

Improving rehabilitation in older people after emergency hospital admission

McKelvie, S; Lasserson, Daniel; Hall, A.M; Richmond, H.R; Finnegan, S

DOI:

[10.1016/j.maturitas.2018.02.011](https://doi.org/10.1016/j.maturitas.2018.02.011)

License:

Creative Commons: Attribution-NonCommercial-NoDerivs (CC BY-NC-ND)

Document Version

Peer reviewed version

Citation for published version (Harvard):

McKelvie, S, Lasserson, D, Hall, AM, Richmond, HR & Finnegan, S 2018, 'Improving rehabilitation in older people after emergency hospital admission', *Maturitas*, vol. 111, pp. 20-30.
<https://doi.org/10.1016/j.maturitas.2018.02.011>

[Link to publication on Research at Birmingham portal](#)

Publisher Rights Statement:

Checked for eligibility: 19/02/2018

General rights

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.

Highlights: Improving rehabilitation in older people after emergency hospital admission

- Older adults are at risk of functional decline during emergency medical hospital admissions
- Exercise based rehabilitation for older patients after emergency hospitalisation improves functional ability, if the exercise component includes both in-hospital and post-discharge components
- Further research is needed to understand the optimal dose and content of exercise intervention for this group
- Reporting on exercise interventions should include detailed descriptions of the exercise intervention content (frequency, intensity, type and timing), the 'usual care' group, the implementation of the programme (training, adherence, fidelity) and use standardised outcome measures.

1
2
3 Title: Improving rehabilitation in older people after emergency hospital admission
4

5 Authors: **McKelvie, S¹, Hall AM^{2,3}, Richmond HR⁴, Finnegan S⁴, Lasserson D⁵**

6 Affiliations:
7

- 8 1) NIHR CLAHRC Oxford, Nuffield Department of Primary Care, Oxford
- 9 2) Faculty of Medicine, Memorial University, Canada
- 10 3) The George Institute for Global Health, University of Oxford
- 11 4) Warwick Clinical Trials Unit, Warwick Medical School, University of Warwick
- 12 5) Institute of Applied Health Research, College of Medical and Dental Sciences, University of
- 13 Birmingham
- 14
- 15
- 16
- 17
- 18

19 Funding acknowledgements:

20 This research was funded by the National Institute for Health Research (NIHR) Collaboration for
21 Leadership in Applied Health Research and Care Oxford at Oxford Health NHS Foundation Trust. The
22 views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the
23 Department of Health.
24
25

26
27
28 Acknowledgements:

29 The authors would like to thank Nia Roberts, Bodleian Health Care Libraries, Knowledge Centre,
30 University of Oxford for conducting the literature search
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59

60
61
62 **Abstract:**

63
64 **Purpose:**

65 Older adults are at risk of functional decline during emergency hospital admissions. This review aims
66 to understand which exercise-based interventions are effective in improving function for older
67 adults who experience unplanned admissions.
68
69

70 **Methods:**

71 Database searches identified randomised control trials (RCTs) comparing exercise-based
72 interventions with usual hospital care. The primary outcome was functional status measured by
73 activities of daily living (ADL) scores. Secondary outcomes were length of hospital stay (LOS),
74 mortality and readmissions. Sub-group meta-analyses were conducted on interventions delivered in-
75 hospital only compared to interventions provided in-hospital and post-discharge.
76
77
78

79 **Results:**

80 After reviewing 8365 studies, nine studies were eligible for inclusion. Seven were included in the
81 meta-analysis. Participants from five countries had a mean age of 79 years (1602 participants). Usual
82 care varied considerably and the interventions showed heterogeneity with different combinations of
83 strengthening, resistance, high intensity or mobility exercises. There were limited descriptions of
84 exercise intervention delivery and participant adherence. There is low quality evidence supporting
85 exercise interventions including both in-hospital and post-discharge components (3 trials, SMD 0.56
86 (-0.02, 1.13)). Trials involving only in-hospital interventions were inconclusive for functional gains (5
87 trials, SMD -0.04 (-0.31, 0.22)).
88
89
90
91
92

93 **Conclusions:**

94 Exercise based rehabilitation for older patients after emergency hospitalisation improves functional
95 ability if the intervention starts in-hospital and continues post-discharge. No conclusions can be
96 made on the effective exercise dose or content.
97
98
99

