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Introduction

Welcome to Volume 52 Issue 1 for the Journal of the Association of Chartered Physiotherapists in Respiratory Care. We continue to be very grateful to our authors for submitting their work to the journal and also to our reviewers in giving their time in providing feedback. We are especially grateful this year with the challenges that COVID has brought.

Within the journal we intend to reflect the diversity of areas in which respiratory physiotherapists work and this edition includes a mix of service evaluations, original research and a commentary piece. Simon Hayward et al. report on a service evaluation in using thoracic ultrasound to diagnose the cause of an opaque hemithorax when patients are referred for physiotherapy; Holly Morris and Geraldine Latchem-Hastings report on a qualitative study exploring final year physiotherapy students’ experiences of early mobilisation and rehabilitation for the critically ill patient; Angharad Volk et al. present a quality improvement project on enhancing early post-operative physiotherapy input to those undergoing oesophagectomy and Lucy Gardiner et al. report on a service evaluation on dance-based versus conventional exercise in pulmonary rehabilitation. There is also a commentary piece by Helen Sanger which considers the questions of How early is early? When should rehabilitation begin in critical illness? We really hope that you enjoy reading this issue of the ACPRC journal as much as we have as editors.

In April 2021 it is our biennial ACPRC conference which is to be held on 23rd and 24th April, so save the date in your diaries now! There will be a call for abstracts in the Autumn and will be inviting those related to both research and service evaluations. As we did in 2019 it is our intention for the posters presented at the conference to be included in a journal supplement, and we are always keen for authors to develop their poster presentations into an article for submission to the journal. Please do get in touch if you would like to discuss ideas further.

We really hope that you enjoy reading this issue of the ACPRC journal and hope that it inspires you to write up your work. To increase the flexibility for authors, we are now accepting submissions to the journal at any time throughout the year. Please remember that we provide members with support through the Research Officer and there are also writing guidelines for authors which are all available on the website www.acprc.org.uk.

With our very best wishes,

Amy Bendall (MSc. MCSP) and Laura Moth (MSc. MCSP).

Email: journal@acprc.org.uk.
Thoracic ultrasound to differentially diagnose the cause of an opaque hemithorax (whiteout) when patients are referred for respiratory physiotherapy: A service evaluation

Simon Hayward¹, Lisa Hayward¹, Chloe Tait¹, Nicola Williams¹, David Seddon¹ and Jemma Gidden¹

Abstract

Purpose
An opaque hemithorax commonly termed a ‘whiteout’ on chest radiograph (CXR) often results in a referral for urgent respiratory physiotherapy. This referral assumes that sputum plugging of either main bronchus has resulted in a whole lung collapse. There are, however, many alternative causes of an opaque hemithorax that would not respond to physiotherapy treatment. Referring medical professionals often use the position of the mediastinum, or more specifically the trachea on CXR to identify the cause of an opaque hemithorax but this may not be a reliable method. Thoracic ultrasound (TUS) could be used to better differentiate between the pathologies causing an opaque hemithorax prior to any physiotherapeutic interventions. We predict that TUS is more accurate than CXR alone in assisting respiratory physiotherapists to differentiate between the pathological causes of an opaque hemithorax.

Method
This service evaluation was undertaken within the acute hospital setting and included all patients referred for chest physiotherapy that had presented with an opaque hemithorax on CXR within the six-month evaluation period. A member of the investigating team performed a TUS scan within an hour of the referral. A respiratory physiotherapy treatment was performed where clinically indicated or if not indicated the patient was referred back to the referring clinician. Data collected included: the side of the opaque hemithorax and direction of any tracheal
shift; documented reason for referral to physiotherapy; TUS scan findings; final medical team findings and the patient’s treatment or management plan.

Results
A total of nine patients were included in this service evaluation within the 6-month evaluation period. Five of the referrals (56%) presented with ipsilateral shifts. The remaining CXRs showed the tracheas to be in a central position. None of the patients referred showed a contralateral shift. The main documented reason for a referral for respiratory physiotherapy in these nine cases was ‘sputum plugging’, ‘consolidation’ or ‘lung collapse’. The primary findings on TUS were pleural effusion (44%), atelectasis (22%), consolidation (22%) and empyema (11%). In four cases the TUS findings highlighted that respiratory physiotherapy treatments remained indicated. In five cases the TUS scans highlighted findings that were not immediately amenable to respiratory physiotherapy. At the time of writing eight of the patients had not survived to the end of the six-month evaluation period.

Discussion
No referral was received by physiotherapy to review a patient with a contralateral shift. This suggests that the referring clinicians are using the position of the trachea on CXR as a way to justify the need for a respiratory physiotherapy referral. The use of the position of the trachea on CXR to accurately determine pathology and clinically justify the need for a physiotherapy referral appears to be unreliable. In our evaluation, sputum plugging and pleural effusions have both caused ipsilateral and central tracheal positions. The use of physiotherapy-initiated TUS has allowed five patients to avoid receiving inappropriate treatments. Alternate medical techniques such as pleural drain insertion, advanced imaging and palliation were employed to manage the patient’s clinical condition. One aspect of this service evaluation that was not predicted prior to its commencement was the mortality rate in these nine patients. Eight of them did not survive to the end of the six-month data collection period. Physiotherapists can use TUS to more accurately identify the causes of an opaque hemithorax prior to the initiation of physiotherapy treatments or limit delays in alternative treatment when physiotherapy is not indicated.

Introduction
An opaque hemithorax, commonly termed a ‘whiteout’ on chest radiograph (CXR) often results in a referral for urgent respiratory physiotherapy due to patient respiratory compromise. This referral assumes that sputum plugging of either main bronchus has resulted in a whole lung collapse. The subsequent physiotherapy treatment consists of sputum removal followed by lung re-expansion. There are, however, many alternative causes of an opaque hemithorax that would not respond to physiotherapy treatment. Making a
differential diagnosis of an opaque hemithorax by CXR alone (Figure 1) proves difficult as it can be caused by pathologies of pleural, parenchymal, diaphragmatic and mediastinal origin (Table 1) (Wu et al. 1989; Yu et al. 1993; Hayward and Hayward 2019).

Figure 1: Chest radiograph showing a left sided opaque hemithorax with ipsilateral shift.

Table 1: Potential causes of an opaque hemithorax (Hayward and Hayward 2019).

<table>
<thead>
<tr>
<th>Pleural effusion</th>
<th>Chylothorax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphyema</td>
<td>Mucus plugging</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>Cyst</td>
</tr>
<tr>
<td>Consolidation</td>
<td>Main bronchus intubation</td>
</tr>
<tr>
<td>Endobronchial mass</td>
<td>Pneumonectomy</td>
</tr>
<tr>
<td>Extrabronchial mass</td>
<td>Diaphragmatic compromise</td>
</tr>
<tr>
<td>Haemothorax</td>
<td>Foreign body occlusion</td>
</tr>
<tr>
<td>Agenesis (including hypoplasia and aplasia)</td>
<td>Bronchial stenosis</td>
</tr>
</tbody>
</table>
Referring medical professionals often use the position of the mediastinum, or more specifically the trachea on CXR to identify the cause of an opaque hemithorax (Murfitt 2002). A shift of the trachea towards the side of the opaque hemithorax (ipsilateral shift) is thought to indicate a main bronchus plug and lung collapse therefore justifying a referral to physiotherapy. A recent review highlighted that even when a tracheal shift is present it does not appear to be a reliable way to identify the underlying cause of an opaque hemithorax (Hayward and Hayward 2019). This presents a problem when, unbeknown to the physiotherapist, they may be referred a patient who has a clinical condition that will not respond to physiotherapy interventions.

Thoracic ultrasound (TUS) has the potential to more accurately differentiate between pulmonary pathologies and could be used to better differentiate between pathologies causing an opaque hemithorax prior to any physiotherapeutic interventions (Winkler et al. 2018) (Figure 2). A TUS scan performed by either the referring professional or the attending physiotherapist themselves would assist clinicians in identifying those patients with conditions amenable to physiotherapy interventions. The benefits of using a more accurate diagnostic approach would be two fold. Firstly, the patient would not experience any delay in receiving the appropriate treatment. Secondly, an inappropriately referred patient would not undergo any unnecessary, and potentially harmful, physiotherapy treatments.

The aim of our service evaluation was to establish if LUS assisted physiotherapists to identify the cause of an opaque hemithorax to a greater extent than CXR when patients were referred for respiratory physiotherapy.

![Thoracic ultrasound scan of the left upper anterior chest wall (patient sitting upright) showing pleural effusion and compression atelectasis of the lung.](image-url)
Methods

This service evaluation had a prospective design including all patients referred within the six-month service evaluation period (1st February to 1st August 2018). This evaluation period was deemed a realistic target considering no additional funding or resources were received for this evaluation.

Data was collected from patients referred for in-patient respiratory physiotherapy across specialties at Blackpool Victoria Hospital presenting with an opaque hemithorax on CXR. Acute in-patient specialities included medicine, surgery, orthopaedics, neurology, paediatrics and cardiothoracics. Other patients within the hospital that presented with opaque hemithoraces but were not referred for respiratory physiotherapy were not evaluated. The physiotherapist receiving the medical team referral contacted a member of the project team to inform them of the referral. A member of the project team trained in thoracic ultrasound (SH, LH, NW or CT) then accompanied the physiotherapist to review the patient. Once consent was gained verbally, or a decision to treat the patient in their best interests was made, a TUS scan was completed to assist in identifying the cause of the opaque hemithorax. If indicated, a respiratory physiotherapy treatment was performed. If no physiotherapy treatment was indicated the findings from the new TUS were reported back to the referring clinician. It was planned that if no TUS trained clinicians were available to complete a TUS scan, then the attending physiotherapist treated as they assessed clinically appropriate so as not to delay treatment to the patient.

The physiotherapists performing the TUS scans have gained accreditation to perform TUS through the Intensive Care Society (United Kingdom) Focused Ultrasound in Intensive Care (FUSIC) programme and have two years’ experience of performing TUS.

Data collected included: the patient’s CXR showing the side of the opaque hemithorax and direction of any tracheal shift, documented reason for referral to physiotherapy, TUS scan findings, final medical team findings and the treatment or management strategy for the patient following all investigations for the opaque hemithorax. The cause for each of the opaque hemithorax was established retrospectively from the medical notes.

Results

A total of nine patients were included in this service evaluation. These referrals were received within the 6-month evaluation period (1st February to 1st August 2018). To the best of the authors’ knowledge these were the only patients in the hospital presenting with an opaque hemithorax on CXR and referred for respiratory physiotherapy during this time period (Table 2).
Table 2: Summary of presentation, findings, treatment and outcome of patients.

