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Introduction

Welcome to the Association of Chartered Physiotherapists in Respiratory Care (ACPRC) journal for 2016. The 3 original articles in this year's journal are themed around Intensive Care discussing the use of outcome measures used in this setting as well as surveys into current practice around rehabilitation in ITU and physiotherapy treatments used on ECMO patients. We, as physiotherapists, play key roles in evaluating services that are provided within both primary and secondary care. This edition of the journal highlights evaluations within critical care and post-operative care which highlight some of the challenges of interventions or adaptations of services for different patient groups. A case study by Allum, p56, looks at whether predictors of a successful or failed tracheostomy decannulation can be identified. Finally, Carley King has written about her personal experiences in being involved in a NICE scholarship scheme which has led to the production of Inspire, a collaboration of guidelines for physiotherapists working within cardiorespiratory. Using the patient and carer experiences as well as professionals, means these guidelines have been put into context within a patient story. Once again all of these articles provide a dissemination of current research and practice that will enable clinicians to make informed clinical decisions into providing the best possible patient care.

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Next year is our bi-annual ACPRC conference which is to be held on 28th & 29th April 2017, in York so save the date in your diaries now! The conference is entitled "Cardiorespiratory Physiotherapy: Now and into the Future". The programme is underpinned by our mission statement of inspiring excellence in cardio-respiratory care and we aim to do this through sharing knowledge and skills, connecting people, facilitating research and best practice and leadership and innovation.

We hope you enjoy this issue of the ACPRC journal and hope it inspires you to get writing. One of the roles of the research officer is to offer support to novice researchers, at any stage of the research process so please feel free to utilise this service. Author guidelines with detailed instructions have been updated and can be found on the ACPRC website www.acprc.org.uk.

With best wishes

Una Jones PhD MSc MCSP
Emma Chaplin BSc MCSP

Current rehabilitation practices for patients admitted to critical care in the UK: a 5 day point prevalence survey of 12 adult general intensive care units.

McWilliams DJ¹, Duffy L¹ and Snelson C¹

Background

Early rehabilitation of critically ill patients is safe and improves functional outcomes and critical care and hospital length of stays. Recent international studies have demonstrated the implementation of early rehabilitation to be limited and inconsistent.

Method

A five day survey was conducted of 12 adult general critical care units in the UK to assess the type of physiotherapy intervention being provided to critically ill patients receiving varying levels of organ support. Interventions were recorded in a number of different categories using a pre-designed tool, designed to include common physiotherapy interventions within the ICU. Data was also collected regarding organ support to determine the clinical status of patients at the time of each intervention.

Aim

To assess the levels of active rehabilitation and the specific impact of organ failure on activity levels.

Results

A total of 657 physiotherapy treatments were administered over the study period, with mobilisation out of bed, defined as sitting on the edge of the bed, sitting out in a chair, standing or walking occurring in 45% (n=293) of all treatments. Levels of mobilisation were much lower in patients receiving mechanical ventilation with these patients actively mobilising significantly less than those receiving non-invasive ventilation or spontaneously breathing (23% vs 62%, $p < 0.0001$). In fact in 4/12 centres no active rehabilitation was delivered whilst patients were invasively ventilated. The presence of an endotracheal tube appeared to be a significant barrier to active mobilisation, with only 7% of interventions included sitting on the edge of the bed and none standing, transferring or walking. Mobilisation levels were also low in patients receiving vasoactive medication or renal support.

Keywords:

Critical Care
Rehabilitation
Physiotherapy
Mobility
Survey

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Conclusions

The survey demonstrated that although physiotherapy is a standard of care in UK critical care units, interventions involving active mobilisation are limited in patients receiving organ support. Specifically, level of activity seen was significantly lower in patients receiving invasive ventilation or renal support despite expert recommendations and data supporting safety of such interventions.

Introduction

Survivors of critical illness experience significant and long lasting physical, psychological and cognitive morbidity (Sukantarant et al, 2007; Cheung et al, 2006; Herridge et al, 2003) . Early mobility programmes within the intensive care unit (ICU) have been shown to decrease hospital and ICU length of stay (LOS) (McWilliams et al, 2014; Needham et al, 2010; Morris et al, 2008) and improve functional ability at the point of hospital discharge (Schweikert et al, 2009; Chiang et al, 2006). Although the safety of mobilisation has been explored in a number of recent studies (Sricharoencha et al, 2014; Perme et al, 2013; Bailey et al, 2007), at present no standardised pathway or protocol exists and patients are presenting with increasing complexity of illness, multiple co morbidities and a multitude of physical and psychological needs. In addition, the optimal timing and delivery of early mobility interventions remains unclear.

A recent international survey by Bakhru et al (2015) showed that only 48% of ICUs stated that they had adopted early mobilization practices and only 27% reported a formal protocol. In the UK, the international survey confirmed that the majority of ICU's had 1:1 nursing and that 92% had dedicated physiotherapy teams, compared to 34% in the US. Rehabilitation was found to be physiotherapy led in the UK, although most patients were generally seen only once per day, with other countries providing 2-3 sessions daily when physiotherapists were available. The basic infrastructure to provide early and regular input for early mobility is therefore likely to be in place in the UK.

The National Institute for Health and Care Excellence (NICE) emphasized the importance of rehabilitation in the short clinical guideline "Rehabilitation after critical illness" (NICE, 2009). This guideline recommended starting rehabilitation as early as clinically possible within the course of an ICU stay, and continuing this on discharge to the ward and then into the community. Very few NHS organisations provide post hospital discharge rehabilitation programmes, with lack of funding, insufficient resources and lack of prioritisation cited as barriers (Connolly et al, 2014).

There is a paucity of data concerning the current rehabilitation practices within the ICU in the UK, although one single centre study found that 'active rehabilitation' occurred in 55% of all physiotherapy episodes (Thomas et al, 2009). We conducted a 5 day point prevalence study in 12 adult general critical care units within the UK to address this evidence gap. The aims of the survey were

- 1) To assess the levels of active rehabilitation taking place within a sample of UK based intensive care units and compare levels between units;
- 2) To evaluate whether the presence of organ failure impacts on activity levels

Methods

A total of 12 mixed adult critical care units participated; 3 university teaching hospitals and 9 district general hospitals with a combined total of 172 beds (range 5 to 29 beds). Survey participants were selected from a cohort of attendees at a physiotherapy critical care study day, which focussed on rehabilitation within the ICU. Survey respondents were asked to record every physiotherapy intervention delivered to each patient in their ICU for 5 consecutive days (Monday 19th to Friday 23rd November 2012). The interventions were recorded prospectively in a number of different categories using a pre-designed tool, designed to include common physiotherapy interventions within the ICU (see Box 1). Categories were adapted from the tool used in a previous survey of physiotherapy practice within the UK (Thomas et al, 2009).

Box 1: Survey physiotherapy interventions

- Body positioning in the bed
- Suctioning
- Manual techniques to facilitate secretion removal
- Manual hyperinflation
- Ventilator hyperinflation
- Breathing exercises
- Passive movements
- Active exercises in the bed
- Sitting on the edge of the bed
- Sitting to standing
- Standing transfers
- Walking any distance
- Hoist transfer into chair
- Patslide transfer into chair
- Standing hoist

Body positioning in this instance referred to the use of positioning for respiratory interventions, such as side lying for postural drainage or lung re expansion. The term “passive movements” refers to the passive mobilisation of a patients limbs through range, with no active participation from patients, whereas active exercise involves patient participation and can refer to upper or lower limb activity in situ, not involving movement onto the edge of the bed or otherwise. More active mobilisation categories are self-explanatory in nature, involving sitting on the edge of the bed, active or passive transfer to a chair and walking. In order to compare practices based on the clinical status of the patients, therapists were also asked to record organ support in terms of airway (self, endotracheal tube or tracheostomy), mode of ventilation (mandatory, pressure support, non-invasive or self) cardiovascular support (vasopressor or inotrope), renal support (including whether the access line was sited in the neck or groin), sedation usage and whether the patient was able to follow commands.

Ethical considerations

This project constituted an evaluation of standard care delivery with no randomisation and thus met the definition of a service evaluation under the NHS Health research authority guidelines. No patient identifiable information was collected, as such on consultation with the Trust's R&D department it was agreed ethical approval was not required and the need for consent was waived.

Statistical Analysis

Standard descriptive statistics are reported, with Fisher exact and chi-square tests used to evaluate statistical associations. Statistical significance was defined as a two sided p value less than 0.05. Statistical analyses were completed using Preacher (2001) Calculation for the chi-square test: An interactive calculation tool for chi-square tests of goodness of fit and independence [Computer software]. Available from <http://quantpsy.org>.

Results

Data was collected for a total of 657 physiotherapy treatments over the 5 days of the study across the 12 intensive care units. There was a median (interquartile range) of 49 (30-69) physiotherapy interventions reported by each individual unit.

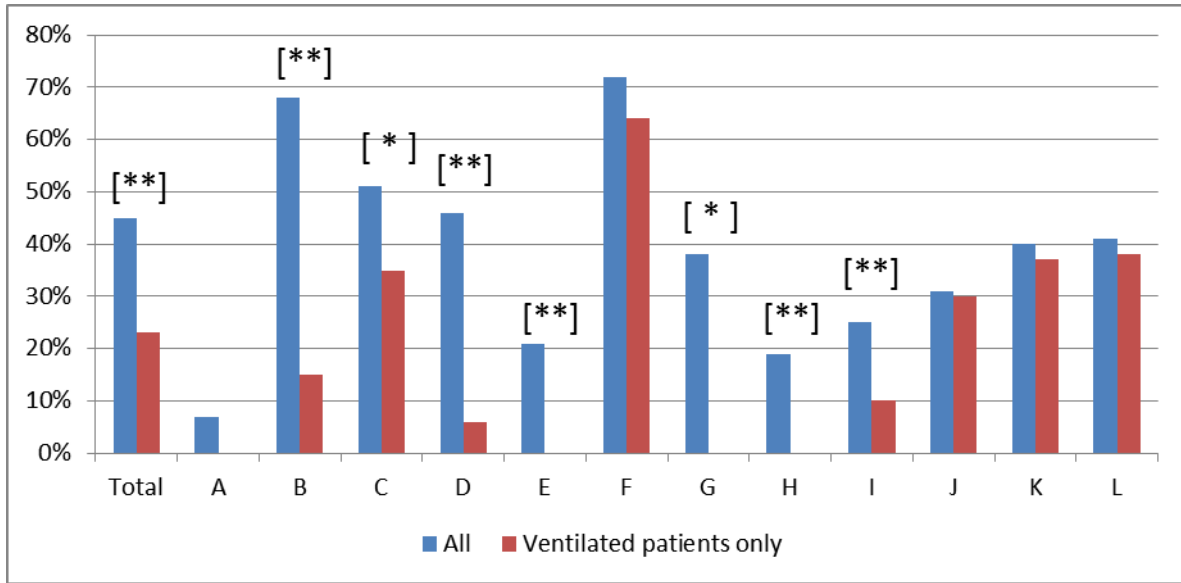
Of these interventions, 289 (44%) concerned patients who were mechanically ventilated, 64 (10%) were receiving non-invasive ventilation and 303 (46%) were breathing spontaneously. Respiratory support was not documented for one treatment session. Inotropic or vasopressor support was present in 148 (23%) of treatments, whilst 41 (6%) were administered whilst the patient was receiving renal support (haemofiltration or haemodialysis). 131 (20%) of the interventions were to patients who were sedated, with 355 (54%) to patients who were alert and following commands. The interventions received during each treatment session (which are not mutually exclusive) are summarised in Table 1.

	ET (n=138)	Trache (n=151)	NIV (n=56)	CPAP (n=56)	Self Vent (n=303)	Inotropes (n=148)	CVVH Neck (n=41)	CVVH Groin (n=5)	Sedated (n=131)	Follows Commands (n=357)
Passive exercises	76	54	0	8	9	66	18	4	77	13
Active exercises	6	25	1	10	53	10	8	0	5	70
Sit on edge of bed	10	10	1	7	13	0	1	0	0	34
Patslide to chair	0	1	0	0	1	0	0	0	0	1
Hoist	0	17	2	0	8	0	0	0	1	18
Sit-stand	0	8	0	4	17	3	3	0	0	27
Step transfers	0	12	1	2	75	23	3	0	0	72
Walking	0	8	1	10	85	19	0	0	0	86

Table 1: Summary of interventions administered during treatment sessions

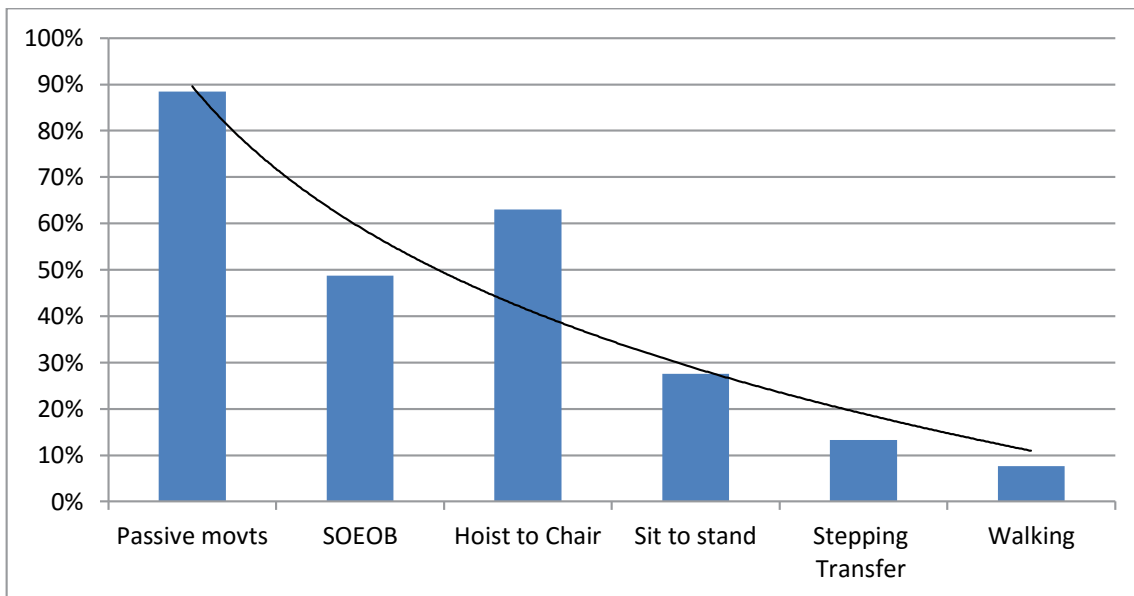
ETT: endotracheal tube; NIV: Non-invasive ventilation; CPAP: Continuous positive airway pressure delivered non-invasively. CVVH: Continuous venous-venous haemofiltration Each treatment session may have included more than one physiotherapy intervention but only highest level of rehabilitation delivered is shown.

Fig.1. Proportion of patients completing active rehabilitation per centre (%)



Active rehabilitation is defined as sitting on the edge of the bed or higher. Comparison made to show centres who have significantly lower levels of active rehabilitation for ventilated patients in comparison to all patients within that centre * Significance $p < 0.05$; ** Significance after correction for 12 comparisons $p < 0.004$

Figure 2: Proportion of rehabilitation interventions taking place in ventilated patients



SOEOB : Sit on edge of the bed; Hoist includes mechanical over-bed or standing hoist,

Only 10 of 138 (7%) treatments administered to patients with an endotracheal tube included sitting on the edge of the bed and none included standing, transferring or walking. All 10 of these instances occurred in the same ICU (unit F) which had a significantly higher level of mobility interventions for ventilated patients in comparison to the total population mean (64% vs 23%, $p < 0.001$). Mobilisation levels during treatment sessions were higher for patients with a tracheostomy, with 37% ($n=56$) sitting on the edge of the bed or higher. Similar levels of mobility were seen in patients receiving inotropic or vasopressor support, with 30% ($n= 45$) standing, transferring or walking, although the majority of these patients were spontaneously breathing (95%), leaving only 5% of patients receiving vasoactive agents and mechanically ventilated mobilised out of bed. Patients receiving renal support also demonstrated low levels of mobilisation, with only 10% sitting on the edge of the bed or standing. No active rehabilitation was delivered in patients receiving haemofiltration via groin lines.

A reduced conscious level due to sedative medications, encephalopathy or delirium can limit the ability to provide active rehabilitation. 77% of patients with an endotracheal tube (ETT) and 14% of patients with a tracheostomy in situ during the physiotherapy intervention were receiving sedative medications. A sub analysis was performed for treatment interventions with those patients alert and able to follow commands (see Table 2). Of these 356 treatments, 229 (64%) involved active mobilisation out of bed or higher, although the majority of these were interventions in subjects who were spontaneously breathing with only 2% involving patients ventilated via an ETT and 17% via a tracheostomy. As previously stated, in both the total cohort and in those able to follow commands, all of the active mobilisation with an ETT in situ took place in 1 critical care unit; all of the interventions which involved walking whilst receiving vasoactive agents also took place in a single centre (although this was a different critical care unit from the one which mobilised patients with an ETT in situ).

	ET (n=18)	Tracheostomy (n=73)	NIV (n=42)	Self Ventilating (n=223)	Inotropes or vasopressors (n=47)	Renal support (n=10)	On sedative medications (n=8)
Passive exercises	4	5	1	3	0	0	1
Active exercises	6	22	7	35	6	6	5
Sit on edge of bed	4	9	8	13	0	0	0
Sit to stand	0	8	4	15	3	2	0
Step transfers	0	10	3	58	20	2	0
Walking (any distance)	0	8	9	69	14	0	0
Hoist to chair	0	8	2	8	0	0	1
Patslide to chair	0	0	0	1	0	0	0

Table 2: Interventions administered to patients who were able to follow commands

ETT: endotracheal tube; NIV: Non-invasive ventilation; Each treatment session may have included more than one physiotherapy intervention but only highest level of rehabilitation delivered is shown.

The level of active rehabilitation, defined as sitting on the edge of the bed or higher, was significantly affected by the presence of organ failure (see table 3) with lower activity levels seen for those patients requiring mechanical ventilation to those who were spontaneously breathing (23% vs 62%, $P < 0.0001$), vasoactive agents vs no vasoactive agents (30% vs 49%, $P < 0.0001$), haemofiltration or haemodialysis vs no renal support (17% vs 47%, $p < 0.001$) and the use of sedative medication vs no sedation (1% vs 56%, $P < 0.0001$).

Organ Support	Yes	No	p
Invasively Ventilated	66 (23%)	227 (62%)	<0.0001
Vasoactive Agents	45 (30%)	249 (49%)	<0.0001
CVVH	7 (17%)	287 (47%)	<0.0001
Sedation	1 (1%)	293 (56%)	<0.0001

Table 3: Proportion of patients mobilised depending on organ support

Number mobilised (%)

Chi squared test

Discussion

Early mobilisation of critically ill patients has been demonstrated to be safe (Sricharoencha et al, 2014; Bailey et al, 2007) and effective in improving functional outcomes and reducing both ICU and total hospital length of stay (McWilliams et al, 2014; Schweikert et al, 2009). Until recently, little was known about the world-wide adoption of early mobilisation. Our survey is the first to assess physiotherapy interventions and rehabilitation practices within critical care in the UK in a mix of district general and teaching hospital units. We have confirmed that patients are receiving daily physiotherapy, with respiratory manoeuvres, breathing exercises, passive interventions and active rehabilitation all being included in the treatment sessions.

However, very few patients with an endotracheal tube (7%) or on vasoactive medications (30%) received active rehabilitation. Most patients with an endotracheal tube or on mandatory ventilatory modes were on sedative medication, highlighting the need for optimum sedation practices to allow early mobility interventions to occur. We also recorded significant differences between centres in the degree of active rehabilitation administered to patients still requiring organ support, with only 1 of the 12 centres actively rehabilitating patients with endotracheal tubes still in situ and 2 out of 12 mobilising those on inotropic support. The reason for these differences is unclear and was outside of the scope of this survey. Future research should evaluate these differences further, analysing limitations or restrictions to mobilisation such as sedation practices, timing of tracheostomy and staffing levels.

