

## Quality improvement article

## Introducing early and structured rehabilitation in critical care: A quality improvement project

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## ABSTRACT

**Objectives:** To assess the potential impact of introducing an already established and effective programme of rehabilitation within a critical care unit in a different organisation.**Design:** Fifteen-month prospective before/after quality improvement project.**Setting:** Seven-bed mixed dependency critical care unit.**Participants:** 209 patients admitted to critical care for  $\geq 4$  days.**Intervention:** A multi-faceted quality improvement project focussed on changing structure and overcoming local barriers to increase levels of rehabilitation within critical care.**Main outcome measure:** Proportion of patients mobilised within critical care, time to first mobilise and highest level of mobility achieved within critical care.**Results:** Compared to before the quality improvement project, significantly more patients mobilised within critical care (92% vs 73%,  $p = 0.003$ ). This resulted in a significant reduction in time to 1st mobilisation (2 vs 3.5 days,  $P < 0.001$ ), particularly for those patients ventilated  $\geq 4$  days (3 vs 14 days) and higher mobility scores at the point of critical care discharge (Manchester mobility score 5 vs 4,  $p = 0.019$ ).**Conclusion:** The results from this quality improvement project demonstrate the positive impact of introducing a programme of early and structured rehabilitation to a critical care unit within a different organisation. This could provide a framework for introducing similar programmes to other critical care units nationally.

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## Implications for clinical practice

- It is possible to positively change rehabilitation practice in critical care units within other organisations utilising a Quality improvement approach.
- A key first stage is the identification of barriers and working collaboratively to overcome them.
- This methodology could be replicated in other centres to aid in implementation of early and structured rehabilitation.

## Introduction

Mortality rates for patients treated in intensive care units (ICU) have decreased over the past two decades (Esteban et al., 2013; Kaukonen et al., 2014), although survivors of critical illness are often left with significant physical, psychological and cognitive

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morbidity collectively termed as post intensive care syndrome (Needham et al., 2012). The effects of post intensive care syndrome can last months to years after hospital discharge (Herridge et al., 2011), with a negative impact on employment and income in ICU survivors and their care-givers; whilst mortality and utilisation of primary care services are elevated and remain high in the immediate post-discharge period (Griffiths et al., 2013). When considering successful outcomes from critical illness, it is now acknowledged that it is no longer sufficient or appropriate to consider survival alone (Desai et al., 2011) and an increased focus has been placed on the role of rehabilitation to improve both short and long term outcomes.

Early and structured rehabilitation in critical care has been shown to be safe (Nydahl et al., 2017), with expert consensus guidelines available to guide initiation (Hodgson et al., 2014). When implemented, programmes of early mobilisation have demonstrated significant improvement in physical and clinical outcomes (Kayambu et al., 2013). Despite this point prevalence surveys suggest the practice of early rehabilitation is still uncommon (Berney et al., 2013; McWilliams et al., 2016a; Nydahl et al., 2014; Sibilla et al., 2017). The barriers to implementation of programmes of early rehabilitation are multifactorial, including factors such as a lack of leadership and ICU culture of mobility, lack of inter-professional communication, expertise and knowledge (Parry et al., 2017). Successful implementation therefore goes beyond solely increasing the dose of physiotherapy, with required interventions needing to incorporate changes in structure and culture to yield benefit (Bakhrui et al., 2016; Dubb et al., 2016).

We recently completed a successful quality improvement (QI) project demonstrating increased levels of rehabilitation within critical care to be associated with significant reductions in both ICU and hospital length of stay (McWilliams et al., 2015). Whilst a strength of this study was that it demonstrated effectiveness in a large tertiary centre within an existing healthcare system, it was unclear whether the intervention would be reproducible in other smaller centres limiting the external validity of these findings.

### Objective

We aimed to assess the potential of introducing an already established and effective programme of early and structured rehabilitation into a critical care unit in a smaller organisation with a different patient cohort.

