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REVIEW ARTICLE

MULTI-DISCIPLINARY REHABILITATION AFTER HIP FRACTURE IS ASSOCIATED WITH IMPROVED OUTCOME: A SYSTEMATIC REVIEW

Julie Halbert[1], Maria Crotty, MD[1], Craig Whitehead[1], Ian Cameron, MD[2], Susan Kurrle, PhD[2], Susan Graham[2], Helen Handoll[3], Terry Finnegan[4], Tim Jones[5], Amanda Foley[6] and Michael Shanahan[7], the Hip Fracture Rehabilitation Trial Collaborative Group

From the [1]Rehabilitation Studies Unit (Flinders University), Repatriation General Hospital, Daw Park, [2]Rehabilitation Studies Unit, University of Sydney, Ryde, Australia, [3]Teesside Centre for Rehabilitation Sciences, University of Teesside, The James Cook University Hospital, Middlesbrough, UK, [4]Department of Aged Care and Rehabilitation Medicine, Royal North Shore Hospital, St Leonards, Australia, [5]The Defence Medical Rehabilitation Centre, Headley Court, Epsom Surrey, UK, [6]Centre for Physical Activity in Ageing, Hampstead Rehabilitation Centre, Northfield and [7]Department of Medicine, Flinders Medical Centre, Bedford Park, Australia

Background: **While hip fractures are an important cause of disability, dependency and death in older adults, the benefit of multi-disciplinary rehabilitation for people who have sustained hip fracture has not been demonstrated.**

Methods: **Systematic review of randomized controlled trials which compare co-ordinated multi-disciplinary rehabilitation with usual orthopaedic care in older people who had sustained a hip fracture. Outcome measures included: mortality, return home, "poor outcome", total length of hospital stay, readmissions and level of function.**

Results: **We identified 11 trials including 2177 patients. Patients who received multi-disciplinary rehabilitation were at a lower risk (Risk Ratio 0.84, 95% CI 0.73–0.96) of a "poor outcome" – that is dying or admission to a nursing home at discharge from the programme, and showed a trend towards higher levels of return home (Risk Ratio 1.07, 95% CI 1.00–1.15). Pooled data for mortality did not demonstrate any difference between multi-disciplinary rehabilitation and usual orthopaedic care.**

Conclusion: **This is the first review of randomized trials to demonstrate a benefit from multi-disciplinary rehabilitation; a 16% reduction in the pooled outcome combining death or admission to a nursing home. This result supports the routine provision of organized care for patients following hip fracture, as is current practice for patients after stroke.**

Key words: multi-disciplinary rehabilitation, hip fracture.

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Correspondence address: Julie Halbert, Rehabilitation Studies Unit (Flinders University), Repatriation General Hospital, Daws Road, Daw Park SA 5041, Australia. E-mail: julie.halbert@rgh.sa.gov.au

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INTRODUCTION

Hip fracture remains an important health burden, both for individuals and for health systems. It has been estimated that, in 1990, there were 1.3 million hip fractures worldwide, with 738,116 deaths attributable to the fracture (1). While there is some recent evidence that suggests that the age-specific, age-adjusted rates of hip fracture are stable for Western countries, future predictions of the problem have the incidence of hip fracture increasing 1–3% per year in most areas of the world (2).

Preventive strategies may eventually have an effect on incidence of hip fracture; however, there is an imperative to provide efficient and effective treatment for people who have sustained hip fractures. Recovery from hip fracture is complicated by the frailty of this population, with a recent report indicating a mortality rate of 33% at one year post-hip fracture (3). Clinical practice guidelines have been published that attempt to specify optimal hip fracture treatment (4). These have supported inpatient geriatric orthopaedic rehabilitation units as providing effective rehabilitation after hip fracture.

This review focuses on programs that provide specialized rehabilitation by a multidisciplinary team with supervision by a geriatrician or rehabilitation physician. A Cochrane Review examining the effects of co-ordinated multi-disciplinary inpatient rehabilitation, compared with usual (orthopaedic care) following hip fracture was first published in 1997. The most recent update of this review (5) included data from 9 trials (1869 patients). None of the outcomes examined demonstrated a statistically significant difference between the 2 treatments and the trials included were heterogeneous. Since these reviews, trials of early supported discharge programs (6–8), characterized by accelerated discharge from hospital and multi-disciplinary rehabilitation services provided in the patient's home have been published. Furthermore, programs (9) involving comprehensive orthopaedic ward geriatric assessment and multi-disciplinary rehabilitation have been trialled and are included in this review.