Despite the higher level of established physiotherapy within the UK, our results regarding rehabilitation levels are similar to those seen in other early mobility surveys elsewhere in the world. Nydahl and colleagues completed a point prevalence survey of mechanically ventilated patients in 116 intensive care units in Germany (Nydahl et al, 2014). They found only 24% of all mechanically ventilated patients were mobilised out of bed as part of routine care, with only 4% of all patients standing, marching or walking. Rates were higher in those patients with a tracheostomy (39%) in comparison to endotracheal tubes (8%). Only 1/401 patients with an endotracheal tube stood, transferred or walked. A low rate of mobilisation in ventilated patients was also demonstrated in a one day point prevalence study of ICU mobility practices in Australia and New Zealand (Berney et al, 2013). A sub group analysis within this study for patients mechanically ventilated for more than 48 hours demonstrated that 31% completed bed exercises only, whilst less than 4% sat on the edge of the bed. No patient on mechanical ventilation sat out in a chair or walked.

The reason for this lack of adoption of early mobility practice is unclear. Numerous recent studies have demonstrated the safety of mobilising patients within critical care, including those receiving mechanical ventilation or renal support (Perme et al, 2013). Despite expert recommendations advocating safety mobilisation for patients receiving haemofiltration, levels were low in the sample analysed with only 7 (17%) of those with neck lines and no patients with groin lines actively mobilised whilst receiving haemofiltration.

Similarly a study by Bailey et al (2007) published 5 years prior to this survey completion demonstrated the safety of mobilisation in over 600 patients ventilated via endotracheal tubes, although again this did not appear to have been adopted into current practice. Our data would suggest despite the increasing evidence base for safety of early mobilisation, a number of perceived barriers still exist. It is unclear why despite numerous publications regarding the safety and effectiveness of early mobilisation there appears to be a lack of transition into clinical practice. There is data indicating that different providers (Physiotherapists versus nursing staff) mobilise their patients to different levels (Garzon-Serrano et al, 2011) and perceive different barriers to mobilisation (Barber et al, 2014). Organisational factors may also be a significant factor, with specific limitations previously reported due to reduced staffing levels and concerns regarding patient and caregiver safety (Bakhru et al, 2015). It is therefore important that future studies explore the specific barriers to implementation rather than simply the levels of rehabilitation occurring.

The limitations of our study are that it was a self-selected population of ICUs, and therefore may not represent true practice within the UK. As centres were chosen from attendance at a specialist respiratory meeting this may have led to a biased sample, either those already more active in rehabilitation or already looking to improve. This study did also not explore specific barriers to early mobilisation or any complications which may have occurred during each physiotherapy session. A recent international survey looked at self-reported barriers to rehabilitation in the UK (Bakhru et al, 2015). These included nurse staffing too low or competing priorities, lack of funding and insufficient staffing, concerns over patient and care-giver safety and lack of specialist equipment. Our survey took place over weekdays only. There is therefore likely to be a larger discrepancy at the weekends, where most hospitals still only provide an on call service for physiotherapy. Future studies would be warranted to explore this issue further involving a larger proportion of hospitals and reviewing activity over the full seven day spectrum. More detailed information would be useful regarding barriers to mobilisation as well as any associated complications in response to this activity such as falls or accidental extubation.

Conclusions

We found a high level of physiotherapy treatments over a 5 day period in 12 intensive care units, but found low levels of active mobilisation in patients who were still receiving organ support, and large variations in practice between different units. International guidelines currently in development to aid the implementation of early mobility programmes may help support therapists in UK critical care units.

Key points

- Rehabilitation practices vary greatly between Critical Care units in the United Kingdom
- Active mobilisation is particularly limited in patients receiving mechanical ventilation
- Despite recent guidance limited mobilisation takes place in patients receiving renal support in critical care

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Predictors and delays to early mobilisation in critical care: A service evaluation

Seddon GR¹ and Douglas EM²

Summary

Early mobilisation in critical care patients is associated with improved quality of life and financial savings. NICE clinical guidelines, (2009) have advocated the importance of implementing early rehabilitation, however evidence highlights the challenges delivering these recommendations. This service evaluation determined the predictors and barriers to early mobilisation in critical care in a large acute NHS Trust.

For each day mobilisation was delayed, length of stay in critical care increased by 0.78 days ($p < 0.0005$). A significant difference in mean first day mobilisation between trauma and surgical patients ($p = 0.034$) suggested diagnosis could be used to facilitate prediction of first mobilisation. The Acute Physiology and Chronic Health Evaluation (APACHE II) and Chelsea Critical Care Physical Assessment Tool (CPAx) did not predict first day of mobilisation.

Diagnosis could potentially be used as a tool to guide clinicians and facilitate prediction of length of stay. This could lead to significant cost savings and improved patient outcomes. Barriers to early mobilisation were medical such as cardiovascular system unstable or low Glasgow Coma Score. Potential barriers of absence of a weekend rehabilitation service and inter-professional communication emerged from the evaluation.

Further research could fully capture barriers to early mobilisation by including barriers beyond first day of mobilisation.

Keywords:

Physiotherapy
Rehabilitaiaion
Critical Care
ITU
Mobilisation

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Introduction

Numerous adverse outcomes have been associated with prolonged length of stay (LOS) in critical care (CC). Survivors of critical illness can have decreased functional capacity five years post discharge (Doiron et al 2013). Immobilisation in CC is accompanied with muscle atrophy, bone demineralisation and reduced maximal oxygen consumption (McWilliams and Pantelides, 2008).

Intensive care unit-acquired weakness (ICU-AW) is used to describe neuromuscular weakness with no aetiology other than critical illness (Appleton and Kinsella, 2012). One potential intervention to treat and prevent ICU-AW is early interruptions of sedation and early mobilisation (Hodgson and Fan 2016).

In 2009, UK National Institute for Health and Care Excellence (NICE) published Clinical Guideline 83 (NICE CG83, 2009) entitled 'Rehabilitation after Critical Illness', which advocated the importance of early rehabilitation in CC. The implementation of NICE GC83 has been inconsistent (Berry et al 2013). Dubb et al (2016) identified 50% of barriers to early mobilisation were patient-related, 18% structural, 18% ITU cultural and 14% process-related. The decision making process to mobilise a critically ill patient is complex and multi-factorial. Identifying indicators to assist physiotherapists' decision making could promote early mobilisation.

McWilliams and Pantelides (2008) demonstrated that early mobilisation in CC significantly reduces LOS. The study identified that 26% of patients were mobilised by day 5 and had a median LOS in CC of 4 days. This compared to a median LOS of 9 days for 22% of patients who were deemed clinically fit but were not mobilised by day 5 due to limited staffing. The difference of 4 days in CC has financial implications as a bed in CC costs £1,700/day (McWilliams and Pantelides, 2008).

This service evaluation (SE) aimed to identify the predictors of and delays to early mobilisation, and inform the service of potentially reversible factors. It aimed to identify methods for cost savings and improved patient outcomes, which would benefit patients on CC and improve financial management.

Method

This service evaluation (SE) was conducted as part of an undergraduate dissertation project. One Band 7 and three Band 6 Physiotherapists working across two 17 bedded CCUs collected data between the hours 0900-1630, 5 days per week Monday to Friday. Data collection took place over a six-month period from August 2014 to January 2015.

One of the CC Units provided Level 3 care; patients requiring advanced respiratory support or in multi-organ failure. The other CC Unit provided care for Level 3 patients and also accommodated Level 2 patients; those requiring specialist medical support or in single organ failure.

The data collection sheet (Appendix 1) was used to collect data on the first day of a patient's mobilisation. The rehabilitation monitoring document was not a validated tool. A small proportion (6%) of data was not completed at the time of collection, when data was unavailable; it was collected retrospectively by the CC Unit data collector and analyst. The data collection procedure is demonstrated in Appendix 2. Mobilisation was classified as any of: sitting on edge of bed; full hoisted; standing; or stepping. Data was made anonymous and coded, prior to the investigator receiving data.

Outcome Measures

In this SE, the Chelsea Critical Care Physical Assessment Tool (CPAx) was completed on the first day of mobilisation, prior to mobilisation taking place. CPAx was developed by Corner et al (2013) and has strong inter-rater reliability and internal consistency. CPAx score was not designed to predict first day of mobilisation, nor has not been evaluated for this purpose. It comprises 10 functional tests providing an overall score of patient's physical morbidity (Corner et al 2015).

The Acute Physiology and Chronic Health Evaluation II (APACHE II) was completed on admission to the CC Unit. APACHE II is valid and reliable in classifying critically ill patient's severity of illness using ordinal data from 0-71, with higher scores correlating to higher illness severity (Kanus et al 1981). It could be expected that patients with a lower APACHE II score, lower illness severity are more likely to mobilise sooner.

Participants

The inclusion and exclusion criteria are described in Table 1. 47 patients met the inclusion criteria. Patients with less than 50% of data recorded were excluded from this SE, therefore one patient was excluded from data analysis. A total of 46 patients were included.

Inclusion Criteria	Exclusion Criteria
Intubated and mechanically ventilated	Planned admission to CC
<18 years of age	Patients who are not intubated

Table 1: Inclusion and Exclusion Criteria

Data Analysis

There was sporadic missing data throughout the collection therefore, the total number of patients in each analysis is indicated by n=x.

Microsoft Excel was used to analyse descriptive data. Scatter plots and bar graphs created in Excel presented relationships between early mobilisation, LOS and barriers to early mobilisation. The relationship between first day of mobilisation and CPAX Score was presented on a scatter plot using excel.

Nominal data was coded to allow data entry to SPSS. Statistical analysis was performed using SPSS Statistics 22 software (SPSS, Chicago, Illinois, USA). A Pearson's Correlation Coefficient was used to assess the relationship between APACHE II Score and first day of mobilisation. A linear regression was conducted to establish if APACHE II Score on admission could predict first day of mobilisation. The data met test assumptions with independence of errors, homoscedasticity and normally distributed errors.

A one-way ANOVA identified whether there was a significant difference in first day mobilisation between groups; trauma, surgical and medical. Further to this, a Tukey-Kramer Post Hoc test was conducted to identify mean difference in LOS between groups and whether this was significant. A linear regression was conducted to establish if first day of mobilisation was statistically significant to predict LOS. Data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$).

Results

A total of 46 critically ill patients met the inclusion criteria for this SE. Demographic and clinical characteristics are provided in Table 2.

	Characteristic	Value
Age (Years)	Mean (+/- SD)	61 (+/- 16)
	Range	18-86
Diagnosis (n=46)	Medical	10
	Surgical	20
	Trauma	16
APACHE II Score (n=40)	Mean (+/- SD)	17 (+/- 7)
	Range	4-30
Length of Stay (Days) (n=40)	Mean (+/- SD)	18 (+/- 12)
	Range	3-62
1st Day Mobilisation	Mean (+/- SD)	12 (+/- 8)
	Range	1-42

Table 2: Demographic and clinical characteristics of patients

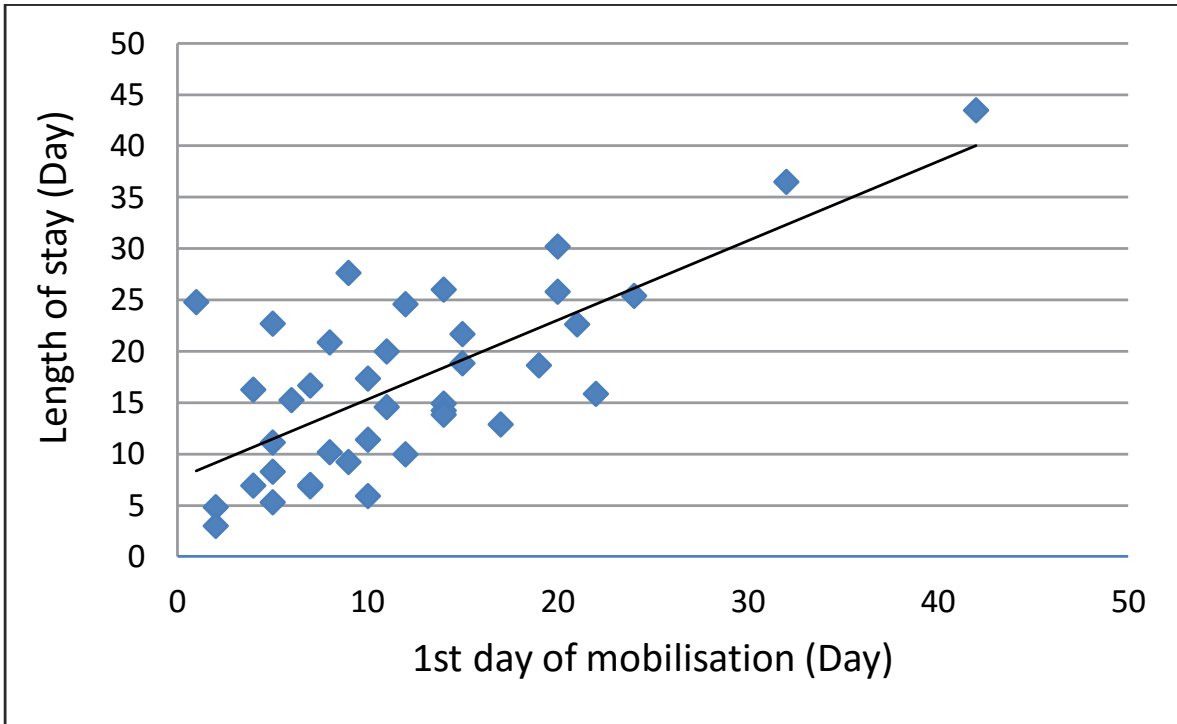


Figure 1: Relationship between 1st day mobilisation and LOS (n=40)

A strong relationship between first day of mobilisation and LOS is shown in Figure 1 ($r = 0.720$). First day of mobilisation could predict length of stay ($p < 0.0005$). The equation indicated that for each day mobilisation was delayed, predicted LOS increased by 0.78 days.

$$\text{Predicted length of stay} = 0.783 (\text{1st day of mobilisation}) + 7.533$$

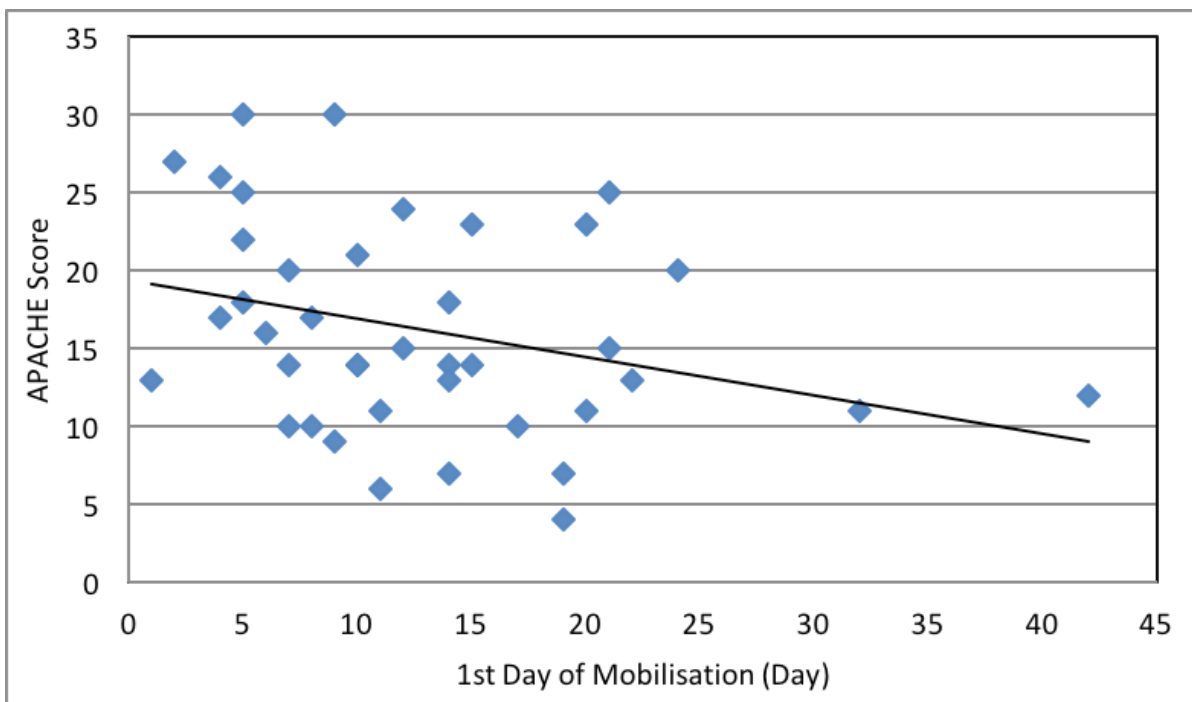


Figure 2 Relationship between APACHE II Score and 1st day mobilisation (n=45)

Figure 2 demonstrates that APACHE II score on admission did not predict first day of mobilisation ($p = 0.120$) as there was a weak negative relationship between APACHE II Score and first day of mobilisation ($r = -0.2$).

Figure 3 shows a large scatter in the data demonstrating a weak relationship between CPAx Score and first day mobilisation ($n=42$).

First day of mobilisation was statistically significantly different between groups of different diagnosis ($p < 0.038$). Figure 4 demonstrates that first day of mobilisation was lowest in the surgical group (8.47 days \pm 6.00), increased for medical patients (12.40 days \pm 5.66) and highest in trauma patients (14.57 days \pm 7.99).

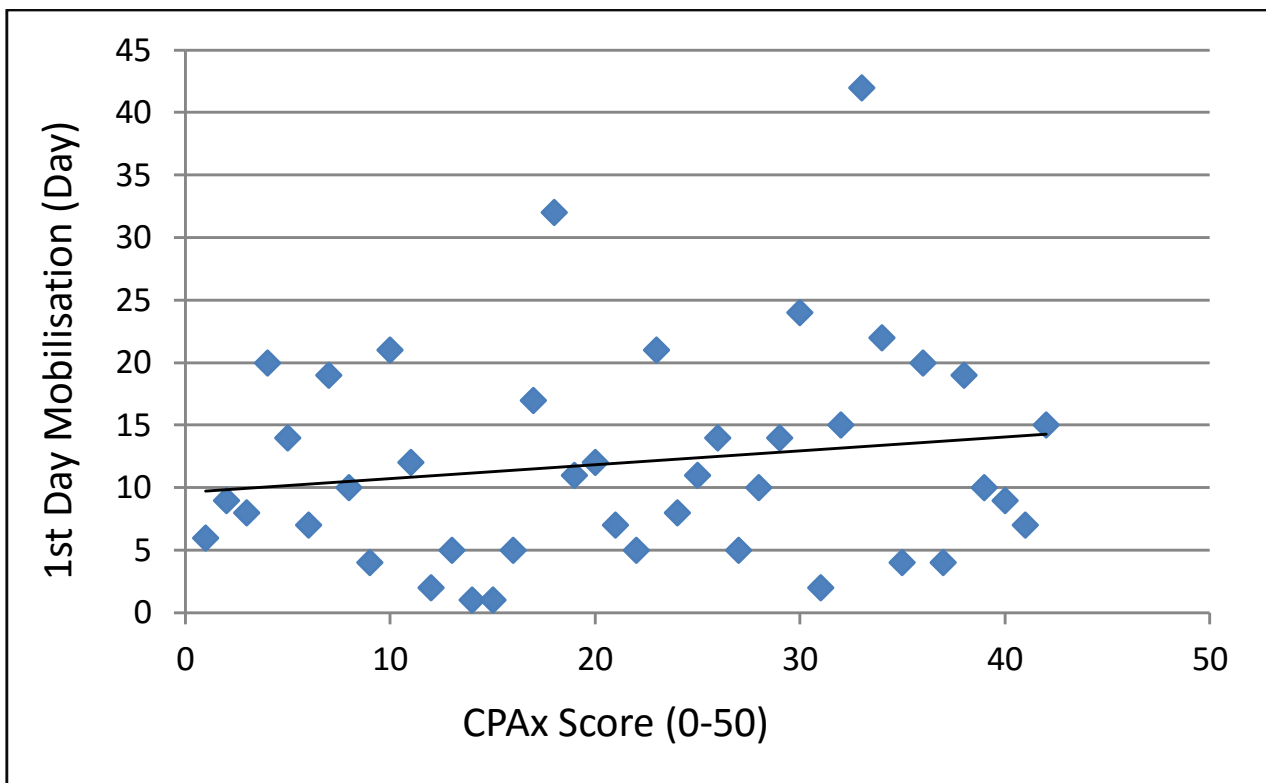


Figure 3: Relationship between CPAx Score and 1st day Mobilisation ($n=42$)

