

The role and staffing of physiotherapy in critical care: a scoping review

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Abstract

Introduction

Physiotherapy services are provided to critical care units across the U.K. and internationally. U.K. guidance documents highlight potential physiotherapy roles and recommended staffing levels. However, this guidance is based on limited evidence and this scoping review was needed to inform workforce planning and future recommendations.

Objectives

The objectives of this scoping review were to:

- Map the volume and nature of evidence in relation to physiotherapy in critical care.
- Describe the role of physiotherapy within critical care.
- Describe recommended physiotherapy staffing ratios in critical care.

Methods

Available literature between January 2009–December 2021 was searched utilising relevant databases. Studies focusing on the role of physiotherapy or physiotherapy staffing levels were included. Data extraction and appraisal was performed using relevant Joanna Briggs Institute proformas.

Results

A total of 1121 titles were screened, with 22 full text papers reviewed. Studies were commonly based in South Africa and United States of America and were survey based ($n = 16, 72\%$). Literature available to define the role of physiotherapy in critical care was limited, which was further complicated by variation of practice across countries.

Variability was observed for existing physiotherapy staffing levels ranging from 1:4 to 1:50 critical care beds.

Discussion

Based on our findings, there is limited evidence to define the role of physiotherapy within critical care, with widespread variation in existing staffing levels. Further research is required to define the role of physiotherapy in critical care and identify appropriate staffing levels in the U.K., including a focus on patient outcomes.

Introduction

The National Guidelines for the Provision of Intensive Care Services (GPICS v2) (1) identify physiotherapy as one of the principle and most consistent therapy services for critical care. Historically, the aim of physiotherapy was to maintain bronchial hygiene for people who were intubated (2), and while this remains a key area, the focus is now towards early rehabilitation and on physical recovery (3, 4, 5).

GPICS (1) recommends that across the U.K., there should be access to, and provision of, for patients in critical care 24 hours a day, seven days per week (1) and may be achieved through the provision of out-of-hours or on-call services and weekend working. Additionally, GPICS recommend physiotherapist to patient ratios of one physiotherapist to every four patients (1). Furthermore, it suggests possible roles to be undertaken by physiotherapists working in critical care, including providing assessment and intervention for a range of acute and chronic respiratory pathologies, promoting early mobilisation and preventing deconditioning during periods of acute illness, in addition to providing specialist rehabilitation following critical illness or severe injury (1).

Whilst these guidelines have been invaluable in advising service standards, audit and future planning, there is limited evidence to either support or counter the recommendations made. Several authors have explored the minimum standards of clinical practice required within critical care (6, 7, 8). These studies identified the key assessment and treatment skills and knowledge required to work as a physiotherapist within critical care. Within the U.K., 107 items were deemed essential as a minimum standard of clinical practice and concluded that the findings may support training programmes in both higher education and the health service, to reduce variability in clinical practice (7). However, given the 'minimum standards' criteria of previous literature, these are unlikely to fully reflect the role of physiotherapy in critical care, nor do they allow guidance of required staffing numbers or structures.

There is a clear need for the role of physiotherapy within critical care to be better defined, both within the U.K. and internationally.

Based on the above, the objectives of this scoping review were to:

- 1 Map the volume and nature of evidence in relation to physiotherapy in critical care.
- 2 Describe the role of physiotherapy within critical care.
- 3 Describe recommended physiotherapy staffing ratios in critical care.

Methods

Review objectives and questions

The *population, concept and context* approach (9) was used to develop the search strategy, with the following criteria:

Objective

To identify the roles and required staffing for physiotherapy services within critical care.

Review questions

- 1 What is the role of physiotherapy within critical care?
- 2 What quantity of physiotherapy staffing is required within critical care?

Population

Physiotherapists and physiotherapy services within critical care units.

Concept

Literature that broadly describes either the role of the physiotherapist or makes recommendations on required staffing levels, including any attempt to increase physiotherapy staffing or involvement.

Context

All adult critical care units, including tertiary services, in any nation.

Eligibility criteria

Articles focused on adult critical care units, available in English language and published during or after 2009 were included. The review period was based on the publication of guidelines for rehabilitation after critical illness (3). All relevant clinical articles were included, and expert opinion papers, clinical guidelines and surveys were also eligible for inclusion. For systematic reviews, relevant research papers were extracted and added to the existing search titles following the same inclusion criteria. To ensure focus on roles and staffing, studies that investigated the effectiveness of physiotherapy interventions in critical care was excluded as were papers focusing on the interventions for single pathologies including COVID-19.

Search strategy

Searches were completed using MEDLINE, CINAHL, Cochrane Library and PEDro (Physiotherapy Evidence Database) databases for articles published from 1st January 2009–31st December 2021. The following terms were used: ‘intensive care unit’ or ‘critical care’ and

‘physical therapy’ or ‘physiotherapy’ or ‘physiotherapist’ or ‘mobilisation’ or ‘walking’ or ‘early ambulation’ or ‘therapeutic exercise’ or ‘rehabilitation’.

Types of study

All forms of study designs were eligible, including cohort observational studies (both prospective and retrospective), case control studies and opinion pieces. Additionally, service improvement projects and audits were included if available in full text.

