



**QUEEN'S
UNIVERSITY
BELFAST**

Physical rehabilitation interventions for adult intensive care patients across the continuum of recovery (i.e. within the intensive care unit (ICU) and following ICU and hospital discharge): an overview of systematic reviews

Connolly, B., O'Neill, B., Salisbury, L., McDowell, K., & Blackwood, B. (2015). Physical rehabilitation interventions for adult intensive care patients across the continuum of recovery (i.e. within the intensive care unit (ICU) and following ICU and hospital discharge): an overview of systematic reviews. *Systematic Reviews*, 4, Article 130. <https://doi.org/10.1186/s13643-015-0119-y>

Published in:
Systematic Reviews

Document Version:
Publisher's PDF, also known as Version of record

Queen's University Belfast - Research Portal:
[Link to publication record in Queen's University Belfast Research Portal](#)

Publisher rights

© 2015 Connolly et al.

Open Access This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.

General rights

Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.

Open Access

This research has been made openly available by Queen's academics and its Open Research team. We would love to hear how access to this research benefits you. – Share your feedback with us: <http://go.qub.ac.uk/oa-feedback>

PROTOCOL

Open Access



Physical rehabilitation interventions for adult patients with critical illness across the continuum of recovery: an overview of systematic reviews protocol

Bronwen Connolly^{1,2,3*}, Brenda O'Neill⁴, Lisa Salisbury⁵, Kathryn McDowell⁴, Bronagh Blackwood⁶ and on behalf of the Enhanced Recovery After Critical Illness Programme Group

Abstract

Background: Patients admitted to the intensive care unit with critical illness often experience significant physical impairments, which typically persist for many years following resolution of the original illness. Physical rehabilitation interventions that enhance restoration of physical function have been evaluated across the continuum of recovery following critical illness including within the intensive care unit, following discharge to the ward and beyond hospital discharge. Multiple systematic reviews have been published appraising the expanding evidence investigating these physical rehabilitation interventions, although there appears to be variability in review methodology and quality. We aim to conduct an overview of existing systematic reviews of physical rehabilitation interventions for adult intensive care patients across the continuum of recovery.

Methods/design: This protocol has been developed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocol (PRISMA-P) guidelines. We will search the Cochrane Systematic Review Database, Database of Abstracts of Reviews of Effectiveness, Cochrane Central Register of Controlled Trials, MEDLINE, Excerpta Medica Database and Cumulative Index to Nursing and Allied Health Literature databases. We will include systematic reviews of randomised controlled trials of adult patients, admitted to the intensive care unit and who have received physical rehabilitation interventions at any time point during their recovery. Data extraction will include systematic review aims and rationale, study types, populations, interventions, comparators, outcomes and quality appraisal method. Primary outcomes of interest will focus on findings reflecting recovery of physical function. Quality of reporting and methodological quality will be appraised using the PRISMA checklist and the Assessment of Multiple Systematic Reviews tool.

Discussion: We anticipate the findings from this novel overview of systematic reviews will contribute to the synthesis and interpretation of existing evidence regarding physical rehabilitation interventions and physical recovery in post-critical illness patients across the continuum of recovery.

Systematic review registration: PROSPERO CRD42015001068.

Keywords: Critical illness, Physical rehabilitation, Recovery, Systematic review, Quality

* Correspondence: bronwen.connolly@nhs.net

¹Lane Fox Clinical Respiratory Physiology Research Unit, Guy's and St. Thomas' NHS Foundation Trust, London, UK

²Centre of Human and Aerospace Physiological Sciences, King's College London, London, UK

Full list of author information is available at the end of the article

Background

Admission to the intensive care unit (ICU) with critical illness is typically associated with significant morbidity for survivors, including profound impairment in physical strength and functional performance. These symptoms contribute to the 'post-intensive care syndrome' evident in survivors of critical illness [1] and have been shown to persist up to 5 years following resolution of the original illness [2–7]. Peripheral skeletal muscle wasting and dysfunction that occurs early and rapidly during critical illness [8] contributes to the development of intensive care unit-acquired weakness (ICU-AW) and these physical sequelae.