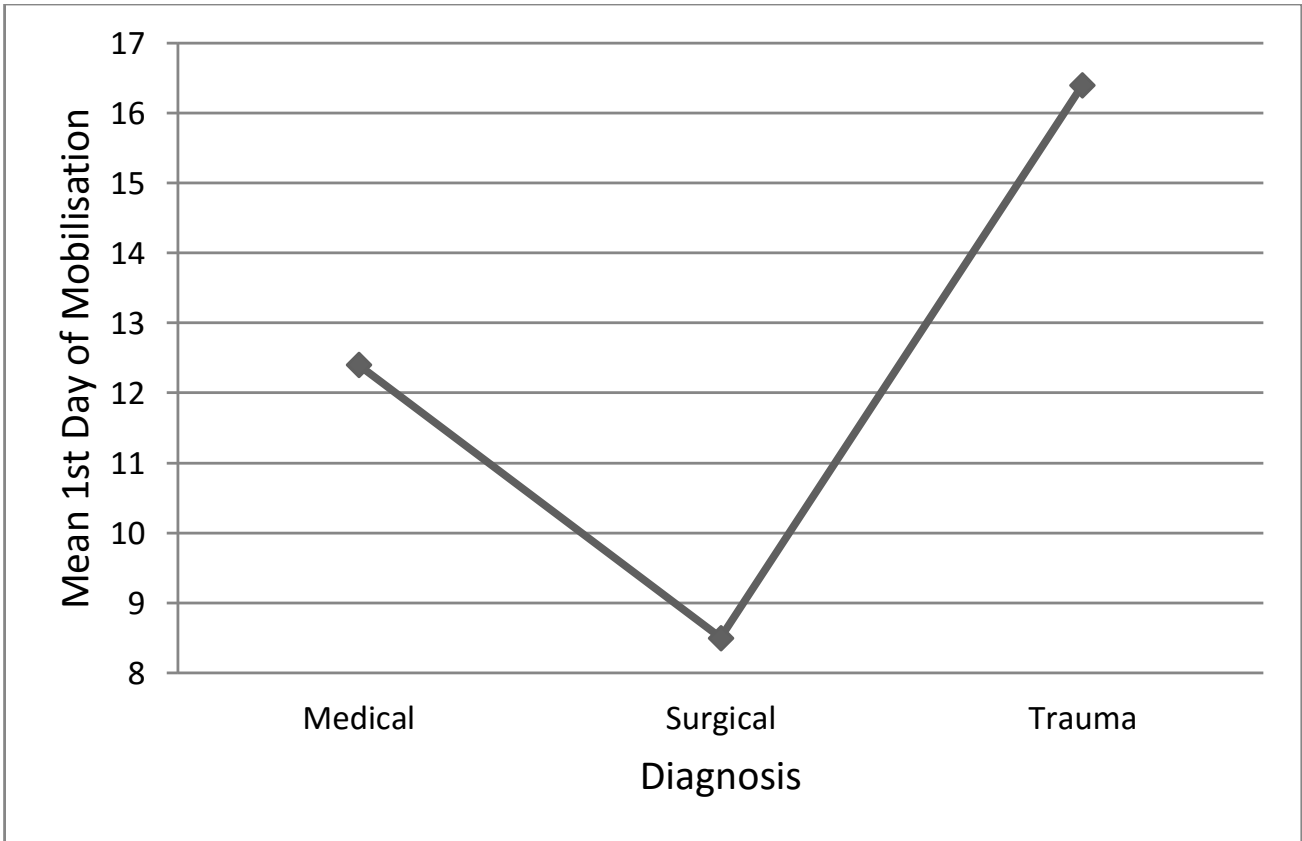


Figure 4: Mean differences in first day of mobilisation between diagnoses

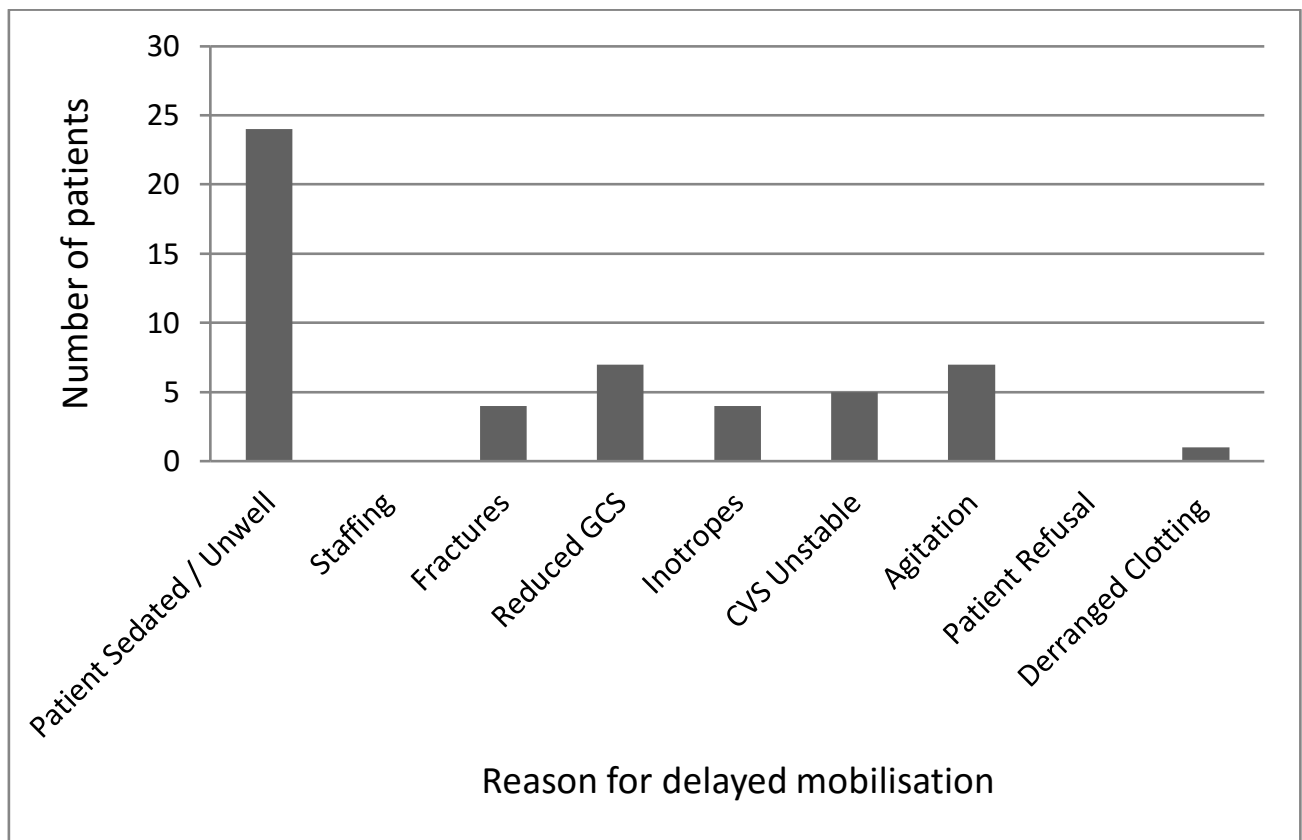


Figure 5: Barriers to early mobilisation (n=36)

Figure 5 presents that the most common barrier to early mobilisation was 'Patient Unwell'. None of the barriers identified were due to lack of staffing or patient refusal. More than one barrier could be recorded for each patient.

Discussion

The first day of mobilisation predicted LOS in CC; for each day mobilisation was delayed, LOS increased by 0.78 days. Diagnosis can be used to facilitate prediction of mobilisation as there was a significant difference in first day of mobilisation between surgical and trauma patients ($p=0.034$). There was no relationship between CPax Score or APACHE II Score with first day of mobilisation. Therefore in this service evaluation, these outcome measures did not predict first day of mobilisation. All barriers to early mobilisation were medical such as patient being unwell and cardiovascular system (CVS) unstable. The explicit reasons for patient being unwell are not provided. Potential reversible barriers emerged such as inter-professional communication and absence of a weekend rehabilitation service.

Early mobilisation and LOS

This SE demonstrated that early mobilisation was associated with reduced length of stay in CC, a finding consistent with that of McWilliams and Pantelides (2008) and Wahab et al (2015). In this SE, 24% of patients were mobilised within 5 days and had a mean LOS of 9.93 days, compared to McWilliams and Pantelides (2008) who identified 26% of patients were mobilised within 5 days and had median LOS 4 days. The authors recognise the limitation that patients showing a faster recovery are more likely to mobilise sooner.

The validity of data relating to LOS is compromised due to different levels of care provided in the two CC Units. LOS was calculated at discharge from the CC Unit. One unit provided care for level 2 and level 3 patients, therefore their LOS was calculated at discharge from level 2 care. The second unit only supported level 3 patients, therefore their LOS was calculated at discharge from the level 3 CCU.

Diagnosis

A significant difference in mean first day mobilisation in surgical patients (8 days) and trauma patients (15 days) indicated that diagnosis can facilitate prediction of mobilisation. Physiotherapists reported that they frequently await clearance from medical staff prior to mobilising trauma patients in order to confirm absence of fractures or internal injury. Trauma patients had a lower mean APACHE II (12) and lower age (58) compared to surgical patients mean APACHE II (19) and age (65). It may be expected the trauma group would mobilise sooner as they were younger with lower severity of illness compared to surgical patients. The suggestion that trauma patients should mobilise sooner was not the case in this SE.

Outcome Measures

This SE identified a weak negative relationship between APACHE II score and first day mobilisation indicating patients with a higher APACHE II score mobilised earlier. APACHE II has been validated to classify surgical and medical critically ill patients, however this SE included a high number of trauma patients therefore APACHE II may not accurately represent severity of illness in trauma patients.

CPax score was not designed or evaluated to predict 1st day of mobilisation in CC patients. Corner et al (2014) supported that CPax may have a role in assessing and monitoring the functional recovery of CC patients. This SE identified no relationship between CPax score and 1st day of mobilisation suggesting that it would not be a useful to support clinician's decision making around mobilising CC patients.

Barriers to Early Mobilisation

McWilliams and Pantelides (2008) identified that lack of staffing accounted for 17% of delayed mobilisation. This SE did not identify staffing as a barrier to mobilisation; however absence of a weekend service and communication between inter-professionals could be potential barriers to early mobilisation.

'Patient Unwell' was the most frequently reported barrier to mobilisation. This term encompassed any uncategoryed physiological reason in which the patient was too unstable to treat. This term has limited the interpretation and exploration of barriers to mobilisation as it does not exclude therapists own clinical reasoning. This term should be clarified in order to identify potential contraindications to mobilisation in future projects.

McWilliams and Pantelides (2008) identified a median LOS of 4 days compared 9.93 days in this SE, for patients mobilised within 5 days. This difference could be associated with cultural ethos within different CC Units. Also, this SE did not capture data after the first day of mobilisation that may have influenced data relating to LOS.

Trauma patients had more delayed first day mobilisation (day 15) which indicates barriers to early mobilisation are associated with trauma diagnosis. Delayed mobilisation due to traumatic fractures is not reversible however it was highlighted by data collectors that improving communication between health care professionals could reduce delays to mobilising trauma patients. A common finding within the literature is that the first day of mobilisation is influenced by team dynamics, the CC culture and multidisciplinary understanding the benefits to early mobilisation (Bassett et al., 2012; Keen, 2012). Therefore improving inter-professional team dynamics and CC culture could promote early mobilisation.

Conclusion

This SE gives insight into the early rehabilitation service in critical care at an acute NHS Trust illustrating the predictors and barriers of early mobilisation as well as the effect on LOS. The literature around this relatively new topic of early mobilisation in critical care advocates critical care rehabilitation programmes.

Diagnosis could be used as a tool to predict first day mobilisation; CPAx and APACHE II were not reliable predictors of 1st day mobilisation. The barriers to early mobilisation were medical rather than organisational. However, potential reversible barriers emerged throughout this SE: inter-professional communication and the absence of a weekend rehabilitation service.

A strong relationship between the first day mobilisation and LOS indicated that maximising early mobilisation could lead to significant cost savings and improved patient outcomes.

Key Points

- First day of mobilisation predicted length of stay in critical care ($p < 0.0005$).
- There was a strong relationship between diagnosis and first day of mobilisation whereas there was no relationship between APACHE II or CPAx Score with first day of mobilisation.
- Barriers to early mobilisation were patient related. Potential reversible barriers emerged; inter-professional communication and absence of a weekend rehabilitation service.

Acknowledgements

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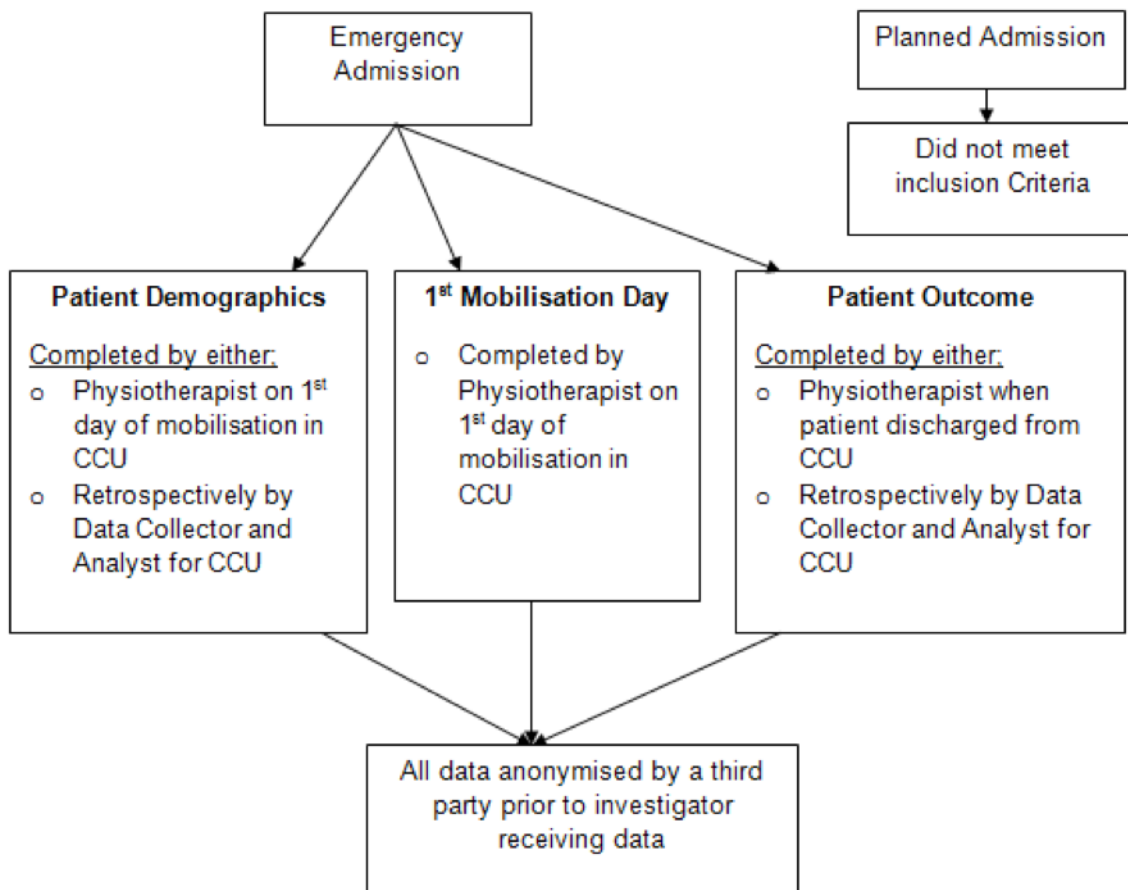
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Patient Demographics					
Patient Number:		Audit number:		Date of Admission:	
APACHE II Score on admission:		Diagnosis:		Patient Age:	
Pre-morbid function: (please tick)	Independent no limitation				
	Use of aids with no limitation				
	Transfers Only				
	Independent limited mobility				
	Use of aids limited mobility				
Immobile					
1 st Mobilisation Day					
Number of days on Unit		CPAx score on 1 st day of mobilisation		Was mobilisation delayed	Yes
					No
Mode of Ventilation:		Adverse event on mobilisation:		Reason mobilisation was delayed (please tick)	
BIPAP/ASB		Yes		Patient unwell	
CPAP/ASB		No		Staffing	
CPAP		If yes please state:		Fractures	
HiFlow				Weekend	
Low Flow				Reduced GCS	
Type of tube:				Inotropes	
ET tube				CVS unstable	
Tracheostomy				Agitation	
				Patient refused	
				Deranged clotting	
				Sedated	
				Propofol	
				Alfentanil	
				Morphine	
				Midazolam	
				Haloperidol	
				Clonidine	
				Other (please state):	
1 st mobilisation task performed:					
Sat on edge of bed					
Hoisted to chair					
Stand					
Transferred bed to chair					
Walked					
Patient Outcome					
Number of Days on ventilator:		Number Days on unit:			

Appendix 1: Rehabilitation Monitoring Document



Appendix 2: Data Collection Process

Feasibility and reliability of the Manchester Mobility Score as a measure of physical function within the Intensive Care Unit.

McWilliams DJ¹, Atkins G¹,
Hodson J², Boyers M¹, Lea T¹ and
Snelson C³

Objective

To test the reliability of the Manchester Mobility Score (MMS) as a quick and simple tool for monitoring rehabilitation within critical care.

Design

Prospective, observational study

Setting

All patients within a large 75 bed, UK based mixed dependency critical care unit.

Intervention

The study was divided into 2 stages: stage one was the inter-rater reliability testing of the Manchester mobility score and stage 2 was to assess for correlation with another validated measure of function within critical care.

Results

Manchester mobility scores were collected for 111 patients over 2 separate days one week apart. All participating physiotherapists and nursing staff reported that the score took less than 1 minute to complete and was easy to use. The inter-rater reliability was excellent with all assessors assigning the same Manchester mobility score for every patient (Kappa value = 1). A subset of 53 patients who had been mechanically ventilated for ≥ 5 days were included in the second stage analysis. Spearman's correlation coefficients demonstrated the correlation between the Manchester mobility score and the Barthel Index on intensive care discharge was found to be strong ($p < 0.001$), with the Manchester mobility score also showing a significant negative association with hospital length of stay ($p < 0.001$).

Key Words

Physiotherapy
Critical Care
Reliability
Scale
Mobility

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Conclusion

The Manchester mobility score is a feasible measure for use within critical care, being both quick and easy to complete with no prior training required for use. There was excellent inter-rater reliability across the entire critical care population with perfect agreement across different staff grades and professions. The negative association with critical care length of stay may offer some predictive value to long term outcome and would warrant further investigation.

Introduction

Critical illness is associated with long term physical and psychological morbidity. Muscle mass decreases at a rate of between 2 and 4% per day during the first 2 to 3 weeks of Intensive Care Unit admission [Helliwell et al., 1998; Brower, 2009] and muscle atrophy is positively correlated with prolonged weaning from mechanical ventilation, longer intensive care and hospital stays and increased mortality levels [Schweickert and Hall, 2007; Griffiths and Hall, 2010]. The evidence base for early mobility programmes and rehabilitation starting within intensive care is growing. Rehabilitation has been demonstrated to be an important measure in improving both short term outcomes and long term recovery in critically ill patients. Specifically, early and structured rehabilitation programmes have been shown to decrease both intensive care and hospital length of stay (LOS) [Morris et al., 2008; Needham et al., 2010; McWilliams et al., 2014] as well as improve functional ability at the point of intensive care discharge [Schweickert et al., 2009].

At present there is no universally accepted method for measuring mobility within the intensive care unit or to track rehabilitation progress [Elliott et al., 2009]. Functional measures commonly used include the Barthel Index and the Functional Independence Measure, although these are considered insensitive to the subtle changes seen in critically ill patients [Dennis et al., 2011]. The Physical Function in Intensive care Test (PFIT) was developed specifically for an intensive care population, but does not calculate a total score, making comparisons between groups of patients difficult [Skinner et al., 2009]. Walking tests such as the 6 minute walk test, Incremental Shuttle Walk Test and Timed Up and Go are not suitable for use in acute critical illness, and critically ill patients may be unable to perform strength tests such as the Medical Research Council scale due to sedation and delirium. Measures designed specifically for use in the intensive care are therefore required.