While there is evidence that good organized care impacts on mortality following stroke (10), there remains controversy around its effectiveness following hip fracture. Therefore, the purpose of this review was to determine, using evidence from randomized controlled trials, the effectiveness of multi-disciplinary rehabilitation in comparison with usual orthopaedic care following hip fracture.

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METHODS

Identification of trials

We included all prospective randomized controlled trials that compared multi-disciplinary rehabilitation with other forms of care for older patients following hip fracture. Trials were included if treatment allocation was randomized and the intervention met our definition of a multi-disciplinary rehabilitation programme. Trial searching was completed in July 2005.

We used the search strategy developed by the Bone, Joint and Muscle Trauma Group of the Cochrane Collaboration (5). A list of potential trials was obtained by searching electronic databases including MEDLINE, EMBASE and CINAHL and searching the reference lists of included articles and papers. Results from the 3 databases were imported into 3 EndNote libraries. The libraries were merged and duplicates identified by EndNote were discarded after visual checks. One of us (IC) scanned the lists for obvious exclusions. Articles were then obtained and 2 of us (IC and MC) assessed them against the inclusion criteria. The opinion of a third party (JH) was sought if study inclusion consensus was not reached. Nine reviewers were sent hard copies of papers, methodological guidelines, checklists and data extraction forms. Each included trial was reviewed by a minimum of 2 reviewers. The reviewers were not blinded to the titles and authors of included papers.

Two reviewers (IC and MC) assessed the methodological quality of the studies independently. The system included the categories: selection bias (allocation to group, concealment of allocation, comparability of groups at baseline), detection/attrition bias (blinding of outcome assessors, study losses, intention to-treat analysis) and external validity (representative study population, length of follow-up). Discrepancies were resolved by a third reviewer (JH). Outcome data from trials that had been included in a previous review by one of our investigators (IC) was re-extracted from the original article(s). However, the methodological quality of these trials was not re-assessed.

Definition of intervention

We defined rehabilitation as services provided by a multi-disciplinary team with the goal of reducing disability by improving task-oriented behaviour, for example, walking and dressing. This definition was developed from a previous descriptive analysis of rehabilitation services (11) and has also been used in reviews of rehabilitation programs following stroke (10).

Data extracted

For each trial, data were collected on trial location and dates, number of randomized participants, age of participants, inclusion criteria, exclusion criteria, description of intervention and control treatment, number of patients who returned home, mortality, total length of hospital stay, measures of physical functioning, and readmissions to hospital. Outcome data which did not appear in the published paper was obtained by contacting the trial authors.

Outcome measures

Outcomes included return home (measured at discharge, including only those patients who were living at home prior to fracture), mortality, "poor outcome" (a pooled outcome including both deaths and nursing home admission at discharge from hospital), total hospital length of stay (including both acute inpatient stay and the length of rehabilitation), readmission to hospital and measures of physical functioning.

Statistical analyses

Data were pooled using Review Manager (12). This calculated the risk ratios (RRs) with 95% confidence intervals (95% CI) for dichotomous outcomes (return home, mortality). We calculated the pooled RRs using both fixed-effect and random-effects models, but we report the results using a random effects model due to the methodological differences between the trials. The significance of any heterogeneity was determined by examining the χ^2 statistic and the I^2 statistic.

RESULTS

Results of the search strategy

A total of 1344 references were obtained from the 3 databases after removal of duplicates. One of the investigators (IC) identified 47 references for which hard copies were required. Three papers were not published in English. It was possible to translate 2 papers (one in Spanish, one in Japanese), however, it was not possible to translate one in Russian. Twenty-eight papers did not meet the inclusion criteria as they were not randomized, a further 8 papers met the inclusion criteria but were excluded for reasons including: rehabilitation for secondary prevention ($n = 2$), difficulty in determining number of included participants with hip fracture ($n = 3$), rehabilitation program not multi-disciplinary ($n = 1$), inappropriate intervention ($n = 2$). One trial (13) which was included in the previous review (5) was excluded as the intervention involved a geriatric assessment that did not constitute a rehabilitation program in line with our definition. One further trial (9) which met the inclusion criteria, was identified in September 2005, after the trial searching was completed.

