Journal of Physiotherapy 64 (2018) 142–158

Journal of PHYSIOTHERAPY

journal homepage: www.elsevier.com/locate/jphys

Research

Additional weekend allied health services reduce length of stay in subacute rehabilitation wards but their effectiveness and cost-effectiveness are unclear in acute general medical and surgical hospital wards: a systematic review

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KEY WORDS

Systematic review
Meta-analysis
Allied health
Physical therapy
Weekend

ABSTRACT

Question: Are additional weekend allied health services effective and cost-effective for acute general medical and surgical wards, and subacute rehabilitation hospital wards? **Design**: Systematic review and meta-analysis of studies published between January 2000 and May 2017. Two reviewers independently screened studies for inclusion, extracted data, and assessed methodological quality. Meta-analyses were conducted for relative measures of effect estimates. **Participants**: Patients admitted to acute general medical and surgical wards, and subacute rehabilitation wards. **Intervention**: All services delivered by allied health professionals during weekends (Saturday and/or Sunday). This study limited allied health professions to: occupational therapy, physiotherapy, social work, speech pathology, dietetics, art therapy, chiropractic, exercise physiology, music therapy, oral health (not dentistry), osteopathy, podiatry, psychology, and allied health assistants. **Outcome measures**: Hospital length of stay, hospital re-admission, adverse events, discharge destination, functional independence, health-related quality of life, and cost of hospital care. **Results**: Nineteen articles (20 studies) were identified, comprising 10 randomised and 10 non-randomised trials. Physiotherapy was the most commonly investigated profession. A meta-analysis of randomised, controlled trials showed that providing additional weekend allied health services in subacute rehabilitation wards reduced hospital length of stay by 2.35 days (95% CI 0.45 to 4.24, $I^2 = 0\%$), and may be a cost-effective way to improve function (SMD 0.09, 95% CI –0.01 to 0.19, $I^2 = 0\%$), and health-related quality of life (SMD 0.10, 95% CI –0.01 to 0.20, $I^2 = 0\%$). For acute general medical and surgical hospital wards, it was unclear whether the weekend allied health service model provided in the two identified randomised trials led to significant changes in measured outcomes. **Conclusion**: The benefit of providing additional allied health services is clearer in subacute rehabilitation settings than for acute general medical and surgical wards in hospitals. **Registration**: PROSPERO CRD76771. **[Sarkies MN, White J, Henderson K, Haas R, Bowles J, Evidence Translation in Allied Health (EviTAH) Group (2018) Additional weekend allied health services reduce length of stay in subacute rehabilitation wards but their effectiveness and cost-effectiveness are unclear in acute general medical and surgical hospital wards: a systematic review. *Journal of Physiotherapy* 64: 142–158]**

Background

Allied health services, medicine and nursing are considered to comprise three pillars of the healthcare system.[1] Allied health professionals provide diagnostic and therapeutic services across different settings,[2] and represent a large proportion of the healthcare workforce internationally.[3,4] Allied health is often organised and managed in professional groups, including physiotherapy, psychology, occupational therapy, speech pathology, dietetics, podiatry, and social work, within an over-riding inter-professional comprehensive care model.[5,6]

The routine provision of weekend allied health services is variable across hospitals both in Australia and worldwide. For example, a survey of tertiary care hospitals in Canada reported that

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https://doi.org/10.1016/j.jphys.2018.05.004

97% of facilities provided routine weekend physiotherapy services, with diversity in the amount and focus of service delivery.[7] In Australia, 61% of hospitals routinely provided physiotherapy on Saturdays, and 45% on Sundays, with more provided in metropolitan and acute hospitals than regional and subacute hospitals.[8] Aside from physiotherapy, comparatively little is known about the practices of other allied health professions. The evidence about the effects of providing these services during weekends is unclear. Providing earlier,[9,10] additional,[11–13] or higher intensity[14] allied health services can improve health outcomes. However, it is unclear whether these benefits occur when weekend allied health staffing models are used to deliver additional services on a routine basis.[15] The provision of allied health services on weekends incurs more cost and logistical difficulty than during traditional business hours, with uncertainty around the experience of staff, appropriateness of referrals, and whether the mix of professions achieves the intended benefits.[16]

The aim of this review was to synthesise the available evidence examining the effectiveness and cost-effectiveness of providing additional weekend allied health services to patients on acute general medical and surgical hospital wards, and subacute rehabilitation hospital wards.

Therefore, the research question for this systematic review was:

Are additional weekend allied health services effective and cost-effective for acute general medical and surgical wards, and subacute rehabilitation hospital wards?

Box 1. Inclusion criteria.

Design
- Randomised, controlled trials
- Non-randomised, controlled trials
- Observational studies

Participants
- In-patients on a general medical or surgical wards or a subacute rehabilitation ward of a hospital

Intervention
- Additional allied health service delivered at the weekend

Outcome measures
- Hospital length of stay
- Hospital re-admission
- Adverse events
- Discharge destination
- Functional independence
- Health-related quality of life
- Cost of hospital care

Comparisons
- Additional allied health services versus usual allied health services only

Methods

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[17]

Identification and selection of studies

Ovid MEDLINE (all fields), PubMed (all fields), CINAHL (keyword, title, CINAHL subject headings, abstract, and instrumentation fields), Cochrane library (title, abstract, keywords), and Scopus (title, abstract, keywords) were searched for articles published between 1 January 2000 to 5 May 2017 to retrieve contemporary literature. Terms relevant to the population and intervention were combined and results were limited to English-language publications. See Appendix 1 on the eAddenda for the full search strategy. Electronic database searches were supplemented by cross-checking the reference list of included articles and relevant systematic reviews identified during the screening process. Publication lists from key authors in the field were also hand searched to identify additional studies. A web-based application[a] was used for reference management.[18]

The inclusion criteria for the review are presented in Box 1. For the purposes of this review, acute general medical and surgical wards included: general medical, general surgical, medical assessment unit, orthopaedic, vascular, plastics, ear nose and throat, thoracic, respiratory, coronary care unit, renal, rheumatology, neurology (including stroke units), infectious diseases, colorectal, endocrine, urological, and gastroenterology. Excluded acute wards were emergency department, intensive care unit, high dependency unit, burns, spinal, maternity, paediatrics, mental health, and palliative care. These wards were excluded because the allied health role was considered to be potentially different in these settings compared to acute general medical and surgical wards. For the purposes of this study, subacute rehabilitation wards included inpatient rehabilitation (both mixed and condition-specific wards), and geriatric evaluation and management wards. Excluded subacute wards comprised mental health and psychiatric, chronic and long-term care, alternative level of care, and extended care patients. The goals of care on these wards were considered to be different to those on inpatient rehabilitation and geriatric evaluation and management wards.

Interventions focused upon in this review included all services delivered by allied health professionals during weekends (Saturday and/or Sunday). This study limited allied health professions to: occupational therapy, physiotherapy, social work, speech pathology, dietetics, art therapy, chiropractic, exercise physiology, music therapy, oral health (not dentistry), osteopathy, podiatry, psychology, and allied health assistants.[19] An allied health service not delivered by an allied health professional or allied health assistant (eg, nursing staff or self-directed) was not eligible. Weekends were defined as complementary to the traditional workweek, as per the country the study was performed in. Studies that reported data relating to the provision of additional allied health services as part of changing timing of commencement, intensity, frequency or duration with a weekend component were included, but only if data relating specifically to weekend services with appropriate controls could be extracted.

Two reviewers (MS and JW) screened titles and abstracts independently against the above criteria. Studies determined to be potentially eligible were retrieved for full-text review. Two reviewers (MS and JW) independently assessed the full-text articles to ascertain eligibility for inclusion. Where there was any disagreement during the screening, a third independent reviewer (KH) was consulted. Authors of studies whose full-text article could not be retrieved were contacted. In the cases of non-response, these articles were excluded.

Assessment of characteristics of studies

Data were extracted using a customised pro-forma, which was developed and piloted for this review. One (JW) and either of two other reviewers (KH or JB) independently extracted data relating to the study details, design, setting, population, intervention, outcomes, and results for all included studies. Discrepancies in extracted data were resolved by discussion. Where agreement could not be reached, a fourth independent reviewer (MS) was consulted.

Quality

Two of three reviewers (JW, KH or JB) independently assessed the risk of bias for randomised, controlled trials using the Cochrane Collaboration's tool for assessing risk of bias,[20] and the Newcastle-Ottawa Quality Assessment Scale for observational studies.[21] Any discrepancy in the assessments of risk of bias was resolved by

discussion and, if necessary, consultation of a fourth independent reviewer (RH).

Participants

To describe the participants in the study, the following data were extracted from the published report: sample size, age, country, and ward (acute or subacute).

Intervention

The details extracted about the allied health service from each included study were: the number of hospitals, wards and/or beds being covered by the service, where reported; the number of additional hours of service; and the number and professions of the allied health staff providing the service. Data about the control intervention were the number of hours of weekday service, where reported, and the number and professions of the allied health staff providing the weekday service.

Outcome measures

The outcomes considered by this review are listed in Box 1. These were intended to cover all patient and health service outcomes that might be reported in the included studies.

Data analysis

Analysis was performed using Stata 13 software[b]. Relative measures of effect estimates were pooled according to study setting and design (separate for acute and subacute settings, and randomised and non-randomised study designs). Random effect meta-analysis accounted for differences in populations, interventions and outcomes across studies, and was performed where data were available for similar outcomes evaluated in more than one study.