## Methods

### Study design

This multi-faceted quality improvement project was completed over a fifteen-month period using a prospective before and after design. This consisted of a 3 month baseline pre QI and 12 month QI period.

### Setting

A district general hospital within an acute NHS Trust in the midlands, comprising a 7 bedded mixed dependency critical care unit for medical and surgical patients. Prior to the quality improvement process, physiotherapy staffing was provided at a ratio of approximately 1 physiotherapist to 7 patients. No dedicated physiotherapist was provided, with input provided from a team which also covered general surgical wards. Patients were assessed daily by the physiotherapy team, with treatment sessions lasting approximately 30 min per patient. Physiotherapy was provided at a ratio

of 1 physiotherapist to 7 patients, between the hours of 8.30am and 4.30 pm from Monday to Friday, with only emergency on call provision available outside of these hours. Weekend provision was delivered by a significantly reduced service focussed on respiratory care only, with limited rehabilitation delivered. Regardless of day of admission all patients were assessed by a physiotherapist within 24 h, with ongoing treatment delivered daily on an individualised basis. Initiation of rehabilitation and mobilisation was led by the physiotherapists, although no set structure or format for rehabilitation delivery was in place. In terms of other members of the healthcare team, nursing staffing was at a ratio of 1:1 for ICU (level 3) patients and 1:2 for High Dependency Unit (level 2) patients. Medical consultant staffing was at a ratio of 1:7.

### Participants

Patients admitted to critical care with a length of stay of  $\geq 4$  days and discharged to the ward were included in the evaluation. This figure was chosen in order to exclude those with shorter stays and likely faster trajectories of recovery, whilst evaluating the impact of those patients hypothesised to benefit the most from increased rehabilitation. Baseline data were collected for a period of 3 months from 1st December 2016 until 28th February 2017 to confirm current practice. This was followed by a 12 month analysis of the QI period from 1st March 2017 – 28th February 2018. Patients were excluded if they had a profound neurological deficit (defined as unlikely to return to a Glasgow Coma Score of at least 14), an orthopaedic injury with contraindications to mobilise (e.g. pelvic fracture or spinal injury), were unable to mobilise at least 10 meters prior to admission (with or without an aid) or had pre-existing neuromuscular disease.

### Quality improvement process

For this evaluation we repeated the quality improvement process used in a previously published successful project (McWilliams et al., 2015), specifically the 4 E's model (Pronovost et al., 2008) of quality improvement (Engage, Educate, Execute and Evaluate). This process was led by an expert physiotherapist from the original quality improvement project, in conjunction with a Consultant physician at the external centre who was keen to review and attempt to improve the rehabilitation service they provided. In order to 'engage' with the external organisation at the start of the quality improvement process a meeting was held with identified key stakeholder groups including critical care consultants, nurse leads and the physiotherapy team. The purpose of these meetings was to identify perceived barriers and potential solutions to support the delivery of early and structured rehabilitation. Through this process a number of potentially reversible barriers were identified, resolutions to which and a comparison to those seen in the original quality improvement project are shown in Table 1. In order to support 'education' and 'execution' of the project the expert physiotherapist worked directly with the home team for a period of one month, with ongoing telephone support and monthly visits throughout the evaluation period.

Allocation of physiotherapy resources were reviewed to allow the creation of a dedicated physiotherapist for critical care, supported by nursing champions for rehabilitation. A structured approach to rehabilitation was then introduced modelled on that previously used (McWilliams et al., 2015). The structured approach consisted of comprehensive baseline assessments, identification of a named physiotherapy key worker, weekly goals setting and individualised rehabilitation plans displayed in the patients bed space. This was also supported through weekly MDT meetings attended by physiotherapist, senior medical and nursing staff. Training sessions for all staff were initially led by the expert physiotherapist