Eleven trials (2177 patients) met the inclusion criteria (6, 9, 14–22) (Table I). The results for each of the included trials are summarized using arrows due to the wide variation in outcomes. Data for the 2 main outcomes appears in Figs 1 and 2. Six trials (15–17, 19–21) (1226 patients) compared a geriatric orthopaedic rehabilitation unit with an orthopaedic ward, 2 trials (14, 22) (323 patients) compared a geriatric hip fracture program with standard orthopaedic care, one trial (6) (66 patients) compared an early supported discharge programme with routine inpatient care, one trial (18) (243 patients) compared a mixed assessment and rehabilitation unit with care in a standard hospital ward and one trial (9) (319 patients) compared an orthopaedic ward geriatric assessment and rehabilitation program with usual care on an orthopaedic ward.

Amongst trials grouped together, there were considerable differences in the treatment of both the intervention and control groups (Table II). For example, for the trials set in a geriatric-orthopaedic unit, access and treatment from allied health professionals varied and the model of geriatric-orthopaedic joint management differed in its input from geriatricians and the frequency of multidisciplinary input. For one trial (16) details were scarce. The 3 trials using geriatric hip fracture programs (14, 21, 22) were similar in terms of the expressed goal of early mobility, early input from geriatrician and an intense multi-disciplinary approach to rehabilitation. The focus of one trial (9) was a comprehensive geriatric evaluation to identify and quantify medical and psychosocial problems and functional capability; however, it was included as it then incorporated multi-disciplinary rehabilitation.

All trials included patients aged > 50 years. Three trials restricted inclusion to females (15, 17, 19) and most excluded patients with terminal illnesses and pathological fractures.

Quality assessment

Five trials (9, 16, 17, 21, 22) did not conceal allocation of participants, 3 trials (14, 16, 18) had groups that were not

Table I. *Multi-disciplinary rehabilitation following hip fracture: characteristics and results of the included trials*

Reference, year	*n*	Age (mean, years)	Return home	Mortality	Total hospital length of stay	Measure of physical functioning	Follow-up (months)
Cameron et al. (14) 1993	252	84	⇧	⇔	⇩	⇧	12
Crotty et al. (6) 2002	66	83	⇔	⇔	⇩ but intervention group longer in rehabilitation overall	⇧	4
Fordham et al. (15) 1986	108	Range 65–95	⇔	⇔	⇔	⇔	Discharge
Galvard & Samuelsson (16) 1995	371	79	⇔	⇔	⇧	⇔	12
Gilchrist et al. (17) 1988	222	82	⇔	⇔	⇔	None reported	6 (after discharge)
Huusko et al. (18) 2000	243	80	⇔	⇔	⇩	⇔some difference at 3 months, none at 12 months	12
Kennie et al. (19) 1988	108	82	⇧	⇔	⇩	⇧	Discharge
Naglie et al. (20) 2002	280	85	⇔	⇔	⇧	⇔	6
Shyu et al. (21) 2005	137	78	⇔	⇔	⇔	⇧	3
Swanson et al. (22) 1998	71	79	⇔	⇔	⇩	⇧	Discharge
Vidan et al. (9) 2005	319	82	⇔	⇔	⇔	⇔	12

⇧: More participants in the intervention group returned home (Return home), participants in the intervention group had a longer total hospital length of stay (Total hospital length of stay), measures of physical functioning were higher for the intervention group or intervention group reported greater improvements in measures of physical functioning (Measure of physical functioning).
⇔: No difference between groups.
⇩: Participants in the intervention group had a shortened total hospital length of stay (Total hospital length of stay).

comparable on baseline functional characteristics, while a further 4 trials (15, 17, 19, 22) had differences between groups at baseline on characteristics other than functional status. Eight trials (14–19, 21, 22) did not confirm the use of blinded outcome assessors. Three trials (9, 18, 21) did not analyse the data on an intention-to-treat basis and 6 trials (6, 15, 17, 20–22) completed the final follow-up at less than 12 months.

Return home

Eleven trials provided data on return home (Fig. 1). For one trial (21) all participants returned home. Using a random effects model the RR (95% CI) of returning home was 1.07 (1.00, 1.15). The I^2 statistic for both the pooled RR was 35%, indicating low to moderate heterogeneity (23).