A majority of analyses used summative, study-level data. Weighted mean difference (WMD) effect size estimates were used for continuous outcomes, where measurements were reported in the same units (eg, length of stay and cost). Where measures used different scales, standardised mean difference (SMD) was used to estimate effect size for function and health-related quality of life outcomes. The effect size for SMD was interpreted according to Cohen's d, with 0.2 considered small, 0.5 moderate, and 0.8 a large effect size.[22] Risk ratios (RR) were used for dichotomous outcomes (eg, number of adverse events, patients discharged home, and delayed discharge).

Authors were contacted to request additional data for studies not reporting sufficient outcome data for inclusion in the meta-analysis. Data were pooled from subgroups to estimate the total population effect size where data were only reported according to subgroups within an individual trial. The proportion of patients discharged to supported residential aged-care facilities reported in subgroups according to level of care were summed to create a total proportion of patients discharged to a supported residential aged care facility. When two control groups were used for non-randomised, controlled trials, the first mentioned control group was selected as the comparator. This applied only to observational studies where multiple time periods/cohorts were reported within the study. If study results were reported as medians and range or interquartile range, and the mean and standard deviation could not be obtained, means and standard deviation were estimated using the methods of Wan et al.[23] A sensitivity analysis was undertaken to assess the effect of excluding studies where data were estimated due to inadequate reporting.

Heterogeneity in study results was represented using the I-squared statistic (I^2), with values $> 50\%$ considered substantial.[24] An iterative approach was used to explore possible explanations for heterogeneity by subgrouping studies according to variables such as allied health profession, patient population, and potential sources of bias. A formal meta-regression was not planned due to the anticipated low number of studies for inclusion in the meta-analysis.

Two of the studies identified and included in this review were stepped-wedge cluster randomised trials, conducted in succession at the same research location (hospitals and wards). These were the only randomised trials identified in the acute setting. Data available from this study were used at the participant level (for continuous outcomes) and cluster level (for proportion outcomes) rather than summative data. This was done to incorporate the dependency of observations gathered from the same wards between the two trials. Weighted mean difference (WMD) was used for continuous outcomes, and risk difference (RD) for proportional outcomes.

Results

Flow of studies through the review

A total of 3413 titles were identified, with 3405 from the electronic search strategy and eight from hand searching publication lists of prominent authors. Duplicates (n = 293) were removed using Endnote (n = 224) and Covidence (n = 69), resulting in 3120 titles remaining for screening (Figure 1). After title and abstract screening, 72 records were considered potentially eligible for inclusion. These were obtained in full text and assessed, resulting in the inclusion of 19 articles (n = 20 studies) in this review.[25–43] (See Appendix 2 on the eAddenda for a list of the excluded full-text articles.)

Characteristics of included studies

Quality

The Cochrane Collaboration tool for assessing risk of bias in the included randomised, controlled trials is presented in Figure 2. Eight studies reported adequate methods of random sequence generation.[25,27–33] All studies reported adequate allocation concealment; however, blinding of participants and personnel was not possible in any included studies. Hospital length of stay was unable to be blinded in any included studies,[25–33] although the stepped-wedge, cluster-randomised trials limited this as a potential source of bias.[25] Risk of bias for selective reporting was identified in two studies,[27,32] with another study reporting further outcomes to be reported in other publications.[25] No other potential sources of bias were identified for any of the included studies.

For non-randomised, controlled trials assessed using the Newcastle-Ottawa quality assessment scale (Table 1), eight studies reported adequate methods to control for potential risk of selection bias,[34–36,38,39,41–43] with two studies potentially at risk of selection bias.[37,40] There was adequate reporting of methods to control for potential risk of comparability bias for all studies. Seven studies reported adequate methods to control for potential outcome or exposure risk of bias,[34,36,38,39,41–43] with three studies potentially at risk of outcome bias.[35,37,40]

Design, setting and participants

Ten randomised, controlled trials (published in nine articles) evaluated the effect of providing allied health services during weekends. Two studies were performed in acute general medical and surgical hospital ward settings.[25,44] Eight were within subacute rehabilitation hospital wards, including mixed patient groups,[26–30] orthopaedic,[31] and stroke rehabilitation.[32,33] Ten non-randomised, controlled trials (10 articles) were also identified. Seven were cohort studies performed in acute general medical and surgical hospital wards, including orthopaedic,[34–37,43] rheumatology,[38] and stroke.[39] Two cohort studies were performed in mixed rehabilitation subacute hospital wards,[40,41] and one cross-sectional study was conducted in a mixed rehabilitation setting.[42] The majority of studies were performed in Australia (n = 14),[25–35,40,41,43] with one study each in England,[38] Canada,[42] Japan,[39] Singapore,[36] and Scotland.[37] Study details are presented in Table 2.

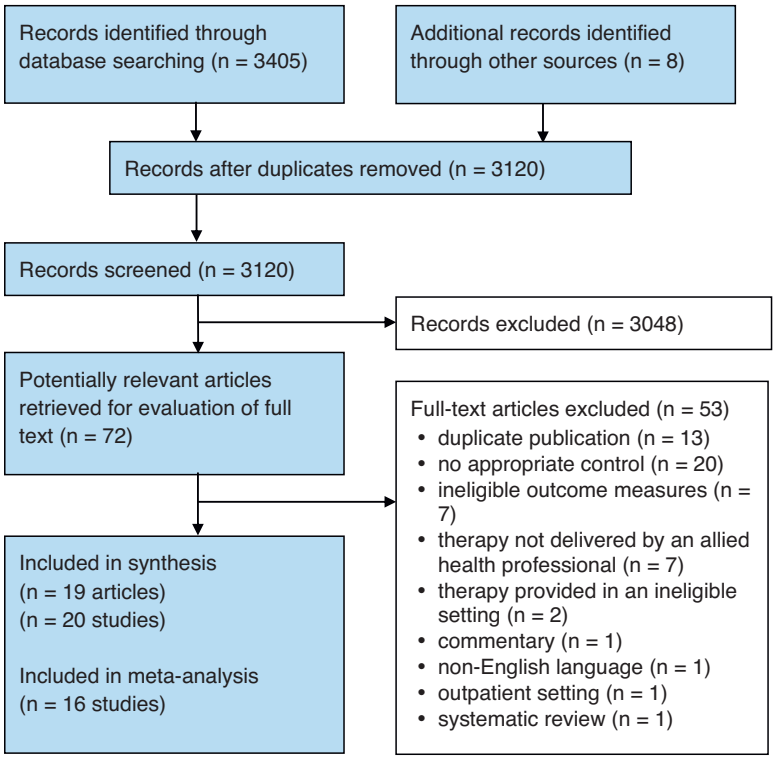

Figure 1. Flow of studies through the review.

Interventions

Provision of physiotherapy during weekends was the most examined allied health service (n = 9),[26,32–38,40] followed by combinations of: physiotherapy and occupational therapy (n = 7);[27–31,39,42] physiotherapy, occupational therapy, and social work (n = 1);[41] and physiotherapy, occupational therapy, speech pathology, dietetics, and social work (n = 3).[25,43]

Ten studies compared a Monday to Friday allied health service with a model that incorporated Saturday and Sunday services,[25,32–35,37,38,42,43] eight compared Monday to Friday with a Saturday service,[26–31,40,41] and one compared a Monday to Saturday service with a Sunday service.[39] One study compared a Monday to Friday (no weekend allied health) service with a 'new stakeholder driven' weekend model including Friday, Saturday, Sunday and Monday services.[25] In this 'new stakeholder driven service', weekend services were distributed across Friday, Saturday, Sunday and Monday. Further details of intervention and control conditions are presented in Table 2.

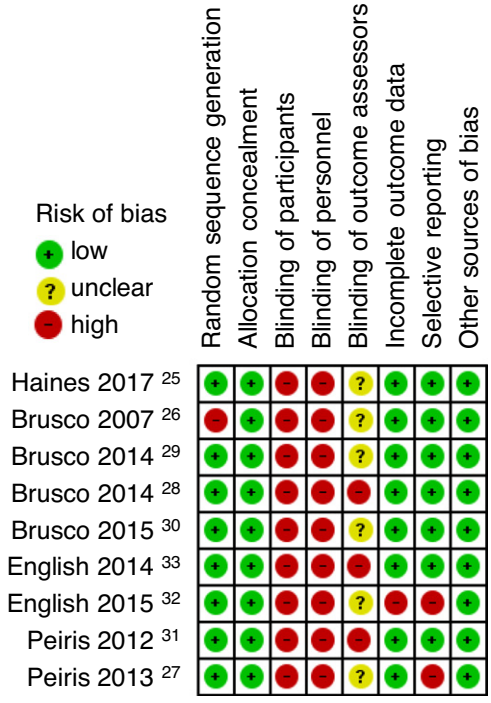

Figure 2. Risk of bias of the included randomised trials, assessed using the Cochrane Risk of Bias tool.

Effect of additional weekend allied health services

The numerical results of all meta-analyses, subgroup analyses and sensitivity analyses are presented in Tables 3, 4, 5 and 6. Streamlined forest plots are presented in the paper, and detailed forest plots are presented in Appendix 3 on the eAddenda.

Effect on hospital length of stay in the acute setting

Randomised trials

Two acute, stepped-wedge, randomised, controlled trials (n = 27 508) were identified.[25] Meta-analysis of individual participant level data in these trials demonstrated no difference between intervention and control conditions for hospital length of stay (WMD 0.08 days, 95% CI −0.15 to 0.32, I^2 = 99%), as shown in

Table 1
Risk of bias of the nine included cohort studies and one included cross-sectional study, assessed using the Newcastle-Ottawa quality assessment scale for observational studies.