A recent review of measurements of physical function found The Physical Function in Intensive care Test (PFIT) and the Functional Status Score for the ICU (FSS-ICU) to be promising measures to assess physical function within critical care populations [Parry et al., 2015]. The FSS-ICU was developed specifically as part of an intensive care mobility trial, with total scores ranging from 5 to 35 [Thrush et al., 2012], but needs further evaluation of reliability and validity and the large floor and ceiling effects on the ICU may limit utility [Denehy et al., 2013]. Another measure, the Chelsea Physical Assessment (CPAx) tool has been validated for use within critical care [Corner et al., 2013], although requires specific training and can be complex and time consuming to administer.

The Manchester Mobility Score was developed in 2005 as a tool to describe the levels of mobility seen within intensive care. Since development, the Manchester mobility score has been used and adapted in several large intensive care units within the United Kingdom and has shown itself to be a useful tool for comparing physical function between populations, but has not previously been investigated in terms of reliability.

The specific aims of this study were to:

- 1) Assess the simplicity and feasibility of the Manchester Mobility Score as a measure of physical function within intensive care.
- 2) Assess the reliability and inter-rater repeatability of the Manchester mobility score between different physiotherapists and physiotherapy and nursing staff.

Methods

This prospective observational study was performed within a large 75 bed, mixed dependency critical care unit based in the United Kingdom. The critical care unit admits over 3500 patients per year from all major specialities including general medicine, liver, trauma, burns, neurocritical care and complex upper gastrointestinal surgery. The Manchester Mobility Score (MMS) consists of a 7 point scale (see appendix 1) describing the maximum activity completed by a patient on each day of their intensive care stay. Staff are asked to assign a score of 1-7 for each patient daily throughout the critical care stay. The study was divided into 2 stages: stage one was the inter-rater reliability testing of the Manchester mobility score and stage 2 was to assess for correlation with another validated measure of function within critical care, the Barthel Index (Mahoney and Barthel, 1965).

Inter-rater reliability

Two physiotherapists (1 senior qualified for 10 years, with > 5 years intensive care experience and 1 junior with less than 6 months intensive care experience) and the individual bedside nurses were asked to independently assess the mobility score of all patients on the critical care unit. The junior therapist had only recently rotated to critical care, and therefore had limited experience of the Manchester mobility score. Similarly, nursing staff are not usually involved in assessing mobility levels of the patients using the MMS. Data was collected over two separate days (one week apart) to allow a large and varied sample size for comparison. The physiotherapist and nurses assessments were made within 30 minutes of each other to ensure consistency, with participating staff asked to score patients based on highest level of mobility achieved in the previous 24 hours. Time taken to complete the Manchester mobility score was also recorded.

Correlation

For the second stage of the analysis, the degree of correlation between the Manchester mobility score and the Barthel index on critical care discharge and the length of hospital stay post critical care discharge was assessed. This stage formed part of an ongoing trial of a mobility aid which was approved by the local Research Ethics Committee and written consent for use of anonymised data was gained from every participant. All patients recruited to the trial between 1st June 2014 and 30th September 2014 were included in the analysis (Inclusion criteria was admission to critical care, mechanical ventilation for ≥ 5 days and surviving to critical care discharge), with both Barthel and MMS scores collected by the trials Band 7 physiotherapist.

Statistical analysis

Inter-rater reliability was assessed using a weighted Kappa statistic. Comparisons between the two scores and length of stay were performed using Spearman's correlation coefficients. The resulting coefficients were compared using the method proposed by Meng et al (1992). Regression models were also produced to compare the MMS and Barthel scores, using log-transformations of skewed variables (after adding one to remove zeros). All analyses were performed using IBM SPSS Statistics 22 (IBM Corp. Armonk, NY), with $p < 0.05$ deemed to be indicative of statistical significance.

Ethical considerations

All patients in our critical care are scored on the MMS daily as part of standard physiotherapy care. This stage therefore met the definition of a service evaluation under the NHS Health research authority guidelines. As such ethical approval was not required and the need for patient consent was waived. Verbal consent was obtained from the participating physiotherapists and nursing staff.

Results

Inter-rater reliability

Manchester Mobility Scores were assessed for 126 patients across the 2 days of the study. No rehabilitation had taken place in 15 (12%) of cases due to agitation or patients deemed to be too unwell, leaving a final cohort of 111 patients for analysis. Demographic data for all patients included in the evaluation are described in table 1. The mean age of patients +/- standard deviation was 56 +/- 18 years and 71 (64%) were male. Mean sequential organ failure assessment (SOFA) score +/- standard was 5 +/- 3.9, with just under half of patients (n= 49 (44%)) mechanically ventilated. Manchester mobility score scores were taken across a range of specialties, the largest of which was trauma / neurosurgery (36%) followed closely by cardiothoracics (30%). For both participating physiotherapists and the 111 individual bedside nurses the MMS took less than 1 minute to complete in all instances. The median (IQR) MMS achieved was 2 (1-5), with excellent inter-rater reliability observed with all 3 assessors assigning the same MMS for every patient. The range of scores obtained are shown in table 2. Correlation/Kappa statistics all therefore had a value of 1, indicating perfect agreement across the three reviewers.

	n=111
Age in years - mean (SD)	56 (18)
Male (%)	71 (64%)
SOFA score - mean (SD)	5 (3.9)
PF ratio - median (IQR)	300 (222-400)
Admission speciality	
<i>Surgical</i>	23 (21%)
<i>Medical</i>	15 (13%)
<i>Trauma and neurosurgical</i>	40 (36%)
<i>Cardiothoracic</i>	33 (30%)
Mechanically ventilated (%)	49 (44%)
Tracheostomy	28 (25%)
Ventilator days - median (IQR)	2.0 (0.0-7.8)

Table 1: Patient Demographics (Stage 1)

MMS	Band 5 Physio	Band 7 Physio	Bedside Nurse
1	52	52	52
2	12	12	12
3	6	6	6
4	5	5	5
5	19	19	19
6	8	8	8
7	9	9	9

Table 2: Frequency of MMS Scores

Correlation

A total of 53 patients were included in the second stage analysis, demographic data is provided in Table 3. The correlation between the Manchester mobility score and the Barthel Index on intensive care discharge was found to be strong, with a Spearman's rho of 0.880 ($p < 0.001$). The relationship between the two scores (Figure 1) follows an exponential shape, with the median Barthel scores increasing gradually from a Manchester mobility score of 1 to 4 (medians: 0, 0, 1, 2), then showing a much more rapid rise from a Manchester mobility score of 5 to 7 (medians: 3, 5, 13). A regression model, using the log-transformation of the Barthel score as the outcome, found that a one unit increase in the

Manchester mobility score is equivalent to a 53% increase in the Barthel score (95% CI: 43% - 63%, $p < 0.001$).

	n=53
Age in years - mean (SD)	53 (18)
Male (%)	35 (66%)
APACHE II - mean (SD)	15 (6.3)
Charlson co morbidity index - median (IQR)	1 (0-2)
Admission speciality	
<i>Surgical</i>	6 (11%)
<i>Medical</i>	10 (19%)
<i>Neurosurgical</i>	25 (49%)
<i>Trauma</i>	11 (21%)
Mechanically ventilated (%)	53 (100%)
Ventilator days - median (IQR)	10 (6-15)

Table 3 - Patient Demographics (Stage 2)

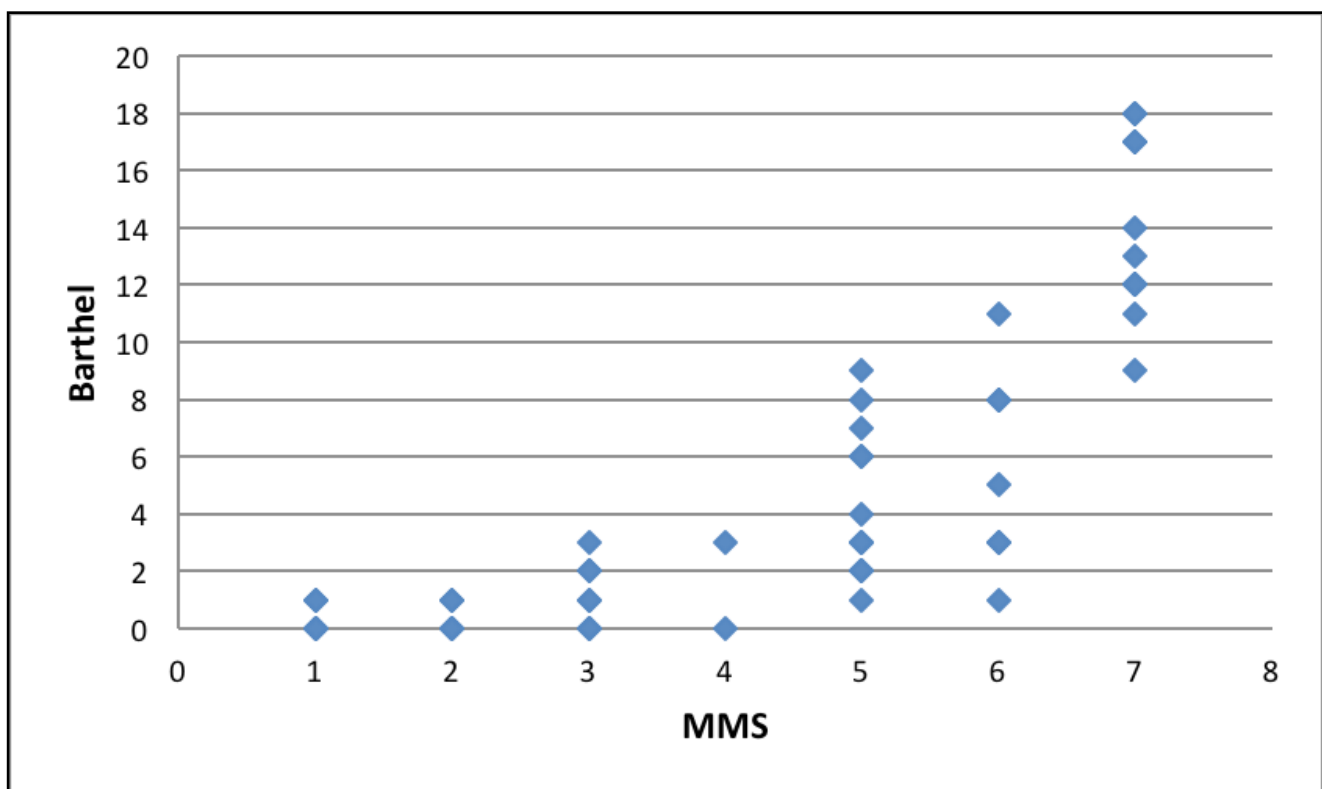


Figure 1: Scatter plot of the relationship between the MMS and Barthel scores (on discharge from ITU)

Associations with length of hospital stay post critical care discharge

In a sub analysis the Manchester mobility score at the point of critical care discharge was found to be significantly negatively associated with length of stay, with Spearman’s rho of -0.575 ($p < 0.001$). Figure 2 illustrates that the Manchester mobility score follows a near linear relationship with length of stay.

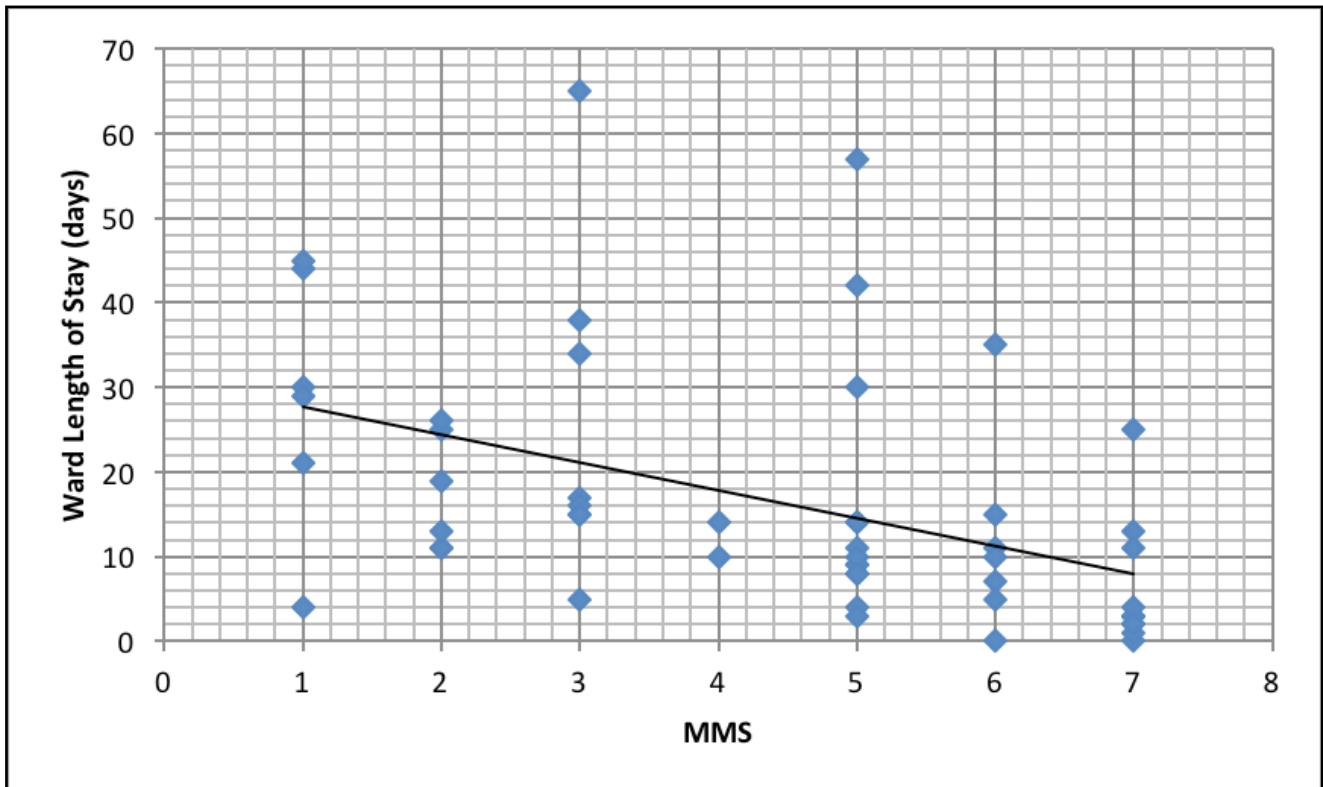


Figure 2: Scatter plot of the relationship between the MMS on critical care discharge and length of stay

Discussion

In this study we have demonstrated the Manchester mobility score to be a feasible measure, being both quick and easy to complete with no prior training required for use. There was excellent inter-rater reliability across the entire critical care population with perfect agreement across different staff grades and professions. As our cohort included the sub-specialities of trauma, neurosurgery and cardiothoracics, we have shown the Manchester mobility score to be a useful measure in varying critical care populations. We assessed validity at critical care discharge against another validated tool used within critical care, the Barthel Index, with the Manchester mobility score demonstrating good correlation. MMS at critical care discharge (negatively) correlates with post-critical care length of stay. Despite the increased focus on rehabilitation within critical care, at present there is a paucity of validated outcome measures to track progress. This is particularly the case at the most acute stages of rehabilitation. Other measures used to track rehabilitation within critical care have been described (Parry et al., 2015), but only two of these has been evaluated for feasibility and interrater reliability (Denehy et al., 2013; Corner et al., 2013). None have previously considered any relationship between overall score and length of stay. This lack of standardised measure can make both tracking rehabilitation and proving any benefits difficult, whilst limiting comparison between units who may have adopted their own tools. The Manchester mobility score was originally developed for this exact reason, although with regular use has proven itself to be effective in highlighting benefits of any changes in rehabilitation delivery [McWilliams et al., 2014]. A number of potential limitations exist to our study. Firstly, the scale itself was intentionally kept small for ease of completion and to avoid confusion. This may have inappropriately grouped certain components, for example a patient transferring via a full overhead hoist is categorised alongside those transferred using a standing hoist. Whilst outcomes appeared well matched with this method, it may limit the sensitivity of any subtle differences in ability. In addition, the Manchester mobility score does not distinguish between a patient walking with or without assistance. However, it is likely that a patient with a level of functional ability to walk unaided will have been discharged to a general ward prior to this being achieved. Our institution is experienced with the use

of the Manchester mobility score and with the concept of early mobility, although we tried to limit the impact of this by including junior physiotherapists new to the ICU as raters. The negative association between the Manchester mobility score at intensive care discharge and hospital length of stay has been reported by other UK centres [McWilliams and Macdonald, 2011; Grant and Gustafson, 2014]. Patients with lower physical scores at the point of critical care discharge are likely to be more debilitated and require longer periods of inpatient rehabilitation. However, whilst critical care units provide intensive monitoring with high staffing ratios, as patients are moved to ward environments, there may be a sudden decrease in level of interaction with clinical staff. By identifying those patients with predicted longer ward stays and most at risk of deterioration, resources may be directed to support their ongoing recovery and improve outcomes. The impact of this warrants further investigation in the future.

In conclusion, the Manchester mobility score is feasible, quick and reliable to complete with strong inter-rater reliability and correlation with the Barthel Index at ICU discharge. It is useful in monitoring daily activity within critical care as well as generating an overall physical level achieved at the point of critical care discharge. This information can be used to evaluate change of practice within an intensive care and could be used as a standardised measure to allow comparison between intensive care units. Future research would be useful to confirm these findings across different hospitals, as well as exploring the potential benefit as a predictor of long term outcomes.

Key Points

- The Manchester Mobility Score is a reliable measure of changes in mobility level over time within intensive care patients.
- It shows a good level of correlation with the already validated Barthel Index for patients admitted to intensive care.
- The Manchester mobility score at the point of intensive care discharge may be a useful predictor of likely length of stay on the ward.

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1	In bed interventions (Passive movements, active exercise, chair position in bed)
2	Sit on edge of bed
3	Hoisted to chair (including standing hoist)
4	Standing practice
5	Step transfers with assistance
6	Mobilising with or without assistance
7	Mobilising > 30m

Appendix 1: The Manchester Mobility Score (MMS)

Incidence of bronchospasm associated with challenge of adult non-CF respiratory patients with 4ml nebulised hypertonic (7%) saline.

Langridge PJ¹ and Fratoye F²

Summary

Nebulised hypertonic saline (HTS) is used to facilitate mucus transport. Before starting this treatment at home, patients are given a test/"challenge" dose to evaluate adverse effects (especially significant bronchospasm/ bronchoconstriction). Anecdotally, physiotherapists often conduct these "challenges" and methods vary between centres. This study retrospectively evaluates bronchospasm associated with a method of performing these "challenges" as documented in 163 clinical respiratory physiotherapy outpatient case notes in terms of change in spirometry and patient subjective report. FEV₁ returned to within 15% of baseline 10 minutes after completing a nebulised 4ml dose of 7% saline in 90% of cases.

All patients completed the challenge test safely in the absence of consistent administration of bronchodilator, and in adopting this challenge protocol physiotherapy services may improve their cost effectiveness while maintaining patient safety.

Introduction

Respiratory disease is the 3rd most reported long term illness reported in Britain, with >6% of adults in 2004 reporting long term respiratory illness (British Thoracic Society 2006). HTS has been used as an expectorant for several years. Nebulised HTS (commonly 7%) is thought to work by increasing sputum salinity, thereby altering its rheology so that it is cleared more easily by the cilia (Bott, et al. 2009). There is evidence that the plateau of the dose response curve is at 6-7% for mucociliary clearance- a desirable therapeutic goal for patients with bronchiectasis, mucus-phenotype asthma and other pathologies where mucus retention is problematic. The study by Kellett et al (2005) admits that non-isotonic solutions may cause bronchospasm and subsequent reduction in lung function. Before a patient uses HTS at home, it is recommended that an initial observed challenge dose is given. These "challenges" are often conducted by physiotherapists in the hospital setting to evaluate patient tolerability of HTS.

There are several methods reported in online discussions via iCSP surrounding HTS challenge (<http://www.csp.org.uk/search/all/hypertonic%20saline>). Recommendations in BTS guidelines include that a predose bronchodilator should be used to minimise bronchospasm with inhalation of HTS and a bronchoconstriction trial should be conducted at the initial dose of HTS to ensure safety and suitability for the patient (Pasteur et al. 2010). There is no acknowledged "gold standard" for this procedure.