Mortality

All 11 trials provided data on mortality. The pooled mortality data was collected at a minimum of 4 weeks (15), 3 months after discharge (21), 4 months (14), 6 months (17, 20, 22) and 12 months (6, 9, 16, 18, 19) follow-up. Using a random effects model the RR (95% CI) of mortality was 0.89 (0.74, 1.07). The I^2 statistic for this pooled RR was 0%.

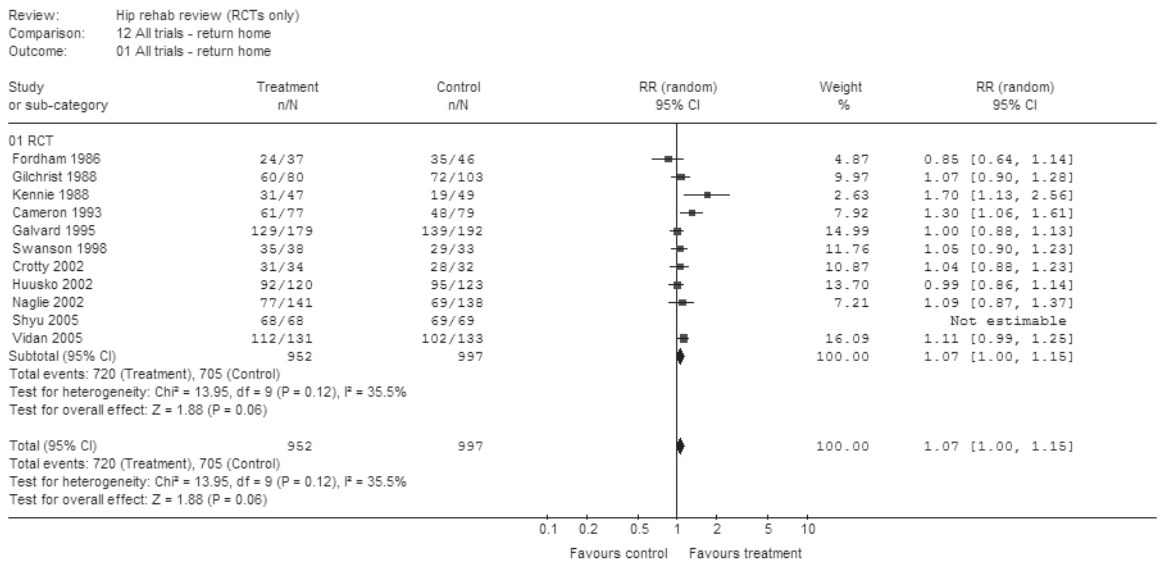

Fig. 1. Multi-disciplinary rehabilitation following hip fracture: the effect on return home. RR: Risk Ratio; CI: Confidence interval; RCT: randomized controlled trial.

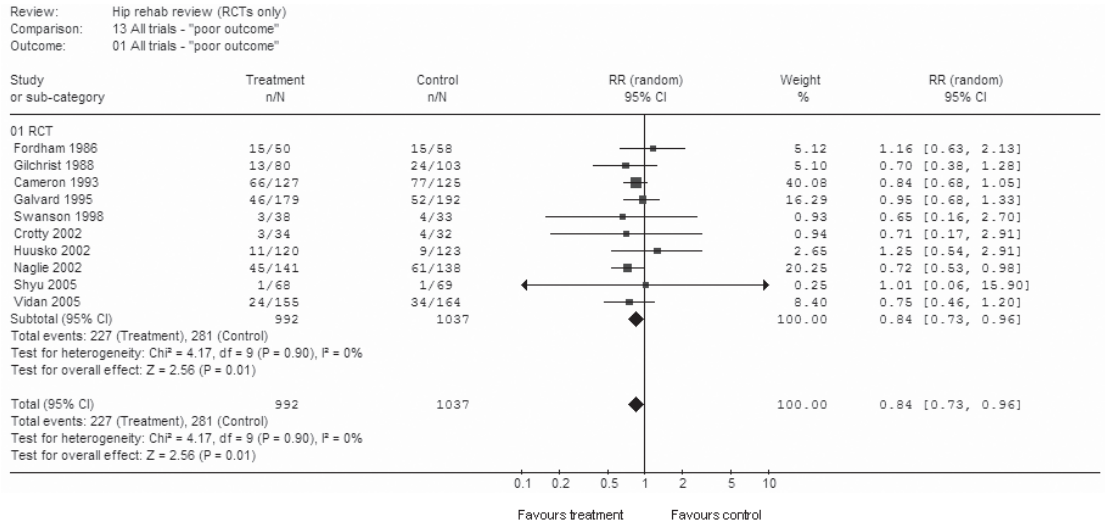

Fig. 2. Multi-disciplinary rehabilitation following hip fracture: the effect on "poor outcome"

"Poor outcome"

Ten trials provided data on both deaths and admission to nursing homes at discharge from hospital (Fig. 2). For one trial (19) it was not possible to determine the number of deaths in each of the groups at discharge from the programme. The RR (95% CI) for the "poor outcome" result was 0.84 (0.73, 0.96). The I^2 statistic for this pooled RR was 0%.