Physical rehabilitation interventions are advocated to address physical and functional deficits associated with ICU-AW, and delivery is advocated across the continuum of the patient pathway commencing in the ICU, following transfer to the ward and beyond hospital discharge into the community [9]. Typically, early mobilisation of patients in the ICU represents a hierarchical progression of increasingly functional activities such as active-assisted bed exercises, sitting on the edge of the bed, standing, marching-on-the-spot and walking [10], with use of adjunctive technologies including electrical muscle stimulation [11], interactive video games [12] and passive cycle ergometry [13]. On ICU discharge to the ward, the emphasis of physical rehabilitation for post-critical illness patients is directed towards the necessary level of functional mobility required to expedite hospital discharge, which can be supplemented by input from generic rehabilitation assistants [14, 15]. Following hospital discharge, physical rehabilitation has been evident in the delivery of either home- or hospital-based exercise rehabilitation programmes including combined strength, cardiovascular and functional components [16–19].

As the profile of physical rehabilitation for critical illness patients has increased and the volume of published data exploring the effectiveness of interventions has grown, multiple systematic reviews have been reported aiming to synthesise available evidence and draw conclusions on the most beneficial therapeutic options. A number of these have focused on interventions delivered within the ICU, e.g. Kayambu et al. [20], Calvo-Ayala et al. [21], Li et al. [22] and Stiller [23], albeit the stages of recovery following ICU discharge are also being evaluated [24, 25]. These systematic reviews are valuable for summarising findings from clinical trials at discrete time points along the recovery trajectory, involving particular types of physical rehabilitation strategies, in defined ICU populations and evaluating impact on select outcomes. However, this specificity of focus fails to provide a broader overview of the existing evidence base for physical rehabilitation during recovery from critical illness spanning the acute to chronic phases, to elucidate patient cohorts that may respond to interventions at different time points, and temporal variation in intervention

effectiveness. In addition, variability in individual review methodology and quality appears evident which can influence robustness and clinical applicability of findings.

Objectives of this overview

We will carry out an overview of existing Systematic review (SR) evaluating physical rehabilitation interventions for adult patients with critical illness patients across the continuum of recovery. Variability in the review question and population, intervention, comparator and outcome components across the large body of currently available reviews is a limiting factor to the overall synthesis of their findings and translation into clinical practice. An overview of SR offers a logical and appropriate step allowing comparison and contrast of individual reviews to be made and providing a precis of evidence at these different levels [26].

Undertaking an overview of existing reviews is a novel approach within the field of physical rehabilitation following critical illness. Adopting this strategy, our aim is to summarise and appraise the best available evidence for the use of physical rehabilitation interventions across the continuum of recovery following critical illness, to address the following questions:

1. At which stage of the post-critical illness recovery continuum (within the ICU, following ICU discharge on the ward and post-hospital discharge) do physical rehabilitation interventions have the most effect?
2. Do particular patient populations gain more benefit from post-critical illness physical rehabilitation interventions than others?
3. Which type of physical rehabilitation interventions produce benefits (short- and long-term) for post-critical illness patients?
4. What adverse events or harmful effects are experienced from receipt of any physical rehabilitation interventions?

Methods/design

Protocol and registration

Our protocol has been written using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocol (PRISMA-P) [27] and is registered on PROSPERO (CRD42015001068).

Data sources and search strategy

We will search the Cochrane Systematic Review Database, Database of Abstracts of Reviews of Effectiveness, Cochrane Central Register of Controlled Trials (CENTRAL), Ovid SP MEDLINE, Ovid SP Excerpta Medica Database (EMBASE) and Cumulative Index to Nursing and Allied Health Literature (CINAHL) via EBSCO host. All authors contributed to devising the search strategies for each database using a combination of subject headings and free-text keywords to

describe critical illness, physical rehabilitation interventions and the different stages of the recovery continuum. Table 1 presents the search strategy for use in Ovid SP MEDLINE. No date or language restrictions will be applied to the initial searches.