Keywords

Hypertonic saline

Challenge

Nebulised

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The study investigated the safety of a challenge protocol (Figure 1) and thus makes recommendations on how patients should be challenged with HTS.

Methods

This was a retrospective service evaluation of a physiotherapy outpatient service. All adult non-CF respiratory physiotherapy outpatient notes concerning challenges with 4ml 7% saline conducted at a large teaching hospital September 2007- January 2010 using the protocol in Figure 1 were analysed. This convenience sample of respiratory outpatient notes was available to the researcher. The 189 challenge tests were performed by band 6 or band 7 physiotherapists working in the Thoracic Medicine service who had received appropriate training in spirometry and medication administration. Primary respiratory diagnoses of those accessing this outpatient service included asthma, bronchiectasis, COPD, emphysema, interstitial lung disease, chronic cough, allergic bronchopulmonary aspergillosis, lung cancer, and chronic pulmonary aspergillosis. Patients with CF are treated using alternative nebulised medication challenge protocols by a separate physiotherapy service and so were excluded from the study. Also excluded were those who did not complete the challenge protocol due to lack of consent, bronchospasm requiring rescue medication (n=2), or being prescribed a reduced dose (2ml) of HTS (n=24).

Descriptive statistics concerning the challenge data in terms of pathology, use of bronchodilator and FEV₁, measures at the time points of the challenge procedure were recorded. The Friedman test was used to compare measures of FEV₁ at baseline, immediately after the HTS and at 10 minutes after completing the HTS dose. Wilcoxon signed ranks test was used to compare FEV₁:

- measures at baseline to immediately post HTS
- immediately post HTS to 10 minutes post HTS
- baseline to 10 mins post HTS.

A post hoc analysis was carried using the bonferroni correction for multiple testing.

The nebuliser used for delivering saline (7% as well as 0.9%) as well as bronchodilators was the Micro-Neb III manufactured by Lifecare. The compressor that is provided for hospital or home use at the author's place of work is Clement Clarke's Econoneb. This combination of equipment was that also used in the study by Kellet et al. (2005).

Results

One hundred and sixty three patients met the inclusion criteria. Table 1 illustrates the primary respiratory pathologies of those challenged.

Twenty patients undertook the challenge test who had a baseline FEV₁ of <1L. In spite of this, 12 did not receive bronchodilator after baseline spirometry and before taking the nebulised 4ml 7% saline. Seventeen patients received bronchodilator before administration of HTS, of which 7 had a baseline FEV₁ <1L. Lung function immediately post bronchodilator was only documented in 7 patients. Only 2 patients displayed an improvement in lung function after administration of bronchodilator, 1 was unchanged, and 4 were reduced (Table 2).

Thirty patients (18%) experienced either subjective adverse effects or a significant (>15%) reduction in FEV₁ at 0 mins post dose compared to baseline (Table 3).

Sixteen patients (9.8%) reported subjective problems on nebulising HTS of whom 12 (75%) did indeed



Figure 1: Challenge procedure

show a significant drop in FEV₁ immediately on finishing the HTS dose. Six of the 16 still had significantly reduced FEV₁ at 10 mins compared to baseline (range -16 to -33% from baseline).

Twenty seven (17%) patients showed significant reduction in FEV₁ on completing the dose of HTS, of whom 8 (30%) had received bronchodilator after baseline spirometry before administration of HTS (Table 4). Eleven of the 27 (40%) who showed significant reduction in FEV₁ continued to have significantly reduced FEV₁ at 10 mins post dose compared to baseline, of whom 1 had reduced further by 0.02L, 1.6% of baseline)

Five patients demonstrated significant drop in FEV₁ at 10 minutes compared to baseline who had not shown a significant reduction immediately after completing the dose.

Eight patients demonstrated significant improvement in FEV₁ at 10 min post dose compared to baseline (range 17.5-100%), none of whom had received bronchodilator therapy as part of the challenge.

The Friedman test was highly significant (p < 0.001), thus there were statistical differences between FEV₁ measurements at different time points related to the hypertonic saline challenge.

The FEV₁ values differed significantly between all time points related to the HTS neb challenge (baseline to immediately after HTS neb p < 0.001, baseline to 10 min after completion of HTS neb p = 0.039, and immediately after HTS to 10 min after completion of HTS neb p < 0.001).The above pair-wise comparisons were not adjusted for multiple testing. After applying a Quasi-Bonferroni correction for multiple testing, the comparison of baseline to 10 min after completion of HTS neb became statistically non-significant (p = 0.117). Hence, definitive differences were only shown for changes from baseline to immediately after HTS neb, and for changes from immediately after HTS neb to 10 min after completion of HTS neb.

Diagnosis	N	Percent (%)
Asthma	23	14.1
Bronchiectasis	114	69.9
Chronic Cough	15	9.2
COPD	5	3.1
Other	6	3.7
Total	163	100.0

Table 1: Primary respiratory diagnoses of those challenged

Diagnosis	Baseline FEV ₁ /L	FEV ₁ /L after bronchodilator	% change in FEV ₁ from baseline
Bronchiectasis	0.81	0.7	-13.6
Bronchiectasis	0.95	0.9	-5.3
Bronchiectasis	1.85	0.94	-49.2
Bronchiectasis	1	1	0.0
Bronchiectasis	0.95	1.05	10.5
Asthma	1.95	1.15	-41.0
COPD	1.7	1.85	8.8

Table 2: The effect of bronchodilator on lung function

Seven of 17 receiving preceding bronchodilator had their FEV₁ evaluated post bronchodilator and pre HTS.

	N	Median	Minimum	Maximum
FEV₁ Values /L				
at baseline	163	1.79	0.65	4.44
after Bronchodilator	7	1.00	0.70	1.85
immediately after HTS Neb	163	1.70	0.50	4.35
10 mins after completion of HTS Neb	163	1.75	0.55	4.47
FEV₁ Values /L				
to Bronchodilator	7	-5.26	-49.19	10.53
to immediately after HTS Neb	163	-4.81	-72.97	100.00
to 10 mins after completion of HTS Neb	163	0.00	-70.27	100.00
FEV₁ Values /L				
from immediately after 10 mins after completion of HTS Neb	163	3.45	-37.04	123.08

Table 3: Overview of changes in FEV₁ during HTS challenge

Diagnosis	Total Number	Baseline FEV₁<1L	Subjective problem reported	FEV₁<15%baseline on completion of neb	Subjective problem but FEV₁ on completion of neb>85% baseline	No subjective problem but >15% drop in FEV₁ on completion of neb	FEV₁ <15% baseline at 10 mins post neb	Patients who used bronchodilator before HTS dose	Patients who used bronchodilator after HTS dose
ABPA	4	0	0	0	0	0	1	0	0
Aspergillosis	1	0	1	1	0	0	0	0	1
Asthma	23	1	2	3	0	0	2	4	1
Bronchiectasis	113	19	11	20	2	2	12	11	3
COPD	5	1	1	0	1	1	0	2	0
Chronic Cough	15	1	0	3	0	0	1	0	0
Hypogamma - Globinaemia	1	0	0	0	0	0	0	0	0
Mucus after Burns injuries	1	0	0	0	0	0	0	0	0
Total	163	22 (13%)	16 (10%)	27 (17%)	3 (2%)	3 (2%)	16 (10%)	17 (10%)	5 (3%)

Table 4: Characteristics of "problematic" challenges

Discussion

No patients undergoing HTS challenge using the protocol required medical assistance or administration of multiple doses of rescue medication. This shows that the practise was safe. Two patients were excluded from the study due to them requiring rescue bronchodilator before completing the 4ml dose of hypertonic saline: prompt action by the physiotherapist maintained patient safety, highlighting the need for individual supervised first dose.

In this study, 27 (17%) of subjects showed an initial >15% drop in FEV₁ reaction to inhalation of 7% saline, none of which had COPD as their primary respiratory diagnosis. Makris et al. (2006) report an incidence of approximately 27% when performing sputum induction with COPD patients. They found 31% presented with a hyperresponsive (>20% drop in FEV₁) reaction to inhalation of 4.5% saline, despite a preceding dose of 200µg salbutamol via metered dose inhaler. This may be partly accounted for by the fact that in the Makris study there was a 4 week washout period with no inhaled/oral steroid use, and that long acting bronchodilators and short acting bronchodilators were omitted 12 and 8 hours respectively before the interventions. The patients attending for hypertonic saline challenge testing in this service evaluation were receiving their usual medical treatment which externally validates the findings.

No primary respiratory diagnosis led to a significantly increased risk of HTS - induced bronchoconstriction or subjective adverse event. Of note is that those with a primary diagnosis of asthma did not have the highest incidence rate of adverse sequelae of HTS challenge. Perhaps this is due to optimal medical baseline control, low numbers of patients with severe asthma that were challenged or asthma being present but undiagnosed.

Sixteen subjects still had FEV₁ values >15% lower than their baselines at 10 minutes post HTS. Some patients require longer recover time after receiving HTS, and this may need to be taken into consideration in allocating sufficient time for consultations and ensuring recovery is monitored by trained staff. If spirometric technique is judged to be sub-maximal throughout the challenge process, its usefulness as an outcome measure comes into question and patient observation (e.g. breathing pattern, wheeze) becomes more important, as does subjective report of symptoms.

Bronchodilator administration did not necessarily improve immediate lung function. Indeed, there was a 49% reduction in one patient challenged after inhaling bronchodilator, which did not worsen further with HTS. Despite receiving antecedent bronchodilator, eight patients demonstrated a significant reduction in FEV₁ immediately after completing the HTS dose, it therefore does not necessarily protect the patient from HTS-associated bronchoconstriction. Also, Salbutamol is known to be a racemic mixture of isomers, one of which may predispose to bronchospasm- a rare but reported phenomenon (Truitt et al 2003).

Of those undergoing the hypertonic saline challenge protocol, 19 subjects who did not have preceding bronchodilator administration showed immediate significant bronchoconstriction post HTS. However, 148 patients (90%) who did not have preceding bronchodilator administered as part of the challenge process had no significant HTS-associated reduction in FEV₁. This supports the practise of not routinely administering bronchodilators prior to challenge with HTS. This has the potential to save patient/physiotherapist time as well as medication burden.

Limitations

It is clear that spirometry is effort-dependent, as well as potentially influenced by movement of sputum. Poor spirometric techniques was commented on in several sets of casenotes analysed in this study. Lack of patient cooperation (intentional and unintentional) may lead to underestimation of FEV₁ and thus overestimation of bronchoconstrictive effect of HTS. This may explain the phenomenon of a reduction in FEV₁ following bronchodilator administration.

Twelve out of 22 patients with a baseline FEV₁ of <1L did not receive bronchodilator after baseline spirometry and before taking the nebulised 4ml 7%. It was not clear from the notes why the protocol was not followed. There are several potential reasons for this failure to administer bronchodilator before administering the HTS. These include patient choice, recent patient use of bronchodilator (e.g. in the hospital waiting room/car park), unavailability of patient's usual medication (e.g. patient not bringing the inhaler they use as and when required), physiotherapist ignorance/misunderstanding of the protocol, or patients not being prescribed bronchodilators. However, this does reflect clinical practice: not all steps in decision - making are always comprehensively documented and physiotherapists assess prior to delivering appropriate treatment.

The author is the clinician who performed the majority of the HTS challenges detailed in the study. He also performed the data collection and analysis, so there is potential researcher bias. Patients were often referred not only for HTS challenge, but also for instruction in chest clearance techniques. This often was discussed/practised with the patient between the spirometry measurements immediately after completing the HTS dose and 10 minutes afterwards. It is unknown what effect this may have had on the results. Sputum clearance can improve FEV₁, but repeated high expiratory flows (e.g. during coughing) may precipitate bronchospasm/bronchoconstriction. Cochrane, Weber and Clarke (1977) have discussed the detrimental effect sputum can have of lung function test results. Expectoration/sputum clearance cannot be excluded as a confounder of measures of FEV₁.

When performing sputum induction Pizzichini et al. (2002) acknowledge that opinion is divided over safety concerns arising when FEV₁ is detected to fall >10-20%, a fall in peak expiratory flow (PEF) of >10% from baseline or whether subjects experience bothersome symptoms.

The work by Newman et al. (1986) examining nebulisation of 4ml 7% saline using a variety of jet nebulisers suggest that the quantity of drug available to the patient depends on the individual nebuliser used, and upon the pressure and flow of the compressed gas. They found that even the same manufactured model of nebuliser delivered different sized droplet output at equivalent flow rates. There is therefore some variability of the nebuliser outputs between the challenges conducted as different compressors/nebulisers were used for separate challenges so there will have been differences in the exact volume of drug delivered to the patients in the study. However, this occurs in everyday clinical practise. What is noteworthy is that the patients who successfully completed the challenge tests may receive different compressors/compressors (albeit the same models) than those used during the challenge test and thus have the potential to receive a different volume of hypertonic saline per administered dose when they continue with this treatment at home. Ideally the challenge procedure should involve the same equipment that the patient will be using at home, but this may not be practicable.

Conclusion

How does this add to current knowledge?

Incidence of significant bronchoconstriction has been reported repeatedly in studies involving sputum induction using 3, 4 and 5% saline (Pizzichini et al. 2002). This study illuminates what actually happens in clinical practice when patients attend for 7% HTS challenge. Makris et al. (2006) share with this study the observed lack of correlation found between dyspnoea and reduction in FEV₁ which has been well reported in other literature. However, their study specifically looked at the association between sputum induction-associated dyspnoea with reduction in FEV₁. This study's data supports their findings of no correlation between the 2 factors.

Pasteur et al. in the 2010 BTS guideline for the management of non-CF bronchiectasis report when nebulised HTS is first administered, FEV₁ or peak expiratory flow readings should be done before and 5 min after treatment to assess for possible bronchoconstriction. The time scale at which to evaluate bronchoconstriction of 5 min after treatment is not justified in the literature referenced (Kellett et al 2006; Suri et al. 2000; Sutton et al 1988; Piper et al.1992; Conway et al.1992; Wills and Greenstone 2002; Sukumalchantra et al. 1965; Ayres et al. 1963). Kellett et al. (2006) did evaluate at 5 minutes after commencing nebulisation of HTS, but treatment was ceased at that point: the subjects only received 5minutes of nebulised HTS therapy, whereas the usual 4ml 7% saline dose takes approximately 10 minutes to nebulise using an Econoneb compressor with a microneb III nebuliser.

Pasteur et al (2010) also suggest that when nebulising HTS the clinician should pretreat with a bronchodilator in those with bronchial hyper-reactivity. This assertion is based on the findings of Suri et al. in a paediatric CF cohort, and it is debatable how transferable their conclusions are to the non-CF adult population. Eight patients exhibited significant bronchospasm despite administration of bronchodilator before the HTS: it is speculative that a higher dose of bronchodilator may have had a greater protective effect from HTS-associated bronchospasm. Bronchial-hyperreactivity is sometimes demonstrated at time of challenge with HTS and may be unknown in advance.

Implications for practice

By not requiring routine administration of bronchodilator as well as a spirometry measure 30 mins post HTS dose (as discussed online: <http://www.csp.org.uk/search/all/hypertonic%20saline>) for every patient challenged it reduces the clinical time needed for the patient to attend hospital, and this may allow busy outpatient clinics to offer a greater number of appointments. The limits to the usefulness of FEV₁ as a definitive safety outcome have been discussed. Other clinical features such as patient report may be more important in defining the suitability for HTS for a given individual patient.

Until this protocol is externally validated by other centres performing service evaluations using the same challenge protocol, it is likely that debate will continue over the "gold standard" for HTS challenge. However, this does appear to be a safe protocol to use. This protocol may not be appropriate for all patients e.g. those with tracheostomy or spirometry-associated syncope. In these cases the physiotherapist must be suitably skilled to use alternative monitoring tools (e.g. auscultation, pulse oximetry) as appropriate. Physiotherapists routinely assess each individual patient prior to treatment, and as such may determine whether the described challenge procedure is appropriate for the individual.

The use of HTS by patients is intended to continue subsequently from a successful challenge test: as with all treatment, risk vs. benefit must be key to the decision making about whether home nebulised HTS is

appropriate for the individual. Physiotherapists are uniquely placed to assess safety of inhalation of HTS whilst simultaneously able to facilitate mucus clearance and manage the acutely breathless patient. Future longitudinal studies detailing subjective adverse symptoms after commencing hypertonic saline are warranted, as is multicenter evaluation of challenge protocols to enable a formalised consensus.

Key points

- Bronchodilator does not necessarily have to be given as part of a HTS challenge procedure
- FEV₁ returned to within 15% of baseline 10 minutes after completing a 4ml dose of 7% saline in 90% of cases
- Significant drop in FEV₁ and adverse symptoms do not necessarily correlate

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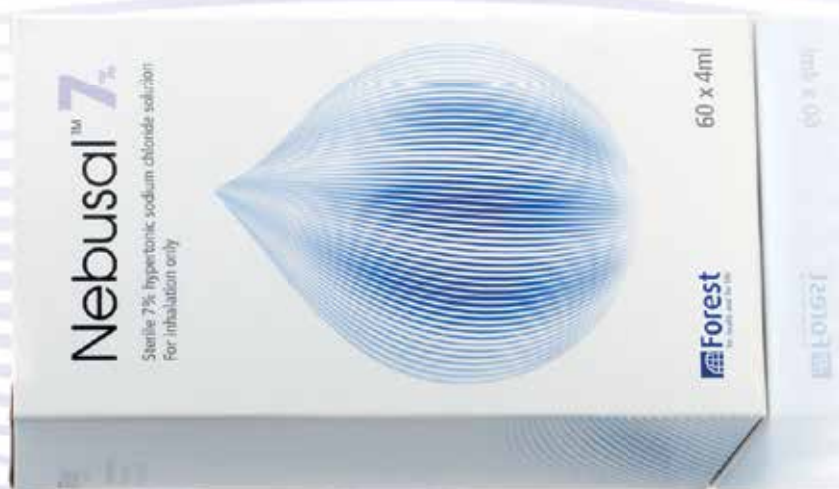
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1. Kelleff F *et al. Respir Med* 2011;**105**(12):1831–1835.
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3. MIMS (June 2015) listed price: £27.00 for a pack of 60 vials.

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Is Pulmonary Rehabilitation appropriate and beneficial for patients after surgery for lung cancer?

A Service Evaluation of Outcomes

Martin K¹, Socci L² and Sheppard A¹.

Purpose

This service evaluation of post-operative lung cancer surgery patients seeks to determine whether their inclusion within existent pulmonary rehabilitation programmes is both beneficial and appropriate to patients and clinicians

Method

Patients attended existing pulmonary rehabilitation classes at a specialist respiratory unit twice weekly for six weeks. Pre and post rehabilitation data was collected from 26 patients using the internationally recognised evidence based protocol for incremental shuttle walk test (ISWT), and endurance shuttle walk test (ESWT) to determine improvement in exercise capacity. A locally developed patient experience questionnaire was implemented to explore patients' perception of benefit and appropriateness. Brief interviews with staff members involved in delivering the programme were analysed to explore the appropriateness of inclusion of patients after lung cancer, from a clinician perspective and identify any challenges.

Results

Significant improvement in exercise capacity was seen in 77% of patients. All patients (100%) enjoyed attending the programme and found it beneficial; adherence was excellent with 93% of those whom enrolled completing. The general consensus of both staff and patients was that inclusion was appropriate with the only modification suggested being educational components.

Key Words

Pulmonary Rehabilitation
Post-operative Rehabilitation
Lung Cancer

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Conclusion

Pulmonary rehabilitation is beneficial and improves exercise capacity in patients following surgery for lung cancer. This patient group could be integrated into existing pulmonary rehabilitation classes with the advantage of access to respiratory expertise. Without a control group it is difficult to substantiate the degree of effectiveness, and cost effectiveness should be explored in future studies.

Introduction

Pulmonary rehabilitation (PR) has an established role within the management of patients with chronic obstructive pulmonary disease (COPD) with significant improvements in exercise capacity, quality of life and symptoms and reduction in hospital admissions being well documented (Bolton et al. 2013). Emerging evidence suggests that these benefits could be extended to other chronic respiratory conditions to include asthma, interstitial lung disease, pulmonary artery hypertension, non-cystic fibrosis, bronchiectasis and lung cancer (Holland, Wadell and Spruit 2013) that present with similar symptoms of dyspnoea, fatigue and reduced exercise tolerance.