<table>
<thead>
<tr>
<th>‘Whiteout’ on CXR</th>
<th>Tracheal shift</th>
<th>Reason for PT referral</th>
<th>TUS findings</th>
<th>Medical findings</th>
<th>Treatment/ management</th>
<th>Patient died</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Ipsilateral</td>
<td>Sputum plug</td>
<td>Pleural effusion</td>
<td>Pleural effusion</td>
<td>Pleural drain</td>
<td>No</td>
</tr>
<tr>
<td>Right</td>
<td>Ipsilateral</td>
<td>Sputum plug</td>
<td>Pleural effusion</td>
<td>Endobronchial mass</td>
<td>Pleural drain</td>
<td>Yes</td>
</tr>
<tr>
<td>Left</td>
<td>Ipsilateral</td>
<td>Consolidation</td>
<td>Consolidation</td>
<td>Pneumonia</td>
<td>Physiotherapy</td>
<td>Yes</td>
</tr>
<tr>
<td>Right</td>
<td>Ipsilateral</td>
<td>Consolidation</td>
<td>Consolidation</td>
<td>Pneumonia</td>
<td>Physiotherapy</td>
<td>Yes</td>
</tr>
<tr>
<td>Left</td>
<td>Ipsilateral</td>
<td>Lung collapse</td>
<td>Atelectasis</td>
<td>Sputum plugging</td>
<td>Physio/Bronch</td>
<td>Yes</td>
</tr>
<tr>
<td>Right</td>
<td>Central</td>
<td>Lung collapse</td>
<td>Empyema</td>
<td>Pleural effusion</td>
<td>Palliation</td>
<td>Yes</td>
</tr>
<tr>
<td>Left</td>
<td>Central</td>
<td>Sputum plug</td>
<td>Pleural effusion</td>
<td>Pleural effusion</td>
<td>Palliation</td>
<td>Yes</td>
</tr>
<tr>
<td>Left</td>
<td>Central</td>
<td>Sputum plug</td>
<td>Pleural effusion</td>
<td>Extrabronchial mass</td>
<td>CT→Palliation</td>
<td>Yes</td>
</tr>
<tr>
<td>Left</td>
<td>Central</td>
<td>Lung collapse</td>
<td>Atelectasis</td>
<td>Sputum plugging</td>
<td>Physio/Bronch</td>
<td>Yes</td>
</tr>
</tbody>
</table>


Five of the referrals (5/9) presented with ipsilateral shifts with tracheas deviated towards the side of the opaque hemithorax, which has historically indicated volume loss/lung collapse. The pathologies that resulted in these ipsilateral shifts were two patients with pleural effusions, one with atelectasis due to sputum plugging and two patients with pneumonic consolidation. The remaining CXRs show the tracheas to be in a central position (4/9), which has historically indicated a lack of lung volume change. The pathologies resulting in these central tracheal positions were an empyema, two pleural effusions and atelectasis due to sputum plugging. None of the patients referred had a CXR showing a contralateral shift where the trachea deviates away from the side of the opaque hemithorax (Figure 3).

The main documented reasons for a referral for respiratory physiotherapy in these nine cases were sputum plugging, consolidation or lung collapse (Table 2).

All nine patients underwent a TUS scan within an hour of the referral for respiratory physiotherapy. In order of frequency, the primary findings on TUS were pleural effusion (4/9), atelectasis (2/9), consolidation (2/9) and empyema (1/9) (Table 3). The results of the TUS scans were reported to the medical teams who originally referred the individual patients. In four cases the TUS findings highlighted that physiotherapy treatments remained indicated and interventions were provided. In five cases the TUS scans highlighted findings that were not immediately amenable to chest physiotherapy such as pleural effusions and empyema. More advanced imaging investigations requested by the medical teams confirmed the TUS findings and highlighted additional underlying causes of the opaque hemithorax (Table 2).

Of the nine cases, four received respiratory physiotherapy treatment with two of these requiring escalation to a bronchoscopy to facilitate tenacious sputum removal; three cases
had an inter-pleural drain inserted to manage a pleural effusion or an empyema and two of the patients were started on end-of-life care. At the time of writing eight of the patients had not survived to the end of the six-month evaluation period.

![Diagram](image)

**Figure 3:** Tracheal positions on chest radiograph and final differential diagnosis.

**Table 3:** Causes of the nine opaque hemithoraces referred for physiotherapy.

### Discussion

The use of CXR to accurately differentiate between the causes of an opaque hemithorax has previously been questioned by Wu et al. (1989) and Yu et al. (1993). The use of the position of the trachea on CXR to accurately determine pathology and clinically justify the need for a respiratory physiotherapy referral also appears to be unreliable (Yu et al. 1993). In our evaluation all nine of the CXRs presented with an ipsilateral (5/9) or central (4/9) tracheal position. No referral was received by physiotherapy to review a patient with a contralateral shift. This suggests that the referring clinicians may be using the position of the trachea on
CXR, along with the clinical picture, as one way to justify or exclude the need for a respiratory physiotherapy referral.

As can be seen from Table 2, our small patient group does not fit the historical pattern of tracheal position being associated with an underlying pathology causing the opaque hemithorax. In our evaluation sputum plugging and pleural effusions have both caused ipsilateral and central tracheal positions. Our patient group appears to substantiate the findings of Yu et al. (1993) and Wu et al. (1989) that using this method of differential diagnosis is unreliable. This may however just be a coincidence and more data from more opaque hemithoraces could be collected as part of a larger evaluation in the future.

It appears from our small patient group that only four of the nine patients had the potential to respond to physiotherapy interventions. The remaining five patients would have received unnecessary and ineffective physiotherapy treatments when the causes of the opaque hemithorax were due to pleural effusions or empyema. The use of physiotherapy-initiated TUS has allowed five patients to avoid receiving inappropriate treatments and instead facilitated well-timed clinically appropriate interventions. For the four patients with the potential to respond to physiotherapy, treatment was initiated in confidence knowing that the opaque hemithorax was most likely caused by whole lung atelectasis or consolidation, with other confounding pathologies having been ruled out.

Since the six-month period for this service evaluation there has been an informal change in how the acute in-patient physiotherapy team manage patients referred with an opaque hemithorax on CXR. If any acute in-patient area receives a referral for a ‘whiteout’ the receiving physiotherapist will contact one of the TUS accredited physiotherapists if there are any doubts about the potential cause of the patients ‘whiteout’. There are ongoing discussions regarding integrating TUS into the management of patients presenting with an opaque hemithorax, while balancing this with avoiding delays to potentially important time-sensitive physiotherapy interventions as part of a hospital trust quality improvement project.

The final diagnosis as to the most likely cause of the opaque hemithorax for each patient was taken from either the patient’s hospital discharge letter or the notification of death sent to the patient’s family doctor or general practitioner. Considering all of these patients had originally been referred for pathologies thought to be amenable to physiotherapy treatments, the medical findings show that only four of these were correct. The remaining five were beyond the scope of physiotherapy treatment with some needing further investigations for potentially serious pathology. Following the use of TUS by physiotherapy to differentiate between lung pathologies causing the opaque hemithorax, alternate medical techniques such as pleural drain insertion, advanced imaging and palliation were employed to manage the patient’s clinical presentation. Without the use of TUS, it is possible some of these important decisions could have been delayed for many hours, if not days, resulting in potentially worse patient outcomes.
One aspect of this case series that was not predicted prior to its commencement was the mortality rate in these nine patients. It was understood prior to the initiation of data collection that an opaque hemithorax was a serious clinical finding on CXR, although it was not appreciated how potentially fatal this finding could be. Nine patients were referred for physiotherapy with an opaque hemithorax but eight of them did not survive to the end of the six-month data collection period. It would appear from our cohort that an opaque hemithorax on CXR is a clinical finding that represents the latter stages of some serious life limiting pathologies.

No funding was secured for this service evaluation, which has resulted in some limitations such as a small sample size of only nine patients. There is also potential inter-rater variability due to different physiotherapists performing the TUS scans.

**Conclusion**

It would appear that referring clinicians could be using the position of the trachea on CXR as an indication for a referral to physiotherapy. However, this method does not appear to accurately differentiate between underlying pathologies. As we predicted, physiotherapists can use TUS to more accurately identify the causes of an opaque hemithorax in order to confidently initiate physiotherapy interventions or limit delays in alternate treatment being provided when physiotherapy is not indicated.

**Key points**

- Caution should be used when using the position of the trachea to differentiate the underlying causes of an opaque hemithorax.
- Appropriately trained physiotherapists can use TUS to differentiate between the causes of an opaque hemithorax.
- Further work needs to be completed around how physiotherapy-initiated TUS will fit patient pathways when managing an opaque hemithorax.

**Contributions**

SH developed the service evaluation methodology. All authors were involved in performing patient scans. SH wrote the manuscript, LH, CT, DS and NW provided feedback on manuscript structure and content.

**Acknowledgements**

Thanks go to the physiotherapy department, critical care teams and the library services at Blackpool Teaching Hospitals NHS Foundation Trust.

**Ethical Approval**

Following application to Blackpool Teaching Hospitals NHS Foundation Trust R&D department ethical approval was not required for this service evaluation.

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References


An exploration of final year physiotherapy students’ experiences of early mobilisation and rehabilitation for critically ill patients during practice education

Holly Morris¹ and Geraldine Latchem-Hastings²

Abstract

Background
Rates of mortality following critical illness are continually improving. With this comes an increasing need to focus on these patients outcomes following discharge from the intensive care unit (ICU). Historically, bed rest was prescribed for these patients. However, in recent years research recognised the adverse effects of prolonged immobility on multiple body systems, particularly its potential impact upon longer-term quality of life. In 2009, the National Institute of Clinical Excellence (NICE) recognised the potential clinical and economical gains associated with early physical rehabilitation. Evidence-based guidelines have been published to recommend rehabilitation starts as early as clinically possible. However, currently there is significant variation in the provision of rehabilitation across ICU sites. Opportunities are available for Cardiff University BSc Physiotherapy students to undertake clinical placement within the ICU setting, presenting a unique opportunity to explore the experiences of those students during the rehabilitation of critically ill patients, across multiple Welsh ICU sites. Additionally, this data can be utilised to assess current rehabilitation practice across ICU sites and inform the ongoing development of the undergraduate respiratory curriculum.

Research question
What are final year physiotherapy students’ experiences of early mobilisation and rehabilitation for critically ill patients during practice education?

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Keywords
Early rehabilitation, ICU, critical care, physiotherapy.

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Accepted for publication in 2019, and this is reflected by the references selected for the paper.
Introduction

In 2016/17 there were 9,280 admissions to Intensive Care Units (ICUs) across Wales. Mortality rates following critical illness are continually improving, with 84% of these admissions surviving to the point of discharge (Welsh Government 2017). Historically, bed rest was prescribed for critically ill patients due to the severity of illness, this combined with the administration of sedative drugs led to the assumption that higher levels of physical activity would be impractical or non-feasible (Brower 2009). However, research has begun to recognise the catastrophic physical and psychological consequences prolonged immobility may pose to patients (King and Gratrix 2009; McWilliams et al. 2018). Thus, the term survivorship has emerged as a major issue within intensive care medicine (Connolly et al. 2014; Fan et al. 2014). This emphasises the importance of patients’ longer-term quality of life (QoL) following critical illness with rehabilitation goals that now extend past just survival (Iwashyna et al. 2012; Engel et al. 2013). Therefore, the topic of early rehabilitation is one that has received significant attention within health literature (Adler and Malone 2012; GPICS 2015). With emerging evidence supporting early physical rehabilitation as both a safe and feasible means of improving long-term QoL for patients post ICU-discharge (McWilliams et al. 2018). The potential clinical and economical gains of early physical rehabilitation have

Methodology

Qualitative, interpretive methodology was used to collect data via two focus groups with a total of seven Cardiff University final year physiotherapy students. Ethical approval was granted in July 2017 by the Cardiff University School of Healthcare Sciences Ethics Committee. Thematic analysis was utilised to analyse the data devising themes and sub themes ready for discussion.

Results

Four main themes were identified (1) Role of the physiotherapist in ICU, (2) Teamwork, (3) Barriers and (4) Evidence-based practice.