Cohort study	Selection	Comparability	Outcome
Boxall 2004 [35]	****	*	**
David 2003 [38]	****	*	***
Haas 2017 [43]	****	*	***
Kinoshita 2017 [39]	****	*	***
Maidment 2014 [34]	****	*	***
Pengus 2015 [37]	***	*	**
Pua 2011 [36]	****	*	***
Caruana 2016 [40]	***	*	**
Hakkennes 2015 [41]	****	*	***
Cross-sectional study	**Selection**	**Comparability**	**Exposure**
DiSotto-Monastero 2012 [42]	****	*	***

The higher the number of stars in each column indicates lower risk of bias.
A different scale version was used for cross-sectional studies, where 'outcome' was replaced with 'exposure'.

Table 2
Detailed characteristics of the included studies.

Study	Setting	Participants [a]	Control	Intervention	Outcome
Haines et al 2017 [25] Study A RCT	Australia Acute	Mixed general medical and surgical (hospitals = 2; wards = 12; n = 14 834) Con: n = 6796, age = 61 (20) Exp: n = 8038, age = 59 (21) Hospital 1, 6 inpatient wards: orthopaedic surgery, stroke, thoracic/vascular/general surgery & medical, general medicine, head/neck/plastics, and surgical Hospital 2, 6 inpatient wards: medical (2 wards), infectious diseases/respiratory, plastics/ENT/head/neck surgery, general surgery/colorectal/breast/endocrine/urology, and general surgery/vascular/thoracic/upper gastrointestinal	No allied health services on weekends	Usual care allied health services on weekends Hospital 1 *(hrs/hospital)* Sat: PT 8, OT 3, SP 3.5, DT 2, SW 1, AHA 4 Sun: PT 11, OT 3, SP 3, DT 2, SW 1, AHA 4 Hospital 2 *(hrs/hospital)* Sat: PT 3.25, OT 3.5 Sun: PT 3.25	Primary • Hospital length of stay • Length of stay longer than expected length of stay • Hospital readmission • Adverse events Secondary • Compliments and complaints • Discharge destination • Occasions of allied health service • Cost of hospital admission • Clinical exceptions • Staff absenteeism
Haines et al 2017 [25] Study B RCT	Australia Acute	Mixed general medical and surgical (hospitals = 2; wards = 11; n = 12 674) Con: n = 6869, age = 60 (21) Exp: n = 5805, age = 60 (20) Hospital 1, 6 inpatient wards: orthopaedic surgery, stroke, thoracic/vascular/general surgery & medical, general medicine, head/neck/plastics, and surgical Hospital 2, 5 inpatient wards: medical (2 wards), infectious diseases/respiratory, plastics/ENT/head/neck surgery, general surgery/colorectal/breast/endocrine/urology, and general surgery/vascular/thoracic/upper gastrointestinal	No allied health services on weekends	Newly developed stakeholder-driven weekend allied health service Hospital 1 *(hrs/hospital)* Fri: PT 8, OT 4, AHA 4 Sat: PT 3.5, OT 2, SP 3.5, DT 1, SW 1 Sun: PT 7, OT 2, SP 3, DT 1, SW 1, AHA 4 Mon: PT 4, OT 4 Hospital 2 *(hrs/hospital)* Sat: ICU PT 1, IRS 4, SP 2 Sun: ICU PT 1	Primary • Hospital length of stay • Length of stay longer than expected length of stay • Hospital readmission • Adverse events Secondary • Compliments and complaints • Discharge destination • Occasions of allied health service • Cost of hospital admission • Clinical exceptions • Staff absenteeism
Brusco et al 2007 [26] RCT	Australia Sub-acute	Mixed rehabilitation (wards = 2; n = 262) Con: n = 132, age = 77 (13) Exp: n = 130, age = 77 (13)	5-day weekday physiotherapy *(daily hrs/patient)* PT 1	Additional Saturday physiotherapy *(hrs/patient)* PT 1	Primary • Hospital length of stay • Physiotherapy length of stay Secondary • EuroQol • Functional Independence Measure • Functional reach • 10-m Walk Test • Timed Up and Go test • Motor Assessment Scale • Knee and hip range of motion • Discharge destination • Adverse events • Follow-up therapy

Table 2 (*Continued*)

Study	Setting	Participants [a]	Control	Intervention	Outcome
Brusco et al 2014 [29] RCT	Australia Sub-acute	Mixed rehabilitation (hospitals = 2; beds = 90; n = 996) Con: n = 500, age = 74 (13) Exp: n = 496, age = 75 (13)	5-day weekday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	Additional Saturday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	• Health service and therapy utilisation (30-day follow-up) • Cost of inpatient rehabilitation (30-day follow-up)
Brusco et al 2014B [28] RCT	Australia Sub-acute	Mixed rehabilitation (hospitals = 2; beds = 90; n = 137) Con: n = 63, age = 61 (13) Exp: n = 74, age = 63 (12)	5-day weekday physiotherapy and occupational therapy (daily hours per patient) PT 1, OT 1	Additional Saturday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	Primary • Return to work • Average hours worked • Paid income Secondary • Functional Independence Measure • EuroQol-5D • Hospital length of stay
Brusco et al 2015 [30] RCT	Australia Sub-acute	Mixed rehabilitation (hospitals = 2; beds = 90; n = 996) Con: n = 500, age = 74 (13) Exp: n = 496, age = 75 (13)	5-day weekday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	Additional Saturday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	• Health service and therapy utilisation (12-month follow-up) • Cost of inpatient rehabilitation (12-month follow-up)
English et al 2014 [33] RCT	Australia Sub-acute	Stroke rehabilitation (centres = 5; n = 21) Con: n = 10, age = N/S Exp: n = 11, age = N/S	Usual care physiotherapy (recruitment sites) Individual therapy 5 days per week (3/5 sites) Individual or group therapy between 1 to 4 days per week (2/5 sites) Weekend therapy for some patients (2/5 sites)	7-day physiotherapy *(daily duration/patient)* PT (matched to preceding week)	• Therapy duration • Reasons for shortened therapy • Reasons for non-attendance • Activity across day • Activity during therapy • Activity outside therapy • Activity location • Activity with people present
English et al 2015 [32] RCT	Australia Sub-acute	Stroke rehabilitation (centres = 5; n = 190) Con: n = 94, age = 68 (13) Exp: n = 96, age = 72 (12)	Usual care physiotherapy (recruitment sites) Individual therapy 5-days per week (3/5 sites) Individual or group therapy between 1 to 4 days per week (2/5 sites) Weekend therapy for some patients (2/5 sites)	7-day physiotherapy *(daily duration/patient)* PT (matched to preceding week)	Primary • Six-minute walk test Secondary • Walking speed • Functional ambulation category • Functional Independence Measure • Wold Motor Function test • Stroke Impact Scale physical subscale • Hospital length of stay • Assessment of quality of life • Adverse events • Resource utilisation

Table 2 (*Continued*)

Study	Setting	Participants [a]	Control	Intervention	Outcome
Peiris et al 2012 [31] RCT	Australia Sub-acute	Mixed rehabilitation (hospitals = 2; beds = 90; n = 105) Con: n = 54, age = 73 (13) Exp: n = 51, age = 75 (12)	5-day weekday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	Additional Saturday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	Primary • Steps per day • Time spent upright Secondary • Time spent inactive • Activity completed in therapy
Peiris et al 2013 [27] RCT	Australia Sub-acute	Mixed rehabilitation (hospitals = 2; beds = 90; n = 996) Con: n = 500, age = 74 (13) Exp: n = 496, age = 75 (13)	5-day weekday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	Additional Saturday physiotherapy and occupational therapy *(daily hrs/patient)* PT 1, OT 1	Primary • Functional Independence Measure • EuroQol-5D • Hospital length of stay Secondary • Personal Care-Participation Assessment and Resource Tool • 10-m Walk Test • Timed Up and Go test • Modified Motor Assessment Scale • Discharge destination • Follow-up therapy • Adverse events
Boxall et al 2004 [35] Cohort	Australia Acute	Orthopaedic (wards = 1; n = 240) Con: n = 120, age = 68 Exp: n = 120, age = 68	5-day weekday physiotherapy	7-day physiotherapy service	• Hospital length of stay • Days to independent transfers • Days to independent mobility • Reasons for delayed discharge •Discharge destination • Pre-admission clinic attendance
David et al 2003 [38] Cohort	England Acute	Rheumatology (wards = 1; beds = 28; n = 361) Con: n = 146, age = N/S Exp: n = 215, age = N/S	5-day weekday physiotherapy *(total EFT)* PT 2, AHA 0.3	Additional weekend physiotherapy *(total EFT)* PT 0.2, AHA 0.4	• Number of rheumatology admissions • Hospital length of stay • Day of admission and discharge • Staff cost and utilisation
Haas et al 2017 [43] Cohort	Australia Acute	Orthopaedic (wards = 2; beds = 48; n = 276) Con: n = 146, age = 69 (10) Exp: n = 130, age = 68 (11)	5-day weekday allied health service: physiotherapy, occupational therapy, speech pathology, dietetics, and social work	Saturday and Sunday allied health: physiotherapy, occupational therapy, speech pathology, dietetics, and social work	• Hospital length of stay • Adverse events • Discharge destination • Time to first postoperative transfer • Staff profession assisting first postoperative transfer • Physiotherapy session rate • Time to first postoperative physiotherapy session • Modified Barthel Index • De Morton Mobility Index • EuroQol-5D utility • EuroQol-5D VAS • Patient satisfaction • Pain • Opioid use

Table 2 (*Continued*)

