logged scans completed prior to the triggered assessment varied slightly and can be seen in Table 1. It seems prudent to begin practice scans as soon as possible after the initial training and to submit the first set of five supervised scan reports soon after that. One trainee was part time which may account for the slightly longer timeframe to complete the triggered assessment.

Early scans were often done on relatively stable patients, where significant pathology wasn't expected, purely to gain experience with the scanning technique and image acquisition. Consent was only gained from these patients following an explanation that the scans were for training purposes only. This situation meant it was hard to justify as a reasonable use of time and resources because it wasn't necessarily going to add to the patient's treatment. However, once more experience was gained the trainees began to use LUS to answer specific clinical questions about their patients. At this point LUS had started to become incorporated in to the physiotherapy assessment process.

The scan reports included a wide range of pathologies including all of the most common identifiable pathologies seen with LUS (see Appendix 1). The four trainees, who submitted scan reports, were consistently identifying pathologies and artefacts correctly after a mean number of ten scans which fit in with findings reported by See et al (2016). It would appear that the learning curve for LUS is steep meaning that an initial investment in time can reward a trainee with the useful basic skills needed to perform LUS. The importance of mentor support and feedback, while gaining a skill such as LUS, was regularly emphasised by participants. This is consistent with an international expert panel (Volpicelli et al, 2012) which placed a strong emphasis on the inclusion of mentor support in any ultrasound training programme.

The use of LUS as an adjunct to a respiratory physiotherapists skill set highlights several issues, particularly clinical governance, that need to be addressed. For example, once deemed competent trainees need to maintain their competency (Volpicelli et al, 2012) and a monitoring system of their practice should be in place in case any issues arise. Even within the medical profession POCUS is an emerging technique and there has been a shortage of CUSIC registered mentors that are able to support training.

As it currently stands there are no physiotherapy CUSIC mentors within the UK, therefore physiotherapists are reliant on medical colleagues for this support. This should be considered by any individual or team wishing to embark on LUS training, as without a local mentor progressing through to competency can be very restrictive. Over time, a network of suitably qualified physiotherapy mentors may emerge once robust governance structures are put in place.

As previously mentioned the CUSIC accreditation format has been adapted for use by physiotherapists during this service evaluation. Unfortunately trainees are unable to gain CUSIC

accreditation because neither the vascular or abdominal component has been completed. A way forward may be to have an individual modular format to the CUSIC training which may enable other critical care professionals to gain accreditation in separate POCUS disciplines. The training programme undertaken by the trainees was based on a critical care model, however a model similar to traditional radiographer training may also be effective. Ultimately, a training programme that blends the two models could offer a robust training format; however, at the time of writing, such a programme is not available.

The authors are aware that there are a number of sources of bias within this service evaluation. The methodology surrounding the peer discussions involved informal questioning and therefore lacked a more robust formal structure. The inclusions of the primary authors own experiences is also a source of bias. We would, however, like to highlight that due to the novel nature of this diagnostic technique for physiotherapists, any information that might aid fellow physiotherapists in gaining LUS competency should be disseminated. To the authors' knowledge there is only one paper, to date, reporting on physiotherapy competency training in LUS (See et al, 2016). As such there remains a vast amount of work to be done around building stronger evidence towards the training of physiotherapists in the use of LUS.

Conclusion

This service evaluation has shown that it is possible for some ultrasound naïve physiotherapists to gain competency in LUS and become independent within 4 to 9 months. It is the author's intention that this service evaluation will aid other physiotherapists in gaining competency in LUS by highlighting some of the obstacles and feedback encountered during training. Physiotherapists are able to begin to become independent and competent in lung ultrasound use once a LUS introductory course has been completed followed by a competency based training programme. It is recommended that sufficient time is allocated for the training and a suitable mentor is recruited prior to embarking on the competency stage of the training.

Key Points

- Ultrasound naïve respiratory physiotherapists can gain competency in LUS.
- Supervision by an experienced LUS mentor is essential.
- An introductory course and detailed training schedule is recommended.

Since this article was accepted for publication, the CUSIC course has been updated and is now modular allowing physiotherapists to gain a separate lung US certification. If you would like further information, please contact Simon Hayward.

Acknowledgements

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Volpicelli, G., Elbarbary, M., Blaivas et al 2012 International evidence-based recommendations for point-of-care lung ultrasound. Intensive Care Medicine 38; pp577-591.

Appendix 1: Lung Ultrasound reporting form*

Date of study	Patient details/study reference number

Name of trainee	

Image quality		Good		Acceptable			Poor	
		Lung sliding	A lines	B lines <3	B lines ≥3	Effusion	Consolidation Min	Consolidation Significant
Right	Upper ant Point							
Right	Lower ant point							
Right	Post-lateral Point							
Left	Upper ant point							
Left	Lower ant point							
Left	Post-lateral point							

Comment/further details

Signature

Supervisor sign off confirming findings

*Adapted from the Intensive Care Society CUSIC accreditation pack.

Is exercise prescription after cardiac surgery evidence based? A survey investigation of physiotherapists in Ireland

Healy S[1], Hashmi-Greenwood M[2], Hinchion J[3]

Objectives

The objectives of this study were to:

- Identify the principles of exercise used by physiotherapists in prescribing exercises/mobility to adult patients in the early post-operative stage (day 1-4) after cardiac surgery in the Republic of Ireland (ROI);
- Evaluate the clinical reasoning used to inform the choice of exercises.

Method

An observational design was used for this study. A postal questionnaire was sent to 22 physiotherapists in the 8 hospitals where cardiac surgery is performed in the ROI. The questionnaire consisted of 21 questions investigating post-operative physiotherapy practice. The main focus was exercise/mobility and clinical reasoning of exercise prescription. Data were analysed using Microsoft excel descriptive statistics.

Results

A response rate of 86% (19/22) was achieved. 90% (11/19) of respondents assessed and treated all patients after cardiac surgery. Only 26% (5/19) of respondents had written guidelines or protocols for physiotherapy (mobility/exercise) management of routine patients after cardiac surgery. The type of exercise prescribed included range of movement exercises, sitting out of bed and mobility. 95% (18/19) respondents advised patients on frequency of exercise/mobility but the frequency prescribed varied both within and between hospitals. 63% (12/19) advised patients on intensity of exercise/mobility mostly based on breathlessness. The main influencing factor on exercise/mobility prescribed was personal experience.

Conclusions

This study highlights variability in the principles of exercise prescribed by physiotherapists to patients in the peri-operative stage after cardiac surgery in the Republic of Ireland. It is mostly influenced by personal experience and is an area that requires more research to guide prescription.

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Keywords

Cardiac surgery, Physiotherapy, Exercise prescription, Clinical reasoning.

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Introduction

The best evidence for physiotherapy management of patients in the perioperative stage after cardiac surgery is for early and progressive mobilisation (Hirschhorn et al, 2012, Hulzebos et al, 2012; Rosenfeldt et al, 2011; Mendes et al, 2010; Herdy et al, 2008; Whaley, 2005; Van der Peijl et al, 2004; Lin et al, 2002). Exercise programmes have been shown to aid recovery in the peri-operative stage (Van der Peijl et al, 2004), help maintain optimal functioning of organs (Hulzebos et al, 2012), promote a healthy active lifestyle (Whaley, 2005) and reduce length of hospital stay (Herdy et al, 2008). These programmes have also been shown to reduce anxiety, depression and stress (Rosenfeldt et al, 2011; Lin et al 2002) and improve self-efficacy, cardiac function and functional capacity (Hirschhorn et al, 2012; Mendes et al, 2010; Whaley, 2005). Self-efficacy expectation after cardiac surgery correlates with activity and is predictive of subsequent activity (Parent and Fortin, 2000). Functional disability in adults correlates with an increased risk of health deterioration (Colon-Emeric et al, 2013). Exercise programmes which help patients to regain functional capacity and self-efficacy as soon as possible are therefore a vital component of recovery after cardiac surgery.

There is however limited evidence on optimal exercise prescription in the peri-operative stage for this patient group. The American College of Sports Medicine (ACSM) recommends (Riebe, 2013):

- Frequency of 2-4 times per day (days 1-3) for early mobilisation for patients after cardiac surgery
- An intensity based on HR rest + 30beats/min (upper limit ≤ 120) or rate of perceived exertion (RPE) ≤13 (6-20 scale)
- Intermittent bouts of 3-5 mins as tolerated with progressively increasing duration. Rest periods should be shorter than exercise bout duration; attempting to achieve 2:1 exercise/rest ratio

They also state however that 'optimal dose of exercise for inpatients remains to be better defined'.

A study by Van der Peijl et al (2004) compared a high frequency (twice daily) to a low frequency (once daily) exercise programme. The high frequency group achieved milestones faster than the low-frequency group and more patients were satisfied in the high frequency group. The evidence available to guide frequency prescription is very limited.

There is also limited evidence other than the ACSM recommendations to guide the prescription of exercise intensity. Hirschhorn et al (2008) used RPE as an indicator of moderate intensity walking exercise when they compared the outcomes of 93 patients randomised to three different walking programmes after cardiac surgery: (1) standard intervention (gentle mobilisation); (2) walking exercise (physiotherapy supervised moderate intensity walking programme) and (3) walking exercise combined with breathing and musculoskeletal exercises. They showed that groups 2 and 3 (i.e. moderate intensity groups) had significantly higher 6 minute walk distance scores on discharge.

Surveys of the physiotherapy management of patients following cardiac surgery have been previously carried out in Australia and New Zealand (Filbay et al, 2012), Sweden (Westerdahl and Moller, 2010), Canada (Overend et al, 2010) and the UK (Reeve and Ewan, 2005) but not in

the Republic of Ireland (ROI). There are no current Irish national guidelines on peri-operative exercise/mobility prescription for this patient group.

The aims of this study were to investigate the principles of exercise used by physiotherapists in prescribing exercises/mobility to adult patients in the early post-operative stage after cardiac surgery in ROI; to ascertain what exercises are prescribed and what factors influence the choice of exercises.

Methods

A national postal questionnaire was sent to physiotherapists in all adult Cardiac Surgery Departments (CSD's) in ROI hospitals in 2015. Postal questionnaires were chosen as the survey mode as they have been found to be a more effective mode for improving response rate than online or mixed modes (Cho et al, 2013). Other considerations in questionnaire design aimed at improving the response rate included personalisation of the cover letter and envelope address, brevity of questionnaire, including an anticipated time for completion of questionnaire, clarifying confidentiality of information and offering feedback to all responders.

Initial postal contact included the questionnaire, a cover letter with comprehensive instructions and a proposed response date and a stamped addressed response envelope. After 2 weeks, reminder letters with a copy of the questionnaire and another stamped addressed envelope were sent to non-responders. Coding of questionnaires facilitated recognition of non-responders.

To answer the proposed research question, a complete overview of clinical practice was required by getting a total population sample, i.e. the questionnaire was sent to every physiotherapist in all 8 CSD departments rather than just senior physiotherapists. Names were obtained by telephone calls to each physiotherapy department.

The questionnaire examined the routine peri-operative (days 1-4) physiotherapy management (mobilisation and exercise) of patients following cardiac surgery to determine an exact description of physiotherapy practice and clinical reasoning. Post-operative respiratory physiotherapy techniques were not included in this survey. The questionnaire was designed following a comprehensive literature review and based on questionnaires of previously published studies to improve content validity (Filbay et al, 2012; Westerdahl and Moller, 2010; Overend et al, 2010; Reeve and Ewan, 2005). The questionnaire was piloted on three senior intensive care physiotherapists in the author's hospital to further improve content validity and then edited (rewording of three questions). Results from this pilot were not included in the final survey results. Questions had mostly pre-defined answers but respondents had opportunity for free text also.

In this study, cardiac surgery was defined as open heart surgery (on bypass machine) including coronary artery bypass graft (CABG), valve surgery or a combination of these, all of which require a median sternotomy.

Ethics approval was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals and Sheffield Hallam University Dissertation Management Group. Return of the questionnaires implied consent to participate in the study. Data were analysed using Microsoft excel descriptive statistics. Proportions are presented as % (numbers). Free text responses are listed as themes or direct quotes.

Results

A response rate of 86% (19/22) was obtained including at least one response from each site. A median of 10 cardiac surgeries per week (IQR=5) were performed at these sites. See Figure 1 for participants and responders.

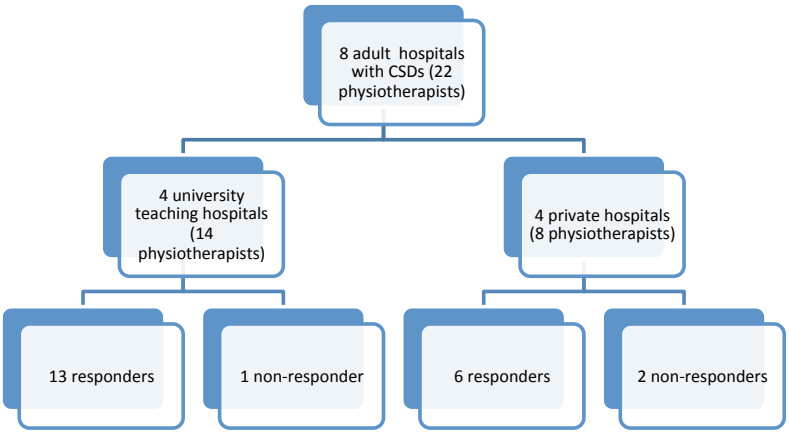

Figure 1: Figure 1 Outline of the participants and responders.

Demographic data can be seen in Table 1. There was a high level of experience amongst the responders with the median number of years working as a physiotherapist being 11 (IQR=9). The median number of years of experience in a CSD was 5 years (IQR=8.5).

Demographic detail	**Number (% of respondents)**
Total respondents	19
Gender	
Male	3(16)
Female	16 (84)
Physiotherapy grade	
Physiotherapy manager	1 (5)
Clinical Specialist	2 (11)
Senior	11 (58)
Staff grade	5 (26)
Length of time working as a physiotherapist	
≥ 5 years' experience	18 (84)
≥10 years' experience	12 (63)
Length of time working in a CSD*	
< 5 years	7 (37)
5-10 years	9 (47)
> 10 years	2 (11)

*one respondent did not answer this question

Table 1: Demographic data of respondents.

Comparisons of data from the current study which overlap with findings from similar surveys carried out in other countries (Filbay et al, 2012; Westerdahl and Moller, 2010; Overend et al, 2010; Reeve and Ewan, 2005) are made in Table 2.

Postoperative management

100% of respondents considered physiotherapy necessary after cardiac surgery with 89% (17/19) reporting that they assess and treat all patients. 84% (16/19) reported that they consider the postoperative physiotherapy treatment (exercise/mobility) provided in their department to be optimal. Only 26% (5/19) of respondents have written guidelines/protocols for perioperative physiotherapy (mobility/exercise) management of routine patients after cardiac surgery. All 5 said that they were based on published guidelines as follows: '*Established practice in the department*', '*Unsure as the guidelines were written by my manager*', '*see reference section of attached guideline*' (1 article and 1 book referenced) and two respondents did not list any guideline.

Respondents were asked to list their (exercise/mobility) objectives in treating patients after cardiac surgery. The objectives from 18 respondents (95%) had one common theme - safely increase or maintain mobility/exercise tolerance and return to functional baseline as soon as possible. Other answers included: increase confidence/self-efficacy/well-being (3/19), prevent fatigue (1/19), optimise shoulder/spine range of movement (1/19).

The postoperative days (POD) on which mobilisation and exercise usually commenced are shown in Figure 2. A majority of respondents report that patients sit out of bed on POD 1 and that mobility is commenced on POD 2 which compares with findings from other international surveys (Filbay et al, 2012; Westerdahl and Moller, 2010; Overend et al, 2010; Reeve and Ewan, 2005). These comparisons are shown in Table 3.

When asked about reasons for not mobilising patients, many respondents (11/19, 58%) indicated that individual reasons would be taken in context of the overall assessment, clinically reasoning the issues based on the individual patient. The most common reasons listed included unstable blood pressure (18/19, 95%), arrhythmia (16/19, 84%), surgical team request (14/19, 74%), inotropes/vasopressors (11/19, 58%).

Postoperative exercise parameters

Frequency

Eighteen respondents (95%) advise patients on frequency of exercise/mobility but there was a large range in frequencies being prescribed – 'hourly/every 2-3 hours/twice daily/3 times daily/4-5 times daily/6 times daily'. Other non-specific answers included '*as tolerated/Depends on patients age'*. Most respondents did not state a reason for choosing a specific frequency but reasons included – '*To prevent postoperative complications*', '*encourage patients to take responsibility for their progression*', '*to improve cardiac function' and 'aid with postoperative respiratory care*'.

Intensity

Twelve respondents (63%) indicated that they advise patients on intensity of exercise/mobility during POD 1-4. Four (21%) of these did not specify the intensity. The other 8 (42%) respondents listed shortness of breath (SOB) as the main indicator of intensity aiming for moderate intensity or less. Reasons given for choosing the specified intensity included: to prevent loss of exercise

Study	Location	Sample size (response rate)	Participants from each site	Number of years qualified	Number of years' experience in cardiothoracic physiotherapy	Saw all patients after cardiac surgery*	Postoperative physiotherapy guidelines or protocols available
Reeve & Ewan 2015	UK	40 (83.3%)	Senior Physiotherapists	>10: 50% 7-10: 15% 4-6: 27.5% <4: 7.5%	>7: 30% 4-7: 25% 1-3: 32.5% <1: 10%	95%	
Overend et al 2010	Canada	18	One physical therapist per site			100%	67% (78% - care plan)
Westerdahl & Mooler 2010	Sweden	29 (88%)	All physiotherapists		Mean: 6±4 years (range 1-16)	90%	72%
Filbay et al 2012	Australia & New Zealand	53 (88%)	Senior Physiotherapists	>6: 72% >12: 53%	>12: 36% ≤6: 47%	96%	91% ('guided by a clinical care pathway)
Current study findings	Republic of Ireland	19 (86%)	All physiotherapists	≥10: 63% ≥5: 84%	>10: 11% 5-10: 47% <5: 37% ***	95% **	26% **

POD = postoperative day.

* = % of Physiotherapists who perform these interventions.

** only mobility/exercise interventions considered for this survey

*** 5% (n=1) did not answer this question. UE = upper extremity. LE = lower extremity

Table 2: Comparison of 5 surveys investigating Physiotherapy management of patients after cardiac surgery.

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tolerance and postoperative complications/experience and postoperative guidelines/maintain confidence.