100 **Implications:**

101 Understanding the components of exercise interventions will improve service planning and delivery.
102 Further studies are needed to understand the effective dose and content of exercise for hospitalised
103 older adults.
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118

119
120
121 **1. Introduction**
122

123 Emergency hospital admissions for older patients are increasing [1, 2]. Hospitalisation is a risk factor
124 for functional decline and disability [4], and can be a 'deconditioning' process leading to loss of
125 independence [3]. Functional decline during an acute hospital admission is multifactorial in nature;
126 contributing factors include lack of activity and immobility, the effects of acute illness in the context
127 of chronic diseases, and the vulnerability of older patients to polypharmacy and nutritional
128 deficiencies [5]. The consequences include reduced muscle strength, reduced physiological reserve
129 and increased risk of falls [3]. Rehabilitation can restore personal autonomy, reduce disability, and
130 reduce the rates of institutionalisation in this older age group; however, the content of optimal
131 rehabilitative interventions is not clear [5].
132
133
134
135
136
137

138 Current rehabilitative interventions in hospital aim to restore functional ability to a level where
139 patients can be safely discharged from hospital, but setting this target for rehabilitation may not be
140 effective at restoring personal autonomy. The current model for medical care for older patients is
141 centred on the comprehensive geriatric assessment (CGA) [5], which restores function through
142 collaborative work by multi-disciplinary teams using a variety of interventions. CGA reduces rates of
143 institutionalisation for older adults [6] as well as mortality [7]. These programmes often have a
144 significant physical component using exercise to maintain muscle strength [8]. Exercise during
145 inpatient hospital admission is not associated with increased adverse events and allows more
146 patients to be discharged home with improved physical function [8] [9].
147
148
149
150
151
152
153

154 This review aims to evaluate which rehabilitation interventions are effective at restoring function in
155 older patients requiring a hospital admission for an acute medical illness. Previous reviews have
156 suggested that targeted CGA based rehabilitation early in a hospital admission can improve function,
157 reduce mortality and the risk of institutionalisation compared with usual care [6, 8, 9]. However,
158 there was great variation in the duration, content, measures used to assess functional ability and the
159 type of patient (medical, surgical and orthopaedic) involved in the exercise interventions evaluated.
160 Consequently, the optimal exercise intervention for older patients remains unknown [3, 5] and an
161 update of the evidence, concentrating on an in-depth description and synthesis of the intervention
162 components, is warranted. This review will concentrate on the effective 'dose', content and timing
163 of rehabilitation.
164
165
166
167
168
169
170
171
172
173
174
175
176
177

178
179
180 **Aim:** To understand which exercise-based rehabilitation interventions are effective in improving
181
182 function for older adults who are hospitalised during an unplanned emergency admission for an
183
184 acute medical condition.
185

186 **2. Methods**

187 188 189 *2.1 Objectives*

190
191
192 To determine the effectiveness of exercise-based rehabilitation programmes that improved the
193
194 functional status of older adults after an emergency hospital admission as measured by their
195
196 activities of daily living (ADL). Secondary outcomes included length of hospital stay (LOS), mortality
197
198 and readmission.
199

200 201 *2.2 Eligibility criteria (Appendix 1)*

202
203 Studies were included in this review if they met the following inclusion criteria:

- 204
205 • Participants were 65 years or older and had been admitted to hospital via the emergency
206
207 department or in an unplanned way.
- 208
209 • Participants' admission to hospital lasted at least 4 hours.
- 210
211 • Randomised controlled trials comparing an exercise-based rehabilitation intervention with usual
212
213 hospital care.
- 214
215 • Exercise was the main component of the intervention and was delivered by a healthcare
216
217 professional, starting after an emergency hospital admission and took place in hospital or at
218
219 home.
- 220
221 • The comparison group was usual hospital care which was defined as an assessment conducted
222
223 by a health professional resulting in the provision of an intervention to ensure that the patient
224
225 was safe to be discharged home.
- 226
227 • Assessed at least one measure of function using either: Barthel index (BI), Katz ADL,
228
229 Instrumental ADL (IADL) and Nottingham Extended ADL, Short Form Health Surveys SF36 or
230
231 SF12, Elderly Mobility Score (EMS)
232

233
234 Exclusion criteria:

- 235
236 • Greater than 20% of the included patient sample were under the age of 65 years.