Study	Setting	Participants [a]	Control	Intervention	Outcome
Kinoshita et al 2017 [39] Cohort	Japan Acute	Stroke (hospitals = 14; n = 3072) Con: n = 1997, age = 73 (13) [b] Exp: n = 1075, age = 74 (12) [b]	5-day or 6-day physiotherapy and occupational therapy	7-day physiotherapy and occupational therapy	• Modified Rankin Scale • Hospital length of stay • Adverse events • Discharge destination
Maidment et al 2014 [34] Cohort	Australia Acute	Orthopaedic (ward = 1; n = 145) Con: n = 59, age = 72 (8) [b] Exp: n = 86, age = 69 (7) [b]	5-day physiotherapy service	7-day physiotherapy service	• Physiotherapy length of stay • Hospital length of stay • Number of physiotherapy sessions • Reasons for delayed discharge
Pengas et al 2015 [37] Cohort	Scotland Acute	Orthopaedic (n = 792) Con: n = 600, age = N/S Exp: n = 192, age = N/S	5-day weekday physiotherapy	Additional Saturday and Sunday physiotherapy provided by an allied health assistant *(daily hours)* AHA 3	• Days to mobilising with two sticks • Hospital length of stay • Time to achieve 90° knee flexion • Range of motion
Pua et al 2011 [36] Cohort	Singapore Acute	Orthopaedic (n = 155) Con: n = 82, age = 65 (7) Exp: n = 73, age = 66 (8)	6-day Monday to Saturday physiotherapy *(daily OOS)* PT 1	Additional Sunday physiotherapy	• Hospital length of stay • Passive range of motion - knee • Straight leg raise • Independent mobility
Caruana et al 2016 [40] Cohort	Australia Sub-acute	Mixed rehabilitation (ward = 1; beds = 40; n = 270) Con: n = 108, age = 75 (4) Exp: n = 162, age = 78 (12)	5-day Monday to Friday physiotherapy, occupational therapy, speech pathology, and dietetics	Additional Saturday physiotherapy *(daily hours)* PT and AIN 4	Primary • Hospital length of stay Secondary • Functional Independence Measure • Timed Up and Go test • 10-m Walk Test • Functional reach • Step test • Feet together eyes closed • Balance Outcome Measure for Elder Rehabilitation
DiSotto-Monastero et al 2012 [42] Cross-sectional	Canada Sub-acute	Mixed rehabilitation (n = 3500) Con: n = 1692, age = 72 (13) Exp: n = 1808, age = 72 (14)	5-day physiotherapy and occupational therapy	7-day physiotherapy and occupational therapy	• Functional Independence Measure • Number of admissions and discharges • Hospital length of stay • Rehabilitation workload
Hakkennes et al 2015 [41] Cohort	Australia Sub-acute	Mixed rehabilitation (hospital = 1; beds = 100; n = 976) Con: n = 499, age = 78 (10) [b] Exp: n = 477, age = 78 (12) [b]	5-day weekday therapy	Additional Saturday physiotherapy, occupational therapy, and social work *(daily hrs/hospital)* PT 20, OT 16, SW 8, AHA 6	• Functional Independence Measure • Hospital length of stay • Number of admissions on Saturday

AHA = allied health assistant, AIN = assistant in nursing, Con = control group, DT = dietician, Exp = experimental group, ICU = Intensive Care Unit, IRS = Immediate Response Service, n = number of patients, N/S = not stated, OOS = occasions of service, OT = occupational therapist, PT = physiotherapist, RCT = randomised, controlled trial, SP = speech pathologist, SW = social worker.

[a] Age is presented as mean (SD) in years.

[b] Converted from median (range/inter-quartile range) to mean (SD).

Table 3
Randomised, controlled trial meta-analysis investigating the effect of weekend allied health on acute general medical and surgical wards.

Outcome	Weighted mean difference (95% CI) I^2	Risk difference (95% CI) I^2
Hospital length of stay *(days)*	−0.08 (−0.32 to 0.15) 99%	
Hospital length of stay *(log transformed)*	−0.02 (−0.05 to 0.02) 88%	
Proportion of patients staying longer than expected		0.00 (−0.02 to 0.02) 78%
Unplanned hospital readmissions within 28 days		0.01 (0.00 to 0.02) 43%
Proportion of patients with any adverse event		0.00 (−0.01 to 0.01) 83%
Proportion of patients discharged to aged care		0.00 (0.00 to 0.01) 31%
Cost to healthcare system per admission *(AUD)*	−118 (−511 to 274) 99%	

Total effect size for continuous outcomes calculated from participant level data, and total effect size for proportion outcomes were calculated from cluster level data. Positive values favour intervention. Negative values favour control.
No subgroup or sensitivity analysis were performed because only two randomised trials in the acute setting were identified.

Figure 3a. When patient diagnosis was taken into account, there was no difference in the proportion of patients whose hospital length of stay was longer than their expected length of stay between intervention and control conditions using cluster-level data (RD 0.00 days; 95% CI −0.02 to 0.02, I^2 = 79%), as shown in Figure 4. High levels of heterogeneity in the study results were examined in post-hoc exploratory analysis by Haines et al,[25] suggesting that there was a significant change in hospital length of stay outcomes between control conditions, but when intervention conditions were compared, there was no significant difference between patient hospital length of stay outcomes.[25]

Non-randomised studies and subgroup analyses

These meta-analyses results were somewhat concordant with those involving non-randomised studies. Meta-analysis (n = 4676) of six acute non-randomised, controlled trials[34–39,43] showed no effect of providing weekend allied health services on hospital length of stay (WMD 0.24 days, 95% CI −0.17 to 0.66, I^2 = 96%), as shown in Figure 3b. Heterogeneity levels were reduced when subgroup analysis of total hip arthroplasty patients was performed (WMD 0.08 days, 95% CI −0.12 to 0.29, I^2 = 24%), which was possible using data from three studies[34,35,37] (Table 4).

Effect on hospital length of stay in the subacute setting

Randomised trials

Meta-analysis (n = 1437) of three randomised, controlled trials[26,27,32] conducted in the subacute setting indicated that weekend allied health services reduced subacute hospital length of stay (WMD 2.35 days, 95% CI 0.45 to 4.24, I^2 = 0.0%), as shown in Figure 3c.

Non-randomised studies and subgroup analyses

The results from the randomised trials in the subacute setting were somewhat concordant with non-randomised studies. A meta-analysis (n = 5012) of three subacute non-randomised, controlled trials[40–42] showed a trend towards reduced hospital length of stay in favour of weekend allied health provision (WMD 0.49 days, 95% CI −0.87 to 1.85, I^2 = 83%), as shown in Figure 3d. However, high levels of heterogeneity in study results were observed between studies.

Effect on hospital readmissions in the acute setting

Randomised trials

Meta-analysis (n = 27 508) of cluster-level data from two acute, stepped-wedge, randomised, controlled trials[25] showed no significant difference in the proportion of patients who had an unplanned hospital re-admission within 28 days of hospital discharge between groups with available and unavailable weekend allied health services (RD 0.01, 95% CI 0.00 to 0.02, I^2 = 43%), as shown in Figure 5.

Non-randomised studies

This was consistent with the results of one non-randomised trial that also demonstrated no between-group difference in unplanned hospital re-admission within 6 weeks of discharge.[39]

Effect on hospital readmissions in the subacute setting

Meta-analysis was unable to be performed for this outcome in either randomised or non-randomised trials in the subacute setting. However, one subacute randomised, controlled trial reported no difference between intervention and control conditions for hospital re-admission within 30 days of discharge.[29]

Effect on adverse events in the acute setting

Randomised trials

Meta-analysis (n = 27 508) of cluster-level data from two acute, stepped-wedge, randomised, controlled trials[25] indicated no statistically significant difference in the proportion of patients experiencing adverse events (n = 2464) for the events measured (falls, pressure injuries, pulmonary embolism, deep vein thrombosis, rapid response medical team call, transfer to intensive care, transfer to high dependency unit, and death) between those receiving and not receiving weekend allied health services (RD 0.00, 95% CI −0.01 to 0.01, I^2 = 83%), as shown in Figure 6a. High levels of heterogeneity in the study results were examined in post-hoc exploratory analysis by Haines et al,[25] suggesting that there was a significant change in patients experiencing any adverse event between control conditions; however, when intervention conditions were compared, there was no significant difference.[25]

Non-randomised studies and subgroup analyses

The results from randomised trials were concordant with those from two acute non-randomised, controlled trials,[39,43] for which meta-analysis (n = 3348) showed no effect of weekend allied health on the number of adverse events (n = 135) for the events measured (falls, pressure injuries, pulmonary embolism, deep vein thrombosis, rapid response medical team calls, transfer to intensive care or high dependency unit, and deaths) between those receiving and not receiving weekend allied health services (RR 1.18, 95% CI 0.51 to 2.73, I^2 = 78%), as shown in Figure 6b. However, high levels of heterogeneity in study results were observed between studies.

Effect on adverse events in the subacute setting

Randomised trials

Meta-analysis (n = 1437) of three subacute randomised, controlled trials[26,27,32] indicated no difference between weekend and no weekend allied health for the number of adverse events (n = 303) for the adverse events measured (falls, skin tears, infections, re-admission to acute service, and death) between those receiving and not receiving weekend allied health services (RR 1.13, 95% CI 0.92 to 1.39, I^2 = 0%), as shown in Figure 6c.

Table 4
Non-randomised, controlled trial meta-analyses, subgroup meta-analyses, and sensitivity analyses investigating the effect of weekend allied health services on acute general medical and surgical hospital wards.