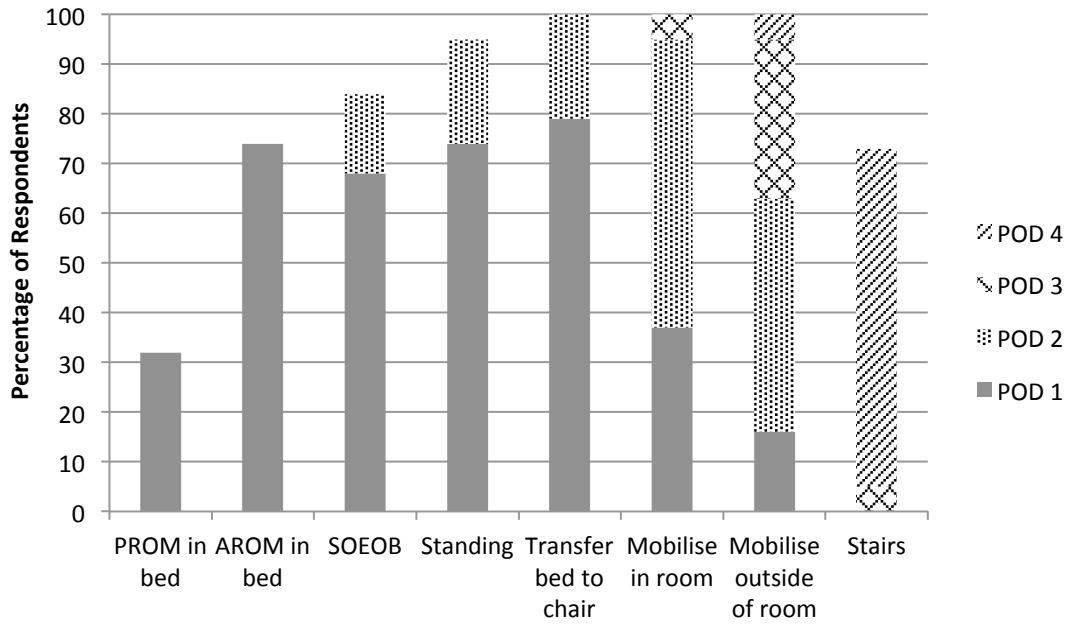
Study	Reeve & Ewan 2005	Overend et al 2010	Westerdahl & Mooler 2010	Filbay et al 2012	Current study findings
Postoperative physiotherapy					
Sat out of bed on POD1*		50%	97%	100%	79%
Mobility*	93%	100%	100%	94%	100%
Day of commencement of mobility		POD1: 22% POD 2: 83% were Walking patients	POD1: 28% (POD2: 79% were walking patients)	Median: day 1 (Range 1-2)	POD1: 37% POD2: 58%
ROM exercises*		89%	UE: 62% Thorax: 59% LE: 72%	79%	74%
Day of commencement of AROM exercises		POD1: UE: 44% (n=8); LE: 67%	POD1: 21% POD2: 76%	Median: day 2 (range 0-5)	POD1: 74%
Exercise parameters					
Frequency		Mobility: POD1: 1-2; POD2: 2-5	ROM ex: 1-3 times daily		From twice daily to hourly

* = % of Physiotherapists who performed these interventions

Table 3: Comparison of postoperative physiotherapy prescription in the Republic of Ireland with international surveys.

Time

Sixteen respondents (84%) indicated that they do not have a usual length of time for which they perform exercise/mobility with patients during POD 1-4, see Figure 2. Of the other 3 respondents (16%), one person did not specify the time; one said approximately 15-30 minutes and the third said 15 minutes in total for mobility and ROM exercises.



Key:

POD = postoperative day. PROM = passive range of movement. AROM = active range of movement. SOEOB = sitting over edge of bed.

Figure 2: Postoperative day on which mobilisation and exercise usually commence.

Influences on clinical practice

The most influential factor on postoperative physiotherapy practice was personal experience. This compares with findings of Filbay et al (2012) and Reeve & Ewan (2005). Public/private hospital patient was the least influential (Figure 3).

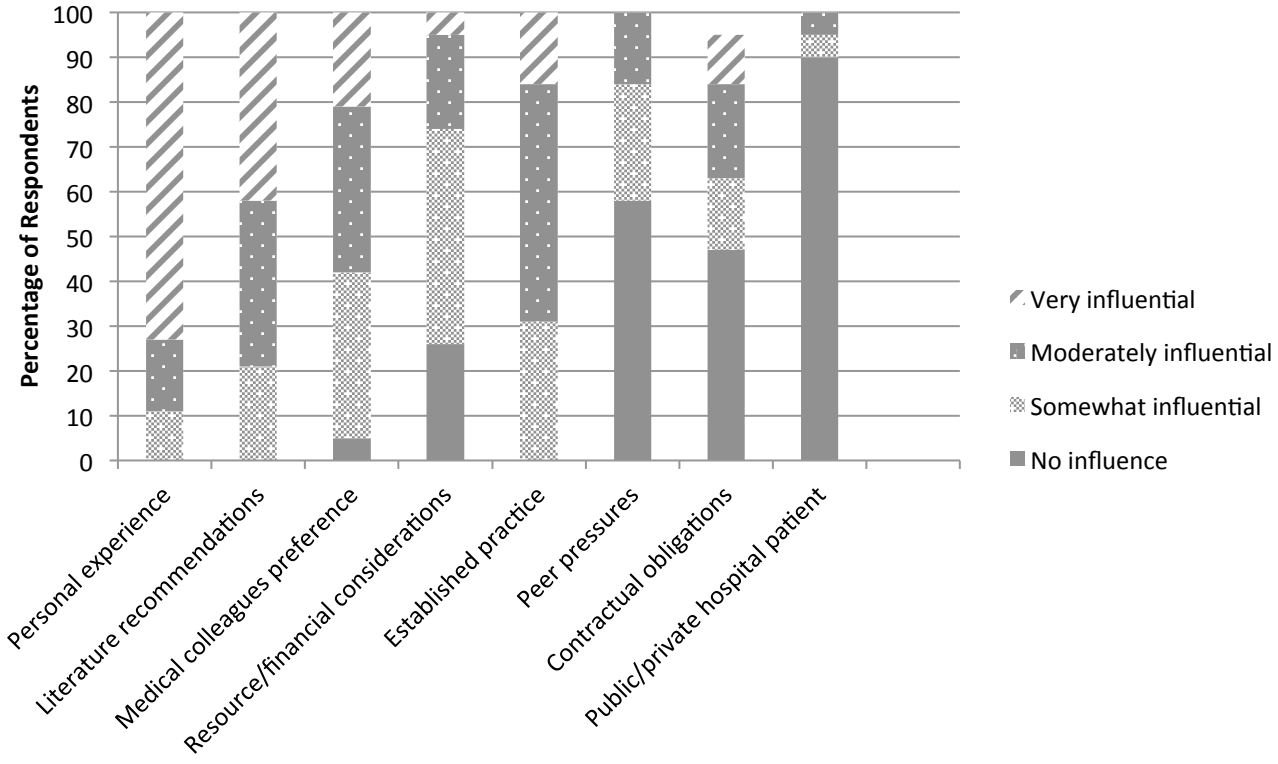


Figure 3: Influence on postoperative physiotherapy practice (exercise/mobility).

Discussion

The high response rate (19/22, 86%) gives an excellent overview of exercise/mobility being prescribed by physiotherapists for patients in the perioperative stage after cardiac surgery in the ROI. The provision of exercise/mobility by physiotherapists is commonplace. Treatment types and intensity being recommended across all hospitals are similar. Prescribed frequency varies significantly both within and between hospitals.

Post-operative management

As physiotherapists working in CSDs in the ROI are experienced (Table 1), practice in these departments should be well developed and established. This is not reflected in the low percentage of respondents (5/19, 26%) who reported having guidelines for postoperative mobility/exercise prescription despite the current emphasis on evidence based practice (EBP) and standardised care. This is significantly lower than other countries (Table 2). Respondents who reported having guidelines failed to demonstrate that they are evidence based. Clinical practice guidelines are informed by a review of the evidence and help facilitate decision making with a view to making care more effective and efficient (Graham et al, 2011).

Postoperative exercise parameters

Frequency

The frequency of exercise/mobility being prescribed by physiotherapists in this survey varies both within and between hospitals and when compared to international surveys (Table 3). Reasons cited for choosing particular frequencies do not reflect EBP. The ACSM recommends a frequency of 2-4 times/day for early mobilisation in days 1-3. A study by Van der Peijl (2004) also favoured a higher frequency (twice daily) exercise programme to a lower frequency (once daily) programme by earlier achievement of milestones. There was however no difference between the two groups in terms of functional independence by day six. Early restoration of physical independence may shorten hospital length of stay. Further studies regarding optimum frequency in terms of clinical and cost efficiency and functional outcomes are required.

Intensity

The intensity of exercise/mobility being recommended in the current study is mostly based on shortness of breath, aiming for moderate intensity or less. The most common methods of determining intensity in the literature are heart rate (HR) and rate of perceived exertion (RPE) (Whaley, 2005). HR is however a subjective measure resulting in different intensities for different individuals depending on age (HR Max = 220 minus age) and on their resting HR. RPE has been found to be a useful tool in estimating exercise intensity in patients on B-blockers (Eston and Connolly, 1996) and patients who have difficulty in achieving a reliable or meaningful heart rate (Mezzani et al, 2013) (e.g. arrhythmias or patients who have temporary pacing wires). The use of the RPE scale has however been shown to have significant inter-individual variability (Whaley et al, 1997) and may not reflect the true intensity of the exercise.

Hirschhorn et al (2008) also used RPE as the indicator of moderate intensity in their study of three different walking programmes for patients following CABG surgery. They found that moderate intensity groups had significantly higher 6MWD scores on discharge. This may lead to earlier discharge if functional improvements are reached sooner, improved self-efficacy and patients being more active in the long term. The improvement however did not carry over to 6MWD four

weeks after discharge where there was no significant difference between groups. Neither was there a difference in HRQOL scores at any stage between groups. Current evidence suggests that recommended exercise intensity should be moderate or less (Riebe, 2013; Hirschhorn et al, 2008).

Time

Findings from this survey and other international surveys are that patients sit out of bed on POD1, begin to mobilise on POD2 and ROM exercises are first prescribed on either POD 1 or 2 (Figure 2 and Table 3). This timing seems appropriate considering a study based on biochemistry investigations of muscle proteolysis after cardiac surgery which concluded that 48 hours after surgery is the optimum time for treatments to preserve skeletal muscle mass (Iida et al, 2014). ACSM recommendations are to commence early mobility on POD 1 but do not break this into activity types such as sitting out of bed, walking etc.

The majority of respondents indicated that they do not have a usual duration for which they perform mobility/exercise with patients in the early postoperative stage. The ACSM recommendations provide a useful guideline for physiotherapists. If interval rest time is at the discretion of the patient however, it may lead to unnecessary overload which again reinforces the importance of individualising exercise programmes to the patients' clinical state.

Type

The types of exercise performed (ROM exercises and mobility) are similar across Irish hospitals and correlate with findings of international studies (Table 3). No respondent reported prescribing any exercises other than those listed in Figure 2. The specific types of ROM exercises were not investigated in this survey. 32% (6/19) of respondents listed PROM as an exercise that they usually provide on POD1. This is unlikely to be efficient use of treatment time considering that 79% of participants report sitting patients out of bed on POD1 and that ACSM recommendations are to commence early mobility on POD1.

Influences on clinical practice

Clinical practice in terms of exercise prescription for patients after cardiac surgery is influenced more by physiotherapists' experience than by literature (Figure 3). These findings are consistent with those of Filbay et al (2012) and Reeve & Ewan (2005). This is not entirely surprising considering the lack of robust evidence but the current survey findings indicate a lack of use of the available evidence.

Due to the complexity of this patient group who often have significant co-morbidities, decision making on appropriate prescription of exercise is multifactorial. Respondents with more than 3 years' experience were more likely to report personal experience as being very influential (11/12 respondents, 92%) than those with 3 years' experience or less (3/7 respondents, 43%). This may be due to the type of clinical reasoning employed or to response bias. Expert physiotherapists have been shown to use pattern recognition (forward planning) in addition to hypothetico-deductive reasoning (Doody and McAteer, 2002). Pattern recognition requires significant domain knowledge and experience (Doody and McAteer, 2002).

Limitations

As the questionnaire was developed specifically for this study, there is a risk of researcher bias. Basing this survey on questionnaires used for previously published similar surveys and an

extensive literature review helps to minimise this bias. With all questionnaires there is a risk of response bias, respondents giving the answer that they think they should give rather than reflecting their actual practice.

Despite ambiguity not being apparent from the pilot study, interpretation of some questions may be another limitation of this study. Non-response bias can also influence the validity of survey findings and can impact on the generalisability of results (Cho et al, 2013).

Conclusion

There is strong evidence for early and progressive exercise/mobility in the perioperative stage following cardiac surgery (Hirschhorn et al, 2012; Hulzebos et al, 2012; Rosenfeldt et al, 2011; Mendes et al, 2010; Herdy et al, 2008; Whaley, 2005; Van der Peijl et al, 2004; Lin et al 2002). This study shows variability in exercise parameters being recommended by physiotherapists in the ROI and a lack of evidence based practice. Parameters prescribed are mostly influenced by personal experience. Due to the complexity of the patient group, current literature recommendations should be used in conjunction with physiotherapists' knowledge and experience to facilitate decision making and optimise quality of patient care. Evidence for the specific parameters of exercise prescription to underpin clinical guidance is an area for further research.

Ethical approval: Ethics approval was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals and by Sheffield Hallam University Dissertation Management Group

Funding: none.

Conflict of interest: none.

Key Points

- There is very little evidence to guide specific principles of exercise prescription in the peri-operative stage after cardiac surgery.
- The prescription of exercise/mobility for patients after cardiac surgery varies both within and between hospitals highlighting a need for established guidelines to inform practice in this area.
- The prescription of exercise/mobility for this patient group in this study was mostly influenced by personal experience.

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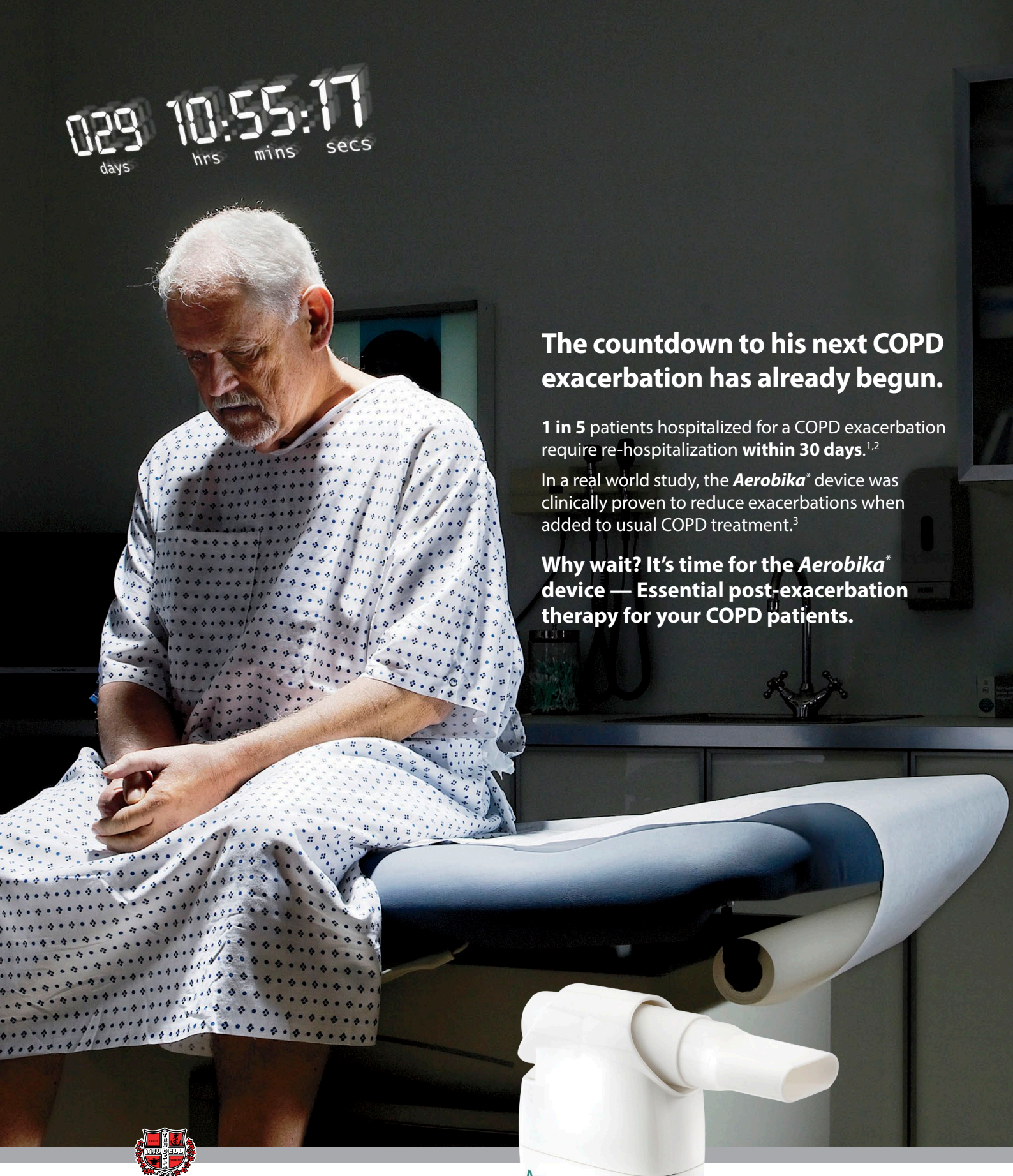

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Review clinical evidence here

Developing a physiotherapy risk assessment tool for abdominal surgery: A service improvement project

Twose P[1,2] and Thornton E[1]

The Cardiff and Vale Abdominal Surgery Risk Assessment (CVASRA) tool was created to risk stratify post-operative abdominal surgery patients based on likelihood of developing pulmonary or mobility complications. However, a recent evaluation of 222 patients demonstrated higher than expected rates of pulmonary complications (7%) and re-referral to physiotherapy (19.6%). Based on this, the CVASRA tool was modified using a quality improvement design (Plan Do Study Act). This current evaluation (n=74) has shown that these changes have resulted in reduced occurrence of post-operative pulmonary complications (1.4%) and a reduction in re-referral to physiotherapy (13.6%) in low risk patients.

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Physiotherapy, Service Improvement, Post-operative complications, Abdominal surgery.

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Introduction

Post-operative physiotherapy reduces the incidence of post-operative pulmonary complications (PPC) by reversing the deleterious effects of anaesthesia and surgery (Silva et al, 2013; Chumillas et al, 1998; Olsen et al, 1997; Hall et al, 1996; Celli et al, 1984). Furthermore, physiotherapeutic intervention encourages early mobilisation, promotes functional independence and reduces hospital length of stay (MacKay, 2005); in addition to its known effects on the management of focal respiratory pathologies (Gosselink et al, 2008; Stiller and Munday, 2005).

Based on its proven effectiveness, physiotherapy, and specifically early mobilisation, has become a cornerstone of enhanced recovery after surgery (ERAS) programmes. Much like post-operative physiotherapy evidence, ERAS is known to shorten length of hospital stay (Melnyk et al, 2011), reduce morbidity (Ramírez et al, 2011; Lassen et al, 2009), reduce patient anxiety and stress and hence speed recovery (Melnyk et al, 2011) and reduce mortality (Ramírez et al, 2011; Lassen et al, 2009).

Based on this plethora of evidence, it is not surprising that most patients undergoing abdominal surgery receive post-operative physiotherapy, either as a single discipline or as part of an ERAS pathway. However, due to increasing NHS demands and reduced physiotherapy resources, this approach is no longer viable. Local health organisations have needed to change their practice to ensure value for money and greater focus on essential services. Thus, risk assessment or

screening tools have been created to allow prioritisation of patients at most need for physiotherapy e.g. those at greatest risk of developing pulmonary or mobility complications.

Of those screening tools already available, only the Southampton Post-operative Physiotherapy Screening Tool (SPPOST) has been published (Ostler et al, 2008). However, little data was provided as to the content and structure of the tool and hence could not be replicated within local practice.

Therefore, in 2013 a team of physiotherapists within the host organisation developed the Cardiff and Vale Abdominal Surgery Risk Assessment (CVASRA) tool. The CVASRA was designed based on a detailed review of the current literature regarding surgical risk factors, local consensus opinion and known information of other screening tools (e.g. limited data regarding SPPOST) in use across the UK. From these sources, the key risk factors identified were: 1) incision location; 2) length of anaesthesia; 3) respiratory co-morbidities (and age >60); 4) smoking history; 5) functional status prior to admission; and 6) current early warning score. Each of these risk factors was assigned a specific scoring criteria based on an ordinal 0-5 scale. These scores could then be added and totalled to provide an overall patient risk of post-operative pulmonary complications or mobility complications (maximum score of 30).

Approximately 60-70 case notes were retrospectively analysed using the CVASRA, and scores of 14 and above were deemed high risk e.g. had highest incidence of PPCs (>5%) and physiotherapy requirements (greater than 3 treatments during admission). Based on these findings, the CVASRA was implemented into clinical practice with those patients scoring 14 or more receiving traditional physiotherapy input, whereas those with score of 13 or less were deemed low risk and received no physiotherapy input (could be re-referred if needed). Due to service limitations, no assessment was made as to the specificity or sensitivity of the tool.