Selection of reviews

Following initial removal of duplicate and non-relevant material, two review authors will independently screen search results (based on abstract and title) against inclusion criteria (see below) for full-text review (BC and LS initial searches; BC and BO'N for updated searches). Full-text papers will then be further screened for eligibility. A bespoke assessment of study eligibility form will be used for documentation. In the absence of consensus, arbitration by a third author (KM) will be sought. References will be managed in Endnote v7.0 (Thomson Reuters).

Types of reviews

We will include systematic reviews of randomised controlled trials (RCTs) investigating the effect of any physical rehabilitation interventions following critical illness at any stage of the recovery continuum. If a review includes quasi-RCTs in addition to RCTs, we will also include these. Where non-RCTs are included in the review, the review will be included only if the RCTs are reported separately.

Types of participants

Participants will be adult patients who have been admitted to the ICU with critical illness, irrespective of causal diagnosis. We will exclude systematic reviews that only include studies of short-stay post-operative management (less than 48-h length of stay in the ICU). This is to focus the review content on patients considered most likely to develop intensive care unit-acquired weakness and go on to experience the physical consequences of critical illness and require physical rehabilitation interventions. Data extraction will include details of the populations included in each eligible systematic review, and these can be discussed and interpreted accordingly.

Types of intervention

We will include all types of physical rehabilitation interventions including exercise-based treatments and adjunctive strategies such as electrical muscle stimulation or cycling. These interventions can either be compared to control interventions (standard or usual care) or an alternative physical rehabilitation. We will exclude reviews including studies of composite interventions such as combined physical and cognitive rehabilitation and reviews including studies where the comparator was the same intervention but delivered at a different level of intensity.

Types of outcomes

Primary outcomes

Primary outcomes of interest are findings reflecting the recovery of any aspect of physical function, long-term measures of physical function or its surrogates. Where applicable, these outcomes will be summarised according to type of physical rehabilitation intervention, e.g. exercise-based rehabilitation programmes or electrical stimulation, and time point of assessment and duration of follow-up (such as 1, 3 or 12 months post-ICU discharge).

Secondary outcomes

Secondary outcomes will include the following: structure, content and format of physical rehabilitation interventions according to recovery continuum stage; details on specific patient populations examined in each included review; reported rates of adverse events or harmful effects associated with interventions; and effect on other domains of outcome such as health-related quality of life where examined and reported.

Data extraction and analysis

Data extraction and analysis will be conducted in line with guidance from the Cochrane Handbook of Systematic Reviews of Interventions. Full texts of included reviews will be retrieved. Two review authors (LS and BO'N) will independently extract descriptive and outcome data from each included review. A third review author (KM) will arbitrate in the event that discrepancies cannot be resolved by consensus. A bespoke data extraction form will be designed, piloted and used to record review features including the aims and rationale, types of studies included, population(s), intervention(s), comparator(s), outcomes (including beneficial and harmful effects and reported adverse events) and date of last search and methods of assessing quality of studies. In the event that we include more than one review containing the same studies, we will examine the review question and comparisons explored, the date of the last search and key aspects of methodological quality (e.g. types of studies included and risk of bias assessment) and will list the individual studies included in each of the review. In this way, we will enable identification of trials included in one review but not another. Using these data, we will determine which of the reviews should contribute data to the results based on the review with the more current search strategy and more recent trials.

Assessment of methodological quality of included reviews

Two review authors (BC and BB) will independently assess the quality of reporting and the methodological quality of included reviews using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [28] checklist and the Assessment of Multiple Systematic