Following surgery for non-small cell lung cancer, daily symptoms of dyspnoea, reduced exercise tolerance and reduced quality of life has been shown to remain impaired for six months or longer (Schulte et al. 2009). These patients often fail to engage with physical activity impulsively, and considering the association between physical activity and improved quality of life, there is a strong rationale to consider these patients for pulmonary rehabilitation (Coups et al. 2009). There is evidence to suggest exercise capacity improves after exercise training in this client group (Cavalheri et al. 2013). Awareness of the availability and patient perceived effectiveness of pulmonary rehabilitation is becoming widespread within the thoracic surgery network, and numbers of patients referred have increased five-fold over the last year in Rotherham.

Improved outcomes for patients with cancer remains high on the government's agenda so intervention which could improve functional outcomes in this patient group should be explored (Department of Health, Public Health England and NHS England 2014).

Patient centred post-operative rehabilitation for lung cancer patients has been trialled as part of a service evaluation alongside traditional pulmonary rehabilitation within our service since 2013. BreathingSpace is a specialist respiratory unit located in Rotherham, South Yorkshire. The outpatient multidisciplinary pulmonary rehabilitation team consists of physiotherapists, nurses and rehabilitation assistant practitioners. Rehabilitation is offered to a range of patients with a chronic respiratory conditions who complain of being functionally impaired by breathlessness.

This service evaluation seeks to explore whether the inclusion of post-operative lung cancer surgery patients within existent pulmonary rehabilitation programmes is both beneficial and appropriate to patients and clinicians.

Objective 1: Beneficial?: To explore the benefits of pulmonary rehabilitation on measures of exercise capacity and endurance, and from the perspective of patients.

Objective 2: Appropriate?: To explore perceptions of staff delivering pulmonary rehabilitation on the appropriateness of the inclusion of this patient cohort into pulmonary rehabilitation and identify any challenges.

Methods

Population

Patients were reviewed 6 weeks post-op lobectomy or anatomical segmentectomy via single port video assisted thoracoscopic surgery (VATS) or thoracotomy by the surgeon, and referred on for pulmonary rehabilitation if observations (for e.g. blood pressure, heart rate, oxygen saturations) were stable and they remained functionally limited primarily by breathlessness. All patients were non-smokers (as this is a pre-requisite for surgery). Patients experiencing post-operative complications, those with multiple co-morbidities affecting mobility, and those with high levels of uncontrolled residual pain were excluded. Patients undergoing multimodal on-going management (e.g. Chemo / Radio therapy) were eligible for inclusion.

Intervention

Patients attended an existing rolling programme of pulmonary rehabilitation at BreathingSpace. Patients attended twice weekly over a six week period, with each session lasting a minimum of one hour to include both exercise and educational components. The class sizes varied between 10-15 patients and were delivered by one physiotherapist and two rehabilitation assistant practitioners.

Individualised gym based programmes were devised as per BTS Guidelines following comprehensive assessment that included screening of co-morbidities, current symptoms, difficulties and goals. Both the aerobic and strength exercise components were progressive in nature and involved the patients exercising to a point of moderate breathlessness as defined by the Borg Dyspnoea scale (Borg, 1982). Numerous pieces of exercise equipment were utilised dependent on comorbidities to include treadmill, exercise bike, cross trainer, step ups and light weights. The starting speed for treadmill was prescribed at 75% of the predicted VO₂ peak which was derived from the incremental shuttle walk test (ISWT), and settings on other machines were set based on patient perceived exertion and specialist clinical input from the physiotherapist. Patients' vital observations including heart rate, saturation levels and Borg were monitored individually during each session.

Exercises were progressed depending on the basis of the patient's breathlessness symptom scores as well as patient performance and feedback from the previous session. The educational sessions delivered included: induction to the gym, types of lung disease, living an active life, speech and language, dietitian, inhaler devices and managing an exacerbation/secretion management.

Outcome measures

Standardised evidence based outcome measures of exercise capacity (ISWT (Singh et al, 1992)) and endurance (endurance treadmill walking test), were completed. These were completed before and after the pulmonary rehabilitation programme by a specialist physiotherapist. These measures were in line with the local standard operating procedure for pulmonary rehabilitation.

Patient reported experience questionnaires (Appendix A) were also completed, to provide additional insight into the pulmonary rehabilitation programme from the patients' perspective.

Brief interviews were conducted by an independent researcher with all five staff members (including specialist physiotherapists/physiotherapist and two rehabilitation assistant practitioners) involved in delivering the programme to attain their views on the appropriateness of inclusion and identify any challenges which had become apparent.

Data Analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 18 (SPSS Ltd, Woking, Surrey). The data were checked for normality and a non-parametric Wilcoxon Matched Pairs Test was used to analyse the difference between pre-and post-intervention outcomes, where $p < 0.05$ was considered statistically significant.

Responses to the patient questionnaire were analysed descriptively. This information was then categorised into themes and summarised. The brief staff interviews, were completed by an independent assessor and data was transcribed onto a proforma at point of interview (See appendix B).

Results

In the twenty-four month period December 2013 to December 2015, 33 patients were referred to BreathingSpace for post-operative pulmonary rehabilitation by the thoracic surgery team at Northern General Hospital, Sheffield. All patients ($n=33$) were invited for a formal assessment of which 29 attended. 28 were enrolled onto the programme, 1 was not appropriate due to an acute onset of low back pain.

Adherence was excellent with 26 (93%) of those patients enrolled completing the 6 weeks (12 sessions). There were two drop outs, one due to other co-morbidities, and one whom did not enjoying the programme.

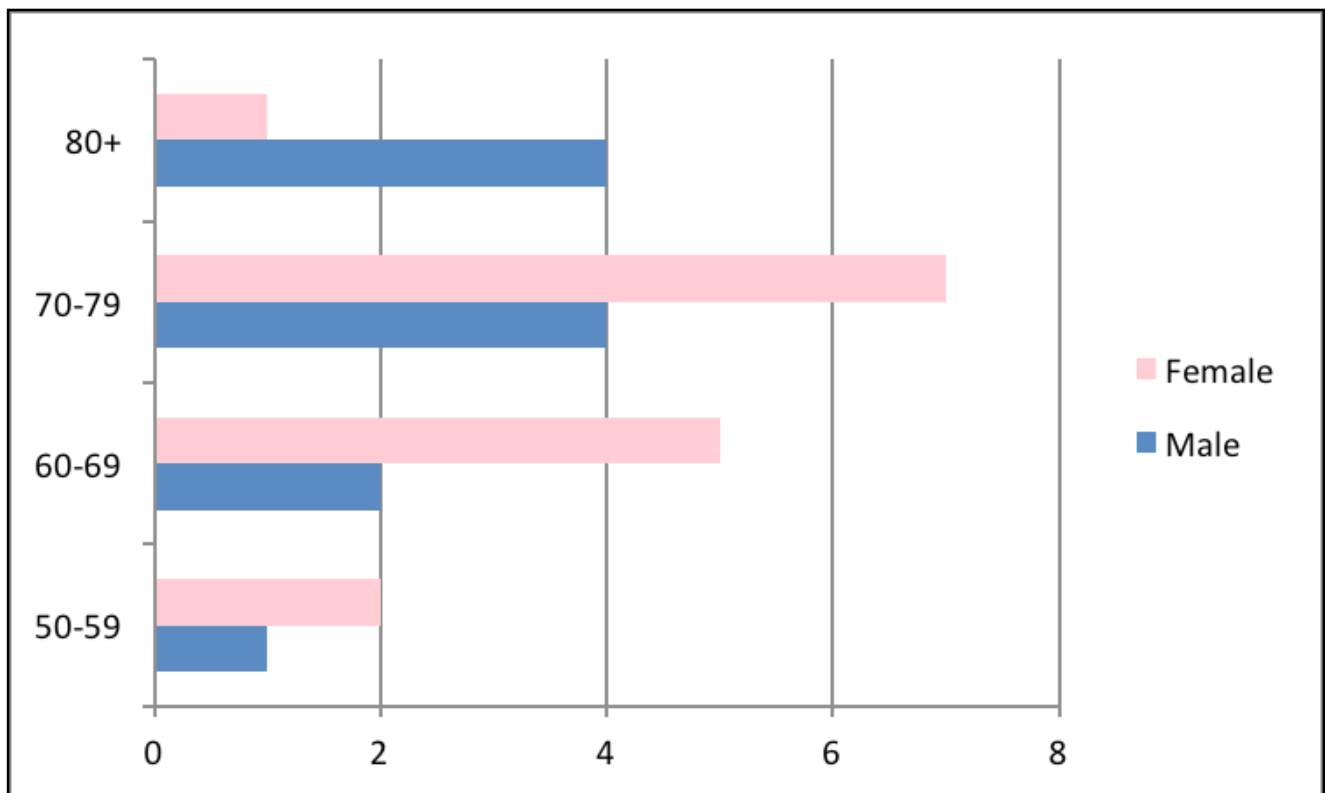


Figure 1: Age categories and gender of completing patients

Benefit

There was an increase in both outcome measures following the intervention (see Table 1). This suggests a statistically relevant difference between the pre and post intervention scores following the intervention. The ISWT has been shown to have a minimum clinically important difference (MCID) of

	Pre-intervention median (Interquartile Range) N=26	Post intervention median (Interquartile Range) N=26	Absolute difference median (Interquartile Range)	Significance Wilcoxon Matched Pairs Test Z statistic and p-value
ISWT metres (m)	270m (168-390m)	365m (289-505m)	90m (50-150m)	Z= -4.360 p= 0.000
ESWT seconds(s)	727s (262-1153s)	1912s (865-2700s)	875s (507-1520s)	Z= -4.432 p= 0.000

Table 1: Statistical Analysis of outcome measures pre and post intervention

47.5m when applied to a COPD population (Singh et al. 2013), if the same was applied to this group then a clinically relevant result was potentially produced in 77% of patients but this cannot be assumed.

Although there is no accepted MCID for the ESWT, 96% of patients showed a degree of improvement from baseline. No patients attending the programme required hospitalisation for the duration of the programme, and additional informal feedback received from the thoracic surgeons was that the programme had allowed more patients to be appropriate for multimodal on-going management (e.g. Chemo / Radio therapy).

Appropriateness

Patient feedback

The feedback received via the patient experience questionnaire completed on their final assessment was extremely positive with all patients stating they enjoyed the programme. Other feedback received offered a useful insight into the patient perceived effectiveness and appropriateness of the programme. The qualitative data received from the patient reported experience questionnaires was categorised into themes, and the data presented below in table 2.

Effectiveness	Appropriateness	Both
Physically I feel more able and stronger	Each person is treated as an individual and helped accordingly	Everything about the programme is excellent
I feel like I have my life back	I have thoroughly enjoyed being part of a group like this	
I am able to manage so much more in everyday life	I have enjoyed attending and meeting others	
I have definitely benefited	The exercise has done me good	
My muscles are stronger and I can do more	The education has been really helpful	
I have more confidence and I can manage my breathlessness better		
I have more energy and I'm stronger		
Stairs are much easier		
I don't cough as much		
It's easier to walk now		
My outlook and positivity are much better		

Table 2: Patient reported experience questionnaires data

Pulmonary Rehabilitation staff feedback

The results of the brief interviews (n=5 staff) were positive. When asked about whether they thought inclusion was appropriate; all clinicians agreed it was appropriate but explicated it was important to include patients with similarity in symptoms and similarities in abilities.

“Providing you put those with more complex comorbidities into the high dependency class they fit in fine – it’s just as important as when you assess a COPD patient with a complex past medical history”(Highly Specialist Physiotherapist)

When asked about how motivated the client group were to attend the sessions, all agreed that attendance was good.

“The attendance has been excellent” (Rehabilitation Assistant Practitioner)

When asked about whether or not the patients had engaged well with the exercise component of the programme, all agreed they had been.

There was a mixed response regarding the educational sessions with the general theme being that some sessions were more appropriate than others with the inhaler device session deemed the most inappropriate.

“The education has been well received – other than the inhaler session, as most of this patient group don’t have inhalers, they struggled to relate to the discussion – that being said they did sit and listen ” (Highly Specialist Physiotherapist)

No adverse symptoms were noted by any clinician during the course of the programme. Progress was noted by clinicians as similar to that seen in other chronic respiratory patients.

“I think progress has been relatively in line with the other patient groups” (Specialist Physiotherapist)

All clinicians questioned agreed they would recommend patients to attend a programme like this post-operatively.

Other comments noted included how well the patients fitted within the traditional client group, and how educational sessions could easily be modified to suit all patients.

“Yes, they fit in well within the groupI think they fit in so well as they have the similar symptom of breathlessness” (Specialist Physiotherapist; Rehabilitation Assistant Practitioner)

One clinician commented on how well the patients had interacted with the other members of the cohort with the common factor a lung condition.

Discussion

This evaluation provides some support for the inclusion of patients following surgery for lung cancer into a traditional PR model. The findings of this evaluation have been very positive, and provide a basis to support the on-going provision of this programme. The results suggest the programme is beneficial to increase exercise capacity, and the subjective data received from patients and staff confirm the general consensus that inclusion within existing pulmonary rehabilitation classes is appropriate.

With rehabilitation provision already in place for respiratory patients at many sites, this appears to be a potentially cost effective way to deliver pulmonary rehabilitation to this patient group, however no

formal cost analysis has been completed. Aligning these services, may present an affordable option for commissioners as it could present a cost efficient use of both expertise and resource. Despite the lack of similar specialist units like BreathingSpace within the NHS, the innovation could still be effectively spread across services nationally through implementation within existing community based pulmonary rehabilitation services.

When compared with outcomes from the recently reported national COPD audit for our service, the margins of improvements made were significantly better than those seen in our COPD patients in both outcome measures of exercise capacity considering the different disease pathways. The improvement achieved on the ISWT in the post-operative patients was 61% better than in the COPD patients, and the time improvement achieved in the endurance walking test was 56% better than the COPD patients (Royal College of Physicians and British Thoracic Society 2015). Seventy seven percent of the post-operative patients achieved the MCID of 47.5m in the ISWT in comparison to 61% of the COPD cohort (Royal College of Physicians and British Thoracic Society 2015), however the MCID is only evidence based within the COPD population and not for cohort post lung surgery for cancer.

Adherence was excellent, 93% of those who enrolled completed the twelve prescribed sessions of rehabilitation (the two drop outs being due to non-related personal circumstances). This is in contrast to data from the audit showing 76% of COPD patients completed a PR programme (Royal College of Physicians and British Thoracic Society 2015). The patient group were well motivated and keen to improve, and as patients have regular contact with NHS professionals post operatively this helped patients continue to improve both physically and psychologically.

All educational sessions delivered except the inhaler technique session appeared to be well received by the patients. This is likely to be secondary to the fact this patient group experience similar symptoms and difficulties to patients with other respiratory diagnoses. If this patient cohort are to be included in the traditional PR model, future work is required to determine the appropriate educational topics relevant for this patient population.

It has become apparent from this service evaluation that the positive patient outcomes are likely dependent on the selection of appropriate patients being referred, and for this a comprehensive interdisciplinary approach is imperative to ensure success (Holland, Waddell and Spruit 2013). Selection of appropriate candidates to facilitate attainment of specific goals is very much reliant on knowledge, awareness and expertise of the cardiothoracic surgeons. Consideration would need to be made for those patients undergoing adjunctive treatment such as chemotherapy, and alternative forms of exercise considered due to increased levels of fatigue, as attendance rates are likely to be lower (Stigt et al. 2013)

Although no formal assessment of quality of life was completed, some of the comments in the patient experience questionnaires alluded to an improvement in some aspects that could impact on quality of life. Our experience was in contrast to Stigt et al. (2013) who described patient improvement in exercise tolerance at the cost of more pain and limitation and recommended rehabilitation is best postponed until three to four months following hospital discharge, however this is likely to be in part due to the advancement in surgical techniques to less invasive video assisted thorascopic surgery which is associated with less pain and improved recovery rates (Li et al. 2014). The data collected from our site, does appear to be in agreement with Granger et al. (2012) as offering PR to this patient population is a safe and feasible option.

It should be noted that the low numbers of participants and the convenience sampling used would potentially reduce the power and clinical relevance of the statistical calculation. The nature of this

service evaluation led to no control/standard therapy comparison group and therefore care should be taken when interpreting and generalising these results. It does demonstrate potential effectiveness of the intervention, but requires further robust comparison to standard care. Direct comparison with the recently issued BreathingSpace Pulmonary Rehabilitation Programme site specific COPD National Clinical Audit results (Royal College of Physicians and British Thoracic Society 2015) was completed to further justify the appropriateness and beneficial domains.

Conclusion

This evaluation demonstrates that inclusion of patients following surgery for lung cancer within pulmonary rehabilitation, is beneficial to improve exercise tolerance. This patient group could be integrated into existing pulmonary rehabilitation classes with the advantage of access to respiratory expertise. Without a control group it is difficult to substantiate the degree of effectiveness and cost effectiveness should be explored in future studies.

Key Points

- Inclusion of patients after surgery for lung cancer within outpatient pulmonary rehabilitation classes appears to be beneficial and appropriate
- Staff delivering pulmonary rehabilitation appear to be supportive of this model, provided specific inclusion criteria are met and educational sessions adapted
- Adherence of patients after surgery for lung cancer attending pulmonary rehabilitation is excellent

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Pulmonary Rehabilitation

Satisfaction Survey

<i>Please tick the relevant column for your answer to each statement below:</i>	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
The course has helped me manage my lung condition more effectively					
The information was pitched at an appropriate level					
The course met my expectations					
I found the course to be worthwhile					
The exercise programme has been helpful					
I would recommend this course to others with a lung condition					

Was there anything missing in the course that you would have liked to be included?

What were the most useful aspects of the course?

APPENDIX 1

Is there anything in particular which you now find easier because of the course?

How would you rate the education sessions you received during your course?

	Excellent	Very Good	Good	Satisfactory	Poor
Induction					
Speech & Language					
Dietitian					
Living an Active Life					
Managing a chest infection / ACBT					
Types of lung disease					
Inhaler devices					

Is there a comment you would like to make that would encourage others to participate, that we could use for promotion of the programme?

Thank you for your time

Interview Questions

Do you feel inclusion of lung cancer patients within pulmonary rehabilitation is appropriate?

Can you explain why you feel this way?

Do you find this patient group are as motivated as the other patients within the group?

Would you say attendance of these patients has been good?

Have the patients engaged well with the exercise component of the programme?

Please can you expand on your answer?

Do you feel these patients have progressed inline with the other patients?

Do you feel the patients have engaged well with the educational aspects of the programme?

Please can you expand on your answer?

Have any adverse symptoms been observed or highlighted to you during the programme by this patient group?

Would you recommend patients attend a programme like this post-operatively?

Any other comments?

Predictors of tracheostomy decannulation success or failure: A short communication

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and Thomas AJ¹

Background

We present the case of an elderly woman, admitted to hospital with respiratory failure, requiring mechanical ventilation and tracheostomy. Despite progressing to a good functional status, minimal oxygen requirements and the ability to speak, eat and drink safely with tracheostomy; repeated attempts to decannulate were unsuccessful. The potential contributing factors to this failure are discussed, with particular reference to dynamic spirometric readings.

This case study exemplifies why further work is needed to establish the predictive value of cough peak flows in successful decannulation, and suggests some characteristics of patients who are most likely to benefit from spirometric measures prior to decannulation.

Introduction

Approximately 12,000 tracheostomies are placed in patients in the UK (not including Scotland) each year (NCEPOD, 2014). The majority of patients follow a straightforward tracheostomy wean and are decannulated once simple criteria are met, but in a proportion of more complex patients, these criteria are not thorough enough to predict decannulation success or failure. These patients may require a more complex wean or a permanent tracheostomy, and whilst there is some data for predictors of decannulation success in neuromuscular patients (Bach and Saporito, 1994) there is little published evidence for similar predictors in the non-neuromuscular population. An international survey of clinicians by Stelfox et al (2008) showed variability in different clinicians' criteria for decannulation, and suggested that further work was necessary to prevent variability in tracheostomy care in different settings.

In the following case study, these predictors and other factors are discussed.

Keywords

Tracheostomy
Decannulation
Cough peak flow

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Case Report

A 75-year-old woman presented to accident and emergency with severe community acquired pneumonia and type II respiratory distress, requiring intubation and mechanical ventilation.