- 237
238
239
240
241
242
243
244
245
246
247
248
- Participants recruited from the community without an acute medical illness requiring an emergency department visit.
 - Participants with surgical or orthopaedic treatment or who had disease processes requiring specialised rehabilitation such as stroke.
 - The intervention was designed to reduce the incidence of falls. These studies were excluded as they have been described in detail elsewhere [10].

249
250
251
252

2.3 Information sources and search strategy (Appendix 2)

253
254
255
256
257
258

The following databases were searched from inception to the 10th February 2017; CINAHL, Cochrane Library, Embase, Ovid Medline, OTSeeker, PEDRO, and Web of Science. The search strategy is detailed in Appendix 2.

259
260
261

2.4 Study Selection

262
263
264
265
266
267

Two authors (SM and AH) screened the studies based on title and abstract and independently selected papers for inclusion after full text retrieval. Any differences in the results were resolved through discussion.

268
269
270
271

2.5 Data collection process

272
273
274
275
276
277
278
279
280
281
282
283
284

Standardised data extraction tables were adapted from the Template for Intervention Description and Replication (TIDieR) guide to ensure systematic data retrieval [11]. Two authors (HR and SF) extracted data on the study participants (mean age), usual care, study intervention (components, frequency and timing), intervention provider (single healthcare professional, multi-disciplinary team), location (hospital, community setting, home), and study outcomes. The results were reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1) [12]. The Cochrane Collaborations Tool for assessing bias was used to judge the risk of bias and methodological quality of the included studies [13].

285
286
287
288

2.6 Study quality

289
290
291
292
293
294
295

Methodological quality was assessed using the 12-item risk of bias tool. The studies were assessed according to the following categories: sequence generation, allocation concealment, participant and

296
297
298 staff blinding, blinding of outcome assessment, incomplete outcome data, selective outcome
299 reporting, and other sources of bias. Each criteria of risk of bias was judged to be 'high', 'low' or
300 'unclear' (Figure 2)
301
302
303

304 2.7 Data analysis

305 We investigated the following contrasts:

- 306 • Rehabilitation interventions delivered in hospital versus usual hospital care
- 307 • Rehabilitation interventions delivered in hospital and post discharge versus usual hospital care

308
309
310
311
312 Studies were assessed for heterogeneity from clinical, methodological and statistical perspectives.
313 Statistical heterogeneity was judged using forest plots, Chi-squared testing and I² statistical tests.
314
315

316
317 A random effects meta-analysis was performed using Review Manager (RevMan) version 5.3, with
318 pooled results from individual studies. The random effect model was used due to expected
319 heterogeneity amongst the interventions and study outcomes, plus variation in the content of
320 'usual care' can also limit the size of the treatment effect [14]. In cases where data was measured
321 using different instruments, the standardised mean difference (SMD) and 95% confidence intervals
322 (CIs) were the primary summary effect measure. A positive SMD indicated an effect in favour of the
323 exercise-based rehabilitation intervention. Effect sizes were interpreted as follows: 0.2 representing
324 a small effect, 0.5 a moderate effect and 0.8 a large effect [15].
325
326
327
328
329

330 Pre-planned subgroup analyses

331 We planned to explore the effect of the setting as previous studies have shown that rehabilitation
332 interventions occur both inside and outside of the hospital [6, 16-18].
333
334
335
336

337 Outcome measure priority

338 Studies were included if they used at least one functional measure assessing activities of daily living
339 such as the Barthel ADL Index. Other functional measures which could be included were the Katz
340 ADL measure, Functional Independence Measure (FIM), Lawton's Instrumental ADL (IADL),
341 Nottingham extended ADL (EADL), Physical functioning components of the Health Related Quality of
342 Life Short Form 36 (HRQOL SF-36 or SF-12), Timed Up and Go (TUG) [9].
343
344
345
346
347

348 2.8 Data synthesis

349
350
351
352
353
354

355
356
357 The GRADE approach was used to describe the quality of evidence for each outcome in each
358 contrast [19]. Quality was downgraded by one level based on four factors; (i) methodological quality,
359 (ii) inconsistency in the results; (iii) indirectness of evidence and (iv) imprecision of evidence. The
360 quality of evidence was described as high, moderate, low, very low or no evidence.
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413