Table 1 Example search strategy for Ovid SP MEDLINE

1. ((intensive or critical) adj1 care unit).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
2. ((intensive or critical) adj1 care).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
3. exp Intensive Care Units/ or exp Intensive Care/ or ICU.mp. or exp Critical Care/
4. critical illness.mp. or exp Critical Illness/
5. mechanical ventilation.mp. or exp Respiration, Artificial/
6. 1 or 2 or 3 or 4 or 5
7. exp Exercise Therapy/ or exercise.mp. or exp Exercise/
8. ((exercise or physical) adj2 rehabilitation).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier]
9. physiotherapy.mp.
10. physical therapy.mp.
11. exp Early Ambulation/ or early mobilisation.mp.
12. early mobilization.mp.
13. physical fitness.mp. or exp Physical Fitness/
14. muscle strength.mp. or exp Muscle Strength/
15. cycling.mp.
16. cycle ergometry.mp.
17. exp Electric Stimulation Therapy/ or electrical muscle stimulation.mp.
18. neuromuscular stimulation.mp.
19. NMES.mp.
20. 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21. randomized controlled trial.pt.
22. controlled clinical trial.pt.
23. randomized.ab.
24. placebo.ab.
25. randomly.ab.
26. trial.ab.
27. groups.ab.
28. 21 or 22 or 23 or 24 or 25 or 26 or 27
29. exp animals/ not humans.sh.
30. 28 not 29
31. Meta-Analysis as Topic/
32. meta analy\$.tw.
33. metaanaly\$.tw.
34. Meta-Analysis/
35. (systematic adj (review\$1 or overview\$1)).tw.
36. exp Review Literature as Topic/

Table 1 Example search strategy for Ovid SP MEDLINE
(Continued)

37. or/31-36
38. cochrane.ab.
39. embase.ab.
40. (cinahl or cinhal).ab.
41. science citation index.ab.
42. or/38-41
43. reference list\$.ab.
44. bibliograph\$.ab.
45. hand-search\$.ab.
46. relevant journals.ab.
47. manual search\$.ab.
48. or/43-47
49. selection criteria.ab.
50. data extraction.ab.
51. 49 or 50
52. Review/
53. 51 and 52
54. Comment/
55. Letter/
56. Editorial/
57. animal/
58. human/
59. 57 not (57 and 58)
60. or/54-56,59
61. 37 or 42 or 48 or 53
62. 61 not 60
63. 6 and 20 and 30
64. 6 and 20 and 62

Reviews (AMSTAR) tool [29], respectively. We will report the proportion of PRISMA quality (number of items reported/27 checklist items*100 %). We will deem systematic reviews achieving an AMSTAR score of 8 to 11 of high methodological quality, 4 to 7 of medium quality and 0 to 3 as low quality [30].

We will use the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach [31] to assess the overall quality of evidence within, and across, the systematic reviews for each outcome. Disagreement will be resolved through consensus, and where this is not achieved, arbitration by a third review author (KM) will be sought.

Dealing with missing data

Reasons for missing data will be recorded as reported by the original reviews. If the original reviews included this

detail, we will report the number of studies that performed intention-to-treat or per protocol analyses.

Data synthesis and reporting

Data will be presented as a narrative synthesis, with textual commentary supplemented with use of summary tables and figures to enhance clarity of reporting [26]. We will document primary and secondary outcomes of each intervention comparison in an included review, as well as the number of studies and number of participants included in the comparison, and (when reported in reviews) the mean difference (or standardised mean difference), 95 % confidence intervals and I^2 statistic for heterogeneity [32]. We will synthesise key information pertaining to the quality of evidence, and documented eligibility criteria, study characteristics and the primary outcome of each review. As previously described, we will also use the GRADE approach to determine overall quality of evidence and methodological checklist items for standardised evaluation of reporting and quality appraisal [28, 29]. Flow diagrams will be used to summarise the study selection process. Finally, reasons for excluding reviews will be reported.

Sensitivity analysis

If applicable, we will conduct sensitivity analysis in relation to studies of differing methodological quality.

Sub-group analysis

Depending on sufficiency of reviews, we plan to analyse the main functional outcomes according to patient population (e.g. age and causal diagnosis), intervention (i.e. type of physical intervention) and setting (i.e. within ICU, within the ward, post-hospital discharge).