Prior to this admission, she was living alone independently, with a supportive family nearby. She had recently been seen in the respiratory clinic previously for increasing breathlessness on exertion and dry cough, limiting her to an exercise tolerance of 500 yards, on a background of a 70 pack-year smoking history. Her spirometry showed a restrictive pattern, and she was awaiting CT chest.

On admission, she had pitting oedema to mid-shins, with suggestion of mild heart failure on echocardiography. She was also centrally obese, with pronounced thoracic kyphosis and reduced neck flexion and extension. Despite a prompt wean from ventilation two extubation attempts failed due to stridor, and a percutaneous tracheostomy was placed 10 days after admission. Once tracheostomised, the patient quickly weaned from mechanical ventilation during the day and was able to tolerate speaking valve, and eat and drink modified consistencies with her tracheostomy. However, she was found to have nocturnal hypercapnia and hypoventilation, and was started on nocturnal Bi-level Positive Airway Pressure (BiPAP) via tracheostomy for this. She was also found to have a hypoxic drive. Rigid bronchoscopy at the time of first failed extubation showed tracheomalacia and damage to the arytenoid cartilage, and it was felt that a period of time at home with tracheostomy would allow airway swelling to settle, and so her swallow was assessed to allow her to eat and drink at home. Despite pharyngeal dysphagia, she was able to eat and drink modified consistencies. She was mobile with a frame, and did not need supplementary oxygen, and went home to recuperate on nocturnal BiPAP via tracheostomy.

Approximately 3 months later, the patient returned to hospital for what became 3 attempts to decannulate. At this point, the patient was alert and ambulant, had been tolerant of cuff deflation for over two months and used a speaking valve throughout the day. Our team were not involved with the first decannulation attempt, but were involved with a second and third final attempt, all of which occurred at approximately 2 weekly intervals.

A neuromuscular diagnosis was suspected, but muscle biopsy results were normal, and the patient was unable to tolerate lying flat for an MRI due to breathlessness. Repeat laryngoscopy prior to the second decannulation attempt showed reduced vocal cord abduction, but no tracheomalacia or oedema. The patient's forced vital capacity (FVC) was 500mls, and her cough peak flow (CPF) measured via tracheostomy was 65 Lmin⁻¹. Bach and Saporito (1996) suggest a CPF value of 160 Lmin⁻¹ as a predictor of successful decannulation in the neuromuscular population, but the generalisability of this CPF value in the non-neuromuscular population is not known. Given these low figures, we planned to supplement peak expiratory flows both prior to and after decannulation, using manual insufflation/exsufflation as suggested by McKim et al (2012), to support effective airway clearance if required. At the final attempt, the patient was uneventfully decannulated during the morning on the high-dependency unit to allow close monitoring. That night, the patient asked to use the toilet, sat up and 'went blue' – becoming unconscious with profound hypoxia and associated bradycardia. Despite attempts to resuscitate via the face, her condition did not improve until a tracheostomy was reinserted. BiPAP was then reinstated, and by the following afternoon, the patient was alert and getting out of bed. She declined further attempts at decannulation, and was discharged home with the tracheostomy in situ.

Discussion

A combination of likely neuromuscular involvement, likely COPD and what we then thought was restricted vocal cord movement made our patient high-risk for decannulation failure in the longer term, particularly in the event of a respiratory infection. However, the reason for our patient's sudden deterioration was unclear to us. Sputum plugging would be a typical cause of a sudden airway deterioration such as this, but no sputum was cleared from her airway during resuscitation. Dynamic airway collapse is possible, but this was not seen on laryngoscopy prior to the final attempt. Two years later, our patient underwent further scoping, which confirmed tracheomalacia, and we now suspect that this was the cause of her failure to decannulate, and an explanation for her poor cough peak flows.

Importantly, according to the simple criteria outlined in Figure 1 used for all patients routinely, our patient would appear suitable for straightforward decannulation. Had the patient not had two unexpected failed extubations prior to tracheostomy, we would perhaps not have assessed her as closely using spirometry prior to attempting decannulation.

The patient:

- Can maintain and protect his airway spontaneously
- Is free from ventilatory support, although decannulation to allow non-invasive ventilation (NIV) can be used in some situations
- Shows no sign of fever or active infection
- Is consistently alert
- Has a strong consistent cough (able to cough into mouth)
- Has control of saliva
- Is not scheduled for procedures requiring anaesthesia within the next few days
- Is considered stable

Figure 1: Criteria for decannulation (National Tracheostomy Safety Project, 2014)

The addition of spirometric testing predicted decannulation failure - albeit during a future chest infection secondary to problems with sputum clearance. Spirometry, particularly in the form of CPF, is not routinely included within simple criteria for decannulation, and further work is needed to determine whether it should be utilised as a screening tool more readily in the complex non-neuromuscular population. Work by Fitzgerald et al (2013) showed that cough peak flows prior to decannulation did not predict cough peak flows after decannulation, and in a sample of 23 patients, 8 had cough peak flows below 160 Lmin^{-1} and 7 of these successfully extubated. Ceriana et al (2003) used a flowchart to aid decisions to decannulate, and used a cut-off maximal expiratory pressures (MEP) of $40 \text{ cm H}_2\text{O}$ to judge cough. In patients with an MEP below this value, a minitracheostomy was used as a bridging stage before decannulation, and all 6 patients successfully decannulated.

Our patient had extremely poor cough peak flow values, and we were aware that she was at high risk for decannulation failure in the event of a future respiratory infection. However, she was functioning well, including living at home, albeit with 24-hour tracheostomy care. She was able to walk short distances and transfer independently, was communicating with speaking valve, and had minimal sputum burden; and coupled with her stable clinical status in the form of blood gases and infection markers, looked like

a good candidate for decannulation using simple decannulation criteria.

Until there is clarity of evidence of the predictive values of cough peak flows in decannulation failure, we suggest that in patients with poor CPF who meet all other usual criteria an attempt to decannulate in a closely monitored environment seems reasonable. Further work is needed to help us understand the relevance of cough peak flows in different clinical groups with tracheostomy, in order to aid accurate decision-making.

Key Points

- Although many patients with tracheostomies will successfully decannulate after meeting straightforward criteria, there is a proportion of patients who may benefit from cough peak flow assessment to ensure they are able to adequately protect their airway with an effective cough.
- The clinical characteristics of these patients is not clear.
- Further work is needed to evaluate the use of cough peak flow in specific clinical populations.

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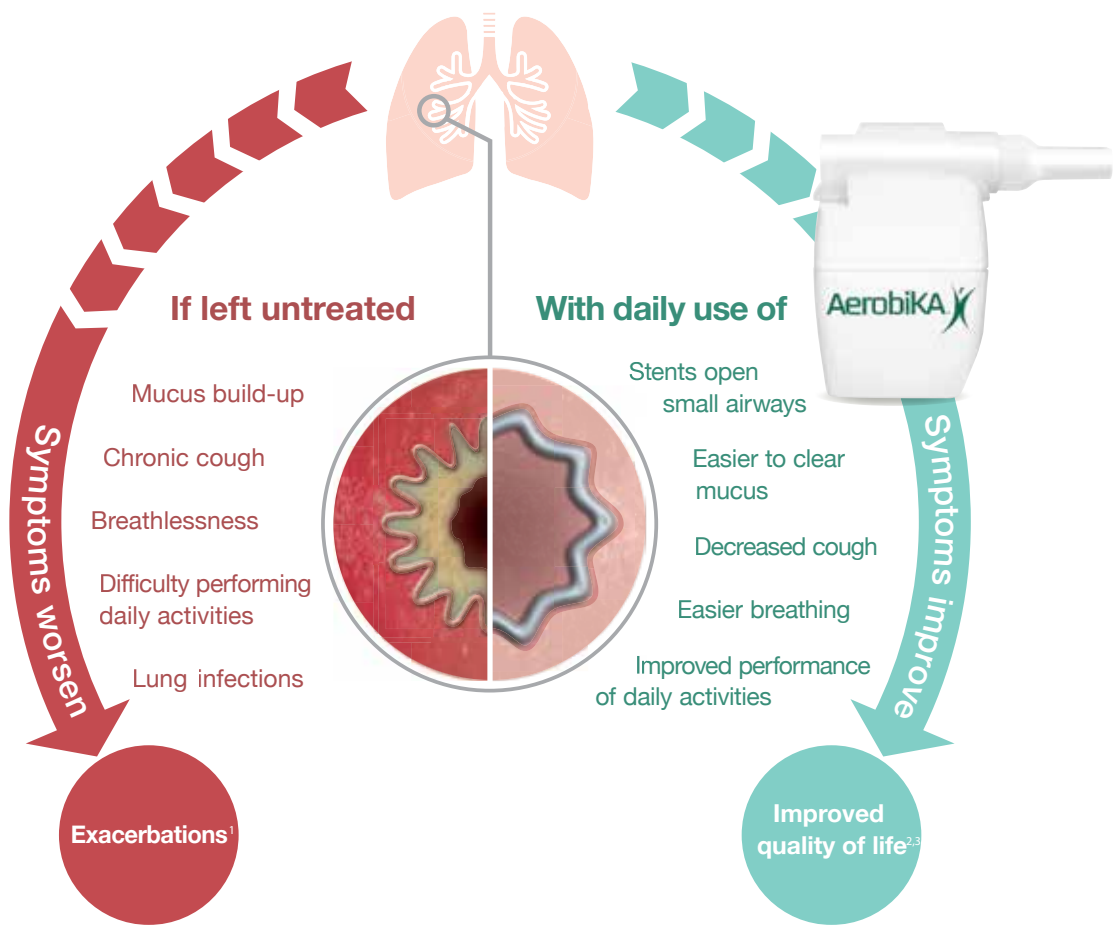
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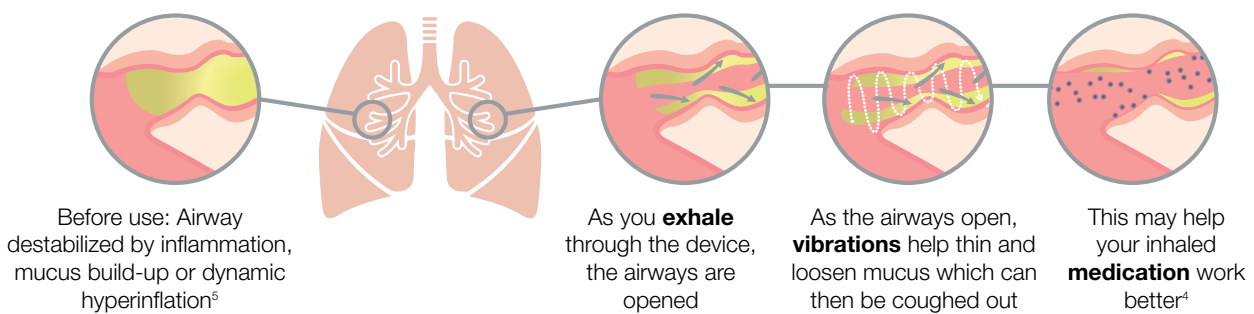
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¹ Ramos FL, Krahnke JS, Kim V. Clinical issues of mucus accumulation in COPD. *International Journal of COPD*. 2014;9:139-150. ² Svenningsen S, et al. Oscillating Positive Expiratory Pressure Therapy in Chronic Obstructive Pulmonary Disease and Bronchiectasis. *European Respiratory Journal* 2014;44(58):P3679. ³ Svenningsen S, et al. Oscillating Positive Expiratory Pressure in Chronic Obstructive Pulmonary Disease. *Journal of COPD* 2016;13(1):66-74. ⁴ Fahy JV and Dickey BF. Airway Mucus Function and Dysfunction. *New England Journal of Medicine* 2010; 363(23):2233-2247. ⁵ O'Donnell DE and Parker CM. COPD exacerbations. *Thorax*. 2006;61:354-361 MD-692A-0716. * trade-marks and registered trade-marks of Trudell Medical International. © TMI 2016. All rights reserved.



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A Single Centre Study of Respiratory and Rehabilitation Physiotherapy Treatments for Adult Patients on Respiratory Extracorporeal Membrane Oxygenation (ECMO)

Eden A¹

Background & Purpose

To investigate the type and frequency of physiotherapy treatments, and adverse events for adult patients on Respiratory Extracorporeal Membrane Oxygenation (ECMO).

Methods

A quantitative, retrospective, cross sectional study in one severe respiratory failure centre providing respiratory ECMO to patients in the United Kingdom. The sample was 42 patients receiving Respiratory ECMO from December 2011 to October 2013. Data parameters included patient demographics, diagnosis, pre-transfer details, admission information on ventilator settings, arterial blood gases, sedation and paralysing agent (types and duration), commencement and frequency of physiotherapy respiratory and rehabilitation treatments, adverse events and CPaX on discharge. Data was analysed in Excel and presented as percentages, range, and mean average.

Results

Length of stay ranged from one to 110 days. Eleven rehabilitation treatment techniques were used with 38 patients, of which 15 patients participated in active rehabilitation. Patients achieved a mean of 5/45 CPaX score before discharge from intensive care (ICU)/ repatriation. This reflects a low level of active physical ability, unfortunately CPaX on admission was not collected for comparison. 35 patients received respiratory treatment, from eight treatment options. There was a 2% incidence of adverse event, these were all reversible with no long-term harm to the patient.

Conclusion

Patients on ECMO received a large range of physiotherapy interventions during their admission to enhance their respiratory function and physical ability. Patients on ECMO have additional risks to treatment compared to ICU patients due to the severity of lung injury and associated risks of cannula insertion points and extracorporeal flow. Despite this active physiotherapy is safe and undertaken with this cohort.

Keywords

Extracorporeal Membrane Oxygenation
Intensive Care
Rehabilitation
Respiratory Physiotherapy

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Introduction

ECMO is a temporary supportive treatment modality used for patients with severe respiratory or cardiac failure who are severely hypoxic and/or hypercapnic despite maximal medical intervention (Hung et al., 2012). A veno-venous configuration provides respiratory support, and veno-arterial supports cardiac function whilst still providing gas exchange. Peripheral cannulae are inserted into the internal jugular vein and femoral vein or artery, and central cannulation is into major cardiac vessels, i.e. vena cava and aorta. The level of ECMO support is determined by the flow rate of blood around the ECMO circuit, the flow speed of oxygen across the membrane ('sweep') and fraction of inspired oxygen (FiO₂). Patients' lungs continue to be supported whilst on ECMO via protective ventilation strategies or supplementary oxygen if self-ventilating (Sidebotham et al., 2010).

Respiratory ECMO is used in severe acute respiratory distress syndrome (ARDS) (Brodie & Bacchetta, 2011; Sidebotham, et al., 2009) and there has been an increase in utilisation of ECMO following its successful use in the 2009/10 H1N1 outbreak (Noble & Peek, 2010). In 2011, the Department of Health commissioned five Trusts to provide this service; broadening the expertise and availability of care (National Health Service Specialised Commissioning Team, 2012). In this report, the term ECMO refers to respiratory ECMO.

With the increase use of ECMO, there is a requirement for Physiotherapists to possess specialist knowledge to assess and treat these patients. Due to the nature of the admitting illness and ECMO therapy, patients on ECMO are often long term ICU patients, with longer ICU and hospital stays than other critically unwell patients (The Australia and New Zealand Extracorporeal Membrane Oxygenation Influenza Investigators, 2009). It is well established that patients in ICU require physiotherapy input to prevent and treat respiratory and musculoskeletal disorders acquired during their critical illness (Needham, 2008), this is reflected by patients on ECMO requirement of respiratory and rehabilitation treatment during admission (Fiddler & Williams, 2000). Chest physiotherapy and early active rehabilitation are key factors in patient recovery (Gosselink et al., 2008; National Institute for Health and Clinical Excellence, 2009). However, there is limited published ECMO specific physiotherapy evidence, with mainly case studies detailing rehabilitation and safety (Cork et al., 2014; Cork & Barrett, 2013; Rahimi et al., 2013; Lowman et al., 2012; Turner et al., 2011).

This study investigated the respiratory and rehabilitation treatments used with a series of patients on ECMO. The methodology is a quantitative, retrospective, cross sectional study. The aim of study is to investigate and summarise the variety and frequency of respiratory and rehabilitative physiotherapy treatments in patients on Respiratory ECMO. The results will be informative of current clinical practice, to support Physiotherapists working with patients on ECMO, and those who have been repatriated to their local hospital after receiving ECMO.

The primary research question is to investigate which main rehabilitation treatments were used by Physiotherapists with patients on ECMO. With the secondary questions being:

- What were the respiratory treatment options used by Physiotherapists with patients on ECMO.
- What, if any, were the adverse events during respiratory and rehabilitation physiotherapy sessions.
- What was the physical ability of patients based on Chelsea Critical Care Physical Assessment (CPAx) outcome measure (Corner et al., 2013).

Method

Study Design

A cross sectional method was used to investigate physiotherapy treatment provided to patients on ECMO.

Subjects

All patients on ECMO from December 2011 to October 2013 were included in the study. Patients are referred from local hospitals within the ECMO centres catchment area. Out of area patients may be transferred, dependent on other ECMO centre occupancy levels. The start date of December 2011 was chosen as the hospital was commissioned as an ECMO centre from this date (National Health Service National Specialised Commissioning Team, 2012).

Ethics

Formal ethical approval was not required as the study was a retrospective data collection exercise, with no direct or indirect patient or staff contact. To reduce the likelihood of patient identification and to increase confidentiality, a unique identification number was used on all data collected.

Data collection and analysis

The data was collected retrospectively from the electronic critical care clinical information system (CIS). The physiotherapy notes were used to assess which treatments were used, and how frequently. All treatment sessions were recorded, capturing treatment provided by Band 4 (Assistant Practitioner) to Band 8 Physiotherapists. Additional ECMO information was obtained from the medical and nursing notes on CIS.

Information collected for demographics included; date of birth, gender, body mass index, diagnosis, length of stay in local ICU pre-transfer, reason for referral, history of respiratory disease, relevant past medical history. Ventilatory parameters and arterial blood gases on admission, ECMO cannula location, type and duration of sedation and neuromuscular blockade, and length of stay in ECMO ICU and discharge destination. Physiotherapy specific information included number of treatment sessions, and types of rehabilitation and respiratory treatment performed, plus frequency of each treatment, and CPaX score pre-discharge from the ECMO centre; i.e. pre-mortality or before repatriation. CPaX is an outcome measure of physical morbidity within critical care, validated for use with general adult ICU patients (Corner et al., 2013). It scores 10 dimensions based on patient's respiratory and physical ability on a scale of 0-5. Its use was commenced at the ECMO centre in June 2013, therefore some data within the study was scored retrospectively. One dimension (grip strength) is not assessed, therefore the maximal possible score is 45. Descriptive statistics, analysed in Microsoft Excel, are presented for patient background, ECMO, clinical and physiotherapy information. Tabulated data is reported as an average (mean) \pm one standard deviation (SD) and range.

Results

All 42 patients admitted for ECMO at the site of the study between December 2011 and October 2013 were included in the data collection and analysis. Baseline characteristics are outlined in table 1.

Referral information

All patients were referred for ECMO due to difficulty of ventilation, often with high ventilation pressures, and significantly deranged arterial blood gases reflecting significant type 1 or type 2 respiratory failures. Figure 1 displays the underlying diagnosis for all patients and the number of cases of each presentation.