414
415
416 3. Results
417

418
419 3.1 Search Strategy
420

421 The search strategy identified 8365 studies after duplicates were removed. Nine studies met the
422 inclusion criteria and were included in the descriptive analysis. Eight studies were involved in the
423 meta-analysis.
424

425
426 3.2 Description of included trials (Table 1)
427

428
429 Participants
430

431 Study participants were older adults with a mean age 79 years (range 73-85 years). In total, 1602
432 patients contributed to this analysis; 795 in the intervention groups and 807 in the control groups.
433 The trials took place in Australia (3), Denmark, France, Norway (2) and the USA (2).
434

435
436 Usual Care
437

438 There were considerable differences in 'usual care' across studies, possibly due to differences in
439 clinical practice and healthcare provision. Six studies described the exercise provision in the usual
440 care groups [20-25]. Exercise was prescribed as two 45 minute sessions weekly [24] three times a
441 week [20, 25] or five times weekly [22]. In three trials patients were also followed up at home [20,
442 24, 25]. One study included a month of rehabilitative exercises at home as part of the usual care
443 group [20], in others, physiotherapists visited patients at home [24] or conducted telephone follow
444 up appointments [25]. In one study, research assistants visited the patient the same number of
445 times (3x 15 minutes twice daily) as the intervention group without providing rehabilitative content,
446 but 35% of this usual care group also received additional physiotherapy [21]. Three studies reported
447 that the intervention group received routine care, however, the content and duration was not
448 defined [26-28].
449
450
451
452
453
454
455

456
457 3.4 Intervention description using the TIDieR Guidelines
458

459 Summary of reporting
460

461 All studies reported on the type and frequency of the exercise intervention. Exercise interventions
462 were provided either as the sole intervention or as part of a geriatric assessment. Functional status
463 was measured at baseline and post-intervention; however, studies varied in the post intervention
464 assessment time point. Four studies reported on participant adherence with the programme. No
465 studies described the fidelity of intervention provision to the exercise intervention protocol.
466
467
468
469
470
471
472

473
474
475 3.5 Description of the interventions (Table 1)
476

477 All exercise interventions involved a physiotherapist or physiotherapy assistant; two studies
478 provided additional training for the therapist. One study stated the experience level of the therapist
479 as measured by the number of years worked [27]. No training manual was provided for the
480 physiotherapists and four studies provided written material for the participants [24, 26-28].
481
482

483
484 All the studies incorporated strengthening exercises. In addition, three programmes included
485 balance exercises [24-26], four studies included general physical activity [24-26, 28] and one
486 included nutritional support [20]. In four studies the patient had specific instructions to follow in the
487 exercise component [20, 24-26].
488
489

490
491 Exercise interventions varied greatly in the frequency of sessions. The most intense programmes had
492 patients exercising twice a day [20, 27, 28], with the remainder between two and five times per
493 week. These sessions ranged between 20 and 60 minutes. Only two studies reported on the total
494 number of sessions [24, 25] completed by participants and these programmes lasted 12 weeks' post
495 discharge. One study lasted four weeks post discharge [28]. The remaining four did not report the
496 duration of the programme.
497
498

499
500 All studies described the location of the intervention. Five trials were conducted solely in hospital
501 [20-23, 27], three trials had both in-hospital and post discharge components [24, 26, 28], and one
502 trial occurred in the patients' home [25]. Of the six in-hospital studies, four reported starting the
503 rehabilitative intervention within 72 hours of admission [20, 23, 26, 27].
504
505
506
507

508
509 3.5 Adherence to treatment and intervention fidelity
510

511 Four studies reported participant adherence to the exercise intervention. One reported that 70% of
512 participants self-reported an adherence level of 80% with the home exercise programme [24]. In a
513 second study adherence varied over 6 months, with 53% of the intervention group undertaking their
514 programme daily or nearly every day, another 19% doing their exercises 3 to 4 days per week, and
515 28% doing their exercises on two or fewer days per week or none of the time [26]. The third study
516 reported that 58% of the intervention subjects had undertaken no home exercise as prescribed and
517 only 19.5% in the intervention group performed 67-100% of their home exercises [28]. A further
518 study measured the mean session attendance rate as 10 sessions per participant [23]. None of the
519 studies reported intervention fidelity.
520
521
522
523
524