**Table 1**  
Barriers to early mobilisation encountered and resolutions.

Barrier	Resolutions	
	Original QIP (McWilliams et al., 2015)	District general Critical Care unit under evaluation
Lack of Leadership	Creation of interdisciplinary champions for rehabilitation and new clinical specialist physiotherapist appointed to lead project	Creation of rehabilitation champions with a physiotherapy leader and named Consultant physician for support
Lack of knowledge and training	Education from clinical specialist physiotherapist to staff Rehabilitation added to nursing new starter and rolling education programme	Expert physiotherapist provided direct training to physiotherapy team and MDT for 2 weeks at start of project Ongoing training provided by champions across disciplines
Lack of Communication	Creation of weekly therapy rehabilitation meetings Weekly MDT rehabilitation ward round	Creation of weekly therapy rehabilitation meetings Weekly MDT rehabilitation ward round
Insufficient staffing	Treatment plans and progress record displayed in patients bed space on whiteboards	Treatment plans and progress record displayed in patients bed space on whiteboards Development of pre existing rehabilitation pathway document
Safety concerns	Charity funding for QI project to create specialist critical care rehabilitation team	Reorganisation of existing staffing resources to dedicate more physiotherapy time within critical care
Lack of equipment	Mobility protocol created with criteria for commencement and progression of rehabilitation New supportive seating options purchased Portable ventilator purchased to allow more active mobilisation	Adoption of mobility protocol used in previous QIP Greater utilisation of existing therapy equipment

and then continued by the dedicated physiotherapist throughout the study period. Primary outcome was a positive change in culture to support rehabilitation, evaluated using measures of rehabilitation practice. Specific parameters measured were the proportion of patients actively mobilised in critical care (defined as a Manchester mobility score  $\geq 2$ ), time taken to first mobilise and the highest level of mobility achieved prior to discharge from critical care to the ward.

#### Data collection

Data were collected prospectively throughout the evaluation period using patient noted and electronic databases. Baseline data including demographics, reason for admission and illness severity scores (APACHE II) were obtained from recorded ICNARC data. This database was also used to obtain data regarding ventilation days, length of stay for both ICU and the ward, and mortality. Physiotherapy activity including time taken to first mobilise and overall level of mobility achieved were collected using the Manchester mobility score (MMS) (McWilliams et al., 2016b).

#### Data analysis

Ordinal and continuous variables were compared between arms using Mann-Whitney tests. Data were summarised as either medians with interquartile ranges (IQRs). Nominal variables were compared between arms using Fisher's exact tests. All analyses were performed using IBM SPSS 22 (IBM Corp. Armonk, NY) and  $p < 0.05$  was deemed to be indicative of statistical significance throughout.

#### Ethical considerations

This project constituted an improvement in standard care delivery with no randomization and thus met the definition of a service evaluation under the NHS Health research authority guidelines [NHSHRA, 2016]. As such, ethical approval was not required, and because all outcome measures are collected as part of routine care, the need for consent was waived. This QI project was reported in accordance with the Standards for Quality Improvement Reporting Excellence (SQUIRE) guidelines (Ogrinc et al., 2015). This service improvement did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Results

All eligible patients were included in the project representing a sample size of 47 in the baseline period and 162 during the QI period. Baseline data are provided in Table 2, with no significant differences seen between groups. After the introduction of the QI project (see Table 3) there was a significant increase in the proportion of patients mobilised within ICU (92% vs 73%,  $p = 0.003$ ). Patients were also mobilised significantly earlier (2 vs 3.5 days,  $p = 0.001$ ) and achieved a higher level of mobility at the point of critical care discharge (MMS 5 vs 4,  $p = 0.019$ ). When assessed on a quarterly basis, the improvements seen were immediate and maintained throughout the evaluation period (see Fig. 1). No significant differences were observed in any of the clinical outcomes assessed. A sub group analysis of those patients ventilated for  $\geq 4$  days demonstrated a much larger reduction in time to first mobilise by a median of 11 days (see Table 4).

## Discussion

This study has demonstrated the feasibility of replicating a previously published QI project in a critical care unit within a different organisation. The quality improvement process was effective at improving rehabilitation delivery within critical care, with patients mobilising earlier, more consistently and achieving higher levels of mobility at the point of critical care discharge. This was particularly the case with those patients ventilated for  $\geq 4$  days. This change was achieved through the implementation of a more structured approach to rehabilitation coupled with a positive change to unit culture, without any additional funding.