Eligibility process

All titles identified were combined and duplicates removed. Titles and subsequently abstracts were reviewed by two of the research team, with any disagreements over inclusion discussed. Where consensus was not reached, a third researcher was utilised. Full text copies were obtained for the included articles, with those not freely available requested from the author through direct contact.

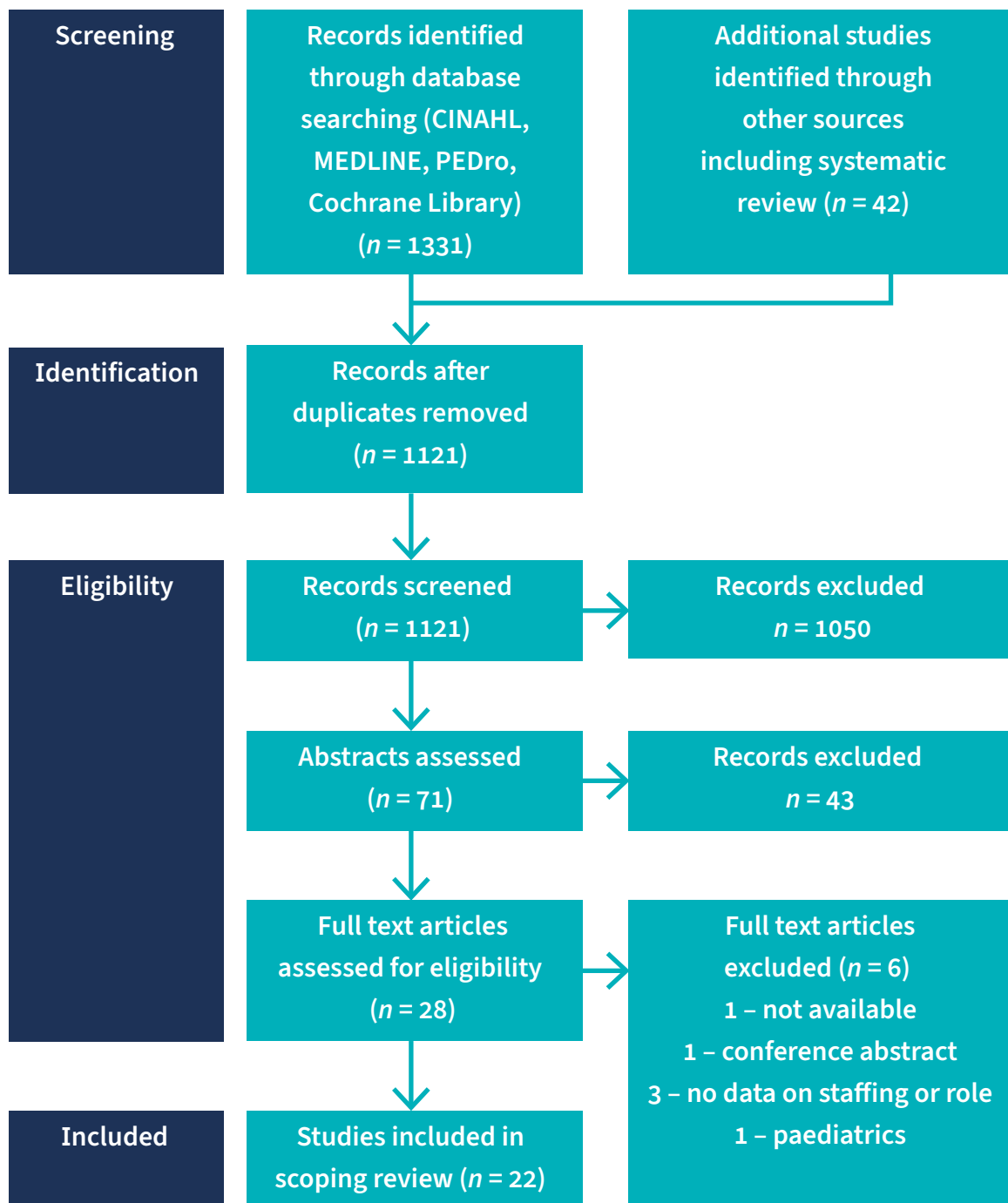
Data extraction and appraisal

Data extraction was performed using Joanna Briggs Institute (JBI) proformas relevant to each article (10). Extraction was completed by one member of the research team and checked for accuracy by another. Once data extraction was completed, only those deemed relevant to the objectives of the scoping review were critically appraised using the JBI methodology (9). Due to the widespread variation in research methodologies, participants and outcomes, a descriptive summary was completed.

Results

Searches performed

Initial searches identified 1331 articles published between January 2009–December 2021, reducing to 1099 after removal of duplicates. One systematic review was identified consisting of 85 primary papers, of which 43 were published prior to 2009 and a further 21 already included in the original searches. Therefore, a total of 1121 titles underwent review, of which 71 proceeded to abstract review and 28 full text papers were generated. Of these, six were excluded prior to critical appraisal (see Figure 1). Articles were most frequently excluded where they did not focus on either the role or recommended staffing for physiotherapists in critical care.