Outcome	Total effect size (95% CI) I^2	Sub-group analyses (95% CI) I^2					Sensitivity analyses (95% CI) I^2		
		Orthopaedic	Orthopaedic total knee arthroplasty	Orthopaedic total hip arthroplasty	Neurological	Studies with PT service only (no other professions)	Studies with identified selection bias removed	Studies with identified outcome bias removed	Studies where data were estimated due to inadequate reporting removed
Hospital length of stay, WMD *(days)*	0.24 (–0.17 to 0.66) 96%	0.51 (0.26 to 0.76) 84%	0.49 (0.11 to 0.87) 90%	0.08 (–0.12 to 0.29) 24%	–0.50 (–0.74 to –0.26) N/A[a]	0.66 (0.49 to 0.83) 68%	0.22 (–0.27 to 0.72) 96%	0.18 (–0.33 to 0.69) 97%	–0.04 (–1.45 to 1.38) 49%
Adverse events, RR	1.18 (0.51 to 2.73) 78%	0.74 (0.39 to 1.41) N/A[a]	No studies	No studies	1.75 (1.11 to 2.75) N/A[a]	No studies	1.18 (0.51 to 2.73) 78%	1.18 (0.51 to 2.73) 78%	1.75 (1.11 to 2.75) N/A[a]
Patients discharged home, RR	1.19 (1.03 to 1.38) 59%	1.22 (0.87 to 1.72) 80%	No studies	No studies	1.17 (1.08 to 1.38) N/A[a]	1.04 (0.86 to 1.25) N/A[a]	1.19 (1.03 to 1.38) 59%	1.27 (1.03 to 1.57) 66%	1.19 (1.03 to 1.38) 59%
Functional independence, SMD	0.19 (–0.12 to 0.50) 77%	0.19 (–0.12 to 0.50) 77%	0.39 (0.15 to 0.64) 0%	0.31 (0.12 to 0.51) 0%	No studies	0.34 (0.19 to 0.49) 0%	0.09 (–0.33 to 0.52) 71%	–0.10 (–0.35 to 0.15) N/A[a]	0.09 (–0.33 to 0.52) 71%

N/A = not applicable, PT = physiotherapist, SMD = standardised mean difference, WMD = weighted mean difference.
Positive values favour intervention. Negative values favour control.
[a] I^2 could not be calculated where data from only one study were available.

Table 5
Randomised, controlled trial meta-analyses, subgroup meta-analyses, and sensitivity analyses investigating the effect of weekend allied health services on subacute rehabilitation wards.

Outcome	Total effect size (95% CI) I^2	Sub-group analyses (95% CI) I^2		Sensitivity analyses (95% CI) I^2					
		Mixed rehabilitation	Neurological rehabilitation	Studies with PT service only (no other professions)	Studies with identified bias for random sequence generation removed	Studies with identified bias for blinding of outcome assessment removed	Studies with identified bias for incomplete outcome data removed	Studies with identified bias for selective reporting removed	Studies where data estimated due to inadequate reporting removed
Hospital length of stay, WMD *(days)*	2.35 (0.45 to 4.24) 0%	2.33 (0.42 to 4.25) 0%	3.00 (−11.12 to 17.12) N/A[a]	3.19 (−0.32 to 6.70) 0%	2.03 (−0.20 to 4.25) 0%	2.03 (−0.20 to 4.25) 0%	2.33 (0.42 to 4.25) 0%	3.20 (−0.43 to 6.83) N/A[a]	2.35 (0.45 to 4.24) 0%
Adverse events, RR	1.13 (0.92 to 1.39) 0%	1.18 (0.95 to 1.46) 0%	0.77 (0.38 to 1.53) N/A[a]	1.01 (0.70 to 1.46) 0%	1.08 (0.75 to 1.45) 30%	1.08 (0.75 to 1.45) 0%	1.18 (0.95 to 1.46) 0%	1.12 (0.73 to 1.73) N/A[a]	1.13 (0.92 to 1.40) 0%
Functional independence, SMD	0.09 (−0.01 to 0.19) 0%	0.09 (−0.02 to 0.20) 0%	0.07 (−0.22 to 0.37) N/A[a]	0.06 (−0.13 to 0.24) 0%	0.10 (−0.01 to 0.21) 0%	0.10 (−0.01 to 0.21) 0%	0.09 (−0.02 to 0.20) 0%	0.04 (−0.20 to 0.29) N/A[a]	0.09 (0.01 to 0.19) 0%
Functional walking speed, SMD	3.36 (0.56 to 6.15) 100%	5.07 (−4.89 to 15.04) 100%	0.12 (−0.17 to 0.42) N/A[a]	5.14 (−4.71 to 14.98) 100%	0.03 (−0.11 to 0.16) 0%	0.03 (−0.11 to 0.16) 0%	5.07 (−4.89 to 15.04) 100%	10.17 (9.26 to 11.08) N/A[a]	3.36 (0.56 to 6.15) 100%
Functional stroke outcomes, SMD	0.03 (−0.20 to 0.26) 0%	−1.05 (−4.95 to 2.86) 43%	0.07 (−0.26 to 0.40) N/A[a]	−1.03 (−5.04 to 2.97) 45%	0.03 (−0.20 to 0.26) 0%	0.03 (−0.20 to 0.26) 0%	−1.05 (−4.95 to 2.86) 43%	−4.83 (−11.98 to 2.31) N/A[a]	0.03 (−0.20 to 0.26) 0%
Functional mobility, SMD	0.06 (−0.09 to 0.21) 18%	0.01 (−0.13 to 0.14) 0%	0.27 (−0.03 to 0.57) N/A[a]	0.16 (−0.08 to 0.38) 14%	0.10 (−0.15 to 0.36) 59%	0.10 (−0.15 to 0.36) 59%	0.01 (−0.13 to 0.14) 0%	0.03 (−0.27 to 0.34) N/A[a]	0.06 (−0.09 to 0.21) 0%
Quality of life, SMD	0.10 (−0.01 to 0.20) 0%	0.12 (0.00 to 0.23) 0%	−0.03 (−0.33 to 0.28) N/A[a]	0.08 (−0.11 to 0.27) 0%	0.09 (−0.03 to 0.20) 0%	0.09 (−0.03 to 0.20) 0%	0.12 (−0.01 to 0.23) 0%	0.15 (−0.10 to 0.39) N/A[a]	0.10 (−0.01 to 0.20) 0%

N/A = not applicable, PT = physiotherapist, SMD = standardised mean difference, WMD = weighted mean difference.
Positive values favour intervention. Negative values favour control.
[a] I^2 could not be calculated where data from only one study were available.

Table 6
Non-randomised, controlled trial meta-analyses and sensitivity analyses investigating the effect of weekend allied health services on subacute rehabilitation wards.

Outcome	Total effect size (95% CI) I^2	Sensitivity analyses (95% CI) I^2			
		Studies with PT service only (no other professions)	Studies with identified selection bias removed	Studies with identified outcome bias removed	Studies where data were estimated due to inadequate reporting removed
Hospital length of stay, WMD *(days)*	0.49 (−0.87 to 1.85) 83%	1.70 (−0.52 to 3.92) N/A[a]	0.18 (−1.29 to 1.64) 88%	0.18 (−1.29 to 1.64) 88%	1.11 (0.22 to 2.00) 0%
Patients discharged to aged care, RR	1.00 (0.75 to 1.34) 0%	No studies	1.00 (0.75 to 1.34) 0%	1.00 (0.75 to 1.34) 0%	1.00 (0.75 to 1.34) 0%
Functional independence, SMD	0.05 (−0.17 to 0.28) 89%	−0.21 (−0.45 to 0.04) N/A[a]	0.15 (−0.11 to 0.42) 93%	0.15 (−0.11 to 0.42) 93%	−0.06 (−0.28 to 0.16) 69%

N/A = not applicable, PT = physiotherapist, SMD = standardised mean difference, WMD = weighted mean difference.
Positive values favour intervention. Negative values favour control.
[a] I^2 could not be calculated where data from only one study were available.

Effect on discharge destination in the acute setting

Randomised trials

Meta-analysis (n = 27 508) of cluster-level data from two acute, stepped-wedge, randomised, controlled trials[25] indicated no difference in the proportion of patients discharged to aged care between those receiving and not receiving weekend allied health services (RD 0.00, 95% CI −0.00 to 0.01; I^2 = 31%), as shown in Figure 7a.

Non-randomised studies and subgroup analyses

This result was somewhat discordant with those from three acute non-randomised studies[35,39,43] (n = 3588), where a meta-analysis showed that patients receiving weekend allied health may have been more likely to be discharged home to private residence from hospital (RR 1.19, 95% CI 1.03 to 1.38, I^2 = 59%), as shown in Figure 7b. However, high levels of heterogeneity in study results were observed between studies.

Effect on discharge destination in the subacute setting

Randomised trials

Meta-analysis was not possible for randomised trials in the subacute setting. However, one subacute randomised, controlled trial reported no difference between intervention and control conditions for the number of patients discharged to aged care.[26]

Non-randomised studies and subgroup analyses

This result was concordant with those from two subacute non-randomised studies[41,42] (n = 4476), for which meta-analysis showed no effect of weekend allied health on the relative risk of patients being discharged to aged care (RR 1.00, 95% CI 0.75 to 1.34, I^2 = 0%), as shown in Figure 7c.

Effect on functional independence in the acute setting

Randomised trials

Meta-analysis was not possible for this outcome in randomised trials in the acute setting.