Conclusion

At present there is a limited literature base supporting early mobilisation and rehabilitation within ICU. As such this novel research fills a gap in the literature base by exploring final year physiotherapy undergraduate experiences of working within ICU. The findings identify students feeling overwhelmed during their ICU placements and reporting an overwhelming sense of reliance on their clinical educators. Additionally, they demonstrate a lack of knowledge surrounding the available evidence-base for practice in this area. These findings can also be utilised to explore the current provision of rehabilitation across Welsh ICU sites and to inform the ongoing development of the undergraduate teaching curriculum to ensure both students feel adequately supported, and newly qualified physiotherapists are confident and competent whilst practicing within the ICU.
been profiled in evidence-based guidelines recommending rehabilitation starts as early as clinically possible (NICE 2009).

The concept of early physical rehabilitation is however still within its relative infancy. To date, there has been limited research conducted to underpin current NICE (2009) guidelines. Furthermore, little guidance is available detailing exact interventions to aid clinicians with their decision making (Twose and Jones 2015). This lack of research has therefore challenged widespread implementation of early physical rehabilitation (Connolly 2014). Thus, the subjectivity of individual physiotherapists’ competence or attitudes is currently all too influential in determining rehabilitation practice within individual ICU sites (McWilliams et al. 2017).

Research involving physiotherapy students’ experiences within the ICU is comparably sparse. Undergraduate physiotherapy students at Cardiff University (CU) are in the unique position to be guaranteed a clinical placement within each of the core specialities including cardiorespiratory. Here presents a unique opportunity to explore, using a qualitative methodology, the experiences of students nearing qualification during clinical placement within the ICU. Additionally, these data can be used to explore current rehabilitation practice across Welsh ICU sites and to inform the ongoing development of the undergraduate respiratory curriculum, supporting practice-based education. Furthermore, it may ensure the appropriate support is provided for students as they transition to newly qualified physiotherapists.

The study research question asks: What are final year physiotherapy students’ experiences of early mobilisation and rehabilitation for critically ill patients during practice education?

**Methodology**

A qualitative, interpretive methodology was chosen to collect data via two focus groups with CU undergraduate physiotherapy students. The interaction elicited between participants during a focus group was seen as advantageous for exploring why participants held particular views, hence they were chosen over other qualitative methods (Barbour 2008). A guide to facilitate this discussion was formulated from key themes identified through an initial literature search. A mixture of questioning styles was employed to enhance the credibility of data collection, including key, open-ended and probing questions (Krueger and Casey 2014).

Prior to conducting the study, the CU School of Healthcare Sciences Research Ethics Committee granted ethical approval for the research to commence in July 2017. Participants were recruited via a non-probability, purposive, volunteer sampling technique. This technique was deemed appropriate due to the narrow focus of inclusion criteria (Silverman 2004): selecting CU undergraduate physiotherapy students in their final year of study, who had completed a cardiorespiratory placement. The project was advertised via an online portal exclusive to CU physiotherapy students. The first seven respondents participated in the study, 3 were allocated to the pilot study and 4 to the main study. The sample size of 7 was determined sufficient to achieve theoretical data saturation (Saunders et al. 2018).
transferability of the results participants were allocated to each group to reflect diversity in both age, gender, and placement locations spanning across acute hospitals within West, North West and South Wales (Shenton 2004). The pilot focus group gave the researcher the opportunity to trial the research process and questions. The pilot study yielded unique and interesting themes, deemed relevant for publication. As the sampling and research methodology remained the same, this pilot data was analysed and presented as part of the main research results (Thabane et al. 2010). A second focus group was conducted a week later.

An information sheet was provided to participants prior at commencement of the study, detailing an overview of the study including the associated benefits and risks. Also, informing participants of their right to withdraw from the research or refuse to answer any question at any time. Adhering to ethical constraints and ensuring participants made a fully informed decision to participate. Privacy was respected, and confidentiality maintained at all times. Participants used pseudonyms to minimise the risk of being made identifiable (Holloway and Galvin 2017). These pseudonyms have been utilised throughout. Participants signed a confidentiality agreement to ensure they understood their responsibilities in maintaining confidentiality throughout the study.

Both focus groups were recorded using a dictaphone and then transcribed verbatim using Express Scribe (NCH, Pty Ltd, USA) transcription software. These data was then combined with comprehensive field notes produced by the assistant moderator creating a complete account for in-depth analysis. Braun and Clarke’s (2006) thematic analysis approach was used to interpret the data from the participants perspective. Thematic analysis consists of six phases; first familiarising with the data set in order to generate initial codes, which are then translated into and reviewed as themes and sub themes. Finally, these themes were presented and discussed in synthesis with existing literature. Triangulation between the researcher, supervisor and participants themselves corroborated the themes, ensuring the researcher had correctly interpreted participants words, enhancing overall confirmability (Birt et al. 2016).

**Results and discussion**

Four themes emerged from the analysis, as shown in (Figure 1) below.

**Theme 1: Role of the physiotherapist in ICU**
Narrates the understanding of the role of the physiotherapist in ICU, including treatment priorities. Detailing the differing emphasis placed upon early mobility across sites.

**Theme 2: Teamwork**
Explores the participant perspective upon where exactly the role of providing routine early physical rehabilitation for critically ill patients falls. Incorporating discussion around who’s responsible for the initial decision upon when a patient is deemed safe for mobilisation.

**Theme 3: Barriers**
Explores the potential difficulties that may be encountered when implementing routine
early mobilisation for critically ill patients. Furthermore, discussion surrounding strategies of how to overcome these potential barriers.

Figure 1: Thematic map.

Theme 4: Evidence-based practice
Discussion regarding the current-evidence base, and how this currently fits within the process of a clinicians clinical reasoning and how this may facilitate patient-centred care avoiding a generalised ‘one size fits all’ approach to rehabilitation.

Role of the physiotherapist in ICU
Lack of emphasis on early mobility
A wealth of literature exists detailing the detrimental effects of prolonged bed rest or immobility (King and Gratrix 2009; Parry et al. 2015). Despite recognising mobility interventions to be the ‘gold standard for respiratory care’ [Zoe]. Participants reported the main role of the physiotherapist in ICU is to focus treatment around clearing airways, to maintain and improve the respiratory system. However, early mobility was not consistently cited as a possible treatment option. Mobility or rehabilitation interventions were consistently cited as less of a priority, with bed rest or immobility occurring as an inevitability of patients’ degree of illness, echoing what has previously been found by researchers such as Connolly et al. (2017).

‘I think on intensive care, ¾ of it was probably focused towards chest physiotherapy’ [Kate].

‘I found it was more directed towards their chests, so maintaining and optimising lung function and making sure their sats didn’t drop’ [Chloe].

The student safety blanket
Williams and Flynn (2013) highlighted the importance of having clinical experience when
developing into an autonomous cardiorespiratory practitioner within the ICU environment: ‘utilising clinical judgement and experience to determine stability for initiation and progression of treatment’ (Williams and Flynn 2013, pp. 96). Clinical-educators acted as powerful role models for these students. At their stage of training, with comparatively little clinical experience, participants resorted to relying upon the support and decisions made by their clinical-educators.

‘I felt like a rabbit in headlights if I’m honest.’ [Megan].

‘We don’t have the judgement of how ill someone is, when you can mobilise them because we don’t have that experience. Whereas the physios there, it’s just down to their experience. They know really well, they can look at someone and work out when it’s ok to mobilise them. Whereas for us, it can be difficult.’ [Kate].

‘I feel like it depends on where you are and what your clinical educator does.’ [Ben].

‘I think your clinical-educator builds you up to have like a safety blanket around you.’ [Chloe].

Teamwork
Role-overlap and consultant led decisions
Participants described the overwhelming time pressures they experienced whilst working within the ICU environment. For effective implementation of early physical rehabilitation, participants emphasised the need for effective teamwork, involving engagement of all members of the Multidisciplinary Team (MDT) and delegation of roles and responsibilities throughout.

‘I think as an assessment tool, finding out what the patient can do, that’s a physiotherapy area. Once that’s established, I think it does kind of fall underneath the nurses too. I think it kind of falls under a bit of teamwork really.’ [Sophie].

‘I think it was very much down to when consultants had cleared them, it was very much we had to make sure that it was safe to do so from their point of view. But it depended on the consultant, like some of the consultants were known for liking early mobilisation. Like the same day or day after, but some were wanting to wait a little longer.’ [Kate].

Corroborating what has previously been documented within both the physiotherapy and nursing literature (Williams and Flynn 2013; Phelan et al. 2018), MDT collaboration and delegation of responsibilities is cited to be key in overcoming barriers and within effective implementation of early physical rehabilitation. Furthermore, this recommendation is strengthened by GPICS (2015), suggesting MDT ward rounds should include regular physiotherapy input.

Barriers to mobilisation
Patient-related barriers
Research has begun to identify various barriers that may challenge the routine
implementation of early physical rehabilitation for critically ill patients. Common barriers included a patient’s degree of physiological instability or level of consciousness, pain, fatigue or attitude towards mobilisation (Dubb et al. 2015; Knott et al. 2015). All of these factors were found to impact upon patients’ adherence to treatment (Williams and Flynn 2013). Participants also described facing such barriers during their time working in ICU.

‘I think because they are acutely unwell. A lot of the time in critical care, they will be, um, medications that they are having will mean they are sedated, or drowsy and it won’t be safe or appropriate to mobilise them’. [Kate].

‘Because they’re not medically stable [interruption from Megan: they’re too unwell] to do anything else at this stage, the primary aim is to get their respiratory stable’. [Henry].

‘I think pain as well, because I saw a couple of people, one patient in particular had lots of fractured ribs and although she wanted to get up and stuff, she physically couldn’t. Because every time she tried, she was just in so much pain. So, she just had to remain in bed’. [Rebecca].

Williams and Flynn (2013) reported strategies to overcoming potential barriers to be focused around building relationships with patients. Participants emphasised this, highlighting the importance of communication and engaging the patient within their rehabilitation journey.

‘I spent a lot of time educating patients on the importance of sitting out, I think that was a big thing’. [Zoe].

ICU cultural related barriers

Participants also cited the various equipment and attachments found within ICU as a frequent barrier to mobilising critically ill patients. Suggesting both the logistical and time constraints associated with such equipment to be challenging. For some, certain equipment presented as an absolute contraindication to mobilisation, whilst for others it only further complicated what already appeared a complex task. Following on from Knott et al. (2015) who demonstrated multiple attachments, and specifically the presence of endotracheal tubes to be a frequently reported barrier.

‘I have never attempted to mobilise someone who’s intubated’. [Beth].

‘They had chest drains, so if you’re trying to get them out of bed, you can’t lift the drains high if they’re not clamped. So, you have to get the nurses in and it makes everything so difficult and you have all these added things to worry about’. [Sophie].

‘There were a couple of patients where, to try and get them into a chair the attachments would be really taut. So that was quite difficult at times. On the odd patient you did get up and mobilise, that would take such a long time, because of all the attachments’. [Rebecca].
Contrastingly, one participant continued to describe their experiences routinely mobilising intubated patients in ICU. Echoing the results of Appleton et al. (2011) who previously found the routine mobilisation of patients with endotracheal tubes to vary significantly across sites.

‘On my placement, we did mobilise quite a lot of patients that were still ventilated. We had lots of long-term trachy patients, who we would switch to manual hyperinflation, and as they were walking we would hyperinflate them.’ [Kate].