📍 **Figure 1: Search and eligibility flowchart.**

Data extraction

A detailed overview of data extracted for both the role of physiotherapy in critical care and physiotherapy staffing is provided in Appendices 1 and 2.

Quality of research

The quality of all the studies were assessed using JBI proformas. No randomised control trials or control trials were included, with the majority ($n = 16$) being survey-based studies. All the included studies had a clear rationale for completion. However, while some had clear research aims and explanations of methods, they frequently reported very low response

rates (often <30%). The minimum standards studies in the U.K. (7) and Australia (6) recorded higher response rates (65% and 90% respectively) but this was achieved through targeted invitation and regular follow-up.

Surveys from two of the articles (11, 12) were completed by either nursing or medical staff members, with no input from physiotherapy staff and therefore generated a lack of clarity of roles and responsibilities. Additionally, three studies (13, 14) used scenario-based questions to review role and responsibilities, however the reviewers (Paul Twose, Vicky Newey and Una Jones) perceived that due to differences in practice across the world with regards to referral criteria and interventions, the results lacked generalisability to other nations or U.K. practice.

Of the non-survey-based studies, two utilised focus groups (8, 15), both of which had clear objectives and methodologies. Additionally, both utilised an appropriately sized and selected sample to ensure congruity between the research question and the results reported. Neither study reflected on the role of the researcher within the method and data analysis however, this was not felt to influence the rigour of the studies.

Sommers et al (16) utilised available evidence in making guidelines for 3 consensus topics for physiotherapy in critical care. There was a clear link between the recommendations made and the available evidence including a detailed approach to systematic review.

Of the remaining studies, 2 followed appropriate methodologies for the completion of a service evaluation (17) and quality improvement project (18). Both had appropriately detailed interventions and clarity regarding the use of routinely collected data. Additionally, the methodologies provide sufficient clarity to allow the studies to be reproduced in other health care settings. Conversely, the discussion by Pawlik (19) lacked some clarity on its purpose and its approach to gathering relevant evidence, and hence appears based on the author opinion and experience.

Summary of findings

Population and country of study

Participants included physical therapists, physiotherapists, and critical care directors (medical staff) with experience ranging from three months to greater than 20 years. By country, most of the publications originated from South Africa ($n = 5, 21.7\%$) (8, 15, 20, 21, 22) or U.S.A. ($n = 4, 17.4\%$) (13, 18, 19, 23).

Study methodology

The 22 included studies were predominantly survey based ($n = 16, 72.7\%$) with only two U.K. based studies (17, 19). Studies utilised a variety of distribution options, including circulation via membership groups (7, 13, 23, 24), direct contact in local hospitals and health establishments (6, 8, 12, 14, 15, 16, 20, 22, 25, 26, 27, 28, 29) or via senior medical clinicians (11, 19, 30).

The non-survey based studies were a mixture of focus group studies ($n = 2$) (8, 15), consensus guidelines ($n = 1$), a discussion paper ($n = 1$) (19), service evaluation ($n = 1$) (17), and quality improvement ($n = 1$) (18). Of these papers, none were U.K.-based.

Study findings

A detailed summary of the study findings can be found in Table 1.

Role of physiotherapy in critical care

The predominant themes from the studies were the role of physiotherapist in the provision of respiratory based interventions. These include management of a range of presentations including atelectasis, pneumonia and acute respiratory distress syndrome (25), and specific respiratory focused physiotherapy interventions, for example, airway clearance techniques and manual hyperventilation (12, 20, 26). Studies also discussed the role (or lack thereof) of physiotherapists in the adjustment of ventilator settings, weaning decisions and readiness for extubation (17, 22, 24). The studies focusing on the minimum standards of clinical practice identified broader roles for physiotherapists including the delivery of rehabilitation and the importance of physiotherapists working as part of the multi-disciplinary team (6, 7, 8, 15). Only Summers et al (30) focused purely on early mobilisation and based on a consensus process, developed protocols for treating patients in critical care.

Physiotherapy staffing in critical care

The studies reviewing physiotherapy staffing levels had significant variations in findings. Physiotherapy to patient ratios were reported between one physiotherapist to four patients (26), increasing to 1:50 (12). This variation occurred across counties but also within nations particularly between urban and rural settings, and different hospital settings for example, private versus public (22). There was also variation in the presence of physiotherapists within critical care with authors reporting only 11–40% of critical care units having physiotherapy presence daily (29). None of the studies attempted to suggest appropriate physiotherapy staffing but more reported on existing levels. Additionally, none of the studies discussed U.K.-based physiotherapy staffing levels.

Discussion

This scoping review, to the authors' knowledge, is the first of its kind to review the evidence base for both the role and staffing levels for physiotherapy in critical care. However, based on the articles identified, it is not possible to form clear recommendations. The methodological quality and nature of studies reviewed mean that findings are not generalisable to physiotherapy practice across countries. The studies found were geographically dispersed across Africa, Europe, U.S.A., and Asia, further limiting generalisability to the U.K. This is particularly pertinent given the known variability in physiotherapy job titles and roles for example, physiotherapist, respiratory therapist, and physical therapist.