Since its implementation in local clinical practice, the CVASRA has been regularly reviewed via service evaluations and deemed appropriate for ongoing use. However, a subsequent review (currently unpublished), of a large patient sample (n=222), demonstrated higher than anticipated rates of PPC (7%) and re-referral rates in low risk patients (19.6%). As a result, a quality improvement programme was devised to review and modify the existing tool using a Plan-Do-Study-Act (PDSA) programme. This is a useful tool for testing a change by developing a plan to test the change (Plan), carrying out the test (Do), observing and learning from the consequences (Study), and determining what modifications should be made to the test (Act) (Taylor et al, 2014).

The aim of the quality improvement programme was to reduce incidence of PPCs and re-referral rates. Secondary outcomes were to explore additional physiotherapy resources requirements and hospital length of stay.

Methodology

As previously stated, the CVASRA previously utilised a score of 14 of more for high risk patients however more recent analysis identified higher than expected rates of PPC and re-referral to physiotherapy.

Based on the data collected from the 2016 service analysis, a number of changes were made to the CVASRA. The high-risk score was reduced from 14 and above to 10 and above. Using the available data this suggested a reduction in re-referral rate from 19.6% to 15.2% and ensured

delivery of prophylactic physiotherapy input to those scoring between 10-13 (of which 8% had PPC in previous evaluation). Furthermore, the criteria wording for functional ability was altered to better reflect pre-operative mobility status, use of mobility aids and ability to complete activities of daily living (see Appendix 1).

The aim of these changes was that if patients routinely received physiotherapy input with a score of 10 or more, not only would re-referral rates improve, but increasing the number of patients receiving physiotherapy intervention would allow those patients to achieve functional independence earlier, reduce incidence of PPCs in the previously deemed low risk group, and potentially reduce overall hospital length of stay for those receiving physiotherapy intervention. It was hoped that increasing the number of patients requiring physiotherapy would be offset by the reduction in re-referrals and associated reactive physiotherapy interventions (e.g. physiotherapy once PPC has occurred rather than preventative).

A prospective analysis was completed over a four-week period between 30th August and 23rd September 2016 to evaluate the effect of changes made to the existing CVASRA. The key outcomes were occurrence of PPCs using Brooks-Brunn (1997) criteria (see Figure 1), rates of re-referral in low risk group and changes in physiotherapy requirements. Additional data was collected for reason for re-referral and hospital length of stay. Data was then compared to the previous service evaluation.

Post-operative Pulmonary Complication defined as: minimum of two criteria be documented as present on 2 or more days at any time during the first 6 postoperative days:

(1) new cough/sputum production
(2) abnormal breath sounds as compared with baseline;
(3) temperature > 38°C;
(4) chest radiograph documentation of atelectasis or new infiltrate;
(5) physician documentation of atelectasis or pneumonia.

Figure 1: Brooks-Brunn Post-operative Pulmonary Complication Criteria.

Descriptive statistics were used to summarise the data recorded. Due to the ordinal nature of the data no statistical analyses were completed.

Results

A total of 74 patients were referred to physiotherapy post abdominal surgery and hence were included in the prospective evaluation, compared to 222 in the one completed previously. All patients who underwent abdominal surgery during the 4-week period were included in the study. Patient demographics were not recorded; however average risk scores using CVASRA are shown in Table 1 as well as percentage of patients requiring physiotherapy intervention, average CVASRA risk score and length of stay data.

	Number of Patients / Number of High Risk	CVASRA Risk Score (median)		Length of Stay (Days)	
		All Patients	High Risk Patients	All Patients	High Risk Patients
Previous Evaluation	222 / 18	7	15	6.8	17.2
Current Evaluation	74 / 8	7	12.5	5.9	8.0

*CVASRA High risk threshold 14 during previous evaluation, versus 10 for current.

Table 1: Demographic data.

PPC rates between the two evaluations are shown in Figure 1, with much lower rates observed in the current study (1.4% versus 7%).

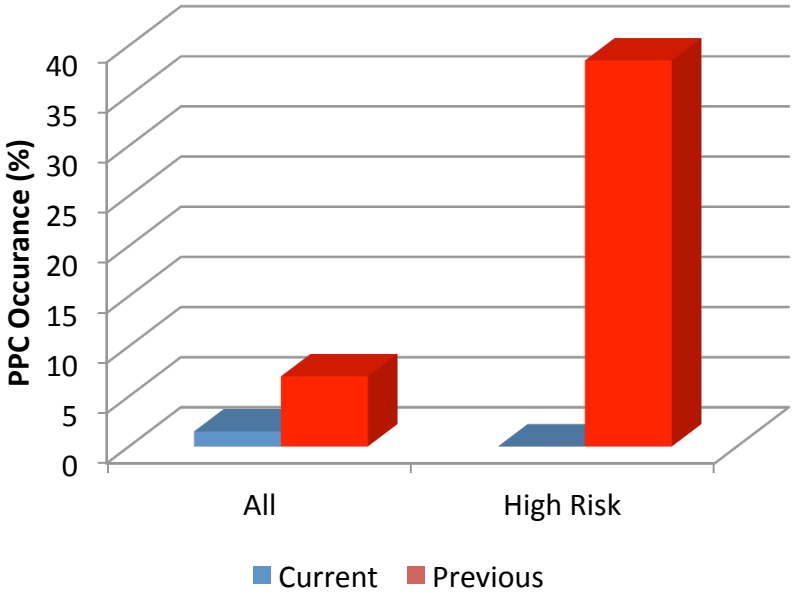

Figure 2: Comparison of PPC rates between evaluations including comparison of high risk patients (based on CVASRA).

Similarly the re-referral rate was lower (as shown in Figure 3) within the prospective evaluation. It was not possible to compare reasons for re-referral (e.g. respiratory or mobility) as this was not collected in the previous evaluation.

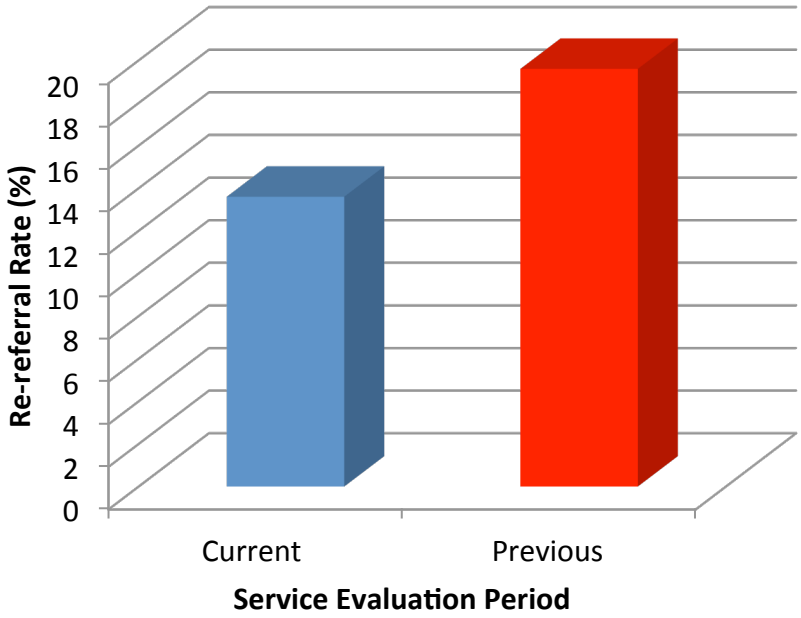

Figure 3: Comparison of re-referral rates between evaluations.

Comparisons of physiotherapy requirements and contact times were also calculated. Within the previous audit, high risk patients received 36.7 minutes of physiotherapy versus 53.6 minutes within the current review.

Discussion

Following the modification of CVASRA, a reduction in the rates of PPC occurrence (1.4%) and re-referral (13.6%) was observed and hence the aims of the service improvement were achieved.

During the 1-month re-evaluation period a total of 74 patients were referred to physiotherapy post abdominal surgery across all surgical wards. This is far less than in the previous evaluation (n=222). This is likely due to seasonal variation and multi-professional awareness of the use of CVASRA (e.g. nursing staff not referring patients that will be low risk). Despite this reduced sample, the results of this re-evaluation support the changes made to the CVASRA.

Following a reduction in the high-risk score from 14 or more to 10 or more, 11% (n=8) of people who had undergone abdominal surgery meet the criteria for routine post operative physiotherapy intervention (compared to 8% previously). Of note, none of these patients were identified as developing a PPC in accordance with the Brooks-Brunn (1997) criteria. This was a vast reduction on the 38.5% previously recorded. Average hospital length of stay for these high-risk patients was 8 days (reduced from previous, 17.2 v 8.0) and they required approximately 53 minutes of physiotherapy intervention during their admission (increase from 37 minutes).

There were 66 patients screened using the CVASRA and were deemed “low risk”; hence they did not receive any physiotherapy input. These low risk patients had a PPC rate of 1.5% and although 3 patients were re-referred for ‘chest physiotherapy’, only 1 patient was identified by the assessing physiotherapist as meeting the criteria of a PPC by Brooks-Brunn (1997).

Total re-referral rate for physiotherapy (including chest and mobility assessments) totalled 13.6% (9 patients) which is lower than the previous 19.6%. A large proportion of those patients re-referred for physiotherapy required assessments for reduced mobility post-operatively. On closer analysis, 3 of the patients re-referred scored highly in the functional status category and

therefore were known to have reduced or poor mobility pre-operatively. However, because they did not score in other categories and did not score 10 or more overall, they did not receive routine physiotherapy input.

Limitation of re-evaluation

Whilst it was aimed that the modification of the CVASRA would reduce rates of PPCs, this re-evaluation has shown a far greater reduction in PPCs than expected (1.4% versus 7.0%). Indeed, none of the high-risk patients were classified as having a PPC. This is in stark contrast to previous evaluations where PPCs occurring in high risk patients was recorded as 38.5%. There are a number of potential reasons for this observed change. Primarily, following the previous evaluation additional training and peer discussion was implemented with a focus on clear understanding of the role of physiotherapy and suggested interventions.

Sample sizes between evaluations also varied greatly. In this current study only 8 patients were identified in comparison to 18 in the previous study. It is due to the small sample size that no statistical analysis was completed. Whilst not calculated or analysed, it is assumed that total physiotherapy caseload was lower during the repeat evaluation period therefore there was a reduction in 'unmet' need and hence more regular early physiotherapy intervention for those which required it. Furthermore the authors acknowledge significant physiotherapy staff change-over between evaluation periods. Whilst it is hoped that this does not influence outcomes, its potential must be considered.

Another limitation to the study could be, through education of multi-professional colleagues, that not all post-operative patients were referred to physiotherapy if these were deemed low risk patients by the nursing staff. It is also unclear if any of the patients in the low risk group developed signs of PPCs but were not referred back to physiotherapy and hence assumed not to have developed post operative pulmonary or mobility complications.

Comparison to SPPOST

Following a review of available literature, it appears that the SPPOST is the only other tool available to assist physiotherapists with screening post operative surgical patients. During a 10-month period, the SPPOST review screened 404 patients and nearly half of those did not require physiotherapy intervention, compared to 11% in the current study. Ostler et al, (2008) suggested the use of the SPPOST allowed the physiotherapists to target those higher risk patients, allowing them to "work smarter". Of the 186 low risk patients identified using the SPPOST, only 16 were re-referred (8.6%), of which 3 were identified as having a diagnosed PPC. This is in close comparison with the 13.6% re-referral rate, with only 1 documented PPC, observed using the CVASRA

When comparing patients who were re-referred to physiotherapy, Ostler et al, (2008) reported that 14 patients were referred for chest physiotherapy, whereas only 2 were referred for mobility assessments. In contrast, during this analysis of the CVASRA, only 3 patients were re-referred for chest physiotherapy and 6 for mobility assessments.

This comparison highlights that both tools appear appropriate in recognising those patients at greatest risk following abdominal surgery. This improved patient selection and physiotherapy input allows for more prudent services focusing on those at greatest need. If required, further

research could now be completed utilising both the CVASRA and the SSPOST to consider direct benefits of either tool.

Summary

The reduction of the CVASRA threshold figure for identifying high risk patients has reduced the occurrence of PPCs and reduced the rate of re-referral to physiotherapy.

As a result of the above findings, we will continue to use 10 as the marker for identifying patients who are deemed high risk. Future adaptations to the tool will now be considered to further reduce re-referral and reduce incidence of post-operative mobility complications. This will include reviewing all patients scoring highly within the functional level category of the CVASRA.

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Appendix 1 Physiotherapy Abdominal Surgery Risks Assessment Tool

	Functional Level	Surgical Category	Length of Operation	Respiratory Co-morbidities	Current Smoker	NEWS
5	Requires assistance with ADL's. Housebound. No stairs due to physical limitations	Open incision above umbilicus & open incision above diaphragm	> 300 mins	Yes – Chronic airway disease with cough and daily sputum production, requiring nebs +/- O2	Yes – with 10 + Pack Years **OR** No – quit within last 8 weeks with >10 Pack Years	> 9
4	Climbs stairs. Mob<100yrds Mob with aid Difficulty with ADL's	Open incisions either rooftop **OR** bilateral subcostal	240 – 299 mins	Yes – Chronic airway disease with cough and daily sputum production	Yes – with <10 Pack years	8 - 9
3	Prev used w/aid. Climbs stairs. Limited by physical limitations.	Open incisions above umbilicus	180-239 mins	Yes – Airflow limitation diagnosed but asymptomatic	No – quit within last 8 weeks with < 10 Pack Years	6 - 7
2	Independent with aid. Mod pace Climbs stairs and manages ADL's	Open incisions below umbilicus	120-179 mins	No and patient age > 60 years	No – gave up > 8 weeks ago	3 - 5
0	Fully independent unaided Unlimited mobility	Laparoscopic	< 60 – 119 mins	No and patient age < 60 years	Never	< 3

For those scoring **10 or more please** completed assessment and treatment as per surgery physiotherapy prioritisation tool.

For those scoring **less than 10** please document the following within the medical notes:

"Based on review of medical history, theatre record and discussion with patient, patient currently not for prophylactic physiotherapy intervention. Please re-refer if develop respiratory or mobility complications"

Pack Year History:

(Number of cigarettes smoked per day/20) x number of years smoked = Number of pack years

e.g.15 cigarettes smoked a day for 40 years

(15/20) × 40 = 30 pack year smoking history

Feasibility of implementing prehabilitation in patients undergoing major oesophagogastric cancer resection: a single centre experience

Weblin J[1], McWilliams DJ[1], Tucker O[2,3]

Introduction

Improved clinical outcomes have been observed in patients undergoing oesophagogastric resection following implementation of standardised care pathways (SCP) such as Enhanced recovery after Surgery (ERAS) pathways. Evidence from colorectal surgery demonstrates additional benefits with exercise based prehabilitation (Gillis et al, 2014; Li et al, 2013). There is limited evidence to support this approach in patients undergoing oesophagectomy and total gastrectomy (Bott et al, 2017; Le Roy et al, 2016; Huang et al, 2015).

Objectives

1. To assess the feasibility of implementing prehabilitation for patients undergoing oesophagectomy and total gastrectomy.
2. To evaluate the impact of prehabilitation for patients undergoing oesophagectomy or total gastrectomy assigned to a SCP compared to traditional postoperative care.

Method

A single centre, prospective, non-randomised feasibility study was performed. Consecutive patients admitted to a large UK tertiary hospital undergoing elective oesophagectomy or total gastrectomy were approached to participate in the study. The SCP was composed of a four week program of exercise based prehabilitation and ERAS with enhanced post-operative physiotherapy (EPP). Primary outcome was recruitment, retention and adherence to prehabilitation. Secondary outcomes included physical, non-physical and clinical measures. Outcomes were compared to historic data of traditional postoperative care from 2014.

Results

25 patients were listed for elective oesophagectomy or total gastrectomy during the trial period. 17/25 (68%) were eligible for prehabilitation of which 13/17 (76%) were recruited and showed 100% adherence to the program. Those that attended prehabilitation had a significant improvement in pre-operative functional capacity ($p<0.001$) and perceived health status ($p=0.006$) with a reduction in depression ($p=0.032$).

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Keywords

Prehabilitation oesophagogastric cancer, Enhanced Recovery after Surgery (ERAS), Physiotherapy.

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19 of 25 (76%) patients underwent surgical resection. Patient participation in ERAS and EPP pathways reduced median hospital length of stay (LOS) compared to historic 2014 data (14 vs 16 days), with the greatest reduction seen in those patients that also completed prehabilitation (13 vs 16 days; p=0.215).

Conclusion

It is feasible to recruit and retain patients awaiting oesophagogastric surgery to prehabilitation. Those that attended showed improvements in assessed outcomes with a reduction in post-operative LOS. An appropriately powered multicentre clinical trial is required to further validate these findings.

Introduction

There are approximately 16,000 new diagnoses of oesophageal and gastric cancer annually, making it the fifth most common cancer in the UK and the fourth most common cause of death (National Oesophago-Gastric Cancer Audit, 2016). The current standard of care in the UK is the provision of neoadjuvant chemotherapy (NAC) prior to surgery in patients with locally advanced oesophagogastric (OG) cancer (Cunningham et al, 2006). NAC has side effects which include fatigue, nausea, vomiting, anorexia, diarrhoea, mucocutaneous ulceration, and decline in functional capacity (West et al, 2016). This decline is further compounded by the patients' poor nutritional status before and during NAC. Poor pre-operative functional capacity is associated with an increased risk of post-operative complications (Mayo et al, 2011; Zingg et al, 2011).

While surgery offers the best chance of cure, oesophagectomy and total gastrectomy are complex surgical procedures with high post-operative morbidity and mortality (Markar et al, 2012). Standardised care pathways (SCP) including Enhanced recovery after surgery (ERAS) pathways aim to reduce the surgical stress response and organ dysfunction by providing a goal-directed approach to treatment including, for example, early enteral feeding to stimulate gut function and target setting of milestones to improve mobility. In OG surgical cohorts SCPs have been shown to reduce hospital LOS without a significant change in mortality or morbidity (Gemmill et al, 2015).

Whilst the incidence of postoperative mortality following oesophagectomy and total gastrectomy has reduced significantly over the last 30 years, post-operative morbidity remains high in comparison to other surgical cohorts (Canet et al, 2010). Prehabilitation prior to surgery aims to promote exercise, reverse the physiological decline seen in patients as a result of NAC and disease pathology, and make improvements in health related behavior.

In 2015, The Anaesthesia and Perioperative Care Priority Setting Partnership, a collaborative involving patients, the public and clinical professionals, identified pre-operative exercise and fitness training, including physiotherapy, to improve outcomes after surgery as one of the top 10 priorities for peri-operative care research (National Institute of Academic Anesthesia, 2015). Defined as optimising an individual's functional and physiological reserve pre-operatively (Topp et al, 2009), prehabilitation is associated with additional post-operative benefits, in comparison to ERAS pathways alone, including reduced complication rates and hospital LOS and a quicker return to baseline functional capacity in patients undergoing abdominal and cardiac surgery (Moran et al, 2016; Gillis et al, 2014; Li et al, 2013; Valkenet et al, 2011). There is currently

evidence to suggest some benefit for the use of inspiratory muscle training (IMT) pre-operatively in reducing post-operative pulmonary complications in patients undergoing oesophagectomy (Van Adrichem et al, 2014). However, IMT does not address the global physiological decline seen during NAC or impact on psychological outcomes. There is limited evidence to support prehabilitation in patients undergoing oesophagectomy and total gastrectomy (Bott et al, 2017; Le Roy et al, 2016; Huang et al, 2015).