Evidence-based practice
Guidelines
Participants displayed a lack of awareness and knowledge surrounding the available NICE (2009) guidelines, for which only one of the participants reported having read. This finding echoes Appleton et al. (2011) who also found a lack of awareness among qualified physiotherapists, subsequently, finding implementation of these guidelines at the time to be comparatively low. Participants further voiced concerns regarding a potential loss of individualised, patient-centred care with the implementation of standardised guidelines or protocols.

‘I think it’s really hard to have a pathway when everyone is individualised. What’s the point in having a strict structure to follow because everyone is so different. So many people just don’t fit the pattern.’ [Zoe].

‘Every patient is completely different, it’s so unpredictable in that setting. So, you can’t have a set pathway.’ [Henry].

However, quality improvement programmes previously undertaken such as Connolly et al. (2017) have utilised individually tailored programmes set for each patient. Thus, suggesting implementation of early mobility, in line with NICE (2009) guidelines, can indeed be individualised and patient-centred.

Limitations of study
A non-probability, purposive, volunteer sampling technique was used to recruit participants. With this method of sampling, there is associated likelihood of response bias, which may impact upon the credibility of the results. However, the appraisal of sampling techniques differs within qualitative research. It is common for qualitative research to employ non-probability sampling as this type of research is concerned with theoretical generalisation, further drawing conclusions deemed valuable for the development of universal theories.

As an insider, the researcher may have posed an unintentional bias upon participants’ responses, further impacting the credibility of results. Triangulation between the researcher, assistant moderator and participants was employed to mitigate any influence of bias.
Despite clinical placement locations mapping across Wales, recruitment of participants from one university ultimately limits transferability of findings. Thus, recommendations drawn are particularly pertinent to the University in which the study took place. Although they may be of use to other institutions with similar teaching curriculums, additional research from other institutions may be required to strengthen findings and recommendations.

**Conclusion**

Currently, there is a growing but limited literature base supporting early mobilisation and rehabilitation within ICU. As such this novel qualitative research fills a gap in the literature by sharing final year physiotherapy undergraduate experiences of working within ICU. The findings make a valuable contribution to the topic area in three ways.

Firstly, it was identified that these students felt overwhelmed during their ICU placements, reporting a great sense of reliance on their clinical-educators. They also demonstrated a lack of knowledge around available evidence and guidelines for practice in this area. Thus, echoing results of previous research conducted with qualified physiotherapists, suggesting a lack of knowledge and utilisation of available guidance. The findings also highlight significant variation in the provision of early mobilisation and rehabilitation across individual ICU sites in Wales.

Secondly, there is a need for future research to follow on from Connolly et al. (2017) and McWilliams et al. (2018) to inform the assembly of specific, evidence-based guidelines or recommendations to guide early mobilisation for the critically ill patient in ICU. Detailing exact safety considerations and contraindications, ultimately aiming to aid clinicians to make standardised, evidence-based clinical decisions for the rehabilitation of this patient group, whilst remaining patient-centred, intending to standardise the rehabilitation provided throughout Welsh ICU sites.

Finally, the findings also suggest higher education institutions may have a greater role to play in helping students understand the importance of evidence-based practice to inform their clinical decisions during practice-based education in ICU. It is important that students recognise the need for this during practice education in order to take forward post-qualification. Such an approach will ensure that newly qualified physiotherapists are equipped with the necessary knowledge and skills to successfully transition into fully competent cardiorespiratory practitioners.

**References**


Introducing **SIMEOX** – the innovative lung clearance device that mechanically changes the physical properties of mucus.

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Enhancing early post-operative physiotherapy input to patients undergoing an oesophagectomy: A quality improvement project

Angharad Volk¹, Rhian Kennedy-Warburton¹ and Paul Twose¹

Abstract

Introduction
Postoperative pulmonary complications are a serious morbidity following an oesophagectomy with rates as high as 45%. In 2017, a local physiotherapy review identified a high number of patients being diagnosed with significant complications such as post-operative pulmonary complications which increased length of stay, requirement for critical care admissions and need for respiratory physiotherapy. As a result, strategies to reduce PPC rates were proposed. This quality improvement project explored the impact of increasing physiotherapy input during the first three days post oesophagectomy on the incidence of PPCs.

Methods
A Plan-Do-Study-Act approach was adopted. Following the increase of physiotherapy input to twice daily during the first 3 post-operative days, data was collected over a 6-month period. This data was then compared to previously collected data pre-quality improvement intervention. The primary outcome was post-operative pulmonary complications occurrence, and secondary measures were mobility markers and hospital length of stay.

Results
Comparison of pre and during quality improvement data demonstrated that despite increased physiotherapy input there was no reduction on the incidence of post-operative pulmonary complications or secondary outcomes.

Conclusion
Enhancing physiotherapy input in the first 3 post-operative days had no effect on reducing the incidence of post-operative pulmonary complications. Similarly, there was no change in the achievement of mobility markers or hospital length of stay. Further
Introduction

Oesophageal cancer is the eighth most common malignancy and the sixth most common cause of cancer-related death worldwide. Surgery is still the only curative therapy option for oesophageal cancer (Tougeron et al. 2011) and long-term survival is poor (Morita et al. 2011). Postoperative pulmonary complications (PPCs) are a serious morbidity following an oesophagectomy with rates as high as 45% (Derogar et al. 2012). Rutegard et al. (2012) carried out a nationwide review of oesophagectomy patients and found that post-operative complications were an independent predictor for poorer long-term survival, even in patients surviving the initial post-operative period. Consequently, strategies to reduce PPCs are of considerable importance (Guinan et al. 2016). Such strategies include the development of enhanced recovery after surgery (ERAS) pathways.

ERAS ensures the patient is given evidence based multidisciplinary care to reduce the risk of complications and help improve outcomes. One element of ERAS is early mobilisation post operatively (NHS Improving Quality 2013). This is not a new concept as the benefits of early mobilisation have been recognised as early as 1946 by Canavarro, who noticed a reduction of PPCs in patients mobilised in the first 24 to 36 hours (Canavarro 1946).

Based on this evidence, and the understanding of the significant risk of complications associated with the oesophagectomy procedure, a local physiotherapy review was completed and identified that despite an ERAS approach, 52% of patients were still being diagnosed with PPCs. It is likely that these PPCs resulted in increased length of stay (LOS), requirement for critical care admissions and increased physiotherapy. All of which required additional healthcare input (and subsequent costs), reduced patient flow and resulted in a worse patient experience.

In response to these complications, a quality improvement (QI) project was initiated to review and improve the model of physiotherapy provided to these patients. The aim of the QI project was to re-prioritise and further enhance physiotherapy input in the early post-operative period, with an anticipated reduction in the incidence of PPCs. Secondary aims were to reduce time to achieve mobility markers and reduce hospital LOS.

Methodology

Design

A QI project utilising the Plan-Do-Study-Act approach. The data collected during the QI project was retrospectively compared to baseline data from the previous year.
Setting
The University Hospital of Wales, part of Cardiff and Vale University Health Board, is a 1000-bed tertiary referral centre for a wide range of clinical services, including neurosciences, transplant and haematology. Additionally, it is the tertiary referral site for those requiring an oesophagectomy from across East and South Wales, with approximately 60 surgical cases completed per annum.

Patients
All patients undergoing an oesophagectomy during the QI intervention period (June–December 2018) were included. These were retrospectively compared to baseline data from patients admitted in a 7-month period during 2017 (April–October).

Quality improvement intervention
The Plan-Do-Study-Act QI programme was utilised to improve early post-operative physiotherapy intervention. A thorough review of the existing physiotherapy model of care was completed. Patients were being seen once a day and then only reviewed in the afternoon if clinically indicated, for example, if they were struggling to clear retained secretions. They were also prioritised the same as all other surgical patients, meaning that they were not guaranteed to be seen due to time constraints and large caseloads. However, it was concluded that due to the high post-operative pulmonary complications (PPCs) occurrence rate and ERAS recommendations, insufficient physiotherapy was being provided during the first 3 post-operative days. As a result, for the QI period, physiotherapy involvement was increased through redistribution of existing resources. The model of care was changed so that all patients undergoing an oesophagectomy were assessed and treated by a physiotherapist twice daily for the first three post-operative days and as clinically indicated thereafter (including weekends where required). No changes were made to pre-operative involvement (nil involvement) or any other aspect of post-operative care.

Data collection
Demographic data was collected for age, gender and surgical type of oesophagectomy. Physiotherapy key performance markers were calculated: time to sit out of bed; time to mobilise independently; length of hospital stay from date of surgery; and occurrence of PPCs. PPCs refer to post-operative pneumonia, atelectasis or other pulmonary complication attributed to undergoing surgery, and were recorded based on Brooks-Brunn classification (Brooks-Brunn 1997). As such, a PPC was confirmed by the presence of two or more of the following, anytime during the first 6 post-operative days:

- New cough/sputum production.
- Abnormal breath sounds compared with baseline.
- Temperature of >38°C.
- Chest radiograph documentation of atelectasis or new infiltrates.
- Physician documentation of atelectasis or pneumonia.
This information was obtained from medical documentation. Brooks-Brunn classification (1997) was utilised as it has been previously validated for use with patients undergoing abdominal surgery.

**Statistics**
Data was analysed using SPSS v25 statistical software (SPSS, Chicago, Ill). All statistical tests were 2-sided, and significance was determined at the 0.05 probability level. Simple descriptive data is presented using median and inter-quartile range.

**Ethical considerations**
This project constituted an improvement in the standard care delivery with no randomisation and thus met the definition of a service evaluation under the NHS Health research authority guidelines. As such ethical approval was not required, and because all outcome measures are collected as part of routine care, the need for consent was waived.

**Results**

**Demographics**
All patients requiring an oesophagectomy during the QI period were included for analysis (n = 17). This data was compared to baseline data in 2017 (n = 27). The data is provided in Table 1.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Baseline (n = 27)</th>
<th>QI (n = 17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (%)</td>
<td>24 (89%)</td>
<td>15 (88.8%)</td>
</tr>
<tr>
<td>Median age</td>
<td>66 (60–68)</td>
<td>66 (62–71)</td>
</tr>
<tr>
<td>Surgical approach</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-stage = 1 (3.7%)</td>
<td>3-stage = 1 (5.9%)</td>
<td></td>
</tr>
<tr>
<td>Ivor-Lewis = 12 (44.4%)</td>
<td>Ivor-Lewis = 10 (58.8%)</td>
<td></td>
</tr>
<tr>
<td>Transhiatal = 14 (51.9%)</td>
<td>Transhiatal = 14 (17.6%)</td>
<td></td>
</tr>
<tr>
<td>Laparoscopic = 3 (17.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory co-morbidity</td>
<td>4 (15%)</td>
<td>3 (18%)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>0 (0%)</td>
<td>2 (12%)</td>
</tr>
</tbody>
</table>

**Physiotherapy intervention**
During the QI period, the aim was to deliver physiotherapy intervention twice daily during the first three post-operative days. Table 2 provides a percentage overview of the achievement of this target.
Table 2: Frequency of physiotherapy intervention in first 3 post-operative days.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>QI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once daily input</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Twice daily input</td>
<td>89%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Day 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once daily input</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td>Twice daily input</td>
<td>63%</td>
<td>82%</td>
</tr>
<tr>
<td><strong>Day 3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once daily input</td>
<td>85%</td>
<td>94%</td>
</tr>
<tr>
<td>Twice daily input</td>
<td>26%</td>
<td>18%</td>
</tr>
</tbody>
</table>

**Incidence of PPCs**

During the QI intervention period the incidence of PPC’s (using Brooks-Brunn classification) was 11 (65%). This compared to an incidence rate of 14 (52%) during the baseline data collection.