Role of physiotherapy in critical care

The role of physiotherapy in critical care is not clearly defined based on the evidence available in this scoping review. There is evidence that physiotherapists are involved in both respiratory management for example, airway clearance, positioning and delivery of on-call services, and a role within rehabilitation within the critical care. However, as most of the included studies had different aims and objectives, it is difficult to generalise the findings and hence define the role. Three studies reported on the minimum standards of practice for physiotherapists in critical care (6, 7, 8). Whilst these papers identified clear skills and knowledge required to work in critical care; these focus on the minimum level required by individuals rather than the overall responsibilities of a physiotherapy service. Furthermore, they are yet to be evaluated to determine the impact of defining these minimum standards on clinical practice or training programmes.

However, this scoping review has highlighted the presence of physiotherapists within critical care units internationally. Whilst the roles may differ from country to country, some fundamentals remain for example, combining both respiratory interventions and rehabilitation. There also appears to be greater similarity in the role of physiotherapy in particular countries, namely the U.K. (7), Australia (6), and South Africa (8, 20).

Physiotherapy staffing in critical care

Based on this scoping exercise, there is widespread variability in physiotherapy staffing within critical care, and the international nature of the studies included make recommendations challenging.

GPICS v2 (1) suggests a physiotherapist to patient ratio of 1:4 within U.K. critical care units, however it is relatively unknown if units are compliant with this suggestion. In 2016 the Critical Care Network National Nurse Leads (CC3N) (4) identified that many critical care units had limited access to AHPs although specific physiotherapy to patient ratios were not recorded (31).

Within this scoping exercise, international staffing ratios were reported in four studies, ranging from one physiotherapist to four beds (1:4) in Jordan (26) to 1:50 in Greece (12); with a theme of increased physiotherapists in the larger cities with teaching/academic hospitals compared to more rural areas (22). Barriers to perceived low staffing numbers included funding, lack of formal training, lack of role understanding and prioritisation of the service need (12, 26). Service provision varied as to whether physiotherapists were present on the unit only on weekdays or had an on-call service. Turkman et al (29) reported the complete absence of physiotherapy on-call services in Turkey versus 90% of respondents in Sri Lanka reporting the presence of an on-call service, of which 28% had overnight residence (25).

There was also variable reporting of static staff who were solely critical care based or those whose remit covered other clinical areas (24). Formal training and specific post qualification critical care training was difficult to clearly define with one study reporting a clear need for further formal training in respiratory physiotherapy (11).

Of the studies included, none were U.K.-based and therefore no assumptions can be made for the current U.K. physiotherapy workforce within critical care. As such it is not possible to generate any theories for appropriate workforce models beyond the recommendations of GPICS.

Limitations of scoping review

This scoping review utilised transparent methods throughout the entire process, ensuring a broad search of the literature. Eligibility of studies was ensured through a step-based approach to review, with all titles and abstracts being independently assessed by two researchers. Additionally, data extraction and appraisals adhered to JBI recommendations, with additional reviews completed by each researcher. The review was limited to 2009 onwards to reflect the timing of the publication of the guidelines for rehabilitation after critical illness and a likely shift in physiotherapy interventions towards delivery of rehabilitation.

As with all scoping reviews, there is the potential that not all available literature will have been captured, as well as some papers not being available to the research team at point of data extraction and appraisal. Specific papers known to the researchers, but not identified in the literature searches, were included at title eligibility phase. There are possible reasons for papers not being identified in the searches including specific journals not being included within databases or may reflect the search terms initially identified for use not capturing all aspects of physiotherapy practice within critical care. No new literature was included after this point.

Further research

Future research is needed to explore the role of physiotherapists working within critical care in the U.K. and to define the required physiotherapy staffing levels, as well as determine the impact of physiotherapy within the critical care environment. This will support future guidelines and service planning to ensure a value-based approach to physiotherapy provision and a focus on improving patient outcomes.

Conclusion

Based on this scoping exercise, there is currently a limited evidence base to support both physiotherapy staffing recommendations and role definition. Existing literature is often methodologically flawed in terms of responder bias and insufficient response rates. Furthermore, most of the available literature is based in healthcare systems outside of the

U.K. However, throughout the literature there is clear evidence of physiotherapy involvement within critical care services, including the provision of on-call services. Furthermore, this scoping review has highlighted the increasing focus on delivering evidence-based practice and recognises the need for further research to provide greater role definition and to explore the impact of physiotherapy involvement.

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Conflict of interest

None of the authors have any declarations of conflict of interest.

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Appendix 1: Data extraction for role of physiotherapy in critical care.