Discussion

Expected significance of the study

The findings of this overview of systematic reviews of physical rehabilitation for adult patients with critical illness across the continuum of recovery will potentially have implications for clinical practice, research and future guideline development and update. It is intended that our results provide greater clarity and synthesis of available evidence on the most effective physical rehabilitation interventions to deliver according to the stage of recovery following critical illness. This is likely to have impact on existing and planned resource allocation in the clinical environment, inform the direction of future research including randomised controlled trials of intervention effectiveness and underpin guideline recommendations. Conclusions from this overview will highlight which, if any, physical rehabilitation interventions demonstrate clear benefit and those for which there is no clear evidence at which, if any, stage in the continuum of recovery. If sufficient data are available, our findings may also add clarity to the 'dose' of physical

rehabilitation intervention, i.e. type, timing, intensity, duration and also circumstances under which any adverse effects of harm was caused as a result of the intervention.

Potential limitations of overview design

We plan to follow the approach outlined by the Cochrane Collaboration for undertaking an overview [33]. As such, including individual studies that have not previously been included in a systematic review is beyond the scope of an overview although this could be considered a limitation if any new evidence exists. We will note when included systematic reviews are out of date and identify any relevant new studies that have been published subsequent to the date of the last reported systematic review search although we will not formally undertake a new systematic review within our overview framework [33]. Our discussion will focus on the current state of the systematic review evidence for physical rehabilitation interventions for adults with critical illness, albeit we will comment on the volume of outstanding evidence identified as awaiting inclusion in systematic review.

Conclusion

It is intended that this overview will provide insight regarding considerations for the design and conduct of future interventional trials of physical rehabilitation intervention in the post-critical illness population, acknowledged to be complex studies [34].

Abbreviations

AMSTAR: Assessment of Multiple Systematic Reviews; GRADE: Grading of Recommendations Assessment, Development and Evaluation; ICU: Intensive care unit; ICU-AW: Intensive care unit-acquired weakness; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT: Randomised controlled trial.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

BC contributed to conception and design of the overview, development of search strategies and construction of PROSPERO review registration. BC drafted and revised the current protocol manuscript and will perform the searches, conduct quality appraisal on included reviews and draft and revise the manuscript for the final review. BON contributed to conception and design of the overview, development of search strategies and construction of the PROSPERO review registration and contributed to manuscript revision of the current protocol manuscript. BON will conduct data extraction on included reviews and contribute to manuscript revision for the final review. LS contributed to conception and design of the overview, development of search strategies and construction of the PROSPERO review registration and contributed to manuscript revision of the current protocol manuscript. LS will conduct data extraction on included reviews and contribute to manuscript revision for the final review. KM contributed to conception and design of the overview, development of search strategies and construction of the PROSPERO review registration. KM will act as arbitrator for data extraction and quality appraisal where required and contribute to manuscript revision for the final review. BB contributed to conception and design of the overview, development of search strategies and construction of the PROSPERO review registration and contributed to manuscript revision of the current protocol manuscript. BB also prepared and submitted the PROSPERO registration. BB will conduct quality appraisal on included reviews and draft and revise the manuscript for the final

review. All authors read and approved the final manuscript for the current review protocol and will agree and act as joint guarantors for the final review manuscript.

Acknowledgements

We did not receive any dedicated funding for this manuscript. BC salary is funded by the Lane Fox Respiratory Unit Patient Association (LFRUPA), Guy's and St. Thomas' NHS Foundation Trust. LFRUPA was not involved in any aspect of the design of this protocol or the systematic review to which it relates and in addition will have no input on the interpretation or publication of results. BC is supported by the National Institute for Health Research (NIHR) Biomedical Research Centre based at Guy's and St Thomas' NHS Foundation Trust and King's College London. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health. The Enhanced Recovery After Critical Illness Programme Group additionally includes the following: Nicholas Hart, Michael Grocott, Stephen Brett, Timothy Walsh, David Griffith, Stephen Shepherd, Judith Merriweather, Nazir Lone, Simon Baudouin, Stephen Bonner, Kathryn McDowell, Dorothy Wade, Natalie Pattison, Danielle Bear, Sallie Lamb, Rebecca Cusack, Daniel F McAuley, Robert Hatch, David Parkin, Mark Foster, Laura Price, Liesl Wandrag and Pamela Ramsay.