**Secondary outcomes**

Additional data was collected for the achievement of mobility markers, as well as PACU and hospital length of stay (see Table 3).

Table 3: Median time to achieve mobility markers and length of stay data.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>QI</th>
<th><em>p</em> value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median time to 1st sit on edge of bed – days (IQR)</td>
<td>2 (1–2)</td>
<td>1 (1–2)</td>
<td>0.216</td>
</tr>
<tr>
<td>Median time to 1st sit out of bed – days (IQR)</td>
<td>2 (2–3)</td>
<td>1 (1–3)</td>
<td>0.847</td>
</tr>
<tr>
<td>Median time to mobilise assisted – days (IQR)</td>
<td>7 (6–9)</td>
<td>7 (3–8)</td>
<td>0.360</td>
</tr>
<tr>
<td>Median PACU length of stay – days (IQR)</td>
<td>2 (1–2)</td>
<td>2 (1–2)</td>
<td>0.453</td>
</tr>
<tr>
<td>Median length of stay – days (IQR)</td>
<td>13 (12–16)</td>
<td>13 (10–25)</td>
<td>0.888</td>
</tr>
</tbody>
</table>

During the QI period, 3 (18%) patients required re-admission to critical care due to complications (non pulmonary), versus 5 (18.5%) in the baseline period.
Discussion
The aim of this QI project was to improve the physiotherapy model of care for patients undergoing an oesophagectomy and reduce the incidence of PPCs. Comparison of data from baseline, demonstrated that despite increased physiotherapy input there was no reduction in the incidence of PPCs or secondary outcomes.

Demographics
Due to the difference in time of year of data collection, it was not possible to make statistical comparisons in demographic data. The baseline data was collected between April and October 2017, covering a 7-month period. Data in 2018 was collected from June to December. There were also substantially fewer oesophagectomies performed during the QI period (17 versus 27 during baseline).

Despite this, the characteristics of the patient group have remained relatively stable over the last two years. The median age remains 66, most patients were male (89.0% and 88.8% respectively) and a large proportion of these patients were ex-smokers.

However, surgical approach altered between the QI and baseline periods. During the QI data collection, 18% of patients underwent a laparoscopic assisted Ivor-Lewis Oesophagectomy compared to 0% during the baseline. There is a national trend towards increasing the use of laparoscopic approaches with the National Oesophago-gastric Cancer Audit Annual Report (HQIP, 2018) suggesting the proportion of patients who had minimally invasive oesophagectomies was 40.8%. Due to the smaller incision site, and therefore better pain control, these patients may have lower PPC rate.

Physiotherapy intervention
This QI project aimed to provide physiotherapy intervention to patients at least twice daily during the first 3-post-operative days. This was consistently achieved on day one only. By days two and three, only 82% and 18% respectively received twice daily intervention. However, when compared to the baseline data, there was still an improvement for all days except day 3.

The possible reasons for non-completion of the aimed twice daily review were not recorded. However, possible reasons include the reduce physiotherapy service at the weekends and de-prioritisation of patients on day 3 where there was no perceived clinical indication for physiotherapy input. All these patients would have been assessed on an individual basis, and by day 3, could have been independent with sputum clearance techniques, however mobility would often still be limited by attachments. Other possible reasons include return to theatre, completion of scans or return to critical care where pulmonary complication was not the driving factor.
Outcomes

Incidence of PPCs
Despite the increase in physiotherapy intervention, the rate of PPC occurrence increased during the QI project when compared to baseline. Indeed, during the QI period, PPC occurrence was 65%, compared to 52% at baseline despite a higher rate of minimally invasive procedures in the QI period.

An explanation behind the increase in PPCs in 2018 is likely multifactorial. For example, 43% of those patients in the QI project that had PPCs required noradrenaline immediately post operatively. This would have limited how quickly these patients could sit on the edge of the bed or out in the chair, and hence may have increased their risk of PPCs. Common themes associated with PPCs were anastamotic leaks (23.5%) +/- pleural effusions and pneumothoracies (11.7%) (Rutegard et al. 2012).

Of those included in our QI project, one patient had a large pneumothorax and 25% had anastomosis leaks requiring re-admission to critical care, further anaesthetic and surgery, and hence increased likelihood of developing PPCs.

Achievement of mobility markers
Early mobilisation and exercise are known to play an important role in post-operative care and are association with less postoperative reduction of fitness and fewer postoperative complications (Jonsson et al. 2018). As a result, one of the key markers noted in this QI was mobility. The time to first sit on the edge of the bed improved by one day during the QI period, as did time to first sit in the chair. Almeida et al. (2017) state that early mobilisation improves cardiopulmonary endurance, decreases fatigue symptoms, improves muscular strength and quality of life. The time to mobilise with assistance from a physiotherapist was the same during the QI period as the baseline data at 7 days. Mobilising away from the bed space was often limited by attachments. It is likely that patients are getting out of bed earlier due to the increased early physiotherapy involvement.

Post Anaesthetic Care Unit and hospital length of stay
All patients requiring an oesophagectomy at the host organisation are admitted to the Post Anaesthetic Care Unit (PACU) after surgery. It is planned that after 24–48 hours in PACU the patient then be transferred to the surgical ward.

The median LOS on PACU was 2 days during both the QI and baseline data collection periods. Analysis demonstrated that 44% of patients were discharged from PACU in the first 24 hours during baseline data collection, whereas only 22% of patients were discharged during the first 24 hour period during the QI project. This increase in those staying more than 24-hours is likely a result of a service decision to monitor these patients for longer rather than physiological differences.

A non-statistically significant increase in hospital length of stay ($p = 0.888$) was observed during the QI period (13.5 days versus 12 days at baseline). This compares to a national
average of 11.2 days (National Oesophago-Gastric Cancer Audit 2018). There are numerous possible reasons for the increase in length of stay. For example, higher PPC occurrence rate, an increased number of patients having anastomosis leaks, a reduced number of oesophagectomies being performed, or procedure incision used.

**Future service development**

Due to the higher PPC rate and the lack of impact increasing physiotherapy input has had on this, further investigation is required on different methods of decreasing the PPC occurrence.

Physiotherapy interventions currently focus on postoperative respiratory function and early mobilisation. These patients all go to PACU post operatively, however they often have issues with pain relief, blood pressure control and fluid administration. All these factors affect physiotherapy input and early mobilisation. Further multi-disciplinary working may identify alternative approaches to ensure appropriate timing of physiotherapy intervention.

Preoperative physiotherapy could also be beneficial. One potential solution to reducing the PPC rate could be seeing patients in a pre-assessment clinic. This would be a useful opportunity to provide education to those patients undergoing an oesophagectomy about physiotherapy involvement, importance of early mobilisation and chest clearance techniques. During a preoperative assessment, it would also be possible to look at risk factors such as co-morbidities and smoking history. Frellick and Barclay (2019) and Boden et al. (2018) discovered that a 30-minute preoperative session halved the number of PPCs and specifically hospital acquired pneumonia in elective patients undergoing upper abdominal surgery.

Depending on a patient’s functional status preoperatively, a prehabilitation service could also be an option. Le Roy et al. (2016) stated that prehabilitation improved postoperative morbidity, length of stay, nutritional and physical status. O’Neil et al. (2017) completed a 12-week multidisciplinary rehabilitation programme consisting of exercise, dietary counselling, and education and found that there was a clinically significant improvement in functional performance and quality of life.

Valkenet et al. (2014) suggest that using inspiratory muscle training preoperatively would prevent the imbalance between ventilation demand and ventilation capacity post oesophagectomy, and therefore reduce the PPC rate.

**Limitations**

One of the major limitations of this QI project was the sample size. This was smaller than the baseline data due to fewer surgeries being completed during the data collection period. The lower sample size makes it more difficult to identify significant relationships from the data (Hackshaw 2008). Future QI projects might consider data collection over a longer time period to increase the sample size.
Another limitation was the use of the Brooks-Brunn classification tool for PPCs. This was used in the QI for continuity and a more accurate comparison of the two sets of data. However, this classification is not overly sensitive to PPCs that physiotherapy can impact. A large proportion of patients will have sputum production postoperatively following the anaesthetic, and a raised temperature could be due to several things, for example, an anastomosis leak, infection or other medical complications. In the future it would be worth looking at other PPC classification tools to ensure that they are more sensitive to PPCs that physiotherapy can impact.

**Conclusion**

In this QI project, enhancing physiotherapy input in the first 3 post-operative days had no effect on reducing the incidence of PPCs. Similarly, there was no change in the achievement of mobility markers or hospital length of stay. Further work is now required to explore other interventions such as prehabilitation and their impact on PPC occurrence.

**References**


Dance-based versus conventional exercise in pulmonary rehabilitation: A retrospective service evaluation

Lucy Gardiner¹,²,³, Harriet Shannon¹ and Leyla Osman¹

Abstract

Background
Pulmonary rehabilitation (PR) is well recognised for improving exercise tolerance and health related quality of life (HRQoL) in people with chronic obstructive pulmonary disease (COPD). However, attendance and completion rates for PR remain suboptimal. Dance is an effective alternative approach to exercise in other chronic disease populations. Latin-based dance may also serve to improve engagement in pulmonary rehabilitation.

Aim
To conduct a service evaluation of a community-based PR programme that includes Latin dance-based exercise, and compare it with outcomes from a comparable, conventional programme. The aim of the evaluation was to ascertain whether the dance-based programme resulted in improvements in exercise tolerance and HRQoL. Further, to determine any differences in completion rates between the dance-based and conventional programmes.

Methods
This retrospective service evaluation compared outcomes from people with COPD who were enrolled into the Barts PR service conventional and dance-based PR programmes, between February and May 2019. The programmes were identical, other than the style of aerobic exercise. Within- and between-group differences following PR in exercise tolerance and HRQoL were compared. Completion rates were also compared.

Results
In total, four participants enrolled into the dance-based group, and five participants to the conventional group. Median change in exercise tolerance following PR was 47.5m in the dance group (incremental shuttle walk test) and 35.0m in the conventional group (six-minute walk test). Median change in the COPD Assessment Test was...
Introduction

Chronic obstructive pulmonary disease (COPD) is characterised by persistent respiratory symptoms and airflow limitation owing to airway and/or alveolar abnormalities, usually resulting from significant exposure to noxious particles or gases (GOLD 2019). Dynamic hyperinflation leading to inefficient breathing and further breathlessness can make physical activity challenging for patients with COPD. Increased breathlessness can induce anxiety, exacerbation of symptoms and panic, all of which can lead to activity avoidance, further muscle de-conditioning and reduced health-related quality of life (HRQoL) (McCarthy et al. 2015).

Recommended management of people with stable COPD includes smoking cessation, vaccinations (pneumococcal and flu), pulmonary rehabilitation (PR) and inhaled therapies (NICE 2018). The American Thoracic Society and European Respiratory Society define PR as:

‘A comprehensive intervention based on a thorough patient assessment followed by patient tailored therapies that include, but are not limited to, exercise training, education, and behaviour change, designed to improve the physical and psychological condition … and to promote the long-term adherence to health-enhancing behaviours’ (Spruit et al. 2013, pp. e14).