A recent systematic review suggested exercise rehabilitation interventions were feasible and safe in patients with gastrointestinal or thoracic cancer during and/or after NAC and was associated with improvement in physical fitness (Bott et al, 2017). Non-responders in one study appeared to have more major post-operative complications and were more likely to have completed their prehabilitation unsupervised, at home (Bott et al, 2017; Huang et al, 2015). However, the quality of the included studies was variable. No randomized controlled trials were identified, and the number of studies and subjects was small (Bott et al, 2017). We hypothesised that total body prehabilitation in a group environment may improve functional capacity before surgery and improve postoperative outcomes.

Objective

1. To assess the feasibility (recruitment, retention, adherence rates) of implementing prehabilitation for patients undergoing oesophagectomy or total gastrectomy.
2. To evaluate the impact of prehabilitation for patients undergoing oesophagectomy or total gastrectomy assigned to a standardised care pathway compared to traditional postoperative care at a single centre.

Methods

All consecutive patients with a diagnosis of oesophagogastric cancer listed for elective resectional surgery at a large UK tertiary hospital between November 2014 and March 2015 were identified at the weekly upper gastrointestinal (UGI) multidisciplinary team meeting. Patients were eligible for prehabilitation if identified ≥5 weeks prior to scheduled oesophagectomy or total gastrectomy. Patients with poor prior level of mobility (<10yards), neuromuscular disease (Motor Neurone Disease), severe neurological injury, psychiatric disorders or inability to give written informed consent were excluded. Patients were approached at their final oncology appointment after completing NAC or at the UGI outpatient clinic to consider entering the study. Those who were identified <5 weeks pre operatively received the ERAS with EPP component only.

Prehabilitation commenced within 1-2 weeks of completion of NAC. It consisted of a four week programme of twice weekly, physiotherapist supervised, 20 minutes circuit based exercises with warm up and cool down in a group environment (See Figure 1).

Exercise description
1. Step up and down with the use of handrail • Stand at bottom of stairs holding onto rail • Step up and down • Complete for 1 minute

Exercise description

2. Passing ball round the body

- Pass ball around body clockwise for 30 seconds and then anticlockwise for 30 seconds
- If you don't have a ball you could use a cushion
- To progress march on the spot

3. Squats

- Stand with a chair for support if required
- Keep your back straight and bend your knees into a squat position
- Straighten your knees and repeat
- Add hand weights to progress

4. Arm raises

- Start with your hands by your side
- Lift your right arm sideways towards the ceiling as far as you can
- Return your arm to your side
- Repeat with your left arm. To progress add weights, you could use an empty 4 pint milk bottle and gradually add water to increase the weight.
- Complete for 1 minute

5. Sit to stand

- Start by sitting on your chair
- Stand up and then sit back down
- Complete for 1 minute
- To make this harder, do not use your hands to help

6. Bicep curls

- In standing, holding onto hand weights slowly bend and straighten your right elbow
- Repeat on your left side
- Continue for 1 minute
- Increase weight of hand weights to progress. Milk bottles could be used instead of hand weights

7. Side steps

- In standing, step out and then back in with your right leg
- Repeat with your left leg
- Continue for 1 minute
- Progress by adding arm raises at the same time, progress further by adding hand weights to arm raises

8. Angels

- Start with your hands by your sides
- Lift your arms sideways towards the ceiling as far as you can then bring them down in front of you.
- Lift your arms up as high as you can in front of you then bring your arms sideways towards the ground

Exercise description
9. Walking • Walk for 1 minute • Increase speed to progress • To progress further add hand weights. If you do not have hand weights use milk bottles
10. Ball lift • Start holding ball in both hands • Lift the ball towards the ceiling as far as you can • Bring the ball back to your chest • Repeat for 1 minute

Exercise circuit completed twice.

Figure 1: Ten exercise components of the prehabilitation class.

An interval approach to training was used for the outpatient-based exercise sessions (American College of Sports Medicine, 2006). Each exercise session consisted of a circuit of 10 stations, with participants completing 1 minute of exercise on each station twice. A combination of cardiovascular exercises involving all major muscle groups with periods of active recovery (American College of Sports Medicine, 2006) was selected. Intensity of exercise was titrated to achieve targets of 50-70% of heart rate reserve (Karvonen, 1957) and a modified Borg breathlessness score of 3-4 (Borg, 1982). Patients were also advised to complete one unsupervised session at home, with adherence monitored with exercise diaries. All patients had access to a dietician for nutritional support.

Post-operatively patients were managed using a SCP including ERAS and EPP which was introduced on 1st November 2014 (See Table. 1).

ERAS pathway		**Enhanced Postoperative Physiotherapy Pathway**
Day of surgery	Nil by mouth Start regular analgesia, PPI and antiemetic Leave NG tube and chest drain(s) on free drainage	1hr in cardiac chair position Twilight physio visit – pulmonary physiotherapy
POD1	Nil by mouth Commence FJ Leave NG tube and chest drain(s) on free drainage	Minimum 4hr in chair - pulmonary physiotherapy Mobilise with Physio 15m on 2 occasions
POD2	Continue FJ *(as tolerated)* Remove apical chest drain *(if output <250mls and serous)* Remove arterial line *(if patient leaving ITU)* Remove CVP line if INR < 1.5	Minimum 4hr in chair – pulmonary physiotherapy Mobilise 30m with physio on 2 occasions

ERAS pathway		Enhanced Postoperative Physiotherapy Pathway
POD3	Continue feeding jejunostomy *(as tolerated)* Leave NG tube and basal chest drain(s) on free drainage	Minimum 6h in chair - pulmonary physiotherapy Mobilise 40m with physio on 2 occasions
POD4	Remove epidural catheter *(dependent on pain assessment on POD4 or 5)* and commence PCA Continue FJ Commence oral clear fluids at 30mls/hr	Minimum 8h in chair - pulmonary physiotherapy Mobilise 100m with physio on 2 occasions
POD5	Remove basal chest drain *(if output <250mls and serous)* Continue FJ Commence 60mls/hr by mouth to build up to free fluids by evening If patient tolerating oral fluids remove NG tube in evening if <250mls	Minimum 8hr in chair - pulmonary physiotherapy Mobilise 180m with physio on 2 occasions Patient to mobilise to the toilet from POD5 onwards with support as required/ instructed by physio
POD6	Commence training to self-administer enoxaparin Commence FJ pump training Commence pureed diet as per altered texture menu Encourage intake of nutritional drinks 3 times daily (900 calories)	Minimum 8hr in chair. Pulmonary Physiotherapy Mobilise minimum 180m with physio on 2 occasions Promote independence with personal care
POD7	Continue training to self-administer enoxaparin Continue FJ pump training Switch to overnight feeding via FJ Pureed diet	Minimum 8 hours in chair. Independently mobile – Minimum target 4 × 180m At or prior to POD7 – stair climb with physio
POD8	Mobilise independently on ward Discharge home when discharge criteria met Overnight feeding via FJ Pureed diet	Independently mobile – Minimum target 4 × 240m Physio to progress exercise intensity and discuss exercises for post discharge
POD9	As per POD 8	Independently mobile – Minimum target 4 × 240m Physio to review exercises in preparation for discharge

ERAS pathway		Enhanced Postoperative Physiotherapy Pathway
POD10	As per POD 8	Independently mobile - Minimum target 4 × 240m Discharge with home exercise program

Abbreviations: FJ, feeding jejunostomy; POD, Post-operative day; PPI, Proton pump inhibitor; PCA, patient controlled analgesia; NG, nasogastric

Table 1: The Enhanced Recovery after Surgery and enhanced Postoperative Physiotherapy pathways.

EPP involved twice daily physiotherapy for the first five days post operatively and once daily from day six onwards, aiming for discharge from therapy by postoperative day 10. EPP sessions included respiratory interventions (deep breathing exercises with an incentive spirometer and airway clearance techniques) and progression of mobility to achieve pre-determined mobility milestones. Prior to the implementation of EPP patients were assessed day 1 post-op by the physiotherapist and subsequently on an ad hoc basis determined by clinical need. Patients were not routinely reviewed daily and no pre-determined targets for mobilisation were defined.

Primary outcome was recruitment, retention and adherence rates to prehabilitation. Recruitment was defined as the percentage of eligible patients who attended prehabilitation. Retention was defined as the number of patients who completed prehabilitation. Adherence was defined as completing a minimum of 80% of available prehabilitation sessions to ensure participants meet recommended guidelines for rehabilitation to exercise for a minimum of three sessions per week (ACSM, 2006). All adverse events were recorded during and after prehabilitation.

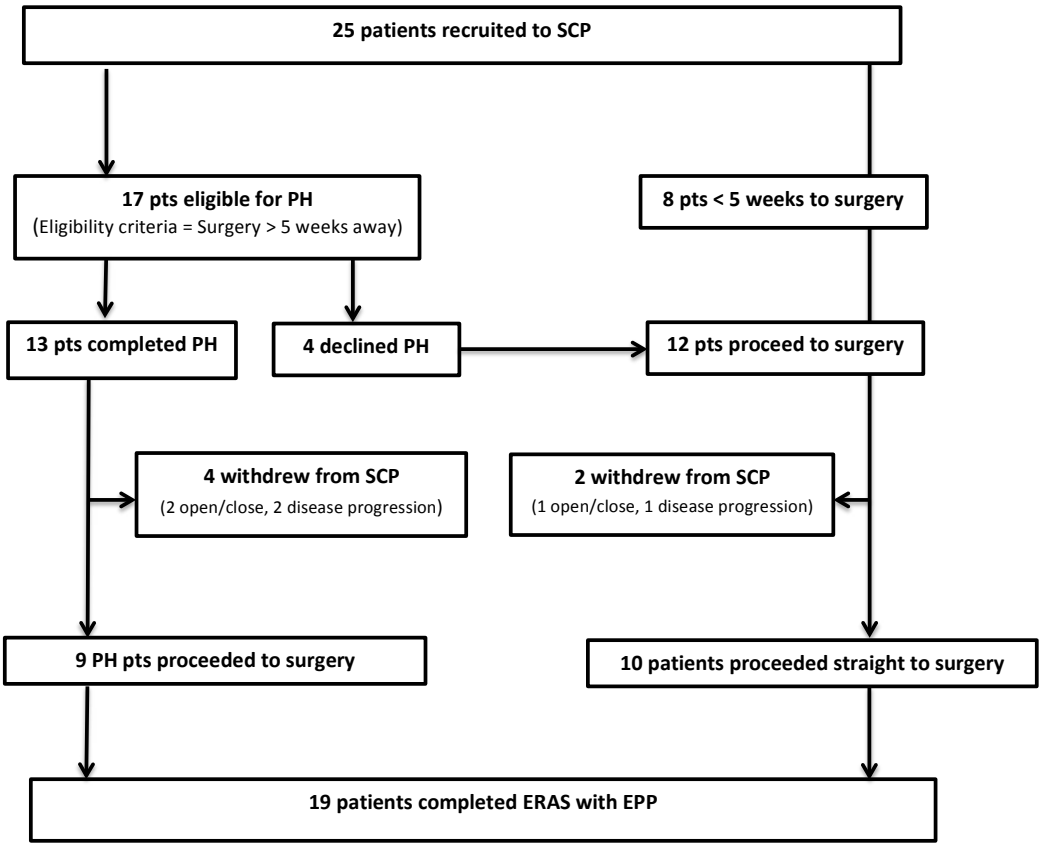
Secondary outcomes were functional capacity assessed using the incremental shuttle walk test (ISWT), anxiety and depression assessed with the Hospital Anxiety and Depression Score (HADS) and perceived health status assessed by EQ-VAS in patients undergoing prehabilitation. Secondary outcomes were collected at pre-admission screening appointment 1-2 weeks post NAC prior to prehabilitation and one week before surgery. Other outcome measures were time to mobilise 30 meters and total hospital LOS after surgical resection compared to the unit's historic data from 2014 for elective oesophagogastric cancer resectional surgery. All data were tested for normality and found to be not normally distributed. Therefore non-parametric tests were utilised for data analysis.

Ethical considerations

At the time of the study the SCP with prehabilitation was delivered as standard care and met the definition of a service evaluation (Department of Health, 2005).

Results

25 consecutive patients were recruited onto the SCP.



Abbreviations: ERAS, Enhanced Recovery after Surgery; EPP, Enhanced Perioperative Physiotherapy; PH, Prehabilitation; SCP, Standardised Care Pathway

Figure 2: Recruitment flow diagram.

The mean age was 64 years (SD 10.5) with a male to female ratio of 4:1. 17/25 patients were eligible for prehabilitation. Four of the 17 patients declined prehabilitation citing travel issues in two and burden on family in two as reasons for non-attendance. The 13 patients who underwent prehabilitation were predominantly male (85%) with a mean age of 67 (SD 9.46) years. All 13 patients adhered to the prehabilitation program. An increase in functional capacity was seen post prehabilitation (ISWT 480m vs 360m, p<0.001), with an increase in perceived health status scores (EQ-VAS 75 vs 80, p=0.006) (Table 2). A reduction was observed in depression scores (2 vs 3) (p=0.032) with a non-statistically significant reduction in anxiety (p=0.130). No serious adverse events or injuries were recorded for either the supervised or unsupervised exercise components.

	Pre-admission screening (n=13)	Post -prehab (n=13)	Change	P (Wilcoxon)
Median ISWT	360 (260-520)	480 (360-590)	120 (33%)	<0.001
EQ- VAS (/100)	75 (65-80)	80 (80-95)	5	0.006
Anxiety	3 (2-9)	3 (1-7)	0	0.130
Depression	3 (2-5)	2 (1-3)	-1	0.032

Median (IQR)

Table 2: Outcome measures in patients who completed prehabilitation.

Six of 25 (24%) patients recruited did not undergo surgical resection due to disease progression (n=3) or unresectable disease at surgery (n=3) (Fig 1). 19 of 25 (76%) patients participated in ERAS with EPP. Compared to 2014 historic data, median time to mobilise 30 meters was shorter for patients on ERAS and EPP (3 vs 4 days) but this did not reach statistical significance on Wilcoxon rank test (p=0.201). A shorter hospital LOS was observed in patients who completed ERAS and EPP compared to 2014 (14 vs 16 days) with a further incremental reduction in patients who completed prehabilitation, ERAS and EPP (13 vs 16 days) (Table 3). In a one-way analysis of variance of the logged data there were no statistically significant differences between the groups with regards to LOS (p=0.215).

	Historic 2014 cohort	ERAS with EPP	Prehabilitation and ERAS with EPP
n	36	19	9
Mean Age (SD)	64.8 (6.19)	63.8 (10.5)	67.1 (9.46)
APACHE II	14.9	15.7	14.75
Median Hospital LOS (days) (IQR)	16 (12 – 28.5)	14 (11.5 – 21)	13 (11 – 20)

Table 3: Patient demographic data and hospital length of stay.

Discussion

This study has demonstrated that it is feasible to recruit a contemporary cohort of patients with OG cancer following NAC to prehabilitation. Recruitment rates to prehabilitation were 76% with 100% retention and 100% adherence to a 4 week program demonstrating patient acceptability of the intervention. A 4 week program was employed in line with other published prehabilitation trials and previous work in colorectal populations where <3 weeks prehabilitation did not demonstrate significantly improved pre-operative functional capacity (Gillis et al, 2014; Li et al, 2013; Dronkers et al, 2010). Completion of prehabilitation resulted in a statistically significant improvement in preoperative physical functional capacity as assessed on the ISWT and perceived health status. The ISWT has been shown to be significantly correlated with VO_2 peak (Singh et al, 1994). In colorectal populations, improvements in pre-operative functional capacity seen as a result of prehabilitation have translated into a quicker return to baseline functional capacity post-operatively (Gillis et al, 2014; Li et al, 2013). The relationship between improving pre-operative functional capacity and functional recovery post hospital discharge has not been previously evaluated in OG surgical patients and warrants further investigation.

We observed a significant reduction in pre-operative depression and a non-statistically significant reduction in anxiety in patients who completed prehabilitation. Symptoms of anxiety and depression can manifest in patients undergoing major elective surgery for a number of reasons including the burden of the surgical intervention and treatment, loss of control, fear of the unknown and fear of death and dying (Pritchard, 2009). A score of ≥8 using HADS has been shown to have a significant impact on patients including an increase in anaesthetic requirements (Hong et al, 2005) and post-operative analgesia, reduced compliance with medical interventions, and reduced ability to understand or/and follow simple instructions (Pritchard, 2009). This could be detrimental to an individual's recovery and quality of life. In this study in the absence of a control

group and the recording of a median HADS score pre-prehabilitation of less than 8 the significance of the findings are speculative. We hypothesis that the observed reduction in anxiety and depression, or lack of evolvement, could be attributable to participation in the prehabilitation program. However we acknowledge that further evaluation by qualitative research methodology is required.

To date most perioperative care pathways have focused on ERAS. This study demonstrates that patients on an ERAS pathway incorporating EPP had a reduced hospital LOS and were quicker to mobilise 30 meters in comparison to the historical data. This did not reach statistical significance but our study was not designed or powered to detect a difference in post-operative outcomes. The results, however, are in line with a recent systematic review that demonstrated ERAS protocols for patients undergoing oesophageal or gastric cancer resection significantly reduced hospital LOS (Gemmill et al, 2015). Interestingly we observed an incremental decrease in LOS for those who completed prehabilitation and ERAS, suggesting an additional benefit with prehabilitation. This has also been seen in patients participating in prehabilitation prior to undergoing abdominal and cardiac surgery (Valkenet et al, 2011).

Despite the introduction of ERAS pathways the incidence of post-operative pneumonias (POPs) amongst OG surgical patients is reported between 34-57% (Biere et al, 2012). POP can increase hospital LOS by 75%, costs by 50% and have a negative impact on postoperative survival (Kuppusamy et al, 2011). Moran et al (2016) and Valkenet et al (2011) both demonstrated that prehabilitation could significantly reduce the incidence of pulmonary complication in patients undergoing abdominal and cardiac surgery. We hypothesize that the addition of prehabilitation to ERAS will translate to improved mobilisation, reduced pulmonary complications and improved post-operative recovery.

A major strength of this study is that the prehabilitation classes employ a validated exercise programme which can easily be transferred and adopted in other hospitals. In addition the programme was delivered according to International guidelines for exercise with progression occurring due to pre-defined criteria (American College of Sports Medicine, 2006). The ERAS pathway facilitated delivery of an enhanced physiotherapy programme in the early post-operative period.

There are several limitations to this study. Firstly, this is a non-randomised trial that recruited consecutive patients using a historic control group for comparison. We recognise that the use of a historic cohort who received traditional postoperative care may limit the validity of our findings as the results may be subject to temporal changes and measurement bias. However, there were no other major quality improvement projects or service developments introduced during this period, with similar senior medical and specialist nursing staffing. An incremental benefit was observed in those completing prehabilitation in addition to ERAS. A lack of blinding could have led to potential bias in the recruitment process, although the recruitment of all eligible consecutive patients within the study period should have eliminated this risk. Study numbers were small, and the study was performed at a single centre and therefore may not be representative of the population.

Further research is required to address the benefit of prehabilitation combined with ERAS and EPP in this high risk surgical population through a multicentre randomized controlled trial with a nested qualitative study.

Key Points

- A four week prehabilitation program is feasible in patients prior to elective oesophagectomy and total gastrectomy.
- Patients attending prehabilitation have significant improvements in pre-operative functional capacity and perceived health status, and a reduction in depression.
- A SCP including enhanced recovery after surgery and enhanced perioperative physiotherapy is associated with a reduction in post-operative LOS, with an incremental benefit seen in patients who completed prehabilitation.

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An evaluation of a physiotherapy proforma for referral to a home non-invasive ventilation service following acute hypercapnic respiratory failure

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Objectives

The objectives of this study were to:

- Develop a referral proforma for inpatient transfer and home non-invasive ventilation, to improve resource utilisation.
- Evaluate patient characteristics and outcomes before and after launch of referral proforma.