Author, country	Aims	Methodology	Participants/outcomes	Results
Baidya et al, 2016 (14), Nepal	To identify the availability of physiotherapy services in ICU and articulate the common practices by physiotherapists in ICUs of Nepal.	Survey	52 physiotherapists from range of hospital types (government, semi-government and private hospitals). Survey consisted of a series of six scenarios of mechanically ventilated patients commonly encountered in the ICU. Questions related to likelihood of review, number of days a week, frequency of treatment, and treatment types.	Physiotherapy services to patients in ICU were provided after physician consultation in 68% of cases. Few hospitals had established criteria (13%). Likelihood of routine physiotherapy input varied with each clinical scenario – stroke most likely to receive physiotherapy whereas myocardial infarction was least likely. Most preferred physiotherapy treatment was chest physiotherapy (53.8%), with limited use of exercise therapy. Limited weekend physiotherapy input was recorded.
Cakmak et al, 2019 (25), Turkey	<p>To:</p> <ul style="list-style-type: none"> Identify the characteristics of physiotherapy practice. Determine barriers toward applying physiotherapy in ICUs in Turkey. 	Survey	65 physiotherapists completed a 54-item survey determining the characteristics of physiotherapists and physiotherapy applications within ICU.	Main reasons for referral to physiotherapy were atelectasis (81.5%), pneumonia/lung infection (80%), acute respiratory failure (73.5%), post-operative cardiovascular surgery (62.5%), and chronic obstructive pulmonary disease-acute exacerbation (60%). Positioning (90.8%), active range of motion exercises (90.8%), breathing exercises (89.2%), passive range of motion exercises (87.7%), percussion (87.7%), mobilization (86.2%), vibration (86.2%), and postural drainage (86.2%) were the most used physiotherapy applications in the ICU.

Author, country	Aims	Method-ology	Participants/outcomes	Results
Cork et al, 2019 (17), U.K.	To determine whether, following an assessment of extubation suitability, physiotherapists could correctly predict the extubation outcome of intubated adults in the ICU.	Service evaluation	61 patients from single site ICU in London, U.K. Included all patients undergoing planned extubation who had a physiotherapy review. Primary outcome was extubation success.	Results for all physiotherapists demonstrated 40% sensitivity and 86% specificity, whereas specialised physiotherapists showed 100% sensitivity and 68 specificity.
Christakou et al, 2018 (24), Greece	To investigate the responsibilities and frequency of clinical procedures that physiotherapists perform within the intensive care unit in Greece, alongside the level of education and training of those physiotherapists.	Survey	140 respondents with a minimum of three months of working experience within a hospital ICU in Greece, recruited from Greek ICU Society's database. Survey consisted of 83 closed and open-ended short form questions. Collected data about hospital, involvement in care, clinical procedures, weaning procedures.	Most frequent respiratory care intervention was suctioning following respiratory care (62.9%). Limited involvement in adjustment of ventilator settings (84.3% never) or weaning (45.7% never). 40% never involved in evaluating method of functional ability, but 9.3% often involved in mobilising on ventilator.
Grammatopoulou et al, 2017 (12), Greece	To determine the scope of physiotherapy services provided in Greek ICUs in Athens.	Survey	103 physiotherapists working in ICUs in Athens completed a three-item survey based on the findings of the ESICM task force on physiotherapy for critically ill patients. 19 ICU directors also completed eight-item questionnaire related to the nature of the ICU and its functioning. What were the questions about?	100% of physiotherapists reported using airway clearance techniques and 33% involved in intubation procedures. 100% of physiotherapists provide active and passive exercise, and 65% involved in bed-to-chair transfers.
Hodgin et al, 2009 (13), U.S.A.	To determine the utilisation of inpatient physical therapy for patients recovering from critical illness.	Survey	482 physical therapy members of the APTA completed survey consisting of 6 different ICU patient scenarios that may require physical therapy input.	Physical therapy most likely to be routinely involved where primary pathology is either neurological or trauma. Therapeutic exercise and functional mobility retraining most likely to be utilised.

Author, country	Aims	Methodology	Participants/outcomes	Results
Lottering et al, 2016 (20), South Africa	<p>To conduct a nationwide survey to:</p> <ul style="list-style-type: none"> Determine the current practice of physiotherapists in SA ICUs. Determine if physiotherapists' practice in ICUs had changed since the previous report. Validate the survey questionnaire. <p>In addition, SA physiotherapists' practice in ICU was compared with that reported in critical care and rehabilitation literature, to determine if current practice is evidence based.</p>	Survey	<p>108 participants completed the questionnaire.</p> <p>The questionnaire included demographics, ICU type, patient referral method, after-hours service provision, assessment and treatment techniques used in patient management, participation in inter-professional team meetings and professional development activities.</p>	<p>56% ($n = 60$) of respondents attended ward rounds in the ICU on a daily or weekly basis.</p> <p>Respondents were involved with the in-service training of colleagues, such as training junior physiotherapists to work safely in the ICU ($n = 51$, 47%). Treatment modalities performed 'very often' included manual chest clearance, mobilisation, and deep breathing exercises.</p>