Non-randomised studies and subgroup analyses

Functional independence with activities of daily living were measured in three acute non-randomised, controlled trials.[35,37,43] The Barthel Index, 'days to mobilising with two sticks', and 'days to independent mobility' were transformed to conform to the same effect direction. These were then pooled and categorised as functional activities of daily living outcomes. Meta-analysis of three acute non-randomised studies (n = 1201) showed no difference in functional independence between those who had weekend allied health services available and those who did not (SMD 0.19, 95% CI −0.12 to 0.50, I^2 = 77%), as shown in Figure 8a. Heterogeneity levels were reduced when subgroup analysis of only total hip arthroplasty patients (SMD 0.31, 95% CI 0.12 to 0.51, I^2 = 0%), total knee arthroplasty patients (SMD 0.39, 95% CI 0.15 to 0.64, I^2 = 0%), or studies examining only physiotherapy (no other professions) was performed (SMD 0.34, 95% CI 0.19 to 0.49, I^2 = 0%), as shown in Table 5.

Effect on functional independence in the subacute setting

Randomised trials

The Functional Independence Measure was pooled and categorised as a functional activity of daily living outcome measured in three subacute randomised, controlled trials.[26,27,32] The Timed Up and Go test, and the Wolf Motor Function Test were transformed to conform to the same effect direction. These were then pooled and categorised as functional mobility outcomes measured in three subacute randomised, controlled trials.[26,27,32] Walking speed and 10-Metre Walk Test were transformed to conform to the same effect direction. These were then pooled and categorised as functional walking speed outcomes measured in three subacute randomised, controlled trials.[26,27,32] The Motor Assessment Scale and the physical dimension of the Stroke Impact Scale were transformed to conform to the same effect direction. These were then pooled and categorised as stroke-specific functional outcomes in three subacute non-randomised, controlled trials.[26,27,32] Measurement time points were grouped prior to inpatient discharge.

Meta-analysis (n = 1437) showed a trend towards improved functional activities of daily living taken prior to hospital discharge in favour of weekend allied health service provision, although this was not statistically significant (SMD 0.09, 95% CI −0.01 to 0.19, I^2 = 0%), as shown in Figure 8b. No difference was identified between intervention and control conditions in meta-analyses of functional mobility (n = 335), walking speed (n = 438), and stroke-specific outcome measures (n = 210).

Non-randomised studies and subgroup analyses

The Functional Independence Measure was pooled and categorised as a functional activity of daily living outcome measure in three subacute non-randomised, controlled trials.[40–42] Results from meta-analysis of randomised, controlled trials were somewhat concordant with meta-analysis of three subacute non-randomised, controlled trials (n = 4746), which showed no statistically significant difference between weekend and no weekend allied health for functional activities of daily living outcome measures (SMD 0.05, 95% CI −0.17 to 0.28, I^2 = 89%), as shown in Figure 8c. However, high levels of heterogeneity in study results were observed between studies.

Effect on quality of life in the acute setting

Meta-analysis was not possible for this outcome in randomised or non-randomised trials in the acute setting. No randomised trials reported health-related quality of life in the acute setting, and one non-randomised trial demonstrated no difference in quality of life

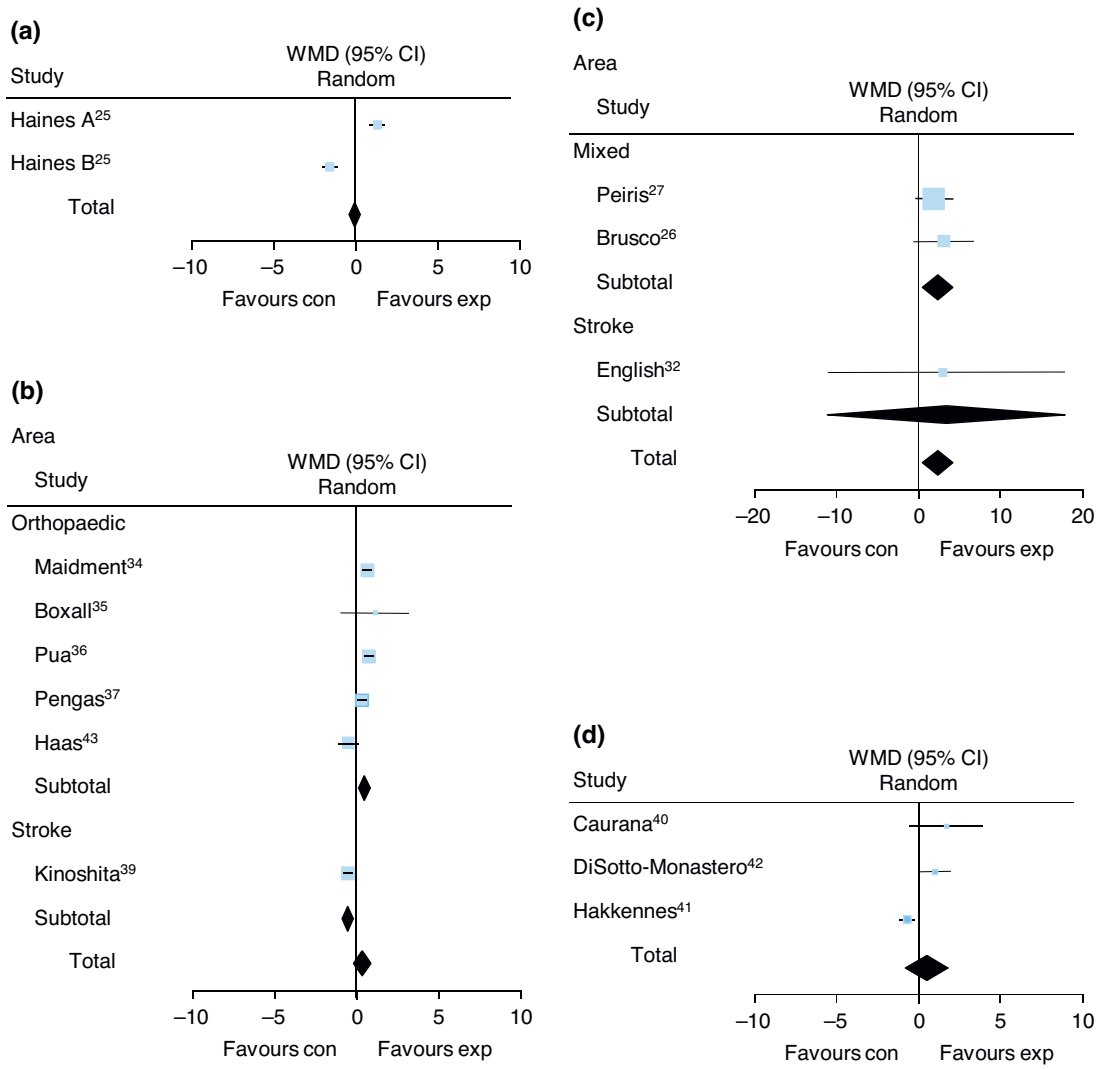

Figure 3. Weighted mean difference (95% CI) in the effect of weekend allied health on hospital length of stay: (a) acute randomised, controlled trials, calculated from participant-level data; (b) acute non-randomised, controlled trials; (c) subacute randomised, controlled trials; (d) subacute non-randomised, controlled trials.

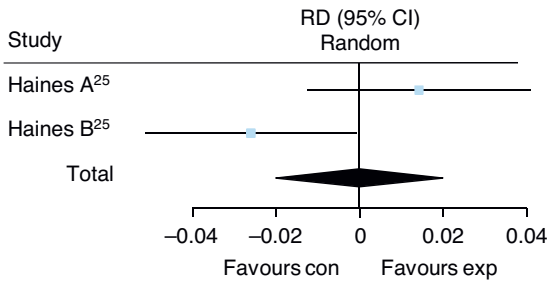

Figure 4. Risk difference (95% CI) in acute randomised, controlled trials of the effect of weekend allied health on proportion of patients whose hospital length of stay was longer then their expected length of stay.

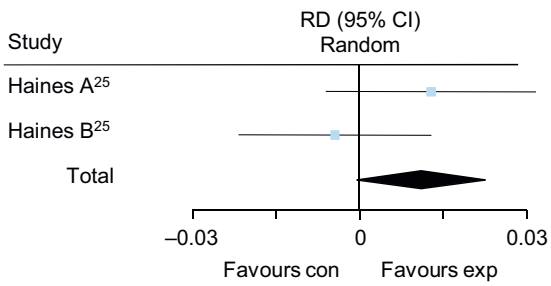

Figure 5. Risk difference (95% CI) in acute randomised, controlled trials of the effect of weekend allied health on hospital readmission.

at 4 days postoperatively between weekend and no-weekend allied health groups.[43]

Effect on quality of life in the subacute setting

In three subacute randomised, controlled trials, the EuroQol Five Dimensions questionnaire and Assessment of Quality of Life were pooled and categorised as health-related quality of life outcome measures taken prior to discharge.[26,27,32] Meta-analysis (n = 1423) indicated a trend towards improved health-related quality of life in favour of weekend allied health service provision (SMD 0.10, 95% CI –0.01 to 0.20, I^2 = 0%), as shown in Figure 9. Although this result was not statistically significant, it indicated possible improved efficiency, as improvements in quality of life may have been achieved during a shorter length of hospital stay.