Total hospital length of stay

All trials provided data on length of stay. For 5 trials (9, 14, 15, 18, 22), the published data were either incomplete or presented in a form that did not allow pooling. Data were available for the remaining 6 trials (6, 16, 17, 19–21). For 2 trials (6, 21), the total hospital length of stay (LOS) was similar, around 10 days. However, using additional data from Crotty (6), which included the length of home-based rehabilitation, the LOS in this trial increased to 28 days. The other 4 trials (16, 17, 19, 20) reported LOS ranging from 21 to 56 days. It was in appropriate to pool the data from these 6 trials given the clearly substantial heterogeneity.

Four trials (14, 18, 19, 22) reported that LOS in hospital was shorter for the intervention group in comparison with the control group. For one trial (20) the mean initial LOS in hospital was longer for the intervention group, however, the total time spent in institutions (including acute hospital, rehabilitation hospital and nursing homes) was similar over the 6 months follow-up.

Readmission to hospital

Readmission to hospital was reported for 5 trials (6, 9, 14, 16, 21). For 4 trials (6, 9, 14, 21), there was no difference between the groups for the number of related or unrelated admissions to hospital after discharge from programme, or the length of related or unrelated admissions (6). A third trial (16) reported that patients from the control group had significantly more admissions in the first postoperative year for orthopaedic-related conditions.

Measures of physical functioning

One trial provided no data on measures of physical functioning (17). Two trials included the Barthel Index (14, 20) and 2 trials used the Modified Barthel Index (6, 22). One trial included measures of ambulation (20) and 3 trials (9, 18, 19) included the Katz index of independence in activities of daily living. Trials also reported on walking ability and walking speed (16) and other measures of daily living including dressing, toileting and cooking (15). Two trials (15, 16) reported that there were no differences between the intervention and control groups, however, they did not undertake any formal analysis of the results. In 2 trials (14, 20) there were no statistically significant differences between the groups. In 5 trials (6, 9, 18, 19, 22) it was reported that the intervention group did better than the controls; however, it was not possible to pool the data.

DISCUSSION

Hip fracture is a major cause of disability in older people, particularly women. In 1990 it was estimated that there were 1.2 million "life years disabled" due to hip fracture (1). While a previous systematic review (24) including non-randomized trials of rehabilitation after hip fracture concluded that certain models of treatment are effective, this is the first review of randomized trials to demonstrate that multi-disciplinary rehabilitation reduces the risk of a "poor outcome", combining death and admission to nursing home, following hip fracture.

While there was a trend towards an increase in the number of participants who returned home following rehabilitation, the

Table II. *Multi-disciplinary rehabilitation following hip fracture: characteristics of the intervention and control groups*