A number of barriers have been identified to implementation of early mobility within critical care, including a lack of equipment, insufficient staffing, concerns regarding patient and caregiver

**Table 2**  
Patients admitted to critical care for  $\geq 4$  days.

	Baseline (n = 47)	QI period (n = 162)	p
Age	71 (56.75–77)	68 (58.75–77.25)	0.757
Gender Male/Female	28 (60%)	90 (56%)	0.739
APACHE II	18.5 (15.75–22.25)	19 (16–24)	0.535
APACHE Mortality	28.1 (11.3–43.2)	26.1 (18.2–44.4)	0.795
ICU Mortality	7 (15%)	26 (16%)	1.000

Data are reported as median (IQR), with p-values from Mann-Whitney tests, or as N (Column %), with p-values from Fisher's exact tests, unless stated otherwise.

**Table 3**  
Outcomes.

	Baseline (n = 40)	Q1 period (n = 136)	
Mobilised in ICU	29 (73%)	125 (92%)	0.003 <sup>*</sup>
Time to mobilise	3.5 (2.75–7.25)	2 (1–3)	0.001 <sup>*</sup>
MMS at ICU discharge	4 (1–5)	5 (3.25–5)	0.019 <sup>*</sup>
ICU Length of stay	6 (4–11.25)	6 (4–8)	0.646
Ventilation days	2 (0–6)	0.5 (0–4)	0.298
Hospital Length of stay	16.5 (10–37.5)	15 (10–29.5)	0.430
Ward Mortality	6 (15%)	15 (11%)	0.579

Data are reported as median (IQR), with p-values from Mann-Whitney tests, or as N (Column %), with p-values from Fisher's exact tests, unless stated otherwise. Bold p-values are significant at  $p < 0.05$ .

<sup>\*</sup> p-Value from a Mann-Whitney test on the untransformed factor.

**Table 4**  
Sub group analysis for patient ventilated  $\geq 4$  days.

	Baseline (n = 15)	Q1 period (n = 35)
Mobilised in ICU	10 (67%)	32 (91%)
Time to mobilise	14 (9.25–15)	3 (1–7)
MMS at ICU discharge	3 (1–4.5)	4 (2–5)
ICU Length of stay	13 (8–26.5)	11 (8–20)
Ventilation days	9 (5.5–14)	7 (5–10.5)
Hospital Length of stay	42 (31–76.5)	37.5 (27–59.25)
Ward Mortality	6 (15%)	15 (11%)

Data are reported as median (IQR), or as N (Column %).