It has been clearly demonstrated within the literature that PR reduces dyspnoea, increases exercise capacity and improves HRQoL in people with COPD (McCarthy et al. 2015). However, despite being one of the most effective and high value interventions for people with COPD, attendance and completion of PR remains poor (Royal College of Physicians 2018). Factors affecting attendance and non-completion are multi-faceted and complex. Four analytical themes of: attitude, social influences, illness, and intervention representation, were identified by Sohanpal et al. (2015) in their qualitative synthesis reviewing patient participation behaviours in studies of COPD support programmes. There is growing interest in the use of alternative exercise modalities in the COPD population, which may serve to address the issue of negative perceptions associated with exercise and PR.

A dance-based PR programme was introduced in January 2019 as an alternative to conventional PR in an attempt to address long-standing issues of adherence and completion rates within the borough of Tower Hamlets. Domene et al. (2016) suggested that Latin-based dance (such as Salsa and Zumba) may assist in overcoming the negative perception of
traditional modalities of exercise, promoting engagement in an increasingly sedentary adult population. Dance has been established as an effective alternative modality of exercise training in other chronic disease populations, such as chronic heart failure (CHF) (Gomes Neto et al. 2014). The efficacy of dance-based exercise in the COPD population is yet to be established.

The aim of the service evaluation was to explore whether the newly established Latin dance-based programme resulted in improvements in exercise tolerance and health-related quality of life, as compared with a conventional programme running concurrently. Further, to determine any differences in completion rates between the dance-based and conventional programmes.

**Methods**

**Study design**
This was a retrospective service evaluation comparing two types of intervention provided by Barts PR service.

**Inclusion and exclusion criteria**
All patients referred to Barts Health PR services between February and May 2019, with a diagnosis of COPD who were enrolled onto a PR programme at one site were included in the service evaluation. Patients were excluded if they had a primary respiratory diagnosis other than COPD, and/or if their primary exercise limitation was not breathlessness. As per usual care, patients were given the choice of attending one of four venues within Tower Hamlets. This included the options of attending either a dance-based or conventional exercise-based programme, both held at the same site. Patients were excluded if they chose to attend a programme at an alternative venue to eliminate the possibility of bias associated with venue choice.

Participants were identified from data collected during initial assessment, upon written confirmation of a primary respiratory diagnosis and exercise limitation factor, and PR venue choice (all of which was available from the patients’ medical notes).

**Pulmonary rehabilitation programme**
According to usual local practice, initial assessment for PR comprises a review of medical history, exercise tolerance, strength testing, COPD-specific HRQoL, perceived respiratory disability, and mood disorder. The PR programmes delivered by Barts Health comprise an eight-week rolling programme of twice weekly, two-hourly supervised sessions. The first hour consists of exercise performed to music involving warm-up, conditioning and cool-down, and the second hour of self-management education. Aerobic exercise intensity is prescribed using the modified Borg scale, which is a self-reported measure of dyspnoea (Kendrick et al. 2000).

Progression over eight weeks is achieved by increasing total continuous aerobic exercise time and titration of intensity to modified Borg 3–4 (BTS 2013). Exercises include: walking,
step-ups, sit-to-stand, and cycling. Strengthening exercises using weights or bodyweight are utilised as a means of active recovery. Prescription and progression of resistance is based on evoking fatigue after 10 to 15 reps (Garvey et al. 2016).

The dance-based programme differs from the conventional exercise-based programme described above only in the form of aerobic exercise being Latin-style dance. The dance routine was originally choreographed by the physiotherapist leading the programme, who was not specifically trained in dance. It consists of basic steps (e.g. three-step weight transfer), simple movements of salsa in forward, backward, and transversal directions, and rhythmic strutting (Granacher et al. 2012). All other elements of the programme are identical, including prescription and progression of aerobic exercise intensity using modified Borg 3–4 and use of strengthening exercise as active recovery. Music was standardised across both programmes, using a selection of popular music from 1960s to 1990s. Whilst music is integral to the choreography of the dance programme, in the conventional programme it serves only as background music. Costings were not looked at as part of this evaluation. However, there was no cost difference associated with the provision of the two programmes; both programmes were delivered at the same venue, using the same equipment, with the same level of staffing.

Outcome measures for the programmes include the incremental shuttle walk test (ISWT) or six-minute walk test (6MWT), COPD Assessment Test (CAT) as a measure of HRQoL and PR completion rates. During the timeframe of the service evaluation, although 6MWT was initially utilised as a measure of exercise tolerance, this was changed to ISWT in recognition of the fact that the 6MWT was not being performed on a 30-metre track (Singh et al. 2014). No additional tests were added for the purposes of the service evaluation.

Data analysis and graphics were performed using SPSS software (version 25) and Microsoft Excel (version 1906).

**Results**

**Patient characteristics**

During the study period of February to July 2019, four patients successfully completed the dance-based PR programme and five patients completed conventional PR. Baseline characteristics of participants in the dance and conventional groups are summarised and compared in Table 1. No statistically significant differences were identified for characteristics tested. However, a clinically significant difference in baseline COPD severity was reported between groups. In accordance with GOLD (2019) classification, the median FEV₁% predicted values of the dance and conventional groups are reflective of moderate and severe COPD, respectively. Notably, this was not reflected in reported CAT with a lower reported median in the conventional group. The dance group only included women, a high proportion of whom were current smokers. Differences in exercise tolerance could not be tested as different measures were used between groups.
Table 1: Baseline patient characteristics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dance</th>
<th>Conventional</th>
<th>Median difference</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>69 (61.8 to 76.3)</td>
<td>72 (59.0 to 75.5)</td>
<td>3</td>
<td>0.91</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>4 (100)</td>
<td>2 (40)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Male</td>
<td>0 (0)</td>
<td>3 (60)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>FEV1 % predicted</td>
<td>75.5 (49.5 to 94.0)</td>
<td>49.0 (31.5 to 64.0)</td>
<td>26.5</td>
<td>0.11</td>
</tr>
<tr>
<td>Smoking status, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>3 (75)</td>
<td>1 (20)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ex</td>
<td>1 (25)</td>
<td>4 (80)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Never</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>mMRC</td>
<td>2 (2.0 to 2.8)</td>
<td>2 (1.5 to 2.5)</td>
<td>0</td>
<td>0.73</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.4 (21.0 to 31.1)</td>
<td>22.8 (21.2 to 29.1)</td>
<td>2.6</td>
<td>1.00</td>
</tr>
<tr>
<td>Exercise tolerance (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISWT</td>
<td>170 (65.0 to 245.0)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6MWT</td>
<td>-</td>
<td>400 (205.0 to 412.5)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAT</td>
<td>24.5 (17.0 to 29.0)</td>
<td>19.0 (18.0 to 22.0)</td>
<td>5.5</td>
<td>0.56</td>
</tr>
<tr>
<td>Handgrip (kg)</td>
<td>19.9 (12.0 to 20.3)</td>
<td>-*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>HADS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>9.5 (5.5 to 13.5)</td>
<td>8.0 (6.0 to 12.0)</td>
<td>1.5</td>
<td>1.00</td>
</tr>
<tr>
<td>Depression</td>
<td>9.0 (7.3 to 11.5)</td>
<td>7.0 (4.5 to 9.5)</td>
<td>2.0</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Data are presented as median (IQR) to one decimal place; p values are presented to two decimal places; significance accepted at p<0.05; *one data value only; BMI = body mass index, CAT = COPD assessment test, FEV₁ = forced expiratory volume in the first second; HADS = hospital anxiety and depression score, ISWT = incremental shuttle walk test, mMRC = medical research council dyspnoea scale.
Response to pulmonary rehabilitation

Within-group response to PR for all measures is shown in Table 2. No statistically significant differences were identified either within- or between- groups for the measures tested. However, change in exercise tolerance exceeded the minimal clinically important difference (MCID) of the 6MWT (30m) in the conventional group and met the MCID of the ISWT (47.5m) in the dance group (Singh et al. 2014). Improvements in the CAT met the MCID (-2 units) in the dance group (Gupta et al. 2014). The wide-ranging interquartile ranges reported are indicative of the great variance between individuals in both groups. This is also reflected in the individual response to PR of primary outcome measures displayed in Figure 1.

Table 2: Change in outcome measures post PR within dance and conventional groups.

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Dance</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median change</td>
<td>Range p value</td>
</tr>
<tr>
<td></td>
<td>(IQR)</td>
<td></td>
</tr>
<tr>
<td>ISWT (m)</td>
<td>47.5 (0.0 to 107.5)</td>
<td>-10 to 130 0.14</td>
</tr>
<tr>
<td>6MWT (m)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CAT</td>
<td>-2.0 (-6.8 to 2.0)</td>
<td>-7 to 2 0.46</td>
</tr>
<tr>
<td>mMRC</td>
<td>0.3 (0 to 0.8)</td>
<td>0 to 1 0.31</td>
</tr>
<tr>
<td>Handgrip (kg)</td>
<td>1.0* (-0.2 to 1.2)</td>
<td>-0.2 to 1.2 0.29</td>
</tr>
<tr>
<td>HADS anxiety</td>
<td>1.0 (-4.8 to 3.8)</td>
<td>-6 to 4 0.59</td>
</tr>
<tr>
<td>HADS Depression</td>
<td>-1.0 (-1.0 to 2.8)</td>
<td>-1 to 4 0.71</td>
</tr>
</tbody>
</table>

Change calculated as post - pre PR values; data are presented as median (IQR) to one decimal place; p values are presented to two decimal places; significance accepted at p<0.05; *one missing data value, **one data value only; CAT = COPD assessment test, HADS = hospital anxiety and depression score, ISWT = incremental shuttle walk test, mMRC = modified medical research council dyspnoea scale, 6MWT = 6-minute walk test.
(A) change in ISWT in dance group (B) change in 6MWT in conventional group; *one missing data set (C) change in CAT in dance group (D) change in CAT in conventional group.

**Figure 1:** Individual response pre-post PR for primary outcome measures.

The proportion of individual participants who achieved the MCID in exercise tolerance (ISWT or 6MWT), CAT and Hospital Anxiety and Depression Scale (HADS) in both the dance and conventional groups is summarised in Figure 2.

**Completion rate**

The number of patients recruited to the dance and conventional programmes was 5 and 11, respectively. The proportion of participants who completed PR, did not complete or never started is presented in Table 3. Completion rate was 34.5% higher in the dance group and all participants who chose dance-based PR, started the programme.
Discussion and conclusion

To the author’s knowledge, this is the first paper to explore the use of dance-based exercise as part of a PR programme in the COPD population. It is well established that PR results in clinically significant improvements in exercise tolerance and HRQoL (McCarthy et al. 2015). Clinically significant improvements were achieved in exercise tolerance in both groups, and in HRQoL in the dance group. However, there were no statistically significant improvements reported within the groups for any of the primary or secondary outcome measures in this study, which may have been due to inadequate power resultant from the small number of programme participants.