Design

Evidence for the use of home NIV in patients after acute hypercapnic respiratory failure (AHRF) was reviewed by physiotherapists in a regional ventilation team of an acute hospital, and a referral proforma to guide patient selection was developed. Service evaluation amongst this patient group took place; all inpatient referrals were included between October 2012 and February 2015, with 12-month follow-up. The referral proforma (RPF) was introduced in January 2014, and data was compared before and after launch. Review of patient demographics, ventilator settings, and length of hospital stay was undertaken, as well as diagnosis profile, and survival at 6- and 12-months post-NIV initiation.

Results

Uptake of the RPF after launch was 40.3% (median referral rate 4.0/month, range 1-9, with 25/62 referred by proforma). In comparison, 55 referrals were received before proforma launch (median 3.0/month, range 0-7). No significant differences were seen in age, gender or IPAP setting, while a statistically significant trend for higher EPAP value was seen post-proforma (p=0.01). Length of stay across proforma phases was unchanged (p=0.17).

The literature review and resultant proforma highlighted the unclear role of home NIV in COPD. Post-RPF, fewer patients with COPD were referred than pre-RPF; this reduction was statistically significant within referrals received by proforma (p=0.02). Survival was not significantly different between those referred pre- and post-proforma, at 6 months (85.1% v. 78.3%, p=0.38) and 12 months (68.1% v. 71.7%, p=0.94).

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Keywords

Physiotherapy, Non-invasive ventilation, Referral proforma, Service evaluation, Chronic obstructive pulmonary disease (COPD).

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Conclusions
A novel physiotherapy-developed proforma may improve referral practice, case mix and resource utilisation in home NIV. Success of NIV was unchanged (length of stay, survival). Low proforma completion rate highlights the challenge of modifying existing behaviours, and future work will focus upon referrer engagement.

Introduction

Little guidance exists on patient selection for home non-invasive ventilation (NIV) following acute hypercapnic respiratory failure (AHRF). Locally, a team of physiotherapists contribute to the delivery of a tertiary home ventilation service; physiotherapy outpatient support of ventilation users follows initiation of ventilation by the same team in the inpatient setting. Home NIV may be commenced after acute hospital admission and transfer into the regional unit; referrals for the latter are received from other centres. No local or published criteria for inpatient transfer and consideration of home NIV existed prior to this project. The physiotherapy team decided to undertake review of the literature on home NIV; clarification of eligible diagnosis was desired, with the aim to develop an evidence-based referral proforma and improve resource utilisation.

In neuromuscular and restrictive thoracic disorders, Ward et al (2005) conducted a small randomised controlled trial amongst patients with hypercapnia; 90% of the control subjects deteriorated, requiring nocturnal NIV. In non-bulbar motor neurone disease (MND), survival benefit with NIV has been demonstrated at controlled trial (Bourke et al, 2006). At the time the proforma was written, home NIV was therefore recommended for use in the Cochrane review on neuromuscular and chest wall disease (Annane et al, 2007) and NICE guidelines on MND (National Institute for Health and Care Excellence, 2010).

Similarly, evidence for the use of home NIV in obesity hypoventilation syndrome (OHS) has been seen in short-term physiological outcomes in a controlled trial (Borel et al, 2012), and long-term arterial blood gas improvement in an observational study (Priou et al, 2010). The diagnosis list for the referral proforma was therefore generated based on evidence of benefit from nocturnal NIV; other diagnoses (obstructive sleep apnoea uncontrolled by CPAP, pulmonary hypertension, central hypoventilation) were derived from a consensus statement on home NIV (American College of Chest Physicians, 1999) in the absence of UK guidelines.

Much debate exists over the role of nocturnal NIV in chronic obstructive pulmonary disease (COPD); randomised controlled trials on long-term NIV in COPD do not reveal strong or consistent findings of benefit in this group. However, before this project, almost half of the inpatient referrals received locally had a diagnosis of COPD; consideration of the literature on home NIV in COPD was therefore undertaken.

Amongst stable, severe COPD patients, Casanova et al (2000) reported no change in survival, hospital admission rates, or physiological outcomes with NIV compared with control group at one year. Similarly, Clini et al (2002) reported no difference in emergency admissions, or survival during two-year follow-up. Finally, McEvoy et al (2009) found no difference in daytime arterial blood gases, or survival at one year and longer. Many subjects were lost to follow-up and death, and the authors describe later adjustment of the groups resulting in borderline statistical significance for reduction in mortality with NIV; this raises questions of methodology and validity.

An improvement in quality of life (QoL) with NIV (Clini et al, 2002) contrasts with worsening QoL observed on similar measures by McEvoy et al (2009). Hence, NIV in stable severe COPD was unsupported by evidence at the time of proforma development, and this is reflected in the Cochrane review findings of the same (Struik et al, 2013).

Consultation with members of the local ventilation team yielded conditions in which home NIV was felt to offer possible benefit in unstable COPD. These are found in previous British Thoracic Society guidance (BTS, 2002), and specify repeated episodes of AHRF, or significant hypercapnia when correcting hypoxaemia with oxygen therapy; in developing the referral proforma it was consequently elected to include the latter statement.

The aims of the project were to:

- Develop a referral proforma for inpatient transfer, to guide patient selection and improve resource utilisation in home NIV following AHRF;
- Evaluate the possible effects of the proforma with comparison of patient characteristics and outcomes before and after launch.

Methods

NHS Health Research Authority (HRA) and Medical Research Council guidance indicates that this study did not require research ethics approval because care is not changed from accepted standards. The project was therefore registered as a service evaluation with the Clinical Audit Department (reference 3458).

The referral proforma (RPF) see Appendix 1 was developed by the physiotherapists, in consultation with the ventilation service multidisciplinary team (including representatives from medical, nursing and clinical psychology staff); meetings were held over a two-month period, and the eighth proforma version was agreed for launch. The proforma was based on current evidence in home NIV, categorising six diagnoses (see Appendix 1) and providing explanatory guidance on COPD. Other criteria for referral included objective markers of hypoventilation (American College of Chest Physicians, 1999), and consideration of possible end-of-life status.

The RPF was launched in January 2014. All referrals received between October 2012 and February 2015 were included in the study (data collected retrospectively to January 2014, prospectively thereafter). Patient demographics, ventilator settings, and length of hospital stay at setup were reviewed as well as patient diagnosis, and survival at 6- and 12-months post NIV-initiation. Inferential statistics were used to compare referrals across proforma phases; referrals received after RPF launch were also analysed in subgroups according to completion of proforma (post-RPF by RPF, and post-RPF no RPF). Statistical analysis was performed using IBM SPSS v23; the chi-square test was used for gender, the independent t-test for ventilator settings, and the Mann-Whitney U-test was used to analyse all other differences due to non-normal distribution or nature of data. A p value of ≤ 0.05 was considered statistically significant.

Results

Uptake of the RPF after launch was 40.3% (median referral rate 4.0/month, range 1-9; 25/62 referred by proforma). All post-proforma patient transfers were deemed appropriate for NIV; two later declined it during treatment. In comparison, 55 referrals were received before proforma launch (median 3.0/month, range 0-7); of these, 8 underwent inpatient transfer but did not need NIV.

Gender, age and IPAP (inspiratory positive airway pressure) settings were not significantly different before and after proforma launch, while a statistically significant trend for higher EPAP (expiratory positive airway pressure, p=0.01) was seen in the post-proforma phase. No significant difference was seen in length of stay across study phases (p=0.17, Table 1).

Referrals	**Pre-RPF (n=55)**	**All Post-RPF (n=62)**	**p-value**
Age, years (median, range)	64.0 (31-89)	65.5 (25-85)	p = 0.49
Gender, male (number, %)	21 (38.2)	25 (40.3)	p = 0.81
Referred patients given NIV	**Pre-RPF (n=47)**	**All Post-RPF (n=60)**	**p-value**
IPAP, cmH2O (mean, SD)	24.3 (4.6)	24.3 (4.9)	p = 0.88
EPAP, cmH2O (mean, SD)	6.4 (1.9)	7.2 (2.1)	p = 0.01
Length of stay, days (median, range)	6.0 (3-25)	5.0 (2-27)	p = 0.17

Legend: SD = standard deviation, RPF = referral proforma, IPAP = inspiratory positive airway pressure, EPAP = expiratory positive airway pressure.

Table 1: Demographics, ventilator settings and length of stay.

Post-RPF, fewer patients with COPD were referred than pre-RPF; the reduction was statistically significant within referrals received by proforma (p=0.02). This was mirrored by a significant increase in OHS referrals (p=0.04). Post-RPF referrals received without RPF completion showed similar COPD rates to pre-RPF (p=0.71; Table 2).

Survival at 6 months post-NIV initiation amongst patients referred pre-RPF was not significantly different from those referred post-RPF (85.1% v. 78.3%, p=0.38); this was also the case at 12 months (68.1% v. 71.7%, p=0.94) see Figure 1. Subgroup analysis of survival amongst COPD patients versus OHS patients found a non-significant trend towards improved survival in OHS at 6-months (79.6% COPD v. 91.7% OHS, p=0.13) and 12-months (68.2% COPD v. 83.3% OHS, p=0.12).

Diagnosis	COPD	p-value
Pre-RPF referrals	26 (47.3)	p=0.14
Post-RPF all referrals	21 (33.9)	
Pre-RPF referrals	26 (47.3)	p=0.02
Post-RPF referrals by RPF	5 (20.0)	
Pre-RPF referrals	26 (47.3)	p=0.71
Post-RPF referrals no RPF	16 (43.2)	
	OHS	
Pre-RPF referrals	12 (21.82)	p=0.04
Post-RPF referrals by RPF	11 (44.00)	

Legend: Data are number (%). RPF = referral proforma, COPD = chronic obstructive pulmonary disease, OHS = obesity hypoventilation syndrome.

Table 2: Diagnosis profile across proforma phases and subgroups.

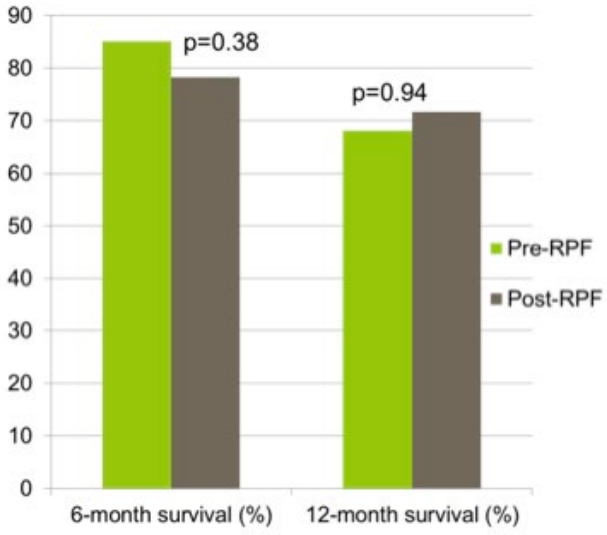

Figure 1: Survival post-NIV initiation.

Discussion

This project aimed to explore referrals and outcomes for patients, before and after the launch of a physiotherapy-developed proforma. A limitation of the study can be found in the low completion rate of the referral proforma. Although subgroup analysis reveals change in diagnosis mix amongst patients referred by proforma, it is acknowledged that RPF utilisation was lower than hoped. Barriers to change when introducing new documentation within respiratory medicine departments have previously been reported (Stoller, 2010); the same work makes

recommendations on collaboration with all stakeholders. The RPF was developed with engagement of the multidisciplinary ventilation team; however, discussion with external referrers did not take place prior to launch. While the aims to develop the referral proforma and explore patient outcomes were achieved, the next steps are planned to involve consultation with our regional partners, to better understand their needs.

Comparison of patient groups across proforma phases found no difference in age, gender or IPAP, but did reveal a small but statistically significant trend for higher EPAP post-proforma (Table 1). This difference in ventilator pressure may be in keeping with the increase seen in OHS patient referrals following proforma launch, whereby higher EPAP values are recommended in acute and home use of NIV in obesity hypoventilation (BTS, 2016).

The statistically significant reduction in COPD referral rate post-proforma would appear to better reflect the evidence base, and other published practice. In a study of EU ventilation services completed since the inception of this project, COPD was the indication for home NIV in 38.5% of prescription (Crimi et al, 2016). This compares with almost half of local inpatient referrals for home NIV, before proforma launch (Table 2). This change in diagnosis profile may be expected to offer better resource utilisation, where home NIV is not associated with clear benefit for patients with stable, severe COPD.

The proforma was based on evidence available at time of development, and there have been further additions since the launch in January 2014. Home NIV continues to be recommended for patients with neuromuscular and chest wall disease, in the updated Cochrane review (Annane et al, 2014), and for patients with MND in the updated NICE guidance (2016); the inclusion of these diagnoses in the proforma therefore remains appropriate.

Two further randomised controlled trials of home NIV in COPD have been published since proforma development. Kohnlein et al (2014) reported improvements in physiological measurements and survival at one-year in severe, stable COPD; five elective hospital admissions were undertaken per patient per year for NIV setup and adjustment, in a model which does not reflect UK practice. Conversely, Struik et al (2014) reported no change in survival or time to emergency readmission at twelve months with home NIV after AHRF, despite reduction in hypercapnia.

In seeking to explain the differing negative and positive results between Struik et al (2014) and Kohnlein et al (2014) on home NIV in COPD, published correspondence has questioned the validity of the sampling. Lobato and Alises (2014) suggest Kohnlein et al (2014) failed to exclude possible obesity hypoventilation patients, where a body mass index (BMI) of up to 35kg/m² was accepted. However, Kohnlein et al (2014) report mean BMI values (24.5kg/m² SD 5.8 control group, 24.8kg/m² SD 5.8 NIV group) which are clearly comparable to those of Struik et al (2014; mean BMI 25kg/m², SD 6). Thus, it does not appear justified to attribute the improved outcomes seen by Kohnlein et al (2014) to the inclusion of COPD in overlap with obesity hypoventilation, and the differing findings are yet to be clearly explained. Locally, BMI data was not collected for evaluation and this is a limitation; future audit will include this measurement.

It is of interest to note that the referrals reviewed in the local project are dissimilar to those of Kohnlein et al (2014), and more comparable with the group studied by Struik et al (2014) by virtue of the presence of AHRF and acute hospital admission. Struik et al (2014) began home NIV amongst inpatients soon after AHRF, closely reflecting the local patient population. The lack of benefit from home NIV reported by Struik et al (2014) would indicate that it continues to be

justifiable to include guidance highlighting unproven treatment effect in COPD after AHRF within future iterations of the referral proforma.

Analysis of length of stay and survival data found no difference between study phases, suggesting no change in success of treatment with proforma use. Subgroup survival analysis undertaken amongst all local COPD referrals allows comparison to be drawn with the 12-month survival data reported by Struik et al (2014); it appears valuable to note that the results are similar. Twelve month survival of 68.2% for all COPD referrals (pre- and post-RPF) approximates to the 70.3% (NIV) and 71% (control) reported by Struik et al (2014). Although it is not possible to apply statistical testing without further data, these figures appear comparable and may be suggested to reflect validity within this project and further similarity of patient group.

It must also be acknowledged that in developing the referral proforma, explanatory guidance in favour of home NIV was included for unstable COPD patients where repeated episodes of AHRF occur, or significant hypercapnia complicates oxygen therapy. These stipulations originated during consultation within the ventilation service, reflecting previous BTS guidance (2002); the recent EU survey on long-term NIV captures the same stance on this issue within other teams (Crimi et al, 2016).

New research is awaited in the field of home NIV in COPD following AHRF; the HoT-HMV UK trial has been completed, and published in abstract form (Murphy et al, 2016). An improvement (2.9 month) in exacerbation-free survival has been reported. Full publication of the study is awaited, and the impact of these findings on the proforma will be considered at that time. Future outcome measurement will also include time from discharge to readmission, which may then be compared with published data from both Struik et al (2014) and Murphy et al (2016).

Conclusions

A novel physiotherapy-developed proforma may improve referral practice, case mix and resource utilisation in home NIV after acute hypercapnic respiratory failure, effecting change in a multidisciplinary ventilation service. Length of inpatient stay and success of NIV (survival at 6 and 12 months) was unchanged. Proforma completion was lower than anticipated, and the challenge of modifying existing behaviours was highlighted; future work will focus upon engagement with referrers.

Since this article was accepted for publication, the HoT-HMV UK trial was published and the proforma used in clinical practice by Ward et al has been updated. If you would like further information, please contact Karen Ward.

Key Points

- Physiotherapists developed a referral proforma for patient selection in home NIV.
- Proforma completion rates could be improved, and future work with referring partners is planned.
- Statistically significant differences were seen in referring practice following proforma launch, changing the diagnosis profile to better reflect the evidence base.

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Appendix 1 Proforma for consideration of Home Non-invasive Ventilation (Home NIV)

AINTREE VENTILATION SERVICE

Proforma for consideration of Home Non-invasive Ventilation (Home NIV)

Referrals for trial of home NIV are considered in the following situations. Please fax completed forms to the Ventilation Inpatient Centre (fax 0151 529 3129), for the attention of 'VIC consultant'. **Where NIV is established, but ongoing discharge planning is needed, we expect patients to return to their referring hospital and ward.**

Please note Home NIV is **not** routinely indicated in COPD (Struik et al, 2013). In COPD NIV may be considered where there is an overlap syndrome e.g. with Obstructive Sleep Apnoea or other conditions predisposing to hypoventilation. It is also an option if the patient has decompensating type 2 respiratory failure without an exacerbation and/or where long term oxygen therapy is required but causes significant hypercapnia i.e. there is hypoxic drive (BTS, 2002). In COPD if acute NIV is repeatedly required during an exacerbation and the patient is not felt to be for terminal palliation, referral for consideration of NIV may be discussed with the duty VIC consultant.

ELIGIBILITY	YES
Stable Condition Resp. infection resolving, pH normal / near-normal; other systems stable	☐
Free from Infection Prevention and Control considerations OR Discussion to take place between consultant microbiologists, if positive results for MRSA / C Diff / VRE / ESBL / any other concerns	☐ ☐
Diagnosis (tick all that apply) 1. Obesity hypoventilation	☐
2. Restrictive thoracic disorder	☐
3. Neuromuscular disorder	☐
4. Obstructive sleep apnoea, not controlled by maximal CPAP therapy	☐
5. Pulmonary hypertension	☐
6. Central hypoventilation	☐
Suboptimal overnight oximetry and/or daytime hypercapnia Please supply most recent arterial blood gas results, and overnight oximetry detailing mean or median SaO_2, time <90%, and 4% dip rate	☐
Can NIV be managed independently by patient? **OR - If carers / residential care** needed, we require funded carers to be identified with patient consent, prior to referral being accepted	☐ ☐
In likely end-of-life care, has patient been accepted by local Palliative Care Team for support? Consider burden NIV may impose in such cases	☐

Referring consultant to telephone VIC consultant to discuss referral, once received
Ventilation Inpatient Centre Tel. 0151 529 3602 / Fax 0151 529 3129

An experimental cross-over study investigating the effect of three body positions on respiratory muscle strength and lung function in healthy subjects

Pierrepoint SE[1] and Bendall AL[1]

Objectives

The objectives of this study were to measure forced vital capacity (FVC), peak cough flow (PCF), maximal expiratory pressure (MEP) and maximal inspiratory pressure (MIP) in 3 differing body positions as existing research is inconclusive regarding the effect that positioning has on respiratory muscle strength (RMS) and lung function (LF) measurements.

Method

An experimental same-subject cross-over design was used which recruited a convenience sample of 20 healthy, non-smoking undergraduate physiotherapy students. Portable electronic spirometry was used to measure FVC, PCF, MEP and MIP in upright sitting (US), forward lean sitting (FLS) and right side lying (RSL). The highest of three acceptable manoeuvres for each measure in each body position was recorded and statistically analysed.

Results

Body position significantly affected FVC, PCF and MIP measurements across the three body positions with higher values achieved in more upright postures.

Conclusion

These tests of LF and RMS are best performed in US or FLS rather than RSL in health.

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Keywords

Body positioning, Respiratory muscle strength Lung function tests, Cough and forced expiratory technique.