Study	Intervention	Control
Cameron et al. (14), 1993	Early mobility and self-care, rehabilitation physician/ geriatrician care, liaison with orthopaedic staff, mobility training, input from physiotherapy and occupational therapy goal setting, re-training physical independence and detailed discharge planning.	Patients from nursing homes and those with limited disability were discharged when orthopaedically appropriate. Patients needing additional assistance were referred to the Rehabilitation and Geriatric Service.
Crotty et al. (6), 2002	Accelerated discharge and home-based rehabilitation by a multi-disciplinary team, including the setting of therapy goals, weekly case conferences attended by team and geriatrician/rehabilitation physician.	Routine hospital care and rehabilitation in hospital, development of care pathways and discharge planning.
Fordham et al. (15), 1986	Joint geriatric-orthopaedic management characterized by early post-admission assessment by geriatrician, joint clinical rounds, rehabilitation programming and discharge planning.	Single specialty orthopaedic management.
Galvard & Samuelsson (16), 1995	Rehabilitation at geriatric department.	Rehabilitation at orthopaedic department.
Gilchrist et al. (17), 1988	Orthopaedic geriatric unit for rehabilitation consisting of a weekly ward round and case conference with geriatrician, orthopaedic senior registrar, senior ward nurse, physiotherapist, occupational therapist and social worker.	Orthopaedic ward with similar nursing cover and access to paramedical services but no case conference. Access to geriatric services via referral letter.
Huusko et al. (18), 2000	Transfer to a geriatric ward for 2 weeks of intensive rehabilitation to promote early ambulation, self-motivation and function.	Local hospital wards for standard care.
Kennie et al. (19), 1988	Multi-disciplinary management with thrice weekly supervision from geriatrician and once per week conference with multidisciplinary team including physiotherapy, occupational therapy and other services.	Orthopaedic ward rounds access to physiotherapy, occupational therapy and other services.
Naglie et al. (20), 2002	Post-operative interdisciplinary care including assessment and care by geriatrician, physiotherapist, occupational therapist, social worker, clinical nurse specialist, with twice weekly interdisciplinary rounds.	Routine postoperative surgical care which could include a geriatric consultation. Access to allied health personnel when consultation requested.
Shyu et al. (21), 2005	Geriatric consultation service, early postoperative rehabilitation to facilitate mobility, rehabilitation both inpatient and at home, discharge-planning.	Trauma or orthopaedic ward, most receive one physical therapy session only, no rehabilitation or nursing care after discharge.
Swanson et al. (22), 1998	Early surgery, minimal narcotic analgesia, early mobilization, early review by geriatrician and intense daily therapy with a multidisciplinary approach.	Standard orthopaedic management including daily physiotherapy visits, social work, occupational therapy, geriatrician review on request.
Vidan et al. (9), 2005	Complete geriatric evaluation. Daily visit from geriatrician. Rehabilitation specialist planned schedule – intensity/ duration of physical therapy. Interdisciplinary meetings, physical therapy, social work.	Management by orthopaedic surgeon and orthopaedic nurses Counselling from different specialists as required Access to physical therapy and social work.

modest size of this result may be a reflection of the increasingly multi-disciplinary approach of routine orthopaedic care. Indeed it is now possibly unethical not to provide access to a geriatrician or rehabilitation specialist, physiotherapy, occupational therapy and other services, goal setting for rehabilitation and discharge planning following hip fracture.

Limitations of the review

Data were pooled for only 3 outcomes; return home, mortality and "poor outcome". For the remaining outcomes there were significant limitations in the data presented in the published trials that did not enable these data to be pooled. Our major conclusion is based on a pooled outcome; "poor outcome" combining both death and admission to nursing home at discharge. This method was chosen for several reasons; it combined the worst outcomes following hip fracture, in 10 out of the 11 included trials raw data on deaths and admissions were available and in most trials the event rates for both admissions and deaths were low. While this approach has been used previously in the stroke literature (10), the validity of the pooled outcome is yet to be determined. Caution should be used when interpreting the pooled or global outcome as it combines the event rates for 2 separate outcomes, and in doing so, may result in an effect that does not exist for either outcome individually.

Publication bias may be a limitation of this review in spite of our thorough search strategy. Furthermore, new studies are being published at a slow rate of less than one eligible study per year.

Research in this area would be easier to interpret if standardized outcome measures in both health services measures such as length of hospital stay, through to functional measures

including activities of daily living and mobility were used. The Standardized Audit of Hip Fractures in Europe (SAHFE) (4) recommended a standard data set and we encourage its use. It should, however, include a validated measure of functioning.

The result of this review is clinically significant. The RR of 0.84 suggests that an additional 16% of people with hip fracture are less likely to have a poor outcome after multi-disciplinary rehabilitation following hip fracture. The absolute difference in poor outcome is 4.1%, giving a number needed to treat of 24, which is within reasonable boundaries of commonly used clinical interventions (25). Therefore, we recommend that health service resources should be organized to allow patients with hip fracture routinely to receive organized multi-disciplinary rehabilitation.

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J Halbert, M Crotty and I Cameron planned and undertook the review, produced and edited the paper. The following members of the Hip Fracture Rehabilitation Trial Collaborative Group obtained primary data and assisted with the editing of the paper: Terry Finnegan, Amanda Foley, Susan Graham, Helen Handoll, Tim Jones, Susan Kurrle, Michael Shanahan and Craig Whitehead.

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