Author, country	Aims	Methodology	Participants/outcomes	Results
Malone et al, 2015 (23), U.S.A.	National survey to determine the current status of physical therapists' practice in the ICU.	Survey	667 physical therapists from the acute care section of APTA, completed a two-part questionnaire. Section one of survey explored demographics of hospital/ICU; staffing patterns; training; self-confidence in working on ITU; consultation and treatment guidelines; barriers to providing rehabilitation. Section two of the questionnaire investigated perceptions of rehabilitation practice related to five scenarios.	For the case studies, physical therapy was less likely for patients with more complex medical conditions and the prescribed frequency was decreased as complexity increased.
Morar et al, 2016 (22), South Africa	To determine the extent of physiotherapists' involvement in weaning and extubation of patients from mechanical ventilation and whether current practice is evidence based.	Survey	425 respondents from intensive care units across SA. Questionnaire explored ventilator weaning and physiotherapy modalities used to support weaning.	Majority (approximately 80%) of respondents 'never' adjusted ventilator settings related to ventilator mode, respiratory rate, inspiratory pressure etc. 73% never or seldom involved in decision to start weaning and 61% not involved in extubation decisions. For physiotherapy modalities exercise, early mobilisation out of bed (77%), and deep breathing exercises (77%) were most utilised.

Author, country	Aims	Methodology	Participants/outcomes	Results
Pawlik et al, 2013 (19), U.S.A.	To explore issues that physical therapy profession needs to address as the rehabilitation management of the patient with critical illness evolves.	Discussion	Discussion by physical therapist and medical doctor aimed to investigate the issues that the physical therapy profession need to address as the rehabilitation management of the patient with critical illness evolves.	Key themes identified as: <ul style="list-style-type: none"> • <i>Competence</i>: academic preparation of physical therapists and role of specialist versus junior staff members. • <i>Resources</i>: physical therapists should be integral members of the critical care team. • <i>Prioritisation</i>: treatment needs to be at optimal time to aid recovery and timely discharge. • <i>Outcome measures</i>: FIM to assess both physical and cognitive disability. Other outcome measures include PFIT and MRC. • Input across the continuum.
Plani et al, 2017 (15), South Africa	Explore the perceptions of physiotherapists on the minimum clinical standards that's physiotherapists working in ICU should adhere to for delivering safe and effective services to critically ill patients.	Focus groups	25 physiotherapists working within ICUs involved in three focus groups. Three domains were explored: <ol style="list-style-type: none"> 1 Knowledge. 2 Skill. 3 Attributes. 	66 concepts (54% knowledge, 35% skills; 10% attributes). Consensus reached on only six concepts. Three overarching themes: <ol style="list-style-type: none"> 1 Integrated medical knowledge. 2 MDT teamwork. 3 Physiotherapy practice.

Author, country	Aims	Methodology	Participants/outcomes	Results
Sigera et al, 2016 (26), Sri Lanka	<p>To determine:</p> <ol style="list-style-type: none"> 1 The availability of critical care physical therapist services. 2 The equipment and techniques used and needed. 3 The training and continuous professional development of physical therapists. 	Survey	213 physical therapists in Sri Lanka completed an interviewer-administered questionnaire. Questions focused on experience of staff, distribution of physical therapists, work patterns and availability of 24-hour physical therapy.	Physical therapy interventions included manual hyperinflation (84%), breathing exercises (67%) and manual airway clearance (59%). Incentive spirometry was present in 80% of critical care units but only utilised by 3% of physical therapists.
Skinner et al, 2016 (6), Australia & New Zealand	To establish a consensus based minimum clinical practice standards for physiotherapists working in critical care in Australia and New Zealand.	Survey	61 physiotherapists working in Australia and New Zealand took part in a Delphi study to establish consensus based minimum clinical practice standards. Consensus based on 70% agreement.	Consensus achieved on 132 items of physiotherapy practice, with 67 items considered not essential for physiotherapy practice. All remaining items failed to reach any consensus. Comments raised recognised that some items were specific to ICU specialities for example, burns or ECMO, and as such were not needed by all physiotherapists working within critical care.

Author, country	Aims	Method-ology	Participants/outcomes	Results
Summers et al, 2015 (31), Netherlands	To formulate an evidence based, expert driven, practical statement within the ICF domains, regarding diagnostics and effective and safe physiotherapy treatment strategies aiming at early mobilisation and physical activity for patients in an intensive care unit.	Guideline	Postal survey to 70 Dutch physiotherapists to identify 3 'clinical key questions', which were then explored via a systematic literature search and expert opinion from 2 intensivists and 16 physiotherapists.	3 key clinical questions on recommendations for mobilisation, clinimetrics for quantifying physical function and which physiotherapy interventions most effective. Physiotherapy modalities identified included passive exercise (level two), stretching (level two), passive cycling (level two), CPM (level two) and splinting (level four).
Twose et al, 2019 (7), U.K.	To standardise the knowledge and skills of physiotherapists working in critical care in U.K. – develop minimum standards to support training and reduce variability in clinical practice.	Survey	114 U.K. based physiotherapists (clinical and academic) took part in a Delphi study to establish consensus based minimum clinical practice standards. Consensus based on 70% agreement.	107 items considered essential to clinical practice in U.K. critical care units. Items categorised into: <ol style="list-style-type: none"> 1 Assessment. 2 Condition. 3 Treatment. 73 items considered not essential, and no consensus achieved for 33 items. Themes reported included specificity to type of critical care for example, burns, and to be included as part of multi-disciplinary approach.