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Introduction

Lung function (LF) and respiratory muscle strength (RMS) tests such as FVC, PCF, MEP and MIP are commonly performed in the clinical setting to monitor disease progression, evaluate treatments and determine cough and forced expiratory technique (FET) efficacy. Guidelines advocate an upright sitting position for testing (Miller et al, 2005b; American Thoracic Society and European Thoracic Society (ATS/ERS), 2002) but alternative positions are also used for pragmatic, therapeutic or comfort purposes. Body position alters lung volumes (Hough, 1984) and respiratory muscle biomechanics (Kera and Maruyama, 2001) and thus may impact LF and RMS measurements.

There is controversy over the effect of differing positions on LF and RMS measurement values. Some report a reduction in MIP, MEP and FVC in recumbent positions such as side lying (SL) compared to US in health (Ogiwara and Miyachi, 2002) yet others report opposing findings (Kera and Maruyama, 2001). PCF measurement, used clinically to monitor cough efficacy, lacks investigation in relation to posture.

The measurement of LF and RMS in differing body positions is underreported and inconsistent. Further investigation in healthy subjects could help inform future studies in other respiratory conditions such as cystic fibrosis (CF) where postural drainage is commonly adopted as part of airways clearance techniques (CF Trust, 2011; Bott et al, 2009). This study may also guide practice as to the optimal body position for FET and cough.

Aims

The aim of this study was to determine if FVC, PCF, MEP and MIP measurements are influenced by three different positions: US, FLS and RSL in healthy subjects.

Methods

An experimental prospective same-subject cross-over design was used which recruited a convenience sample of 20 healthy undergraduate physiotherapy students. A health questionnaire excluded respiratory conditions, cardiovascular conditions, recent facial, thoracic or abdominal surgery and current smokers (Miller et al, 2005a). The School of Healthcare Sciences Research Ethics Committee, Cardiff University granted approval of the study in August 2015. The data were collected by eight undergraduate physiotherapy students. The study method is illustrated in Figure 1.

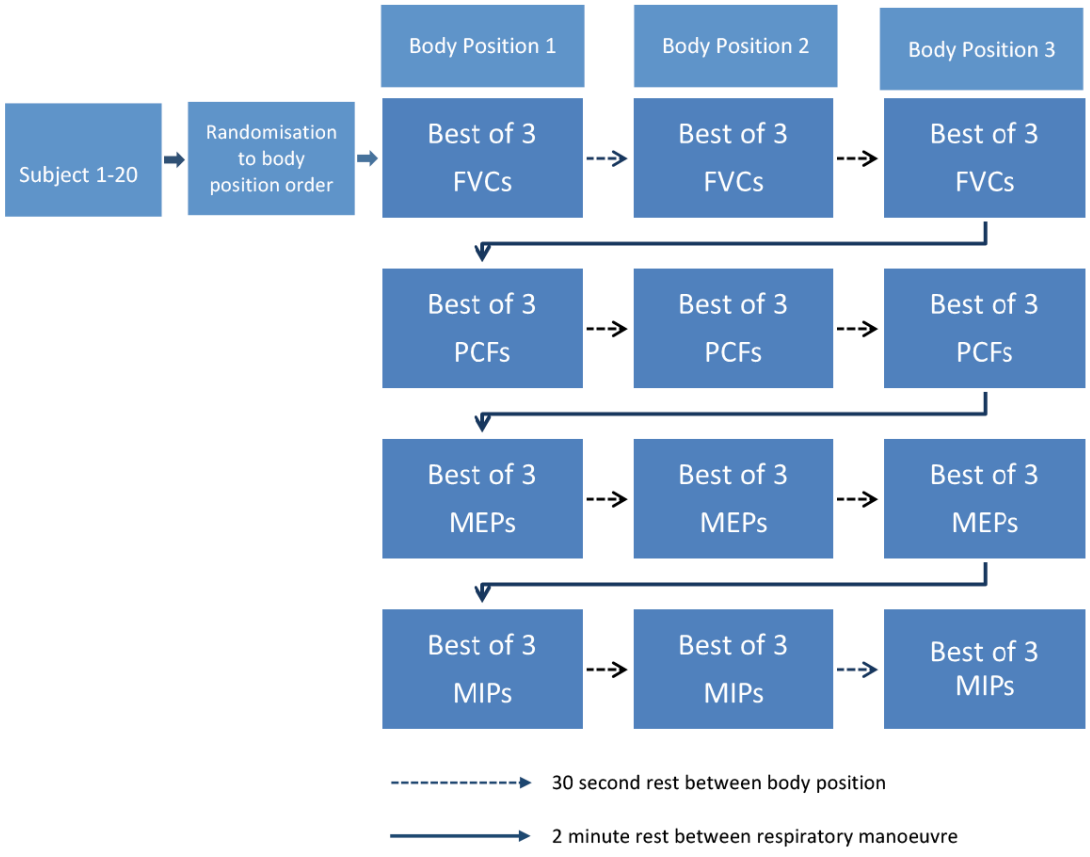

Figure 1: Study Design.

Each subject performed four respiratory manoeuvres ordered as: FVC, the gas volume forcibly exhaled following full inspiration (Miller et al, 2005b); PCF, the maximum velocity of expiratory airflow generated during a cough after glottis opening (Toussaint et al, 2009); MEP, the maximum expiratory static pressure generated at the mouth and MIP, the maximum inspiratory static pressure generated at the mouth (ATS/ERS, 2002). PCF was measured by modifying the peak expiratory flow (PEF) manoeuvre (Bott et al, 2009) so a strong cough was performed subsequent to full inspiration. This reflects clinical pragmatic measurement and physiotherapy guidelines (Bott et al, 2009). Each manoeuvre was performed in three positions which were standardised by goniometry and bespoke photographs:

1. FLS: chair sitting with elbows on a lap-pillow, feet flat on the floor, 90°at ankles and knees and 45° hip flexion.
2. US: chair sitting with a small back rest, feet on the floor and 90°hip, knee and ankle flexion.
3. RSL: RSL on a plinth with one head-supporting pillow and one pillow stabilising 45°right hip flexion.

All possible combinations of the ordering of these body positions were listed on slips of paper numbered between 1 and 6 (Table 1) which were then placed in a non-transparent bag. Each subject took one slip from the bag which was not replaced until the bag was empty.

Randomisation Option	First Position	Second position	Third Position
1	RSL	FLS	US
2	FLS	RSL	US
3	US	FLS	RSL
4	FLS	US	RSL
5	RSL	US	FLS
6	US	RSL	FLS

Key: RSL: right side lying, FLS:forward lean sitting, US: upright sitting.

Table 1: Randomisation of Body Position Orders.

A set script and video detailing each respiratory manoeuvre was shown prior to testing. A portable electronic spirometer measured FVC and PCF which has accuracy levels conforming to ATS recommendations (Micro Medical MicroLab CareFusion, Kent, UK 2009). A portable electronic mouth pressure device measured MEP and MIP (Micro Medical Respiratory Pressure Meter, MicroRPM, CareFusion, Kent, UK) which demonstrates good reliability and validity (Dimitriadis et al, 2011).

Each respiratory manoeuvre was repeated three times with the highest acceptable measurement recorded providing the two largest measurements were within 0.150 L/s for FVC, 0.67L/s for PCF (Miller et al, 2005b) and 20% for MIP and MEP (ATS/ERS, 2002) of each other. Unacceptable measurements were those interrupted by: artefact such as cough (except PCF) or air leakage. Each respiratory manoeuvre type was completed in all three body positions before repeating the procedure with the next manoeuvre type. A two-minute rest was allowed after

each completed manoeuvre type curbing carry-over effects, fatigue and dizziness (Miller et al, 2005a). Thirty seconds was permitted between body positions.

Respiratory manoeuvre performance followed recommendations (Bott et al, 2009; Miller et al, 2005b; ATS/ERS, 2002); FVC: subjects inhaled to total lung capacity (TLC) then exhaled as forcibly as able for at least six seconds, PCF: subjects inhaled to TLC then performed a strong cough into the mouthpiece, MIP: subjects slowly exhaled to residual volume then inhaled forcibly, sustaining the pressure for at least two seconds, MEP: subjects slowly inhaled to TLC then exhaled forcibly, sustaining the pressure for at least two seconds. A good lip-seal, nose clip and cheek support was encouraged to prevent air or pressure loss. Subjects were required to avoid caffeine and food for two hours before testing and loose clothing was worn.

The pooled raw data were analysed using SPSS for IBM (version 20.0). The Kolmogorov-Smirnov test was applied to the data to assess for normal distribution. Mauchley's test was used to assess for homogeneity of variance in the scores over time. Statistical significance was set at $p \leq 0.05$. A post hoc analysis of achieved statistical power was attained using G*Power which calculated the effect size from the ANOVA output for PCF.

Results

Twenty subjects completed the study. Table 2 shows population demographics.

	Age (years)	Height (m)	Weight (kg)	BMI (Kg/m²)
Range	19-38	1.56 - 1.90	50.4 - 111.20	20.44 - 31.80
Mean	22.10	1.7011	70.81	24.24
SD	4.644	0.07795	15.95	3.542

Table 2: Demographics of Study Population (n = 20 Female = 14).

FVC

Body position significantly affected FVC across positions (F=6.604, 2 df, p=0.05) with values higher in US than RSL (mean difference 0.237L/m, p<0.001). There was no statistically significant difference between US and FLS (mean difference -0.015L/m, p=1.0).

PCF

Body position significantly affected PCF across positions (F=80.052, 2df, p<0.01) with values higher in FLS than US (mean difference-1.219 L/min, p<0.01) and FLS than RSL (mean difference-1.479 L/min, p<0.01). There was no statistically significant difference between US and RSL.

MIP

Body position significantly affected MIP across positions (F=6.064, 2df, p=0.05) with higher values between US and RSL (mean difference 6.8cmH_20) but not US and FLS (mean difference 2.30 cmH_20; p=0.363) or RSL and FLS (mean difference -4.50cmH_20; p=0.184).

MEP

No statistical difference was found between body position and MEP (F=1.209, 2df, p=0.310).

Table 3 shows the mean values for the respiratory measurements in each body position.

Post hoc analysis of achieved statistical power was 0.99.

Difference in Body Position (mean [95%CI]) Significant difference p<0.05						
Respiratory Manoeuvre	**US-RSL mean difference**	p [95% CI]	**US-FLS mean difference**	p [95%CI]	**RSL-FLS mean difference**	p [95%CI]
PCF (L/Min)	0.259	p = 0.071 [-0.018 to 0.537]	-1.219	p < 0.01 [-1.560 to -0.878]	-1.479	p < 0.01 [-1.837 to -1.120]
FVC (L)	0.237	p <0.001 [0.124 to 350]	-0.015	p =1.0 [-0.146 to 0.116]	-0.252	p < 0.001 [-0.356 to -0.148]
MIP (cmH_20)	6.8	p =0.016 [1.101 to 12.499]	2.3	p = 0.363 [-1.418 to 6.018]	-4.5	p =0.184 [-10.439 to 1.439]
MEP (cmH_20)	4.7	p =0.420 [-3.310 to 12.710]	3.75	p=0.718 [-4.354 to 11.854]	-0.95	p =1.000 [-9.966 to 8.066]

Table 3: Mean difference for Respiratory Measurements in Body Positions.

Discussion

Our findings show that in healthy subjects, body position significantly affects FVC, PCF and MIP with upright postures achieving greater values. Mean values recorded for FVC and MIP were highest in US whilst PCF was highest in FLS. Position did not significantly affect MEP.

Others partially support these findings. Costa et al (2014) reported statistically significant increases in MIP and MEP in US compared with recumbence. The most reclined posture investigated was supine not RSL, as completed in this study, though equivalent RMS has been found between these positions (Tsubaki et al, 2009). In SL, MIP may be curbed by reduced thoracic expansion from body weight compression (Ogiwara and Miyachi, 2002) and plinth restriction (Badr et al, 2002), counteracting benefits of a more elongated dependent hemidiaphragm from forward displacement of the abdominal viscera (Gianinis et al, 2013).

Superior RMS in upright over reclined postures is anticipated. In US, augmented inspiratory accessory muscle activation, improved diaphragmatic mechanical advantage and excursion (Ogiwara and Miyachi, 2002) culminate in higher inspiratory lung volumes leading to enhanced lung elastic recoil and favourable abdominal muscle length-tension relationships (McCool, 2006). Costa et al's (2014) differing MEP findings may relate to fewer overall expiratory manoeuvres or an undefined US posture. Our study used a small-backed chair and 90° hip flexion (HF) for US. Unsupported sitting may compromise the expiratory function of the abdominal muscles as their postural role increases (Griffiths and McConnell, 2012); conversely spinal flexion from slouching could disadvantage respiratory muscle length-tension relationships and limit diaphragmatic descent due to cephalad compression from the abdominal contents (Ogiwara and Miyachi, 2002). However, full-backed chair support may limit dorsal thoracic expansion and thus inspiratory volumes (Badr et al, 2002). Further investigation is needed to clarify the most favourable US variables.

Similar results for PEF have been found between long-sitting and RSL in 20 stable CF patients (Elkins et al, 2005), though familiarity with expiratory manoeuvres in multiple postures (Badr et al, 2002), airway obstruction (Elkins et al, 2005) and use of PEF not PCF need consideration. Yet similar findings between health and chronic airflow limitation are reported (Badr et al, 2002) advocating upright postures for LFTs, FET and cough, and interchangeable recommendations between healthy and diseased groups. However, the older samples in these studies challenge comparisons with our findings as age reduces RMS and RF. In recumbence PEF reduction is linked to raised intrathoracic pressure from postural trunk muscle activation causing airway compression and reduced airflow (McCool, 2006), a factor exerting less impact on static mouth pressures such as MEP (Griffiths and McConnell, 2012) as seen in our study.

Other studies contradict our results. Tsubaki et al (2009) found no significant difference in MIP, FVC or PEF across US, left 45°rotative prone and supine in 15 females. The authors surmise that in health and youth, position has negligible lung volume or respiratory muscle length-tension relationship effects. Ogiwara and Miyachi (2002) report similar RMS findings across postures from US to supine in 20 physiotherapy students, but a trend towards lower recumbent values lead the authors to advocate respiratory muscle training in upright postures, especially in the respiratory-compromised where posture may have more profound effects. Practice tests, gender homogeneity and SL position differences may explain their disparate findings. Both studies used an anteriorly-displaced supported trunk with bilateral 45° or 90°HF. This elongates the dependent diaphragm and abdominal muscles perhaps enhancing RMS (Badr et al, 2002) but could hinder abdominal or diaphragm excursion via the bed and HF (Badr et al, 2002; Ogiwara and Miyachi, 2002). Our study relied on a neutral right and 45°left hip angle for stability. Clinically, judicious trunk support with an extended lower hip for FET is advised, especially for fatigued, weakened patients with compromised strength.

In the literature FLS is seldom considered. We found FVC and PCF significantly higher in FLS than RSL and US respectively. In FLS, increased intraabdominal pressure causes greater anterior diaphragmatic curvature thus improving inspiratory volumes and hence elastic lung recoil (Kera and Maruyama, 2005). Additionally, external oblique activity is significantly higher in FLS (Kera and Maruyama, 2005). Our study used 45°HF as more acute angles could restrict abdominal excursion. However, Griffiths and McConnell (2012) found no difference in RMS or RF between FLS and US in 16 young rowers with 70°HF. Standardisation of starting lung volumes, high fitness levels, familiarity with the FLS position and uncertainty regarding arm positioning limits comparisons with our study. The current study fixed elbows on a lap pillow. Arm-bracing supports the upper thorax relieving the abdominals of postural co-contraction thereby increasing their length-tension and respiratory function (Kera and Maruyama, 2001). It promotes pectoralis major's accessory respiratory function as its postural role diminishes (Kera and Maruyama, 2005). Hojat and Mahdi (2011) advocate higher arm-fixing, reporting better PEF in FLS (with 35°HF and forearm-bracing on a desk) over US in 20 adolescents. Clinically, patients may choose arm-fixing postures such as high-sill or low-lap positions during expectoration. Further studies exploring the optimal hip angle are indicated. It is recommended that the easy transition from US to FLS is made for coughing and that FET is performed in FLS over RSL if feasible.

Study Limitations

This study recruited a non-randomised small, female-dominated healthy sample whose data were collected by multiple researchers. Rigorous measures were taken to optimise

standardisation of the methods carried out by each researcher so that all measurements were taken in the same setting and with the same tools and instruction. Each subject was required to perform a total of 36 respiratory measurements during data collection which could have led to fatigue although rests were incorporated and practice tests eliminated to minimise this.

Pooling of data potentially leads to an enhanced statistical power. A power calculation was not performed but the sample size reflects that used in a similar study (Tsubaki et al, 2009) and post hoc analysis of achieved statistical power was attained using G*Power. Subjects were not blinded to their digital measurement values, allowing feedback to potentially modify their effort.

Conclusion

Body positioning had a statistically significant influence on FVC, PCF and MIP but not MEP in healthy subjects. This study found FLS as the optimal position to obtain higher PCF measurements, whereas US promotes higher FVC measurements. It also found MEP measurements can be recorded in US, FLS or RSL with similar results. With the measures of FVC, PCF, MIP and MEP being determinants of cough and FET efficacy, these findings support the clinical practice of using body position therapeutically to aid sputum expectoration. This study also reiterates the importance of body position being considered, and also accurately documented, when taking baseline or ongoing measurements that may be used to inform the initiation or continuation of cough augmentation devices and techniques.

The authors recommend further research on this topic involving larger, more diverse healthy populations and pulmonary disorders such as CF where modified postural drainage is utilised.

Key Points

In healthy subjects:

- FLS is the optimal position for PCF and coughing manoeuvres over US and RSL
- US is the optimal position for FVC and FET manoeuvres over FLS and RSL
- MEP can be performed with equal validity in FLS, US or RSL

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A service evaluation of tracheosotomy care and documentation pre and post implementation of a tracheostomy care pathway in a district general hospital

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Purpose

People with a tracheostomy often have complex needs and the management of these artificial airways depend on staff with appropriate knowledge and skills to ensure patient safety.

A service evaluation was undertaken in a district general hospital in the UK without an established tracheostomy team to assess adherence to the South East Wales Critical Care Network (SEWCCN) Tracheostomy guidelines (2009). Interventions were evaluated using the SEWCCN guidelines as a standard across critical care and acute inpatient wards, followed by the implementation of the SEWCCN tracheostomy care pathway and bed head signs as recommended by the National Tracheostomy Safety Project (NTSP).

Aim

To review the impact of implementing the SEWCCN tracheostomy care pathway and NTSP bed head signs on tracheostomy care and its documentation.

Results

The results showed that at baseline there was poor compliance with the SEWCCN guidelines in most clinical areas. The re-evaluation following use of the SEWCCN daily care pathway showed improved compliance across most areas and a reduction in compliance in an area which had not continued using the pathway.

Conclusion

The service evaluation demonstrated that using a tracheostomy daily care plan led to increased compliance with standards of care and documentation. Significant improvements remain to be achieved to comply with current standards.

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Introduction

Historically, tracheostomy has been used in cases of upper airway obstruction to maintain a patent airway and to avoid laryngeal complications associated with prolonged tracheal intubation (Intensive Care Society (ICS), 2008). In order to improve patient comfort and facilitate weaning from mechanical ventilation, the number of temporary tracheostomies has increased in recent

years particularly within a critical care environment (National Confidential Enquiry into Patient Outcome and Death (NCEPOD), 2014).

The UK National Patient Safety Agency (NPSA) (2005-2007) collected data from 150 Trusts which showed that 53/1085 (5%) of airway incidents reported related to tracheostomies. To address some of the potential complications of an altered airway, the South East Wales Critical Care Network (SEWCCN) produced tracheostomy guidelines (2009) based on the ICS and NPSA guidelines to ensure that a consistent approach to care is followed in the management of tracheostomy patients.