Effect on cost of hospital care in the acute setting

Randomised trials

Meta-analysis (n = 27 508) of individual participant level data from two acute, stepped-wedge, randomised, controlled trials[25] indicated no difference in patient cost to the healthcare system per hospital admission between those with weekend allied health services available and unavailable (WMD AUD118, 95% CI –274.5 to 510.5, I^2 = 99%), as shown in Figure 10. Clinical costing data were captured using routinely applied hospital data collection and resource allocation procedures, largely driven by hospital length of stay and procedures performed, which do not take into consideration cost

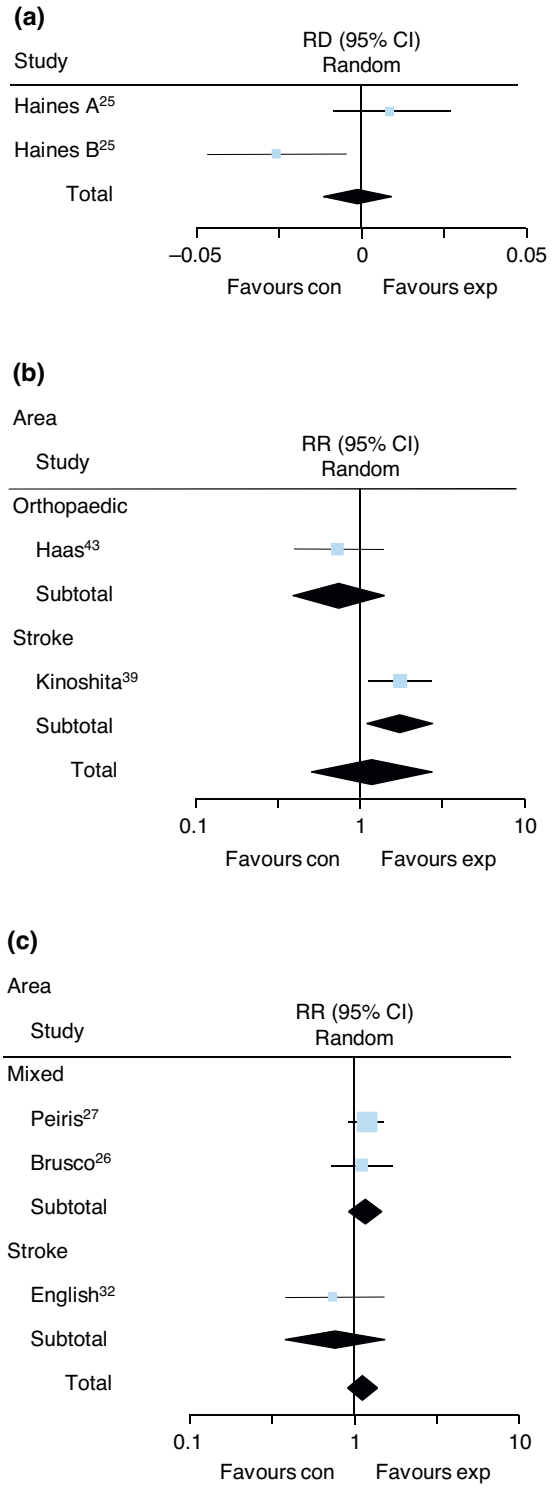

Figure 6. Effect of weekend allied health on adverse events, calculated as risk difference (95% CI) in: (a) acute randomised, controlled trials, calculated from cluster-level data, and calculated as relative risk (95% CI); (b) acute non-randomised, controlled trials; and (c) subacute randomised, controlled trials.

relative to patient diagnosis. High levels of heterogeneity in the study results were explained in exploratory analysis by Haines et al,[25] indicating that there was a significant change in total cost favouring the original weekend allied health service delivery model, although these outcomes did not account for differences in patient diagnosis categories between phases.[25]

Effect on cost of hospital care in the subacute setting

Meta-analysis was not possible for this outcome in randomised or non-randomised trials in the subacute setting. However, one subacute

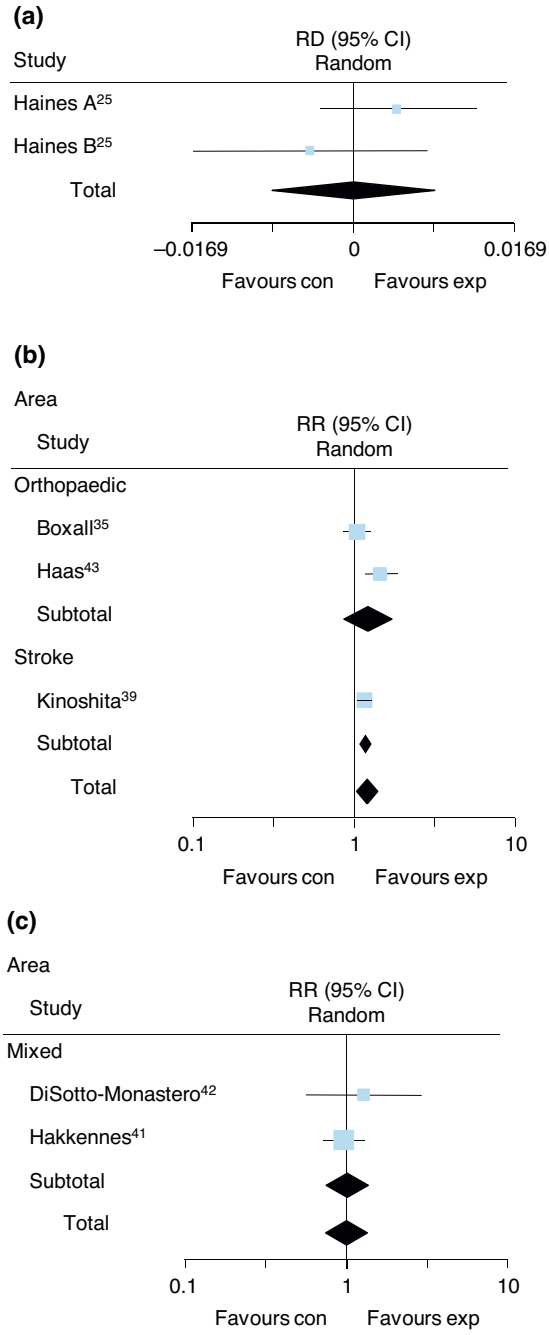

Figure 7. Effect of weekend allied health on discharge destination, calculated as risk difference (95% CI) in: (a) acute randomised, controlled trials, calculated from cluster-level data, and calculated as relative risk (95% CI); (b) acute non-randomised, controlled trials; and (c) subacute non-randomised, controlled trials.

randomised, controlled trial reported economic outcomes at 3-month, 6-month and 12-month follow-up.[29,30] At 3-month follow-up post hospital discharge, there was a mean cost saving of AUD1673 favouring weekend allied health service provision. An incremental cost utility ratio saving of AUD41 825 per quality of life year gained, and an incremental cost-effectiveness ratio found a saving of AUD16 003 in achieving a minimal clinically important difference in functional independence for the group receiving additional weekend allied health service provision. If willingness to pay per quality of life year gained or minimal clinically important difference in functional independence was AUD0, the probability of cost-effectiveness would be 96 and 95%, respectively. A sensitivity analysis removing the Saturday penalty rate salary loading of 50% did not alter the results of the primary analysis. At 6-month follow-up there was a mean cost saving of AUD6445 favouring weekend allied health service provision; however, this saving was no longer significant at 12-month follow-up. The incremental cost-effectiveness

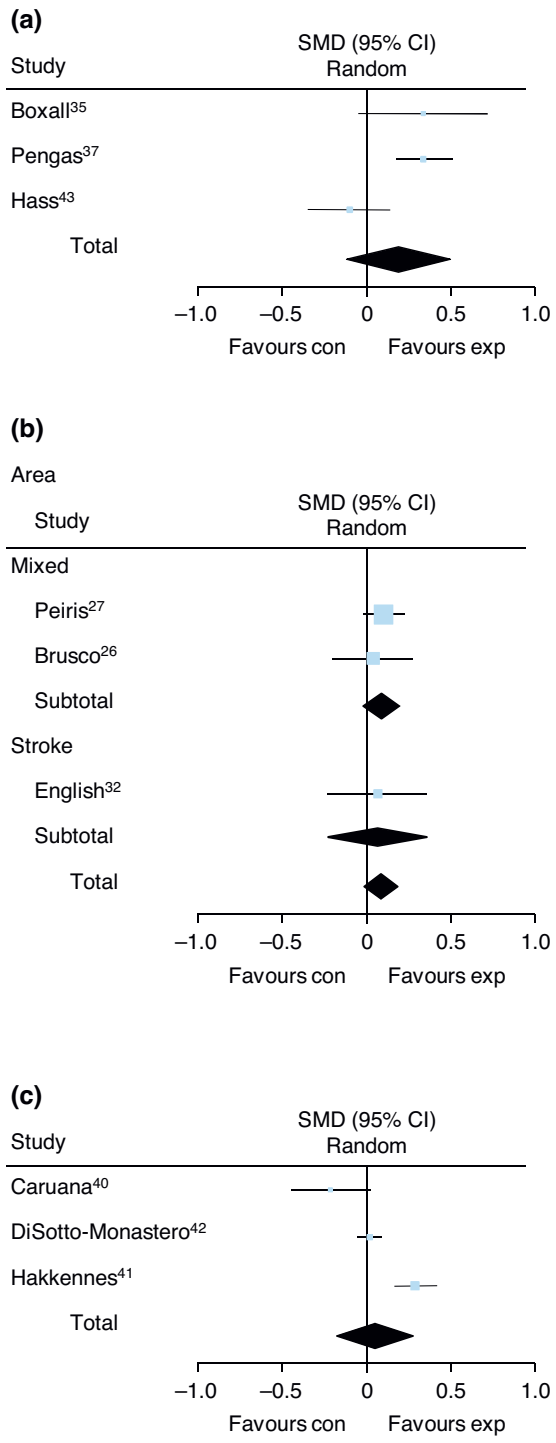

Figure 8. Standardised mean difference (95% CI) in the effect of weekend allied health on functional independence in: (a) acute non-randomised, controlled trials; (b) subacute randomised, controlled trials; and (c) subacute non-randomised, controlled trials.

ratio found a saving of AUD41 825 (95% CI –2817 to 74 620) per quality of life year gained for the weekend allied health group at 6 months.