The use of the ISWT rather than the 6MWT (on a 10m track) in the dance group may have influenced the low proportion of participants in the dance group achieving the MCID. It is unclear as to why none of the dance participants met the MCID for change in depression (as measured by HADS). The individual responses to PR in primary outcomes presented in Figure 1 show a mixture of negative and positive results in change following PR. Interpretation is challenging due to issues of confounding and power. The current COPD literature base in dance-based interventions is similarly limited. Further adequately powered

<table>
<thead>
<tr>
<th>Group</th>
<th>Never started</th>
<th>Non-completers</th>
<th>Completers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dance</td>
<td>0 (0.0)</td>
<td>1/5 (20.0)</td>
<td>4/5 (80.0)</td>
</tr>
<tr>
<td>Conventional</td>
<td>4/11 (36.4)</td>
<td>2/11 (18.1)</td>
<td>5/11 (45.5)</td>
</tr>
</tbody>
</table>

Data presented as n (%) to one decimal place.
research into the use of dance as a rehabilitative strategy in the COPD population is required. Completion rates were 34.5% higher in the dance group compared with the conventional group. The small sample size limits the reliability of this result, which is reflected in the inability to assess for statistical significance, although this finding is in keeping with the chronic heart failure literature base (Vordos et al. 2017). Of note, all participants enrolled onto the dance programme started their programme, compared with 4/11 who never started the conventional programme. In a thematic synthesis, it was identified that positive perception of COPD interventions and perception of symptoms influenced attendance (Sohanpal et al. 2015).

In agreement with principles of health behaviour change, it has been suggested that providing patients with a choice of exercise styles may assist in improving uptake to PR and adherence to regular physical activity (McNamara et al. 2018). Further research is required to explore optimal models of care and their influence on attendance.

The retrospective service evaluation model was an appropriate design to provide a reflection of clinical effectiveness in the local population of Tower Hamlets. Unlike Randomised Control Trials (RCTs), observational studies do not have the benefit of randomisation in reducing selection bias. However, it can be argued that RCTs are too far removed from real-life clinical practice, thereby reducing their external validity. Patient choice of PR programme is routine protocol and removing choice could lead to possible ethical issues should the patient decline to participate based on their allocation.

A convenience sample is vulnerable to bias, under-representation and sampling error, limiting the ability to generalise findings. However no statistically significant differences in baseline characteristics recognised to be confounding factors were identified. These included: age, COPD severity (FEV₁ % predicted), self-reported health status (mMRC and CAT), smoking status and BMI (Selzler et al. 2012). The clinically significant difference in COPD severity between groups may have negatively biased the results of the dance group. Baseline exercise tolerance (ISWT or 6MWT) could not be statistically compared due to the differing measures used. This both limited the ability to compare exercise tolerance between groups and may have influenced the reported results owing to differing qualities of the two outcome measures. The dance group was comprised of females only which may reflect cultural influences as well as personal preference of exercise style.

A strength of this service evaluation was the matched elements of the two PR programmes other than the form of aerobic exercise used. It is often the case in clinical practice that the choice of programme is based on geographical location due to challenges associated with travel in this population. The matched venue removed this as a potential confounding variable.

The Latin style of dance was chosen with the aim of overcoming the traditional perception of exercise and optimising enjoyment (Domene et al. 2016). The population in Tower
Hamlets has a significant Bangladeshi community. Future studies in the local COPD population could consider the use of traditional Bangladeshi dance with the aim of optimising engagement.

Clinical implications and recommendations for practice
A larger service evaluation is warranted using consistent, appropriately selected measures of exercise tolerance. It is recommended that evidence-based protocol for performing these measures is documented in the standard operating procedure of the Barts PR service to ensure validity of reported results.

The introduction of an alternative measure of exercise tolerance, which is appropriate for patients who are limited by co-morbidities as well as breathlessness, has been discussed with the Trust. As a result of these discussions, the Barts PR service is planning to implement the 1-minute sit to stand into routine practice. This will be in conjunction with the ISWT to gain a broader understanding of exercise tolerance across the full range of physical limitation.

Discussions are also underway regarding the use of traditional Bangladeshi dance in the dance-based programme to promote engagement of the local population. Further consideration regarding the music used in both dance and conventional PR programmes is indicated.

Conclusion
The results of this service evaluation of the Barts PR service provided inconclusive findings. Completion rate was found to be higher in the dance-based PR programme compared with the conventional programme. However, caution should be exercised in interpreting this finding due to the recognised limitations of this retrospective, single centre study. A larger, adequately powered observational study is required to address the intended primary aim of this evaluation.

Acknowledgement
I am indebted to my academic supervisors, Dr Leyla Osman and Dr Harriet Shannon, for their expert feedback and guidance, as well as their unwavering support throughout this project.

I would like to thank my colleagues in the Barts adult respiratory care team for their support, with particular thanks to clinical lead Jane Simpson. I am also very thankful to the patients who attended our pulmonary rehabilitation programme.

Funding
The author’s MSc dissertation with UCL was funded by Barts Charity.

Ethical and R&D approval
This study was not considered research as confirmed by the NHS Health Research Authority decision tool. Ethical approval was therefore not required, as confirmed by both the
research services of Barts Health and University College London. The study was registered with, and approved by, the Barts Clinical Effectiveness department (registration number 9884), as per local policy.

Pulmonary rehabilitation was delivered within the definition of usual practice. The Barts PR service regularly collects data for the purpose of audit and evaluation. Article nine of the General Data Protection Regulation (2018) states that it is permissible to use personal data concerning health for direct care and related administrative purposes including local clinical audit (UK Parliament 2018).

References


How early is early? When should rehabilitation begin in critical illness?

Helen Sanger

Critical care mortality has significantly declined over the last decade, resulting in a growing population of individuals who have survived a period of critical illness (Zimmerman et al. 2013). In the United Kingdom (UK) alone almost 140,000 people were discharged alive from critical care in the year to April 2018, in comparison with under 75,000 in the same period to 2009 (Intensive Care National Audit and Research Centre (ICNARC) 2010; ICNARC 2018). However, this survivorship is frequently characterised by long-term deficits in physical, cognitive and psychological health (Cuthbertson et al. 2010; Herridge et al. 2011; Pandhari-pande et al. 2013). Therefore, the National Institute for Health and Care Excellence (NICE) recommends that rehabilitation with the aim of optimising recovery commence ‘as early as clinically possible’ in those at risk of morbidity (NICE 2009). Despite this, the paucity of evidence in favour of any given rehabilitation strategy means that the optimal type and timing of intervention remains an area of debate. The following review will explore when physical rehabilitation should begin in critical illness, focusing on some of the key factors that limit the current evidence base.

The physical sequelae of critical illness are most commonly loss of skeletal muscle strength and endurance, with associated loss of function and independence (Herridge et al. 2011; Batt et al. 2013). The term intensive care unit acquired weakness (ICU-AW) is used to refer to this presentation of weakness. ICU-AW is attributed to multiple physiological mechanisms relating to systemic inflammation and catabolic illness, resulting in varying proportions of polyneuropathy, polymyopathy, or both (Kress and Hall 2014). Those with ICU-AW take longer to wean from mechanical ventilation, and have poorer long-term functional outcomes than those without (De Jonghe et al. 2002; Dinglas et al. 2017; Kelmenson et al. 2017).

Early physical rehabilitation has been proposed as a potential treatment, or prophylaxis, for ICU-AW (Morris and Herridge 2007; Needham 2008). For the purposes of this discussion, ‘early rehabilitation’ is defined as active exercise of some form, commenced whilst an individual is on critical care. Passive exercises are not included, as there is no evidence for...
these increasing muscle strength or endurance (for example, Nafziger et al. 1992; Marshall et al. 2011). Multiple other definitions of early rehabilitation exist: some specifying beginning rehabilitation within a certain number of days or hours of critical care admission or commencement of mechanical ventilation; some include passive movements; while others simply fail to define early rehabilitation at all. A recent systematic review of early mobilisation in mechanically ventilated patients found that only 15 of the 76 included studies defined early mobilisation fully (Clarissa et al. 2019).

It might appear axiomatic that physical rehabilitation should be a treatment option for ICU-AW. Exercise-based interventions have strong evidence for improving strength and function in other clinical populations, such as chronic respiratory disease (McCarthy et al. 2015). However, evidence for early rehabilitation on critical care as a treatment for ICU-AW remains poor. Initial studies demonstrating benefit have been followed by multiple subsequent trials showing no effect of intervention (Castro-Avila et al. 2015; Hodgson and Cuthbertson 2016; Tipping et al. 2016; Fuke et al. 2018). One problem with demonstrating effect may be due to a change in usual care on ICU, due to early indications of benefits of rehabilitation. For example, in Schweickert’s 2009 randomised control trial comparing early physical and occupational therapy on critical care with ‘usual care’ (data collected between 2005 and 2007). The control group was usual care in two North American hospitals at the time. They commented that ‘neither site routinely provides physical therapy for patients who are on mechanical ventilation for less than 2 weeks, nor has dedicated physiotherapists for such practice’ (Schweickert et al. 2009). Usual care therefore, was little or no physical rehabilitation on critical care. Subsequent studies, particularly those based in Australia or Europe, have compared ‘usual care’ – provision of some physical rehabilitation on critical care – with an intervention of either increased dose, earlier commencement, or more prolonged delivery of rehabilitation (e.g. Denehy et al. 2013; Walsh et al. 2015). Although these interventions have been shown to be feasible and safe, they have demonstrated little or no improvement in functional outcomes (for reviews, see Castro-Avila et al. 2015; Hodgson and Cuthbertson 2016; Nydahl et al. 2017; Tipping et al. 2017).

The NICE Clinical Guideline ‘Rehabilitation after Critical Illness’ (NICE 2009), Quality Standard of the same name (NICE 2017), and the Intensive Care Society (ICS) Guidelines for the Provision of Intensive Care Services (ICS 2015), all recommend early rehabilitation to improve physical functioning. The NICE 2017 quality standard states, ‘[I]n the critical care unit, reduced mobility, weakness and fatigue will be the main problems, for which the overall goal will be early mobilisation’ (NICE 2017, p. 8), and that adherence to the quality standards are expected to contribute to improvements across multiple outcomes, including physical recovery and quality of life. However, both NICE and the ICS could be criticised for making recommendations in the absence of a strong evidence base to support them. For example, the statement above in the NICE quality standard is referenced as being supported by ‘expert opinion’ only, the weakest quality of graded evidence (Ryan 2016).
This is precisely because there is still no higher quality evidence to support it, even eight years after the publication of the corresponding clinical guideline (NICE 2009).

The speed of onset of muscle wasting (Puthucheary et al. 2013; Parry et al. 2015) and resultant loss of strength and function that occurs in ICU, means that many clinicians feel rehabilitation should be commenced as soon as possible following admission. Proponents of early rehabilitation often cite studies that commenced their intervention within 72 hours of ICU admission as those with positive outcomes (Schweickert et al. 2009; Dong et al. 2016; Schaller et al. 2016). They then explain the failure of other studies to show benefit as being due to later initiation of the intervention (such as Denehy et al. 2013; Morris et al. 2016; Wright et al. 2018). This is a possibility, but downplays the range of other differences between these studies that could have affected the outcomes, such as differing inclusion and exclusion criteria, differences in usual care of the control group, varied interventions, and different primary outcomes. For example, Schweickert and colleagues’ only included patients who were ‘functionally independent’ prior to admission, and Dong and colleagues’ only patients who were able to ‘stand up and walk’ at enrolment (Schweickert et al. 2009; Dong et al. 2016). Whereas, Denehy and Wright’s trials had no exclusion on the basis of pre-morbid or enrolment function (Denehy et al. 2013; Wright et al. 2018). As such, the evidence base does not clearly support the statement that physical rehabilitation improves function in all critical care patients provided it is commenced in the first two or three days, and not if it is not (Castro-Avila et al. 2015; Hodgson and Cuthbertson 2016; Tipping et al. 2016).