The 4th National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society (NAP4, 2011) provided further recommendations to facilitate changes in practice with tracheostomy patients. The Global Tracheostomy Collaborative (GTC) was formed in 2012 with the aim to improve tracheostomy care throughout a patient's journey using five interdependent key drivers. Despite this national drive to improve delivery and safety of care with these patients, a further national review NCEPOD (2014) – "On the right trach?" illustrates that there remains significant morbidity and mortality relating to patients with a tracheostomy, with much preventable harm.

The Shine Project 2014 introduced innovative changes into four hospitals in South Manchester. Resources included staff education, equipment provision and reorganisation of care. The project resulted in a significant reduction in the severity of harm and tracheostomy related patient safety incidents demonstrating that it is possible to improve quality and safety of care by introducing innovative changes to the management of these patients.

Growing evidence supporting the importance of high quality care has provided an opportunity to evaluate local practice and procedures when managing tracheostomy patients. Efforts to reduce variation in practice can improve clarity, facilitate training and should help to minimise complications (Zhu et al, 2014). Pressure on intensive care beds to use resources appropriately can result in patients with a temporary tracheostomy being cared for in multiple locations throughout a hospital that have irregular exposure to this patient group. This is despite recommendation from NTSP that patients are corralled into identified wards. It is therefore important to evaluate local service provision to ensure that staff have appropriate knowledge and skills to support the complex needs of patients with tracheostomies.

There are many reasons why local improvements in tracheostomy care have not yet been widely implemented (Mace et al, 2006). One reason is the possibility that there are few validated quality and outcome measures specifically for tracheostomy care. Local consensus is also hard to achieve, evidenced by the wide variation that exists in tracheostomy care between and within institutions, and is often based on 'common sense' and clinical experience (Zhu et al, 2014).

The aims of the service evaluation were to:

1) Undertake baseline data collection to review current tracheostomy care based on the SEWCCN guidelines;
2) Implement the SEWCCN tracheostomy daily care pathway and then re-evaluate practice;
3) Implement bed head signs for all patients based on the NTSP recommendations.

Method

The district general hospital (DGH) participating in the service evaluation provides a service to all patients requiring a tracheostomy, the majority of cases being managed on the critical care unit or the Ear Nose and Throat (ENT) ward. Occasionally patients are managed on respiratory or stroke wards. Tracheostomy care at this hospital is managed via individual specialties with no established tracheostomy team. Physiotherapy and outreach support are offered to patients on outlying wards alongside input from ENT advanced practitioners as required.

Prior to the service evaluation, a speculative questionnaire regarding perceived tracheostomy knowledge was distributed to critical care staff nurses to highlight any learning needs. Compliance was poor, with a return rate of 2/20 and therefore the data was not feasible to use as a scoping exercise and highlights the importance of undertaking the service review. A prospective service evaluation was undertaken over a six-month period between May and October 2014. The SEWCCN tracheostomy care pathway was used as the standard and also as a data collection method in all cases (Figure 1). The main components of this daily care plan are based on two sections:

- Section 1 – Shift checks reviewing procedures and safety equipment
- Section 2 – Daily 2 hour clinical activities and assessment

Procedures and Equipment Check	EARLY	LATE	NIGHT
Safety equipment present			
Suction working effectively			
Appropriate sized suction catheters			
Oxygen working if required			
Spare inner tube available			
Spare tracheostomy tube at bedside unopened			
Gloves, aprons and visor available			
Tracheostomy cleaning equipment present			
2 competent professionals to change dressing and tapes as required or at least once every 24 hours			
Competent professional to check if tapes are secure			
Stoma site condition			

Section 1 – Shift checks reviewing procedures and safety equipment:

ACTIVITY CODE	DAILY – ACTIVITY Clinical assessments – TIME 2 HOURLY
1.0	Competent health care professional to check oxygen percentage and record FIO_2
1.1	Record O_2 saturations 2 hourly
1.2	Record respiratory rate with observations
1.3	Competent health care professional to check adequate humidification 2 hourly o Aquapak(A) o Swedish nose(S) o Buchanan protector (B)
1.4	Competent health care professional to record: V =speaking valve attached N= speaking valve not attached ***Ensure cuff deflation if speaking valve is attached. Speaking valve must be removed for sleep.***
1.5	Competent health care professional to assess need for suction 2 hourly *If required pre oxygenate patient with 100 % oxygen for 1 minute prior to commencing procedure and return to prior oxygen setting on completion of suction.*
1.6	Competent health care professional to record quantity and type of secretions when tracheal suction has been performed 1=scanty, 2= moderate, 3=copious, M=mucoid B=blood stained, P=purulent e.g. 1P
1.7	Competent health care professional to perform subglottic suction 2 hourly and record quantity
1.8	Competent health care professional to check inner tube 2 hourly and clean if necessary With sterile water/ tracheostomy swabs (refer to guidelines)
1.9	Competent health care professional to check tracheal cuff pressure and record (adjust to 16-24 cms H_20)
1.91	Record **I** if cuff inflated and **D** if cuff deflated
	PLEASE INITIAL and TIME

Section 2 – Daily 2 hourly clinical activities and assessment

Figure 1. South East Wales Critical Care Network tracheostomy daily care plan.

During the baseline evaluation phase between May – October 2014, two physiotherapists reviewed the SEWCCN daily care pathway at the same time each day. Sections one and two were reviewed to assess whether the information contained in the daily care pathway was documented within the patients notes by using a mixture of observation charts and nursing notes to extract the relevant information. If there was no record of the activities in the nursing documentation or equipment was not found at the bedside, the activity was counted as incomplete. Both section 1 and 2 of the care pathway were reviewed for completion of shift checks and clinical activities (%). The total for both sections was calculated and divided by 2 which then

provided a mean compliance figure of completion of the pathway. A total of 19 patients were included in the evaluation. Twelve patients presented across a 16-bed mixed dependency critical care unit, five patients were on the ENT ward, one patient was on the stroke ward and a further one patient was on the respiratory ward. During the initial data collection period a total of 71 episodes of care were evaluated across the four areas.

Due to poor compliance with SEWCCN standards for tracheostomy care at baseline data collection, the pathway and bed head signs were introduced to clinical areas with education sessions on use provided by physiotherapy staff. Data collection was repeated using the same method as baseline. Fifteen patients were included in the second data collection period between April and July 2015. The aim was to replicate the initial data collection over a six-month period however, due to service needs data was collected for a shorter 4 month period. Ten patients presented on critical care, three patients were on the ENT ward and two patients were on the respiratory ward. There were no patients with a tracheostomy on the stroke ward during this time. A total of 53 episodes of care were analysed in the re-evaluation. The target aim was to achieve >90% mean compliance with sections 1 and 2 with the implementation of the tracheostomy care pathway. As the information was being used for local service development, approval was not required from the research and development or ethics committee. The lead consultant for critical care approved the service review and there were no financial costs involved.

Results

Table 1 shows the results of the 2014 baseline service review. The most compliant area was the stroke ward with a compliance of 90% for both sections combined (mean). Compliance was lowest on the ENT ward with an overall 30% mean compliance for both sections.

Ward	N	Episodes of care, N	Section 1 Compliance (%)	Section 2 Compliance (%)	Mean Compliance of Section 1 & 2 (%)
Critical Care	12	45	79	58	**69**
ENT	5	13	46	14	**30**
Stroke	1	10	95	85	**90**
Respiratory	1	3	55	57	**56**

Table 1: Compliance with Sections 1 and 2 of the tracheostomy care pathway at baseline.

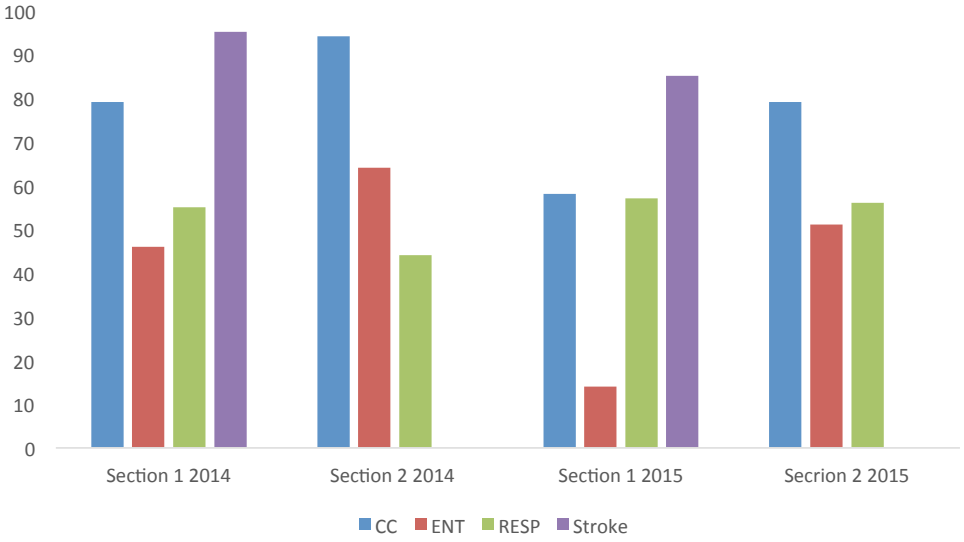
The most frequently omitted care tasks in section 2 of the pathway were the measurement of tracheostomy cuff pressure and documentation regarding cuff inflation/deflation. Inner tube checks were either not recorded or were not completed 2 hourly as recommended in the SEWCCN tracheostomy guidelines.

Following implementation of the care pathway (Table 2) there was some improved compliance with the SEWCCN tracheostomy guidelines and documentation of care for critical care and the ENT ward. There were no tracheostomy related incidents during the data collection period.

Ward	N	Episodes of care, N	Section 1 Compliance (%)	Section 2 Compliance (%)	Mean Compliance (%)	Comparison of mean compliance with 2014 review (%)
Critical Care	10	39	94	79	87	⇧**18**
ENT	3	9	64	51	50	⇧**20**
Respiratory	2	5	44	56	50	⇩**6**

Table 2: Compliance with the tracheostomy care pathway during the re-evaluation.

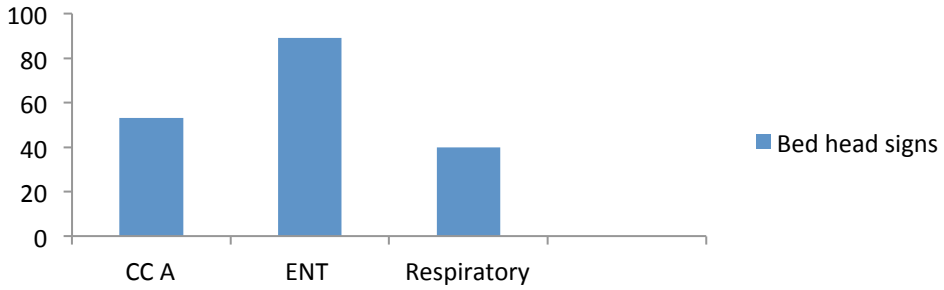
Across most areas there was greater compliance to the safety checks (section 1) compared to the care tasks (section 2) as demonstrated in Figure 2. The greatest improvement in compliance was on the ENT ward where compliance for both sections combined (mean) increased from 30% to 50%. It must be acknowledged that, although adherence to the care pathway allowed improvements from the baseline review, compliance remains low and is a cause for concern. Results in Critical Care demonstrated compliance less than 90% and therefore must be addressed. Furthermore, the respiratory ward did not continue with use of the pathway for reasons unknown and so tracheostomy care and documentation has reduced from baseline.



Key: CC: Critical Care, ENT: Ear, Nose & Throat ward, RESP: Respiratory ward.

Figure 2: Percentage compliance with Section 1 and Section 2 of the tracheostomy daily care plan pre and post implementation of the SEWCCN daily care pathway.

The use of bed head signs was most prevalent on the ENT ward (89%). Half of all patients on critical care had a bed head sign displayed (53%), (Figure 3). Bed head signs were displayed in 40% of cases on the respiratory ward. Aside from the respiratory ward that had discontinued use of the daily care pathway with no explanation provided for this, all other areas demonstrated some improved mean compliance in comparison to baseline (Figure 4).



Key: CC: Critical Care, ENT: Ear, Nose & Throat.

Figure 3: Bar chart showing percentage compliance with bed head sign use.

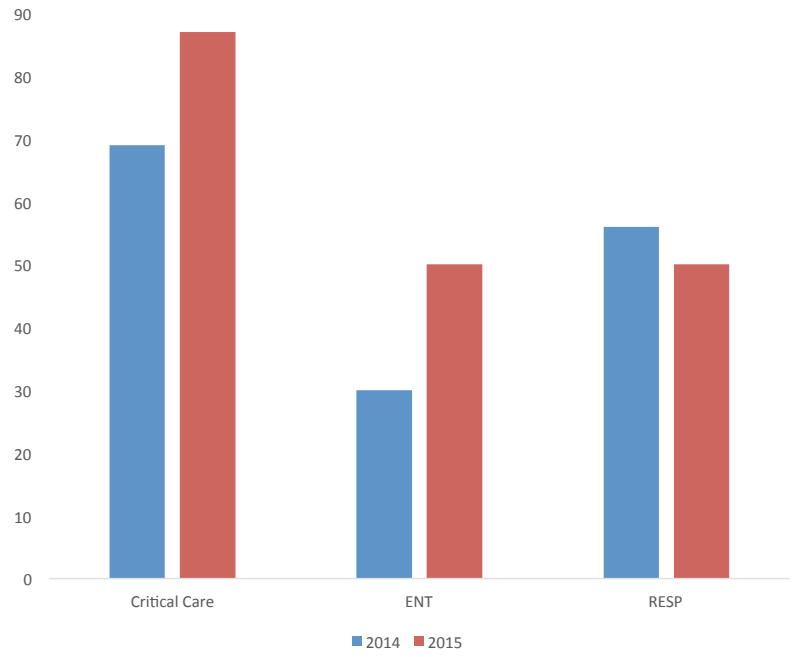


Figure 4: Bar chart showing comparison of overall compliance (%) to SEWCCN tracheostomy guidelines following implementation of tracheostomy daily care pathway (2014–2015).

Discussion

Within the initial six-month evaluation period a total of 71 episodes of tracheostomy care were evaluated showing poor compliance with standards of care and documentation outside of critical care based on the SEWCCN tracheostomy guidelines.

Studies suggest that using guidelines to support practice can facilitate clinical change and improve the quality and safety of care delivered to patients (NICE 2007). The small increase in total compliance in the re-evaluation could be explained by the introduction of a daily care plan, which may have helped to prompt and educate staff in tracheostomy care. This assumption can be further justified by the fact that compliance on the respiratory ward reduced in the re-evaluation and was the only clinical area not to have used a standardised daily care plan for reasons unknown to the author.

As there were no adverse tracheostomy incidents during the evaluation, it is unclear why there was positive compliance to the bed head signs yet poor use of the care pathway in some areas. As there were no patients on the stroke ward during the re-evaluation period, data was not available and therefore prevents comparison to baseline to explore the benefits fully of

implementing the tracheostomy care pathway and is a limitation to the service review. Secondly, the initial data collection period was over 6 months and this timeframe was the aim for the re-evaluation. Due to service provision requirements, staff discontinued data collection at 4 months limiting the amount of data collected.

There were discrepancies with paperwork completion at times, which suggests a lack of education regarding the importance of documentation as directed by the SEWCCN (2009) guidelines. The Francis Report (2013) states that accurate recording of information is vital to contribute to safe and effective care. It should be acknowledged that there is a possibility that care was actually delivered to the patients as per the guidance, but was not documented accurately and therefore was not reflected in the results, however, professional accountability dictates that if an activity has not been documented fully then it must be presumed to have not been undertaken. There were inconsistencies with infrequent recording of observations in some cases outside critical care and there was a significant lack of cuff pressure measuring. This variance could highlight training issues, particularly as the Francis Report (2013) recommends that observations must be monitored and easily available to all staff.

One element of staff education requiring attention is that of subglottic suction. There were frequent episodes where subglottic suction was recorded as a completed care task, which was not a possibility as the patients did not have this type of tracheostomy tube in situ. Subglottic suction is an addition to the SEWCCN daily tracheostomy care plan at this local hospital due to the use of these tubes with increasing frequency and therefore, training on this tube is a priority based on the findings of the evaluation.

Staff may not have had an awareness of the SEWCCN Tracheostomy guidelines as part of their training to inform the quality of care delivered to patients. It is important to ensure that tracheostomy knowledge is maintained across the multi-disciplinary team; identifying learning needs and implementing education strategies is essential to ensure the delivery of quality and safe care. As a result of the service evaluation, education sessions have been increased across critical care via physiotherapy staff and ENT Advanced Nurse Practitioners have commenced ward-based education to comply with recommendations (NTSP (2013), NCEPOD (2014)).

Following physiotherapy presentation of the service evaluation data to directorates, information will be used to influence future change with the aim to formulate working groups to evaluate change of practice with tracheostomy patients. In view of poor compliance with national and local guidelines, future service reviews are warranted and to explore this issue further a recommendation would ideally be to compare practice between different hospitals.

In order to be compliant with national standards and improve safety, the tracheostomy daily care pathway and bed head signs should continue to be used for all tracheostomy patients. Although improvements have been demonstrated in most areas there needs to be further education and development to ensure that continuity of care and documentation are standardised throughout the patient's healthcare journey.

Key Points

- Improved compliance with NCEPOD and NTSP recommendations
- Improved compliance with SEWCCN standards using a daily care pathway
- Supportive of the Francis Report highlighting the importance of accurate documentation of care delivered

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Evaluation of a post discharge pulmonary rehabilitation service

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Objectives
To investigate change in outcomes and 90-day readmission rates for a hospital-provided post exacerbation pulmonary rehabilitation (PEPR) programme for patients admitted with an acute exacerbation of COPD (AECOPD).

Design
A service audit using the outcome measures and methodology of the intervention arm of a published RCT by Seymour et al (2010) which demonstrated significant reduction in re-admission rates for AECOPD.

Setting
Participants were recruited from an inner city (UK) acute hospital.

Participants
Patients with an AECOPD who had not attended PR in the previous 18 months.

Interventions
PEPR delivered as an 8 week, twice weekly, rolling programme starting within 10 days of discharge from hospital.

Outcome measures
Primary outcome measure was 90 day re-admission rate; secondary outcome measures included: 6 Minute Walk Test (6MWT), Hospital Anxiety and Depression Score (HADS), and interview administered Chronic Respiratory Disease Questionnaire (CRDQ).

Results
43 AECOPD patients were offered PEPR, 31 started and 20 completed the course. Mean (±SD) age was 67(±9) years and FEV_1% predicted 32(±15)%. Clinically significant improvement was only seen in the CRDQ dyspnoea domain median (range) 0.79(-0.60 – 3.00) with no clear benefit to 90-day re-admission rate.

Conclusion
This study failed to replicate published reductions in re-admission rates found by Seymour et al (2010) however the patients population was more severe compared to that of comparison study with FEV_1% predicted was 34(±17)% compared to 52(±20)%. The expectation for PEPR programmes to reduce re-admission rates for AECOPD needs further investigation across disease severity spectrum.

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Introduction

Pulmonary rehabilitation (PR) has been shown to have good medium term benefits, including decreased breathlessness, improved exercise performance, improved health-related quality of life and reduced usage of health care resources (ZuWallack, 2007). The British Thoracic Society (BTS) and the National Institute for Health and Care Excellence (NICE) quality standards recommend that all patients with chronic obstructive pulmonary disease (COPD) who are limited by breathlessness should have access to PR (BTS, 2014; NICE, 2011). In addition the joint statement by the American Thoracic Society (ATS) and European Respiratory Society (ERS) promotes PR as an integral part of the clinical management of all patients with symptomatic chronic respiratory disease (Nici et al, 2006). Increasingly there has been evidence to suggest that PR administered within 7 to 10 days of hospital discharge can, not only generate improvements in exercise capacity, but also but also reduce emergency department re-attendances over a 3-month period (Man et al, 2004, Seymour et al, 2010). The study by Seymour et al (2010) demonstrated that the proportion of patients readmitted to hospital with an exacerbation was 33% in the group who received usual care (n=30), which was significantly (p=0.02) higher compared to 7% of those receiving post exacerbation pulmonary rehabilitation (PEPR) (n=30) within 1 week of hospital discharge. Further, the proportion of patients that experienced an exacerbation resulting in an unplanned hospital attendance (either admission or review and discharge from the emergency department) was 57% in the usual care group and 27% in those receiving PEPR (p=0.02). This study was included in the meta-analysis of 9 studies by Puhan et al, (2011a) which concluded that PEPR can reduce readmissions.