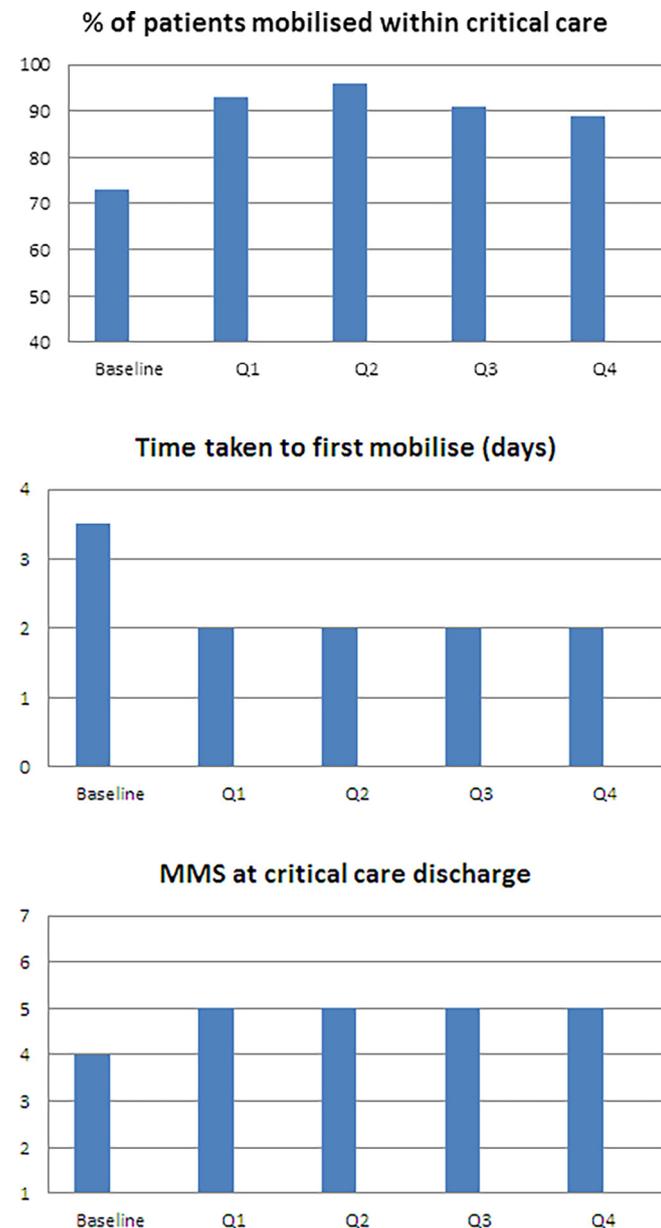


Fig. 1. Rehabilitation outcomes per quarter.

safety, and competing priorities (Dubb et al., 2016). In ICUs without early mobilisation adoption, 78% had considered implementation but cited barriers including competing priorities and the need for further planning (Bakhrui et al., 2016). What is now clear is that

implementation, whether through trials or quality improvement projects, must account for more than just ICU staffing and practice patterns for success. Increasing the dose or frequency of physiotherapy has shown to be of some benefit (Denehy et al., 2013; Wright et al., 2017) but building on the work of previous quality improvement projects (McWilliams et al., 2015), our aim was to identify barriers and methods to overcome them as a key component to improving the delivery of early rehabilitation goals. Potential confounding variables such as pre-existing rehabilitation culture or patient case mix may have impacted on the results seen (Connolly & Denehy, 2018). This highlights the key importance of having direct measurable components for both the structure and individual delivery of rehabilitation practice. For example, identifying the overall proportion of active mobility sessions or highest level of mobility achieved allows identification of changes in the content rather than simply the duration rehabilitation provided. Furthermore, by reporting measures such as goals being both set and regularly reviewed help to identify changes at a structural level.

### Limitations

There are a number of limitations to this study. Firstly, the lack of randomisation and blinding to study outcomes means the results may have been attributable to measurement bias. By nature of utilising a before and after design any improvements seen may have been the result of temporal changes rather than directly attributable to the QI itself. However, there were no other major QI projects or service developments introduced during the study period, and consultant medical and senior nurse staffing were consistent. The use of only 3 months of baseline data may also have introduced the possibility of seasonal differences affecting results, and the presentation of quarterly data prevents the creation of a statistical process control (SPC) chart to allow further analysis regarding changes over time. Additionally the purpose of the study was not to test the efficacy of the included interventions, the safety and effectiveness of which have been demonstrated previously (McWilliams et al., 2015), but instead to implement a QI project to see if changes in rehabilitation practice could be facilitated. Whilst this was achieved, the multifaceted approach used within the QI process makes it impossible to determine which specific components were effective in fostering this change and would warrant further investigation.

### Conclusion

We have demonstrated the positive impact of a multifaceted QI project to improve levels of rehabilitation in a critical care unit within a different organisation. The findings of this study may help to provide a framework for implementation of similar programmes in other units. Future research should evaluate the effectiveness of this programme on long term outcomes and evaluate implementation across a wider range of critical care units.

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The authors have no sources of funding to declare.

## Conflict of interest statement

The authors have no conflict of interest to declare.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.iccn.2019.04.006>.

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