Discussion

This meta-analysis supported previous syntheses showing that allied health rehabilitation therapy services improve patient outcomes.[12,15,45] This is the first review to show that benefits can be achieved in the subacute rehabilitation setting by providing additional allied health services on weekends. The same benefits have not been demonstrated by additional weekend nursing and medical staffing in the subacute rehabilitation setting. A study examining the effect of additional rehabilitation provided by

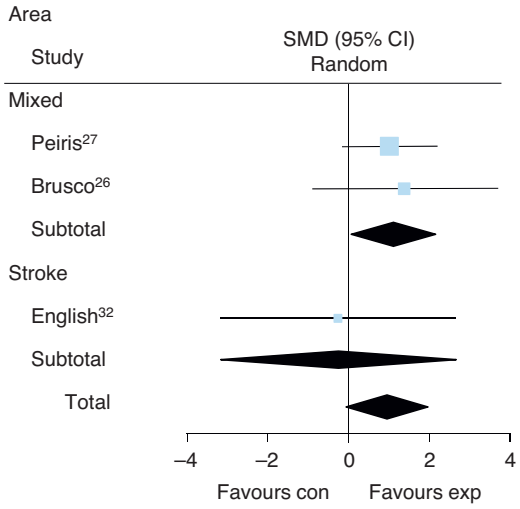

Figure 9. Standardised mean difference (95% CI) in subacute randomised, controlled trials of the effect of weekend allied health on health-related quality of life.

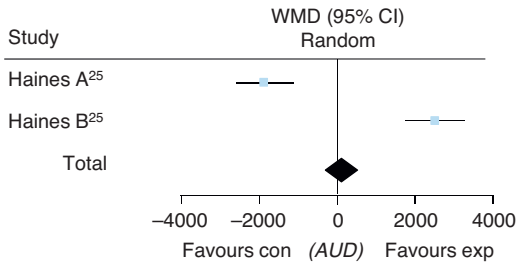

Figure 10. Weighted mean difference (95% CI) in the effect of weekend allied health on cost in acute randomised, controlled trials, calculated from participant-level data.

nursing did not produce favourable results,[46] and there is a paucity of research on medical staffing models in subacute rehabilitation settings.

The evidence generated by this review may assist resource allocation decisions by healthcare policymakers and managers considering implementing out-of-hours and 7-day healthcare service models. The identified benefits include improved patient function and health-related quality of life during shorter hospital length of stay, which indicate that increased rehabilitation efficiency is achievable. Further, the reduced hospital length of stay may also provide incentives for investment in additional weekend allied health service provision because reductions in length of stay in subacute rehabilitation hospitals can improve patient flow in acute services and contribute to improved cost-effectiveness.[47]

In contrast, there was insufficient evidence to conclude that routinely using a weekend allied health model to provide additional services in the acute general medical and surgical ward setting would achieve intended benefits for all patients. It is possible that the difference in outcomes between acute and subacute ward types is due to variability in the focus of allied health activities in these settings. For example, physiotherapy services for chronic obstructive pulmonary disease in the acute hospital ward setting may focus on preventing respiratory failure by providing non-invasive ventilation,[48] whereas in the subacute rehabilitation ward setting, these services may emphasise therapies specifically aimed at improving functional independence.[49] Therefore, an evaluation of providing weekend allied health services in either the acute or subacute ward setting should reflect these outcomes of interest. Another possible explanation for unclear results in the acute setting is that providing additional allied health services in isolation may not change outcomes, due to limited medical and nursing staffing. A recent study in the acute general medical setting incorporated a multi-disciplinary 7-day medical, nursing, and allied health staffing model, which reported improvements in hospital length of stay, reduced general medical bed occupancy days, and improved weekend discharges.[50] However, comprehensive 7-day

medical, nursing, and allied health service provision may not improve outcomes in all circumstances.[51] Unclear results in the acute setting could also be explained by previously examined logistical difficulties in implementing weekend allied health service models. This may be due to the employment of less experienced staff during weekends to reduce cost;[16] employing staff who work outside of the organisation during normal business hours;[16] reduced medical and nursing staffing over the weekend;[52–54] unavailability of services from community-based organisations needed to facilitate discharge on weekends; and patient expectation of rest on the weekend.[55] Findings in the acute general medical and surgical ward setting should not be extrapolated to weekday, after-hours, on-call, or 7-days a week service provision models, and only applies to relevant wards, as defined in this review. However, it should also be noted that only two randomised, controlled trials (one article) from a single country have been published evaluating acute weekend allied health services;[25] considering weekend service variability, it is possible that other untested targeted models of weekend allied health service could provide benefit. Future studies could consider whether alternative models have the potential to deliver cost-effective weekend allied health services.

It is believed that this is the first systematic review examining the effectiveness of providing additional allied health services to acute and subacute hospital wards during weekends. It is also the first meta-analysis to include a stepped-wedge, randomised, controlled trial design. This design is valuable because it provides a statistically powerful, methodologically rigorous approach for evaluating weekend allied health services where provision is considered usual care. The comprehensive search strategy resulted in 19 articles (20 studies) being identified, with 38 732 participants, which is the largest and most contemporaneous review to be conducted on this topic area. The pooling of results according to study designs and setting may assist the understanding of how non-randomised trials can be compared with the results from randomised studies, and applied to clinical areas of interest. However, a number of excluded studies exploring interventions that include a weekend allied health service component must be acknowledged.[13,56–58] In most cases these were excluded, as the effect of weekend therapy was unable to be isolated from concurrent weekday interventions within the trials (eg, increased weekday, after-hours, or on-call services in addition to a weekend service). Future research should focus on implementing additional allied health through different models such as increasing frequency, intensity, time, and type of services during normal departmental operating hours; 7-day service provision; evaluating outreach models; on-call services; comprehensive care compared to discipline-specific models; and after-hours provision.

Despite the large number of trials that were identified overall, the relatively small number of studies with randomised and non-randomised designs in acute and subacute settings limited the generalisability of these findings. This was particularly evident for the acute randomised, controlled trials, where there were only two studies. However, a large number of participants were included in the acute randomised trial meta-analysis (n = 27 508), and there were relatively narrow confidence intervals for effect size estimates and the overall meta-analysis. Heterogeneity in the results of randomised studies in the acute setting for hospital length of stay and adverse event outcomes was examined via exploratory analysis in the original study, suggesting that there was a significant change in outcomes between control conditions, and when intervention conditions were compared, there was no significant difference in outcomes.[25] However, this post-hoc analysis was hypothesis generating, suggesting the need for additional research in this setting. Data relating to the frequency, intensity, time and type of additional weekend allied health service provision were unable to be extracted due to limitations in reporting. Therefore, the results of this meta-analysis should be interpreted as applying to staffing models, rather than specific allied health assessments and particular interventions.

Due to the nature of providing additional allied health services over weekends, blinding of participants and allied health personnel was not possible. Blinding of outcome assessors was used to reduce risk of bias in some studies; however, there was a potential risk of bias for outcomes unable to be blinded such as hospital length of stay, where allied health personnel could delay or expedite hospital discharge for either the intervention or control groups, thereby affecting the hospital length of stay outcome data. The use of a stepped-wedge, randomised, controlled trial design in the acute setting may have reduced this risk of bias, as service demands would be prohibitive to interference across extended control and intervention periods. Also, use of outcome measures, such as hospital length of stay and cost to the health service per admission, was potentially problematic in some of the included studies. It was not always clear whether the data for hospital length of stay and cost were relative or absolute because patient cohorts varied over time. Changes in these outcome variables could have resulted from changing cohorts, as well as improvements from interventions. One way to control for this would be to consider outcomes relative to diagnoses using coding data, for example hospital length of stay relative to expected length of stay.

Providing additional allied health services to patients in subacute rehabilitation wards on the weekend reduced hospital length of stay, and may be an economically efficient way to improve functional independence and health-related quality of life. However, for acute general medical and surgical hospital wards, the impact of weekend allied health services is unclear. This synthesis of evidence to date suggests that the benefits of routinely providing additional allied health services on subacute rehabilitation wards is clearer than in the acute general medical and surgical ward setting. Future studies are required to further investigate the effect of targeted weekend allied health services. However, the goals of care for weekend allied health service provision may differ between acute and subacute hospital ward settings, and should therefore be reflected in the outcomes evaluated in future studies.

What was already known on this topic: The provision of weekend allied health services in hospitals is variable, with differences in the amount and focus of service delivery. Providing earlier, additional or high-intensity allied health services is generally beneficial, but the specific effect of additional weekend services is unclear.

What this study adds: Providing additional weekend allied health services in subacute rehabilitation wards significantly reduced hospital length of stay, and may be a cost-effective way of improving function and quality of life. The effect in acute general medical and surgical wards remains unclear despite substantial data.

Footnotes: [a] Covidence, Melbourne, Australia. [b] StataCorp LP, College Station, USA.

eAddenda: Appendices 1, 2, 3 can be found online at https://doi.org/10.1016/j.jphys.2018.05.004.

Ethics approval: Not applicable.

Competing interests: Nil.

Sources of support: This systematic review was funded by a partnership grant from the National Health and Medical Research Council (NHMRC) Australia (APP1114210), and the Victorian Department of Health and Human Services.

Acknowledgements: We wish to thank Monash University, Monash Health, and the Victorian Department of Health and Human Services for providing the support for this project.

Provenance: Not invited. Peer reviewed.

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