Author details

¹Lane Fox Clinical Respiratory Physiology Research Unit, Guy's and St. Thomas' NHS Foundation Trust, London, UK. ²Centre of Human and Aerospace Physiological Sciences, King's College London, London, UK. ³Guy's & St Thomas' NHS Foundation Trust and King's College London, National Institute of Health Research Biomedical Research Centre, London, UK. ⁴School of Health Sciences, Institute of Nursing and Health Research, Ulster University, Ulster, UK. ⁵School of Health in Social Science, The University of Edinburgh, Edinburgh, UK. ⁶School of Medicine, Dentistry and Biomedical Sciences, Queen's University Belfast, Belfast, UK.

Received: 12 June 2015 Accepted: 16 September 2015

Published online: 29 September 2015

References

- Needham DM, Davidson J, Cohen H, Hopkins RO, Weinert C, Wunsch H, et al. Improving long-term outcomes after discharge from intensive care unit: report from a stakeholders' conference. *Crit Care Med*. 2012;40:502–9.
- Cheung A, Tansey C, Tomlinson G, Diaz-Granados N, Matte A, Barr A, et al. Two-year outcomes, health care use, and costs of survivors of acute respiratory distress syndrome. *Am J Resp Crit Care Med*. 2006;174:538–44.
- Dennis DM, Hebden-Todd TK, Marsh LJ, Cipriano LJ, Parson RW. How do Australian ICU survivors fare functionally 6 months after admission? *Crit Care Resusc*. 2011;13:9–16.
- Herridge M, Cheung A, Tansey C, Matte-Martyn A, Diaz-Granados N, Al-Saidi F, et al. One-year outcomes in survivors of the acute respiratory distress syndrome. *N Engl J Med*. 2003;348:683–93.
- Herridge MS, Tansey CM, Matté A, Tomlinson G, Diaz-Granados N, Cooper A, et al. Functional disability 5 years after acute respiratory distress syndrome. *N Engl J Med*. 2011;364:1293–304.
- Needham D, Colantuoni E, Mendez-Tellez, Dinglas V, Sevransky J, Himmelfarb C, et al. Lung protective mechanical ventilation and two year survival in patients with acute lung injury: prospective cohort study. *BMJ*. 2012;344:e2124.
- Needham D, Dinglas V, Bienvenu OJ, Colantuoni E, Wozniak AW, Rice TW, et al. One year outcomes in patients with acute lung injury randomised to initial trophic or full enteral feeding: prospective follow-up of EDEN randomised trial. *BMJ*. 2013;346:f1532.
- Puttuchearu ZA, Rawal J, McPhail M, Connolly B, Ratnayake G, Chan P, et al. Acute skeletal muscle wasting in critical illness. *JAMA*. 2013;310:1591–600.
- NICE. Rehabilitation after critical illness. NICE clinical guideline 83. London, UK: National Institute for Health and Care Excellence; 2009. available at <http://www.nice.org.uk/guidance/cg83>; Accessed 01/05/15.
- Hodgson C, Needham D, Haines K, Bailey M, Ward A, Harrold M, et al. Feasibility and inter-rater reliability of the ICU Mobility Scale. *Heart Lung*. 2014;43:19–24.
- Parry S, Berney S, Granger C, Koopman R, El-Ansary D, Denehy L. Electrical muscle stimulation in the intensive care setting: a systematic review. *Crit Care Med*. 2013;41:2406–18.
- Kho ME, Damluji A, Zanni JM, Needham DM. Feasibility and observed safety of interactive video games for physical rehabilitation in the intensive care unit: a case series. *J Crit Care*. 2012;27:219. e211–219.e216.
- Pires-Neto R, Kawaguchi Y, Hirota A, Fu C, Tanaka C, Caruso P, et al. Very early passive cycling exercise in mechanically ventilated critically ill patients: physiological and safety aspects - a case series. *Plos One*. 2013;8:e74182.
- Salisbury L, Merriweather J, Walsh T. The development and feasibility of a ward-based physiotherapy and nutritional rehabilitation package for people experiencing critical illness. *Clin Rehabil*. 2010;24:489–500.