In this service evaluation we have attempted replication and confirmation of these published observations by providing PEPR for COPD patients within 10 days of discharge from hospital for an acute exacerbation of COPD (AECOPD). Uptake of the service, completion rates, standard PR outcomes and 90-day re-admission rates were audited. 90-day re-admission rate was then compared with patients who declined PEPR and were discharged from hospital with usual care.

Methods

Ethics

The study was registered as a service development audit with the Whittington Health Clinical Effectiveness and Audit Department.

Recruitment

Referrals to PR by the ward multi-disciplinary team were monitored daily through the week. Patients were offered PEPR if: they were referred to PR during an in-patient admission for AECOPD; they met the standard inclusion and exclusion criteria for PR; space was available to start PEPR within 10 days of discharge; they had not done PR within the last 18 months. For the purpose of this study AECOPD was taken as the reason for admission if confirmed during the admission as the primary cause for admission and chest x-ray excluded pneumonia. Where possible, patients were visited during the hospital stay by the PEPR physiotherapist to explain PR but if this was not possible they were telephoned at home, after discharge, by the PEPR physiotherapist. All patients were offered funded taxi transport to and from the programme.

PR programme design

PEPR was delivered as an 8 week, twice weekly, rolling out-patient programme running 2 sessions a week comprising one hour of exercise and one hour of education/discussion to support self-management goals. The exercise programme comprised limb strengthening and aerobic activities, tailored to individual baseline function, and was augmented with a home exercise programme. Interventions to optimise patient care, including exacerbation management were considered as integral to the programme.

Outcome measures

Patient demographics (age, gender) and measures of disease severity: FEV_1, FVC, Medical Research Council (MRC) Dyspnoea Scale (Fletcher et al, 1959), maintenance medication, long term oxygen therapy (LTOT), smoking status, co-morbidities, and number of admissions in the previous year were recorded. Referral details, uptake, PEPR completion, re-admission within 90 days, and standard PR outcomes: 6-Minute Walk Test (6MWT) (ATS, 2002), Hospital Anxiety and Depression Score (HADS) (Zigmond and Snaith, 1983), and Chronic Respiratory Disease Questionnaire (CRDQ) (Guyatt et al, 1987) were collected prospectively. The COPD Assessment Test (CAT) (Kon et al, 2014) was added mid-way through the service evaluation. PEPR completion was defined as attendance at > 7 of 16 sessions to maintain consistency with criteria used by Seymour at el (2010).

Statistics

Recruitment, uptake, demographics and outcome data was recorded contemporaneously in Microsoft Excel. In line with our standard practice for pulmonary rehabilitation programmes, PR outcomes were reported against the minimal clinical important difference (MCID) for each with results given as median (range) due to the small numbers of patients involved. A retrospective analysis of 90 day readmission rates for patients offered PEPR, comparing those taking up a place on PEPR with those unable to take up a place, was conducted using the Mann-Whitney U Test to compare differences between these two independent groups, and using Minitab statistical package.

Results

Patients were considered for PEPR over a continuous 18 month period.

Demographics

The demographics for patients referred to PEPR, starting PR and compared to the study by Seymour et al (2010) are given in Table 1.

Outcome	All referrals (n = 43)	PEPR starters (n = 31)	PEPR non-starters (n = 12)	Seymour et al (2010) (n = 30)
Age (years)	67(9)	68(10)	65(6)	67(10)
M:F	23:20	18:13	5:7	13:17
FEV_1 (L)	0.82(0.40)	0.83(0.43)	0.78(0.3)	1.2(0.40)
FEV_1 % predicted (%)	32(15)	34(17)	30(9)	52(20)
MRC (n)	4.02(0.77)	4.06(0.85)	3.92(0.51)	3.6(0.80)
LTOT n(%)		5 (16)		Not given
Smoking status – current n(%)		6 (19)		11 (37)

Figures given are mean(SD) unless otherwise indicated

Key M: male, F: female, FEV_1: forced expiratory volume in 1 second, MRC: Medical Research Council dyspnoea scale, LTOT: long term oxygen therapy, SD: standard deviation.

Table 1: Patient baseline demographics referred to, and starting PEPR, and from the Seymour et al, 2010 paper for comparison.

Referral, uptake and completion

Forty-three patients referred to pulmonary rehabilitation during an in-patient admission for AECOPD were offered a place on PEPR programme; 31 (72%) accepted and attended a first appointment, 12 declined or did not attend a first appointment. All patients were offered a PR start date within 10 days of discharge from hospital but due to a range of social factors the median (range) time between discharge from hospital and starting PEPR was 8 (0 – 17) days with 22 of 31 patients starting within 10 days. All patients were offered taxi transportation to the programme and all patients attending first assessment did so by taxi; 1 patient subsequently attended by bus. Completion rate for PEPR was 74% (23/31) of patients assessed and 53% (23/43) of patients referred.

90-day re-admission

14 (45%) patients who started PEPR were re-admitted within 90 days with a primary respiratory condition. One further admission was due to a myocardial infarction. For those who declined PEPR, 7/12 (58%) were readmitted within 90 days. This compares to a 39% 90-day re-admission rate for all AECOPD admissions to this hospital in the same year. The post hoc analysis with Mann-Whitney U test showed no statistically significant difference (p = 0.52) between the lower re-admission rate for the patients starting PEPR compared to those who declined PR.

Clinical outcomes

Standard PR outcomes for exercise capacity and health related quality of life are given in Tables 2 and 3. The only clinical significant improvement was a median change following PR in the CRDQ dyspnoea domain which was greater than the known MCID of the domain score, 0.5; CRDQ

dyspnoea domain with median (range) improvements from baseline of 0.79(-0.6 – 3.0) units. Twelve patients were started on medication to manage an exacerbation.

Median (range)	Pre	Post	change
6MWT n = 20	140 (30 – 360)m	190 (60 – 315)m	22.5 (-60 – 130)m
CAT n = 13	22(9 – 31)	19(9 - 28)	-2(-18 - 14)
CRDQ-D n = 18			0.79 (-0.6 – 3.00)
CRDQ-F n = 18			0.38 (-3.0 – 3.0)
CRDQ-EF n = 18			0.29 (-3.43 – 4.29)
CRDQ-M n = 18			0.13 (-2.5 – 3.25)
HADS-A n = 17	5 (0 – 19)	5 (0 – 19)	
HADS-D n = 17	6 (2 – 13)	6 (2 – 13)	

[6 MWT six minute walk test; CAT COPD assessment test; CRDQ Chronic respiratory disease questionnaire -D dyspnoea, -F fatigue, -EF emotional function, -M mastery domains; HADS Hospital Anxiety and Depression scale -A anxiety, -D dyspnoea domains]

Table 2: 6MWT and CAT score pre and post PEPR for local PEPR cohort.

HADS-A	**0 -7**	**8 -10**	**11+**
Pre PEPR	10	3	4
Post PEPR	13	2	2
HADS-D	**0 -7**	**8 -10**	**11+**
Pre PEPR	11	3	3
Post PEPR	11	4	2

[Where 0 – 7 indicates no significant symptoms, 8 – 10 doubtful, 11+ likely significant symptoms]

Table 3: Number of patients by category for HAD anxiety and depression raw scores pre and post pulmonary rehabilitation.

Discussion

Summary of main findings

This study demonstrates successful recruitment of patients with severe and very severe COPD into pulmonary rehabilitation, when offered to start within 10 days of hospital discharge following an AECOPD. Completion rates were in excess of the 40% that was reported in the much larger study by Hogg et al (2012) . However, the expected improvements in exercise capacity and HRQoL were more limited than those for standard PR programmes (Puhan et al, 2011) or those published by Seymour et al (2010).

The disease severity of patients recruited to PEPR in this study was greater than reported in the study by Seymour at al (2010) but the impact of PEPR on decreasing re-admission rates was not observed. In this study, 90 day re-admission rate increased compared to the average rate documented in that year for all patients admitted for an AECOPD in the referring hospital.

The control group of AECOPD patients who declined PEPR did have a higher 90 day all reasons readmission rate compared to the PEPR group (58% v 45% respectively) but the difference was statistically non-significant. This observation may warrant further investigation to determine if it is sustained with groups of equivalent and larger numbers.

Strengths and limitations

The data is derived from a service evaluation with small numbers, a retrospective analysis of outcomes, and was not a randomised controlled trial. However, the use of the same outcome measures used in the published RCT by Seymour at al (2010) enabled a structured approach to evaluating the reproducibility of 90 day re-admission reduction with PEPR.

Review of existing literature

The primary aim of this evaluation was to pilot local provision of PEPR and benchmark the outcomes against the best available published data. The potential importance of PEPR relates primarily to the possibility of reducing re-admission rates given that, following an AECOPD, patients are at increased risk of re-exacerbation and hospitalisation (NICE, 2010; Alrawi et al, 2008; Price et al, 2006). Readmission is associated not only with increasing severity of disease and poorer quality of life, but also has implications for hospital resource utilisation. Further, this observation appears to be a national problem, and prior to the PEPR evidence, there appeared to be no intervention that could improve the average 90 day readmission rate of approximately 30% post AECOPD (Alrawi et al, 2008; Price et al, 2006).

In this service evaluation there was no observable reduction in readmission rates following PEPR. On the contrary, the readmission rate in this group was higher than the national average and even higher than our local readmission rate (39%) following hospitalisation for AECOPD. This observation may be explained by the markedly more severe COPD in the patient population who had severe and very severe COPD (NICE, 2010), compared to the patients studied by Seymour et al (2010) who had moderate and severe disease. Similarly MRC scores for our patient population were 4.02(±0.77) compared to 3.6 (±0.8) in the comparison study (Seymour at al, 2010).

Of the standard clinical outcome measures used for PR, only the median change in CRDQ dyspnoea component achieved the minimal clinical important difference (MCID) of a 0.5 or greater increase (Curtis & Patrick, 2003), although the median improvement in CAT score, at more

than 2, also indicates a likely clinically significant change (Kon et al, 2014). However spontaneous improvement of symptoms following admission over 60 days has previously been reported, in the absence of further PEPR (Parker et al, 2005). With respect to 6MWT outcome, for patients with severe COPD a MCID of 26m +/- 2m has been reported (Puhan et al, 2011b) with data from the same study reporting a mean (±SD) change post PR of only 22.8 (±53.6)m in a population of 1217 patients suitable for lung volumes reduction surgery (mean(±SD) FEV_1% 26.9(±7.1)%). This may indicate a decreasing likelihood of PR leading to marked improvement in walking distance with increasing severity of COPD. Regardless however, given the reported expectation of spontaneous improvements during the time period of PEPR, it can be questioned whether the standard outcomes for PR remain relevant for PEPR cohorts.

The median HAD score, was below the clinically important range suggesting that this was a group of patients with no symptoms of anxiety or depression. Closer analysis of the data by category (Table 3) however, indicates that for individual patients with clinically symptomatic baseline scores, there was a trend towards improvement in anxiety but not for depression in symptomatic individuals.

Implications for future research and clinical practice

Uptake (71%) and completion rates (53%) exceeded those of published completions rates of 40% (Hogg et al, 2012). This might be explained by the offer of fully subsidised taxi transport to PR sessions. Benzo et al (2015), in a much larger study (n = 772) identified 69% of patients were not interested in post discharge PR and discuss the need for "customizing the type of intervention in the post-hospitalization period"; funded taxi transportation to PR may be one way to improve uptake and adherence to PR particularly in our inner city location.

Assuming PR is considered important post hospital admission, we considered how feasible it would be to include these post discharge patients in a conventional rolling PR programme. As compared with our experience of conventional PR the patients in this study had markedly reduced functionally demonstrated lower limb strength e.g. participant unable to stand from chair without assistance, and higher levels of disabling breathlessness and so needed a greater degree of assistance and supervision to safely engage in exercise; we used a staff: patient ratio of 2:4 with no safety incidents. The finding by Seymour et al (2010) that "quadriceps muscle strength is increased by PEPR and may, at least in part, underlie the observed increase in exercise capacity" was echoed in our clinical observations; patients on the PEPR programme became functionally more independent and more able in those exercises requiring improved lower limb large muscle strength e.g. getting up from sitting and step ups, as they progressed through PR.

Conclusion

This service evaluation of PEPR failed to demonstrate the previously reported reduction in 90 day re-admission rates. Well evidenced improvements in standard functional and quality of life outcome measures associated with completion of PR were also not achieved in this group of patients. Both these observations may, at least in part, be explained by the worse disease severity of the group of COPD patients recruited, reflecting too, the severity of disease associated with hospitalisation for AECOPD.

It is possible that, while patients being managed for AECOPD who have less severe disease and have not previously done PR should be fast tracked into a PEPR programme (i.e. post

exacerbation pulmonary rehabilitation), this recommendation should not be globally applied as post *discharge* pulmonary rehabilitation (PDPR) until further RCT studies have evidenced its effect in severe and very severe COPD patients following hospitalisation for AECOPD.

Key points

- Post discharge pulmonary rehabilitation can be safely delivered to patients with severe and very severe COPD following discharge from hospital after AECOPD but may need higher staffing rations
- Assumptions relating to reduced readmission rates should be confirmed by audit
- Consideration needs to be given to PR outcomes for patients enrolled into PR post exacerbation given documented improvement in symptoms (without PR)

Ethical Approval

The study was registered as an audit of service development with the Whittington Health Clinical Effectiveness and Audit Department. Patients were not randomised or allocated to receive one treatment or another but were offered PEPR as it was delivered at the time of referral to PR. The subsequent retrospective study of outcomes involved analysis of existing data and was designed and conducted to inform delivery of best care. Research Ethics Committee approval was therefore not required as defined by National Research Ethics Board.

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L Restrick, Consultant Physician, Dept., Respiratory Medicine, Whittington Health.

Conflict of interest

None.

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Evaluating current physiotherapy airway clearance management for Bronchiectasis patients admitted for intravenous antibiotics

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Introduction

A variety of airway clearance techniques (ACTs) have been endorsed for patients with bronchiectasis (Bx). Research has shown ACTs are safe for stable patients but there is limited evidence into the impact of ACTs on unstable Bx. The purpose of this research was to firstly evaluate current physiotherapy airway clearance management for patients admitted with unstable Bx. Secondly, to analyse whether ACTs are altered during the admission alongside patient reported outcome measures.

Method

Patients admitted with an exacerbation completed a physiotherapy assessment alongside a visual analogue scale (VAS) for ease of clearance (EOC) and Leicester cough questionnaire (LCQ) on admission and discharge. Changes in ACTs and the clinical reasoning behind each change was recorded.

Results

Twenty patients were included (Table 1). Eighty percent had their technique altered from admission to discharge (figure 1 & 2) in parallel with a statistical improvement in their LCQ and EOC VAS (Table 2). The most common reason for changes to ACTs was 'sticky lower lobe secretions'.

Table 1: Demographic data

N=20	Median (IQR)
Age	58 (46-71)
Male/Female	3/17
Length of stay	11 (10-12)
FEV1	1.28 (0.78-2.19)
FVC	2.48 (1.91-3.12)

Table 2: Median differences in outcome measures pre and post admission

	Median (IQR) pre score	Median (IQR) post score	Wilcoxon Z score
LCQ	66 (51-89)	86 (75-102)*	-2.778
EOC VAS	4.3 (2.2-7.9)	7 (6-8.4)*	-3.828

*p>0.005

Figure 1: ACT on admission

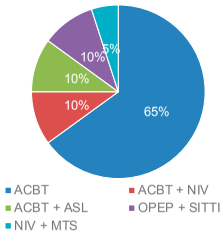
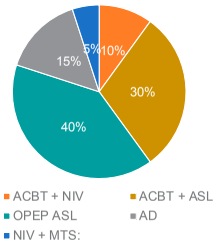


Figure 2: ACT on discharge



Conclusion & Summary

Previous studies have shown ACBT is a prominent ACT. However, our results suggest ACBT is rarely used in isolation. A large proportion of patients were advised to complete mPD. Evidence suggests mPD is effective but often unpopular; therefore further follow up should be completed to ascertain if this remains suitable for the patient during stability.

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BTS Guideline for non-CF bronchiectasis (2010): Thorax, Vol 65

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Recording breathing patterns using a contactless optical device (Structured Light Plethysmography (SLP))

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Introduction

New non-invasive technologies have been developed to assess respiratory motion. Structured Light Plethysmography (SLP) (Figure 1) is a fully contactless device which uses PC gaming techniques. A grid pattern is projected onto individuals' chest area to record chest wall motion. However there is no evidence regarding the measurement validity of SLP under different breathing conditions.

Purpose

To examine the measurement validity of SLP by comparing recordings at rest and after 10 minutes of submaximal exercise with the reference standard device Respiratory Inductive Plethysmography (RIP)

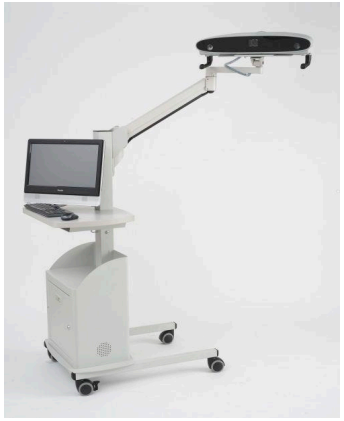


Figure 1: Structured Light Plethysmograph

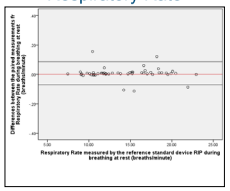
Methods

50 heathy adults (30 males) with mean age 29 years (SD 6.79) were recruited. Simultaneous breathing pattern recordings were taken from RIP and SLP at rest and after ergometry exercise. Examined breathing parameters were: 1) Inspiration and Expiration times, 2) Respiratory Rate, 3) Inspiration and Expiration Assumed volumes and 4) Regional contributions to chest wall movement. Bland and Altman plots (plus 95% limits of agreement) were used to examine measurement agreement between the devices. Paired-sample T-tests were used to look for significant differences between the measurements under each breathing condition. Breath-by-breath analysis was also performed to examine whether breathing pattern variability could affect the measurement agreement of the devices.

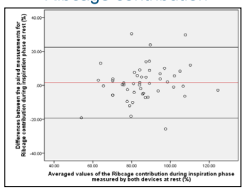
Results

At rest

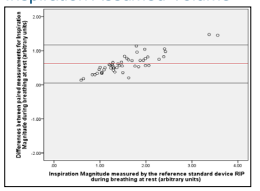
Respiratory Rate



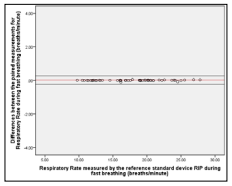
Ribcage contribution

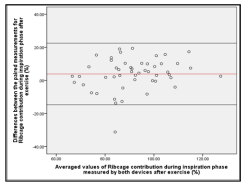


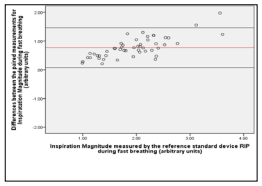
Inspiration Assumed Volume



After exercise







Conclusions

- Good agreement was found for timing parameters before and after exercise
- Good agreement was found between the devices for all regional contributions to the chest wall motion at rest, but not after exercise.
- When "customised" regional contributions from SLP were compared to respective measurements from RIP, closer agreement between devices was found.
- Low agreement was found for both inspiration and expiration assumed volumes at rest and after exercise.

SLP is a valid device to record timing parameters and regional contributions to the chest wall motion at rest, but not assumed volumes

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