Another factor that may contribute to the inability of early rehabilitation trials to show improvements in morbidity or mortality is the heterogeneity of the patient group, both in their individual characteristics, and the way in which they respond to an intervention. Multiple authors have suggested this as a likely confounder when analysing their results (for example, Denehy et al. 2013; Wright et al. 2018). In fact, heterogeneity of treatment effect – the idea that not every critical care patient will respond in the same way to a given intervention – is thought to contribute to the difficulty in showing effect of intervention in other areas of critical care medicine too, not only in rehabilitation (Iwashyna et al. 2015). Many early rehabilitation studies have included all patients on one or more critical care units, therefore assessing the impact of a given intervention on a cohort of patients for whom acuity of illness and associated dependence are the only guaranteed common factors. Even cohorts with more narrowly defined inclusion criteria, such as patients with acute respiratory distress syndrome, or sepsis, have significant variation within groups, due to the syndromic nature of such diagnoses (Iwashyna et al. 2010; Herridge et al. 2011).

Critical care patients as a cohort have worse mortality and morbidity outcomes than hospital inpatients requiring ward-based level of care (Lone et al. 2016), but acuity of illness within a critical care population is a poor predictor of outcome (Cuthbertson 2016; Bagshaw et al. 2018). Therefore, although all critical care patients clearly have something in common (how sick they are), the discriminatory ability of this severity of illness is limited.
This makes trial design inherently difficult. There are few, if any, other areas of research into physical rehabilitation that select their patient cohort on the basis of acuity of illness, unrelated to specific diagnosis. This might be equivalent to an outpatient physiotherapy programme providing the same intervention to all patients with a certain severity of symptoms, unrelated to part of the body affected.

In light of this, various authors have suggested stratification of the ICU cohort by factors that correlate with levels of physical morbidity post-ICU (Iwashyna 2012; Hodgson and Cuthbertson 2016; Herridge et al. 2016). They aim to describe the differing recovery trajectories following ICU for specific groups of patients. In particular, allowing identification of those at risk of prolonged severe morbidity. Cuthbertson hypothesises three distinct group of ICU survivors – those with broadly preserved function, those with some functional decline, and those who either do not survive, or do so with severe disability (Cuthbertson 2016). He identifies pre-hospital morbidity, acuity of illness and overall hospital exposure as discriminatory factors to identify these distinct groups; citing work by Iwashyna and colleague (2010), who identified a link between pre-hospital functional trajectory and post-ICU function in a cohort of patients with sepsis, as well as that of Lone et al. (2016) and Ou et al. (2016). Iwashyna (2012) suggested three possible trajectories of recovery following critical illness: ‘The big hit’, an initial loss of function as a result of acute illness, followed by a period of recovery to near pre-morbid level; ‘the slow burn’, in which the initial impact of critical illness permanently alters a person’s functional trajectory to one of decline; and the ‘relapsing recurrences’, similar to that understood in populations with multiple sclerosis, or chronic obstructive pulmonary disease (COPD). He discusses these in the context of a study by Woon and colleagues (2012) examining cognitive outcomes following ICU, which demonstrates subgroups of patients following each of these trajectories. However, he argues that they hold true for physical functioning also, and emphasises the importance of an ‘appropriately defined patient population’ when designing controlled trials in critical care (Iwashyna 2012). This could be crucial when assessing physical rehabilitation interventions in those with critical illness, as the impact of a given intervention may depend on the recovery trajectory of each patient, and the extent to which this is modifiable. If early physical rehabilitation does improve functional outcome, perhaps it is only in those on a certain trajectory – the ‘big hit’, or broadly preserved function, say. If we were able to identify these groups, then interventions could be assessed against their ability to modify these trajectories. It is worth recalling that both the trials led by Dong et al. (2016) and Schweickert et al. (2009) demonstrating positive impact of early rehabilitation interventions, excluded individuals with poor pre-morbid function from their study sample.

Herridge and colleagues have performed the most thorough stratification analysis of an ICU patient cohort, retrospectively examining outcomes of almost 400 ICU patients who had received a week or more of mechanical ventilatory support (Herridge et al. 2016). This was a diverse sample of medical and surgical patients, from five different ICUs, therefore should be generalisable to most ICU populations. They found that age and ICU length of
stay (LOS) could be used to divide the sample into four distinct ‘disability risk groups’, where LOS is defined as short if less than two weeks, long if more than. These groups, in order of risk of physical morbidity, were: young (less than 42) with short LOS; mixed-age and variable LOS (either older than 42 with short LOS, or less than 45 with long LOS); older (46–66 years) with a long LOS; or oldest (greater than 66) with long LOS. Group membership predicted functional ability at one-week post ICU discharge, as measured by the functional independence measure (FIM). This score in turn, was predictive of FIM score at one-year post critical care. Therefore, age and LOS alone were able to predict physical functioning at one year following ICU discharge. This is a significant result, as it allows those designing future interventional trials to perform subgroup analysis by disability risk group, thereby assessing the impact of a given intervention on the predicted one-year recovery trajectory of physical functioning. This analysis differed in that it did not identify pre-ICU morbidity as a discriminatory factor explicitly. However, the lowest risk group had the lowest level of pre-ICU morbidity (estimated by comorbidity indices and work status), and the highest risk group the highest level. Indicating that age, LOS and pre-ICU morbidity are closely linked.

Accurately assessing the pre-admission morbidity burden of an ICU cohort is challenging. Ideally, all patients would be assessed over a period of time prior to ICU admission, to give an indication of functional trajectory prior to the onset of critical illness. However, the unpredictable nature of acute illness and therefore number of unplanned admissions to ICU renders this impractical, if not impossible. There may be some sub-populations of patients for whom these data are already collected as part of the management of a long-term condition; those with COPD, for example, for whom measures of functional ability and disease burden are routinely measured. These could give an indication of morbidity severity prior to ICU-admission for this group. For the majority of patients, surrogate measures must be used to retrospectively attempt to assess pre-ICU morbidity, such as work status, or an estimated functional measure based on proxy report (Schweickert et al. 2009; Herridge et al. 2016).

If factors such as pre-ICU morbidity, age and LOS combined were able to create a model with consistent predictive ability for trajectory of physical functioning post-ICU, then it may also identify groups of ‘responders’ versus ‘non-responders’ to early physical rehabilitation interventions. For example, perhaps older patients with poor pre-morbid function, who require a prolonged critical care stay, will not regain the physical function lost as a result of their critical illness, regardless of exercise-based intervention. It is important in this context to consider both appropriate utilisation of resources – targeting treatments at those most likely to benefit, and treatment burden for individual patients. Qualitative analysis performed by Corner (2017) examined the experience of early rehabilitation from the point of view of individuals who have survived ICU. This highlighted that physical rehabilitation on ICU is something that patients find fatiguing, and often dread. Therefore, it is imperative that the critical care community work to identify groups of potential ‘non-responders’ to this intervention. It is ethically problematic to ask patients to engage in a treatment that
is difficult and tiring, for potentially little or no gain. If such groups were identified, then it could be argued that we are at a point of equipoise – should any physical rehabilitation be offered on critical care to those with risk factors making them likely to be non-responders to this intervention? Rather than asking ‘when’ we should commence early rehabilitation, a trial comparing current usual care of physical rehabilitation on critical care, with no physical rehabilitation may be warranted.

As the number of people surviving an ICU admission continues to grow, the population of individuals living with the residual effects of critical illness, including ICU-AW, grows also. Although it is well established that the pathophysiological mechanisms driving ICU-AW begin early in critical illness, there is currently insufficient evidence to recommend any specific treatment strategies to combat it. The question of timing – when early rehabilitation should commence on ICU – cannot be answered until one or more interventions, undertaken at any time, are found to consistently improve outcomes. An appraisal of the current evidence base with a focus solely on timing is problematic, because of the multiple other methodological differences between any given studies. Clarification, and perhaps standardisation, of usual care for control groups; as well as stratification of ICU populations according to factors that influence functional outcome trajectory, may aid future trials assessing the impact of rehabilitation interventions. Interestingly, NICE recommended ‘individualised’ rehabilitation plans in their guideline in 2009 (NICE 2009). Given the failure of trials to date to demonstrate benefit of interventions undertaken with heterogeneous cohorts of critical care patients, perhaps further individualisation is the answer. A focus on patients’ individual characteristics may be essential in designing an effective rehabilitation intervention. After which, optimisation of timing could be considered.

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Hough’s cardiorespiratory care: An evidence based, problem solving approach, 5th edition 2017

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This is the latest addition of Alexandra Hough’s comprehensive text previously titled Physiotherapy in Respiratory and Cardiac Care: An Evidence-Based Approach. It remains an excellent resource which has been thoroughly updated and enhanced covering a broad range of specialty populations including paediatrics, palliative care and the elderly. It was pleasing to see some new collaborators on this addition providing fresh eyes and expertise from across the UK.

The overall structure is logical with each chapter beginning with clear learning objectives to focus the reader and establish learning levels. The first chapter focuses on physiological principles, clearly aligning them to physiotherapy practice and broader considerations including lifestyle factors such a stress and immobility. There is no anatomy section so readers are expected to have prior knowledge of the structure and function of the cardiorespiratory system.
The chapter on assessment is thorough including a comprehensive section on imaging. Throughout the first 2 chapters there are ‘practice tips’ which give quick and easy tasks to help readers understand the knowledge being presented.

Most common respiratory and cardiovascular disorders are summarised clearly through pathophysiology and clinical features, to diagnosis and management including signposting to some clinical guidelines. The inclusion of relevant outcome measures is useful to reinforce the need to evaluate and evidence practice in patient centered ways.

Physiotherapy techniques are split into broad categories including pulmonary and cardiac rehabilitation, and links are made to the physiology and up to date evidence base surrounding interventions.

The extended chapter on surgery establishes the importance of both pre and post-operative input and the multidisciplinary team. As in previous editions paediatrics is thoughtfully split into infants and children allowing deeper evaluation of this patient group. Hyperventilation syndrome is again included and although a broader topic on breathing pattern disorders may enhance the book, it provides a good baseline for further learning should the reader wish. The detailed chapter on critical care remains very comprehensive covering commonly seen procedures and rehabilitation.

Chapters on specialty populations include quotes and comments from patients reminding the reader that patients are the centre of our care and facilitating constant reflection on the patient experience and the impact of physiotherapy. At points during these latter sections ‘Clinical Reasoning’ boxes are present to promote critical thinking, including ethical issues, encouraging readers to critically appraise and reflect upon their practice.

The final chapter considers evaluation of physiotherapy providing definitions and overviews of key concepts relating to clinical research that would be useful for students and newly qualified physiotherapists or those who would like a refresher. A brief case study is utilised to promote questioning of literature and put context to the chapter.

Images and diagrams are prevalent throughout the book adding to its readability and ease of understanding. Key points are highlighted regularly in coloured boxes allowing clarification and chapters are complimented by case studies to illustrate points and consolidate knowledge in a clinical scenario. Terminology is suitable for undergraduate level upwards with key terms are explained throughout the text and in separate boxes, as well as the inclusion of a comprehensive glossary of terms.

An exciting element of this book is the availability of the online resources as the linked website includes full reference lists, images and additional appendices to enhance the text. Although occasional frustrating to not have access to a full reference in the text immediately, the positives outweigh this.
This a very considered and comprehensive text which would align well to undergraduate curriculums and most suited to those newer to cardiorespiratory care, however its readability means it would be a great addition to the library of student, qualified and education-based physiotherapists alike.