Author, country	Aims	Methodology	Participants/outcomes	Results
van Aswegen et al, 2017 (8), South Africa	<p>To explore the perceptions of experienced physiotherapists as to the minimum clinical standards for physiotherapy in SA ICUs. To better understand the:</p> <ol style="list-style-type: none"> 1 Knowledge base to be mobilised. 2 Skills and competencies to possess. 3 Attributes to be engaged by physiotherapists working in ICU to ensure safe and effective service delivery to critically ill patients. 	Focus group	<p>25 physiotherapists working in SA ICUs. Three categories explored:</p> <ol style="list-style-type: none"> 1 Knowledge base to be mobilised. 2 Skills and competencies to possess. 3 Attributes to be engaged by physiotherapists working in ICU to ensure safe and effective service delivery to critically ill patients. 	<p>Three key themes identified:</p> <ol style="list-style-type: none"> 1 Integrated medical knowledge including pathology, anatomy and physiology. ICU environment. 2 Multidisciplinary working including CPD, communication, team members and ethics. 3 Physiotherapy practice including handling skills, clinical reasoning, patient care and interventions.
van der Lee et al, 2019 (28), Australia	To determine expert consensus for respiratory physiotherapy management of intubated and mechanically ventilated adults with CAP, which could inform development of guidelines for clinical practice.	Survey	29 physiotherapists took part in a Delphi study to establish physiotherapy management of intubated and mechanically ventilated adults with CAP. Consensus based on 70% agreement.	The Delphi study resulted in 38 expert consensus statements covering the seven key domains. A high proportion on consensus items related to physiotherapy assessment based on a systems approach. A much lower proportion of items related to physiotherapy treatment, reflecting the variability in clinical practice.

Author, country	Aims	Method-ology	Participants/outcomes	Results
Yeole et al, 2015 (29), India	To evaluate qualifications of physiotherapists, hospital infrastructure available for physiotherapists, and the current physiotherapy practices in ICUs of hospitals across the state of Maharashtra, India.	Survey	73 physiotherapists across 50 hospitals completed questionnaire. Data captured on hospital type, physiotherapy demographics and the role of physiotherapists.	68% of respondents were working private hospitals. 63% reporting being available overnight (48% as a resident). Majority of respondents (80%) performed 'chest wall techniques', with 86% using positioning and 61% joint mobilisation. Only 44% of physiotherapists involved in patient and family education regarding the condition and prognosis of the patient's health.

APTA = American Physical Therapy Association; CAP = community acquired pneumonia; CPD = continuous professional development; CPM = continuous passive movement; ESICM = European Society of Intensive Care Medicine; FIM = functional independence measure; ICU = intensive care units; MDT = multi-disciplinary team; MRC = Medical Research Council; PFIT = physical function in intensive care test; SA = South Africa; U.K. = United Kingdom.

Appendix 2: Data extraction for physiotherapy staffing within critical care.

Author, country	Aims	Methodology	Participants/ outcomes	Results
Al-Nassan et al, 2018 (27), Jordan	To determine the current status of physical therapy practice in the ICUs in four different sectors of Jordanian hospitals.	Survey	Online survey completed by 50 physical therapists. Survey consisted of three sections with 23 items: <ul style="list-style-type: none"> Section one addressed demographics and descriptions of physical therapy practice in ICUs (10 items). Section two addressed the level of education and training for intensive care physical therapy (7 items). Section three addressed the main barriers to practice (6 items). 	Staffing of physical therapists working in ICUs relative to the total ICU beds was highest in public hospitals (1:4 versus overall 1:10). Among all participants only 4% had specialist post graduate ICU training. Barriers to ICU practice included prioritisation of service and adequate perceived importance.
Christakou et al, 2018 (24), Greece	To investigate the responsibilities and frequency of clinical procedures that physiotherapists perform within the intensive care unit in Greece, alongside the level of education and training of those physiotherapists.	Survey	140 respondents with a minimum of three months of working experience within a hospital ICU in Greece recruited from Greek ICU society's database. Survey consisted of 83 closed and open-ended short form questions. Collected data about hospital, involvement in care, clinical procedures, weaning procedures.	21% of physiotherapists were fulltime within critical care, with 40% of ICUs having one physiotherapist on ICU each day.

Grammatopoulou et al, 2017 (12), Greece	To determine the scope of physiotherapy services provided in Greek ICUs in Athens.	Survey	103 Physiotherapists working in ICUs in Athens completed a three-item survey based on the findings of the ESICM task force on physiotherapy for critically ill patients. 19 ICU directors also completed eight-item questionnaire related to the nature of the ICU, number and availability of physiotherapists, and adequacy of the physiotherapy service.	Results showed a 1:50 to 1:12 range of physiotherapists to ICU beds. Majority of staff were rotational (78.9%) with physiotherapist services provided in all ICUs in the morning and less frequently during the afternoon (52.6%). 89.5% of ICU directors reported the number of physiotherapy shifts in ICU were inadequate.
Johnson et al, 2019 (18), U.S.A.	The primary aim of this study was to investigate if changes in PT delivery and patient outcomes occurred for patients with prolonged cardiovascular critical illness as a result of increased physical therapy staff dedicated to ICU.	Quality improvement	During six-month quality improvement initiative ICU physical therapy staff increased from two to 4. 114 cardiovascular patients (52 in the baseline period and 62 in the QI period) met the criteria for prolonged critical illness.	Daily PT treatment duration increased (significantly or non-significantly?) for each patient from 51.7 (± 12.9) minutes in the baseline period to 59.4 (± 25.5) minutes in the QI period. There were non-significant differences observed in physical function change between the baseline and QI period, for both the ICU and overall hospital stay. The median (IQR) post-ICU LOS in the baseline period was 5.0 (0.0, 7.7) (is this range or CI?) days compared to 2.0 (0.0, 6.5) days in the QI period.