- Walsh TS, Salisbury LG, Merriweather JL, Boyd JA, Griffith DM, Huby G, et al. Increased hospital-based physical rehabilitation and information provision after intensive care unit discharge: the RECOVER randomized clinical trial. *JAMA Intern Med*. 2015;175:901–10.
- Batterham AM, Bonner S, Wright J, Howell SJ, Huggill K, Danjoug G. Effect of supervised aerobic exercise rehabilitation on physical fitness and quality-of-life in survivors of critical illness: an exploratory minimized controlled trial (PIX study). *Br J Anaesth*. 2014;113:130–7.
- Connolly B, Thompson A, Douiri A, Moxham J, Hart N. Exercise-based rehabilitation after hospital discharge for survivors of critical illness with intensive care unit-acquired weakness: a pilot feasibility trial. *J Crit Care*. 2015;30:589–98.
- Denehy L, Skinner E, Edbrooke L, Haines K, Warrillow S, Hawthorne G, et al. Exercise rehabilitation for patients with critical illness: a randomized controlled trial with 12 months of follow-up. *Crit Care*. 2013;17:R156.
- Elliott D, McKinley S, Alison J, Aitken L, King M, Leslie G, et al. Health-related quality of life and physical recovery after a critical illness: a multi-centre randomised controlled trial of a home-based physical rehabilitation program. *Crit Care*. 2011;15:R142.
- Kayambu G, Boots R, Paratz J. Physical therapy for the critically ill in the ICU: a systematic review and meta-analysis. *Crit Care Med*. 2013;41:1543–54.
- Calvo-Ayala E, Khan BA, Farber MO, Ely EW, Boustani MA. Interventions to improve the physical function of ICU survivors: a systematic review. *Chest*. 2013;144:1469–80.
- Li Z, Peng X, Zhu B, Zhang Y, Xi X. Active mobilization for mechanically ventilated patients: a systematic review. *Arch Phys Med Rehabil*. 2013;94:551–61.
- Stiller K. Physiotherapy in intensive care: an updated systematic review. *Chest*. 2013;144:825–47.
- Connolly B, Salisbury L, O'Neill B, Genee L, Douiri A, Grocott M, et al. Exercise rehabilitation for recovery from critical illness following intensive care unit discharge. *Cochrane Database Syst Rev*. 2015;6:CD008632.
- Mendez-Tellez PA, Needham DM. Early physical rehabilitation in the ICU and ventilator liberation. *Respir Care*. 2012;57:1663–9.
- Smith V, Devane D, Begley C, Clarke M. Methodology in conducting a systematic review of systematic reviews of healthcare interventions. *BMC Med Res Method*. 2011;11:15.
- Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. 2015;4:1.
- Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ*. 2009;339:b2700.
- Shea B, Grimshaw J, Wells G, Boers M, Andersson N, Hamel C, et al. Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med Res Methodol*. 2007;7:10.
- Sharif M, Sharif F, Ahmed H. Systematic reviews explained: AMSTAR - how to tell the good from the bad and the ugly. *Oral Health Dent Manage*. 2013;12:9–16.
- Guyatt GH, Oxman AD, Vist GE, Kunz R, Falck-Ytter Y, Alonso-Coello P, et al. GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. *BMJ*. 2008;336:924–6.
- Deeks JJ. Systematic reviews of evaluations of diagnostic and screening tests. *BMJ: Br Med J*. 2001;323:157–62.
- Higgins J, Green SE. *Cochrane handbook for systematic reviews of interventions* version 5.1.0 [updated March 2011]. The Cochrane Collaboration; 2011. Available from www.cochrane-handbook.org.
- Developing and evaluating complex interventions: new guidance. Medical Research Council; 2008. Available at <http://www.mrc.ac.uk/complexinterventionsguidance>. Accessed 01/06/15.