	Mean (\pm SD)	Range
Age (in years)	43.9 (\pm 15)	17-69
Body Mass Index (kg/m ²)	27.9 (\pm 9)	17-55
Gender: male/female	24/18 ratio 4:3	
LOS in referring hospital (in days)*	4.7 (\pm 4.8)	0-20
LOS in ECMO centre (in days)	20.9 (\pm 23.6)	1-110
Positive End Expiratory Pressure (cm/H ₂ O)	8.9 (\pm 2.6)	3-15
Pressure Control (cm/H ₂ O)**	18.3 (\pm 4.6)	10-27
Peak Pressure (cm/H ₂ O)	28.1 (\pm 4.2)	15-35
FiO ₂	0.9 (\pm 0.1)	0.3-1

Table 1: Baseline characteristics

LOS: Length of Stay

*n=40 as data missing for 2 LOS in referring hospital

**n=40 as 2 patients not on pressure ventilation

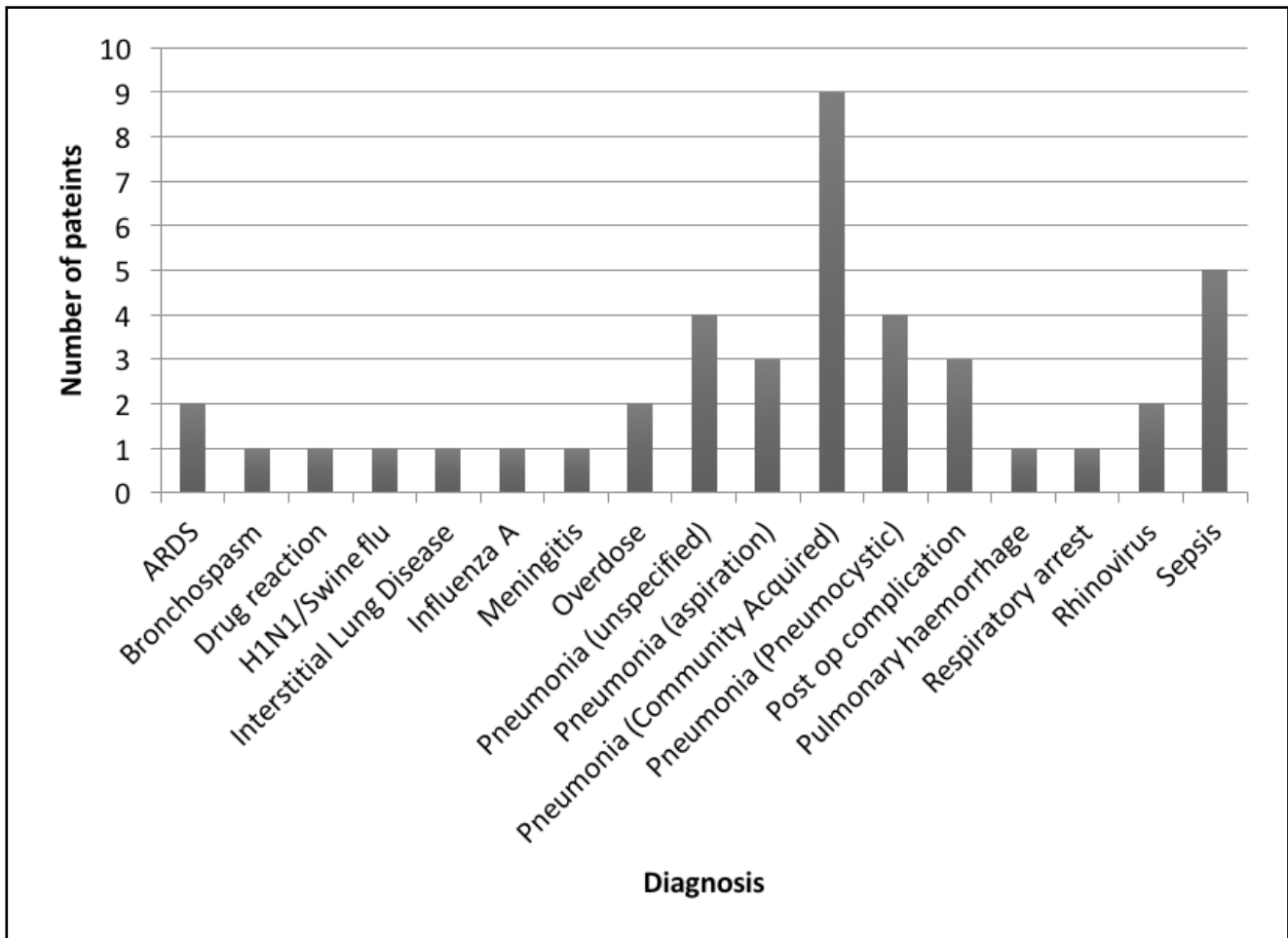


Figure 1: Diagnosis

The most common underlying causes of respiratory failure leading to referral for ECMO were community acquired pneumonia (nine patients), followed by sepsis (five patients), and other types of pneumonia (11 patients in total).

Past medical history

Eight patients had a history of previous underlying respiratory disease; these were tuberculosis, interstitial lung disease, COPD and asthma. Two of these patients respiratory disease directly related to them requiring ECMO. One patient was diagnosed with active tuberculosis following ECMO insertion, and another was treated due to an exacerbation of pulmonary fibrosis.

ECMO centre information

The mean length of stay was 21 ± 23 days. 55 % of patients were repatriated to their referring hospital, 36% died at the ECMO centre, 7% were discharged to the ward at the ECMO centre, and 2% (one patient) was discharged to a local regional centre for abdominal specialist care.

ECMO cannulation

33 (79%) patients had a double lumen cannula situated in the right internal jugular, six (14%) patients had right internal jugular and right femoral vein insertion, two patients (5%) had right internal jugular and left femoral vein insertion, and one patient (2%) had right internal jugular and bi- femoral vein insertion. The mean duration of ECMO was 420 hours (17.5 days), with a range of 14-2626 hours (0.5 – 109 days).

Physiotherapy Treatment

The total number of physiotherapy treatments ranged from one to 104 sessions. The mean number of sessions was 22 ± 23 , with a mean daily number of physiotherapy treatments as one per day. Four patients were assessed with no physiotherapy treatment provided as it was not indicated, and all of these patients died within 24 hours.

All types of passive and active rehabilitation treatments undertaken, the number of patients receiving these and the number of treatment sessions are displayed in table 2. All patients admitted to ICU are routinely assessed and treated as appropriate.

38 patients received rehabilitative treatment; it should be noted that patients may have participated in additional rehabilitation with the nursing staff (e.g. hoisted to chair without physiotherapy assistance) and this activity has not been captured. The main rehabilitation treatment used by physiotherapists with patients on ECMO was passive range of movement (33 patients, 87%), followed by active assisted and active range of movement (18 patients, 47%). 15 patients (39%) sat on the edge of the bed and 13 (34%) sat out of bed in a chair. No patients received glenohumeral head mobilisation, neuromuscular stimulation (NMES), or stand aid as part of their rehabilitation. Treatments provided to fewer than 10 patients included foot splints (six patients), chair pedals (nine patients) and bed bike (eight patients).

Patient's ability before discharge was measured by CPaX. The CPaX score on admission was not collected in this study, therefore comparison of admission and discharge ability cannot be made. The mean CPaX score was 5.6 ± 8.8 , with 19 patients scoring 0 which indicates no voluntary respiratory or physical function. The majority of patients remained sedated and sometimes paralysed during their admission at the ECMO centre, to enable optimal ventilation and reduction of metabolic demand whilst hypoxic. Patients scoring level 2 in each dimension (total 18) indicates a moderate level of respiratory and physical function, four patients scored more than 18 on discharge.

All forms of respiratory treatments undertaken, the number of patients receiving and the number of treatment sessions are displayed in table 3.

	Number of patients receiving Rx	Total number of Rx sessions	Mean number of sessions (\pm SD)	Range
Passive range of movements	33	261	7.9 (\pm 6.9)	1-25
Foot splints	6	31	5.1 (\pm 7.3)	1-20
Glenohumeral mobilisation	0	0	0	0
Active assisted and active range of movement	18	142	7.8 (\pm 8.4)	1-31
Neuromuscular electrical stimulation	0	0	0	0
Bed bike	8	34	4.25 (\pm 3.5)	1-9
Sit on edge of bed	15	50	3.3 (\pm 2.3)	1-9
Sit out of bed	13	29	2.2 (\pm 1.3)	1-5
Chair pedals	9	35	3.8 (\pm 3.2)	1-11
Sit to stand	5	16	3.2 (\pm 13.4)	1-9
Stand aid	0	0	0	0
Tilt table	1	2	2 (\pm 0)	0
March on spot	1	4	4 (\pm 0)	0
Mobilised	2	2	1 (\pm 0)	0

Table 2: Rehabilitation treatments

Treatment techniques	Number of patients receiving Rx	Total number of Rx sessions	Mean number of sessions (\pm SD)	Range
Suction	35	280	8 (\pm 7)	1-34
Saline	14	41	2.9 (\pm 2.3)	1-8
Positioning	12	18	1.5 (\pm 1)	1-4
Manual techniques	10	15	1.5 (\pm 0.8)	1-3
Deep breathing exercises	10	24	2.4 (\pm 1.8)	1-6
Coughing	5	13	2.6 (\pm 1.3)	1-5
Ventilator hyperinflation	2	2	1 (\pm 0)	0
Manual hyperinflation	1	1	1 (\pm 0)	0

Table 3: Respiratory treatments

35 patients received respiratory treatment; three less than received rehabilitation intervention. Following assessment it was clinically reasoned that these three patients did not require respiratory treatment, but received passive range of movement, therefore are included in the rehabilitation statistics. These three patients died following a short admission. All patients were suctioned on a frequent basis. 14 patients (40%) received instillation of saline before suctioning and 12 patients (34%) were positioned for chest clearance. Fewer patients required deep breathing (10 patients) and coughing exercises (five patients), but these were provided in a higher intensity than the other remaining treatment options.

Adverse Events

From a total number of 843 treatment sessions, there were 17 adverse events (2%) recorded during treatment, experienced by nine patients (21%). The types of adverse events are outlined in table 4, and had no long-term harmful effect on the patient.

Adverse event	Number during rehabilitation treatment	Number during respiratory treatment	Total
Bradycardia/asystole	5	2	7
Tachycardia	2	0	2
Drop in ECMO flow	1	1	2
Increase in respiratory rate	2	0	2
Air leak from tracheostomy	1	0	1
Desaturation	0	3	3

Table 4: Adverse events

Discussion

In support of previously published case reports, this study provides more detail of what types of physiotherapy treatment patients on ECMO receive. In answer to the primary research question, a range of 11 passive to fully active rehabilitation techniques were used with this population. Glenohumeral head mobilisation were not used at the ECMO centre during the data collection period. As a direct result of this study anterior-posterior glides are now performed when ECMO cannula position limits shoulder movement. NMES was not, and still not used at the ECMO centre but included in data collection due to evidence within the literature (Gosselink et al., 2013; Lowman et al., 2012). Standing aids are used in the ECMO centre, however, it is likely that the equipment is not used in patients on ECMO due to cannula position and risk of displacement.

The large number of patients achieving low CPax scores prior to discharge reflects the high number of patients repatriated to their referring centre whilst sedated and the 36% who died. The most physically able patient scored 34, which indicates that they were self-ventilating, and able to move in and from the bed with minimal support. On reflection the peak CPax score during admission would have provided better representation of patient's best ability and rehabilitation potential before any deterioration or re-sedation for transfer.

With regard to respiratory techniques in relation to the restrictive nature of many respiratory diseases requiring ECMO, ventilation parameters are set to maintain low tidal volumes and pressures as recommended by The Acute Respiratory Distress Syndrome Network (2000). Airway secretion

movement is affected by a low volume of gas flow and poor lung compliance (Volpe et al., 2008) as seen in this cohort of patients. Although optimising chest clearance is important for recovery, after the initial stage of pulmonary infiltrates, ARDS is not a productive condition, therefore a high volume of secretions is not typical (NHLBI ARDS Network, 2010).

VHI and MHI were both used in a very small capacity in the latter stages of treatment. This reflects that the use of increased pressure to improve lung volume is not often used in this group of patients and these techniques were most likely used once the restrictive ARDS pattern had resolved. It is interesting that physiotherapists in other UK ECMO centres routinely use MHI and manual techniques with patients on ECMO (National meeting of physiotherapists working in ECMO, personal communication, September 10, 2013). The reason for this difference is unclear and worthy of further investigation.

15 patients reached the ability to participate actively in treatment, and during this period, physical rehabilitation commenced which is proven to be more beneficial in improving tidal volume than breathing exercise, (Zafiropoulos et al., 2004), which may explain the small amount of deep breathing treatment.

A small number of adverse incidents were reported, all of which quickly resolved, and did not impede patients progression with treatment. It is thought that the adverse events that occurred during rehabilitation were due to the ECMO cannula affecting nodal activity in the heart, orthostatic hypotension affecting flows when positioning the patient upright, positioning of the tracheostomy whilst moving the patient, and significantly increased work of breathing during exertion. Respiratory treatment related adverse events may have been due to raising intrathoracic pressure during coughing, and loss of positive pressure and oxygenation during suctioning.

Limitations

Limitations of this study include the small number of patients, selected from within one institution. With support from a statistician, more thorough data analysis may have been performed, for example sub group analysis of patients participating in active treatment, and time to activity in relation to sedation levels and duration. The retrospective assessment of CPax was not a robust method of completing the outcome measure used.

Development

Future work should involve all five UK ECMO centres to improve sample size and to capture the variability in national practice. A consensus agreement for clinical care has been developed using the knowledge and experience of specialist physiotherapists working in the ECMO field.

Conclusion

In conclusion, patients on ECMO received a large range of physiotherapy interventions during their admission to enhance their respiratory function and physical ability. Although patients on ECMO have additional risks to treatment compared to other patients on ICU, active and intensive physiotherapy is safe and undertaken with the possible occurrence of known adverse events. This paper is informative for physiotherapists working within ECMO centres, but also provides reassurance for physiotherapists involved with continuing care following repatriation. With 55% of patients repatriated to their referring hospital it is important for Physiotherapists to understand the clinical care these patients receive whilst at an ECMO centre.

Key Points

- Patients on ECMO receive passive and active, respiratory and rehabilitation physiotherapy treatment through-out their admission
- More than 50% of patients on ECMO are repatriated to their local hospital, therefore it is important for physiotherapists working in ICU to understand the care patients receive at ECMO centres
- Patients on ECMO do experience adverse events during treatment, therefore appropriate risk assessments should be undertaken to ensure safety

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NICE scholarship: putting the patient in the centre

Personal Perspective

King C¹

The National Institute for Health and Care Excellence (NICE) is an internationally renowned guideline producing body. If somebody mentions the word “NICE” to you, it’s unlikely the first thing you think of is “patient-centred care”. This reflective piece will outline how I shifted my lens from guideline content to the individual, as part of a NICE scholarship undertaken during 2015-2016.

NICE’s scholarship and fellowship scheme is a growing network of people committed to ensuring that high-quality care is provided across the health and social care system. The lynchpin of the scholarship is the completion of a project related to NICE guidelines. I completed a project looking at whether collating guidelines into one place is useful in raising physiotherapists’ awareness of what guidelines say. The choice of project was based on a number of different factors: the barriers to guideline implementation; the time-scale and the remit of a national professional body.

In collaboration with a dedicated steering group of expert physiotherapists, and a patient and carer representative, a resource called *Inspire* was produced. *Inspire* brings together existing guidelines for physiotherapy staff who work with patients who have a cardiorespiratory condition. The resource is designed to increase physiotherapists’ awareness of guidelines relevant to people with cardiorespiratory disease. It makes the links between different guidelines including those related to cardiorespiratory disease, such as obesity and depression. *Inspire* can be accessed on the CSP website here: www.csp.org.uk/inspire

The thing that makes *Inspire* different is how the guideline content is presented. *Inspire* uses the patient story to illustrate guideline content, helping readers see what the guideline could look like in practice. The patient is so often lost in the language of guidelines, therefore putting the voice of the patient at the centre of *Inspire* emphasises how guidelines are intended to be used; as an aide to decision making, not a replacement for clinical reasoning. This focus was a result of discussions within the steering group, with the importance of patient centred care being a key theme arising from our meetings.

As with all resources *Inspire* has its limitations; only guidelines accredited by NICE were included, so there are many relevant guidelines out there that are not in *Inspire*. Also, *Inspire* is limited by the recommendations forming the guidelines. How many of the research studies that informed the recommendations included true patient involvement, as opposed to consultation only? This limits how patient-centred the resource can be, but using patient stories to illustrate guidelines helps to shift readers’ focus back to the patient.

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But a NICE scholarship is not just about the project. It provided me with a chance to gain an insight into the workings of NICE, with ample opportunity to hear the likes of David Haslam (NICE chair) and Sir Andrew Dillon (chief executive of NICE) give their views on the challenges that NICE faces, and how NICE keeps its core values at the fore of all decision making. Being able to put individual faces to an organisation as large and seemingly impenetrable as NICE has helped me appreciate the nuance behind many of their guidelines, and the direction that NICE are taking to produce guidelines that are as useful to practitioners and patients as possible.

The scholarship has helped me understand the ethos in which NICE guidelines are produced – as a way of pulling together the best available evidence, which is then used alongside clinician experience and patient preferences to jointly decide the most appropriate route forward for that individual. But it does raise questions about the type of evidence that is used to inform guidelines. If *Inspire* does not quite say what we as physiotherapists want it to, where do we go from here? It is difficult to imagine a world where we don't hear the words "more research needed", but do we need a different type of research to show the value of physiotherapy? And does our current research involve patients at the heart of its design – are we even asking the right questions? *Inspire* has generated more questions than it has answered.

The evaluation of *Inspire* should be completed by December 2016, and all members have an opportunity to provide feedback via the *Inspire* webpage. This will help the CSP decide if this type of resource would be useful for other areas of physiotherapy as well, such as neurology and musculoskeletal, so your input could help decide the future work of the CSP.

Book Review – Sandy Thomas

Cardiorespiratory Physiotherapy Adults and Paediatrics 5th Edition 2016

Authors:

Eleanor Main and Linda Denehy

Published by Elsevier

ISBN 978-0-7020-4731-2

Price £39.99 Print book/ £31.99 e-book

This textbook is the latest edition of the book previously titled 'Physiotherapy for Respiratory and Cardiac Problems' and continues to be an essential text for the respiratory physiotherapist. It provides a current, comprehensive and in depth review of evidence-based respiratory physiotherapy and is an excellent reference and definitive resource.

The book is produced by an international team of collaborators who are all experts in their particular field. Each chapter is based on a wide collection of references to both current and historical research, presented and interpreted pragmatically, using expert opinion to enable clinical reasoning even when the research itself is insufficient to provide a conclusive answer.

The book opens with a useful chapter on Respiratory Anatomy and Physiology, followed by a section on Clinical Assessment which contains some useful tables. There follows an excellent review of the pathology, clinical features and medical management of Cardiac, Cardiovascular and Respiratory diseases.

There is a very extensive chapter on the use of outcome measures in respiratory care, including exercise and functional measures as well as specific respiratory outcomes. This section uses tables to show issues of validity and reliability of each measure.

Physiotherapy interventions are discussed in some detail using over 800 references. Boxes of key points are useful where they are included as they enable the reader to extract the principles of use from the evidence of effectiveness and there are some good photographs in this section to show the application of some of these procedures. This is a very comprehensive chapter and includes, for example, oxygen therapy and musculoskeletal mobilisation techniques as well as basic respiratory procedures such as ACBT.

The chapter on optimising engagement acknowledges the problem of adherence and suggests approaches to help improve patient involvement. The chapters on Intensive Care include a wealth of information about ventilation and monitoring with separate sections for adults and paediatrics to address the significant differences between the two.

There is a detailed chapter on Upper Abdominal and Cardiothoracic Surgery for adults which discusses current research and uses tables to give an overview of the, sometimes conflicting, results and implications of these studies and enable some comparison.

The section on Physical activity and Rehabilitation recognises the increasing importance of physical activity in cardiorespiratory management. It provides principles of exercise physiology and prescription particularly related to Pulmonary and Cardiac Rehabilitation.

Finally there is a chapter that looks at special populations including 'burns', 'head injuries', 'liver disease', 'survivors of intensive care' and other current topic areas.

The overall structure of the book is logical and the writing is clear and detailed. Boxes are used for key points, and tables are really helpful for overviews and comparisons. There are great photographs and diagrams to enable the reader to visualise equipment, clinical presentations and physiotherapy assessment and treatment techniques.

This book uses medical terminology immediately and throughout which, along with the many references, may prove rather a challenge to first year students! A good knowledge of medical and physiological terms is required in order to best digest this material and it is therefore better suited to the respiratory clinician than to students or the newly qualified. Those starting out are likely to appreciate the section on 'Clinical Assessment', aspects of 'Physiotherapy interventions' (both with helpful photographs) and the chapter on 'Respiratory diseases' which includes issues of relevance to the physiotherapist - often not easy to find at the appropriate level in medical or nursing texts.

This is an invaluable addition to the respiratory physiotherapist's collection. It includes much new material and is well worth the update from previous editions in this series.

Inspiring
Excellence in
Cardio -
Respiratory
Care



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