Lottering et al, 2016 (20), South Africa	<p>To conduct a nationwide survey to:</p> <ol style="list-style-type: none"> 1 Determine the current practice of physiotherapists in SA ICUs. 2 Determine if physiotherapists' practice in ICUs had changed since the previous report. 3 Validate the survey questionnaire. In addition, SA physiotherapists' practice in ICU was compared with that reported in critical care and rehabilitation literature, to determine if current practice is evidence based. 	Survey	<p>108 participants completed the questionnaire. The questionnaire included demographics, ICU type, patient referral method, after-hours service provision, assessment and treatment techniques used in patient management, participation in inter-professional team meetings and professional development activities.</p>	<p>Respondents indicated that patients in ICU were referred for physiotherapy by doctors or nurses (number of respondents = 59, 54%). An after-hours physiotherapy service was provided by 72% (<i>n</i> = 78) of respondents to ICUs during weekdays. Most respondents (<i>n</i> = 105, 97%) provided weekend physiotherapy services to their ICUs.</p>
Li et al, 2012 (11), China	<p>To explore current ICU respiratory care resources and practices, requirements for respiratory therapists, and the barriers to recruit respiratory therapists.</p>	Survey	<p>194 respondents from ICUs in Beijing, China: 134 physicians, 60 nurses. Survey explored existing staffing, respiratory interventions, and perceived requirement for respiratory therapists.</p>	<p>18 respiratory therapists working across 7 ICUs (6 hospitals) with ratio of 1:36 patients. 86.1% of respondents suggested that respiratory care services should be provided by respiratory therapists. The main barrier for recruitment was access to formal training.</p>

Malone et al, 2015 (23), U.S.A.	National survey to determine the status of physical therapists' practice in the ICU.	Survey	667 physical therapists from the acute care section (ACS) of APTA. Section one of survey explored demographics of hospital/ICU; staffing patterns; training; self-confidence in working on ITU; consultation and treatment guidelines; barriers to providing rehabilitation. Section two investigated perceptions of rehabilitation practice related to five scenarios.	Staffing (number of PTs per 100 beds) -2.4 (1.7-3.3) for hospital beds and 6.3 (4-10) for the ICU, with academic hospitals reporting lower ICU staffing than community hospitals. 31% of respondents had formal training in ICU. Common barriers to physical therapy were insufficient staffing (44%), lower prioritisation (36%) and lack of consultation criteria (35%). 38.6% reported faculty-based guidelines for ICU consultations.
Sigera et al, 2016 (26), Sri Lanka	To determine: <ol style="list-style-type: none"> 1 The availability of critical care physical therapist services. 2 The equipment and techniques used and needed. 3 The training and continuous professional development of physical therapists. 	Survey	213 physical therapists in Sri Lanka completed an interviewer-administered questionnaire. Questions focused on experience of staff, distribution of physical therapists, work patterns and availability of 24-hour physical therapy.	54% of respondents had >5 years' experience of which most, 56%, worked within specialised critical care units. 90% of critical care units had a PT oncall system including 28% resident overnight.

Turkmen et al, 2014 (30), Turkey	To investigate to what extent ICUs in university and private hospitals in Turkey meet the minimum requirements for equipment and workforce set out by national standards.	Survey	Survey questionnaire together with a permit letter was mailed to the Chief of Medicine and the Head of the Nursing Department at each of the identified hospitals 145 questionnaires returned. Questions were devoted to medical devices and equipment, and workforce.	11.7% respondents reported the presence of a physiotherapist within intensive care unit. Where present, most worked within neurosurgical ICUs. No physiotherapists worked oncall/out of hours. 2008 standards for Turkish ICUs did not state requirement for physiotherapist within intensive care unit.
Yeole et al, 2015 (29), India	To evaluate qualifications of physiotherapists, hospital infrastructure available for physiotherapists, and the current physiotherapy practices in ICUs of hospitals across the state of Maharashtra, India.	Survey	73 physiotherapists across 50 hospitals completed questionnaire. Data captured on hospital type, physiotherapy demographics and the role of physiotherapists.	68% of respondents were working private hospitals. 63% reporting being available overnight (48% as a resident).

APTA = American Physical Therapy Association; ESICM = European Society of Intensive Care Medicine; ICU = intensive care units; PT = physical therapist; SA = South Africa.