525
526 3.6 Methodological Quality (Figure 2)
527
528
529
530
531

532
533
534 Based on the five key risk of bias items, seven out of nine studies were rated as low risk of bias
535 (three or more items judged at low risk). For most trials (7/9), patients and intervention providers
536 were un-blinded to the exercise allocation. One trial allocated participants blindly to groups so they
537 were unaware which group received the intervention [27]. All studies employed patient-reported
538 measures of function, and this outcome was thus un-blinded in all studies. Other common reasons
539 for high or unclear risk of bias were greater than 20% data loss at short-term follow-up (71%) and
540 lack of intention to treat analysis (43%). The risk of bias ratings for each study is presented in Figure
541
542
543
544
545 2.

546 547 3.7 In hospital rehabilitation vs Usual Care

548
549
550 Five studies [20-23, 27] compared an exercise based rehabilitation programme delivered in hospital
551 to usual care. All studies measured daily function with questionnaires (Barthel Index, Katz, EMS).
552
553 Three studies [22, 23, 27] objectively measured function with the TUG. Outcomes were assessed on
554 hospital discharge with two studies also repeating the functional measures at 1-month post
555 discharge [20, 21].
556

557 558 Effect on primary and secondary outcomes (Table 2)

559
560
561 In four trials, both control and intervention groups showed improvement in their functional scores
562 (Katz, ADL and Barthel scores) between admission and discharge [20, 22, 23, 27]. One trial showed
563 little difference in the mean ADL score (8.2 at discharge, both groups) between intervention groups
564 ($p=0.62$) and also with change over time ($p=0.77$) [21] but this may be related to a relatively short
565 length of stay (4.06 days for both groups). In the three trials measuring TUG there was no significant
566 difference between the control and intervention groups [22, 23, 27].
567
568

569
570
571 Four studies were included in a random effects meta-analysis. Pooled results found no significant
572 difference between the intervention and control groups on functional ability (SMD -0.04 (-0.31, 0.22))
573 [20, 21, 23, 27]. Raymond et al (2016) was not included due to the non-parametric nature of the
574 data [22] (Figure 3).
575
576

577
578 Two studies reported mean LOS. In one trial the patients in the intervention group stayed 4.6 days
579 compared to 3.6 days in the control arm [21]. The second reported 28 days (intervention) and 24
580 days (control) [23]. Studies reporting median LOS showed little difference between the groups [22,
581 27]. One study reported on the time to clinical stability which was 12.6 days for both groups [20].
582
583

584
585 Readmissions data was available for one trial with a 28-day readmission rate of 20% in the
586 intervention group and 19% in the control group with relative risk of readmission 1.10 (95% CI 0.65-
587
588
589
590

591
592
593 1.86)) [27]. Patient deaths were reported by two trials; in one study two patients in the intervention
594 group died and one in the control group [21]. In the second trial, two from each arm died (relative
595 risk 1.15% (0.16-8))[27].
596
597

598 3.8 In hospital and post discharge rehabilitation vs Usual Care

600
601 Three trials (530 participants) [24, 26, 28] compared a rehabilitation programme delivered both in-
602 hospital and post-discharge to usual care. All studies measured general physical function with
603 questionnaires (SF12, SF36 or IADL) assessing activities of daily living or similar. Two measured
604 physical performance using the TUG [24, 26]. Outcomes were reported at 1-month [28], 3-months
605 [24] or 6-months after discharge [26].
606
607

608 Effect on the primary and secondary outcomes (Table 2)

609
610 For activities of daily living, one study found a statistically significant improvement in the SF12 scores
611 in the intervention group compared to the control group at 4, 12 and 24 weeks after discharge [26].
612 Brovold et al (2012) reported improved mean SF36 scores in both groups after 3-months but was
613 considered as a result of time effect ($p=0.0001$) rather than treatment effect ($p=0.5$) [24]. The third
614 study reported a reduced average number of independent ADLs at 1-month post discharge. All three
615 studies were included in the random effects meta-analysis which showed a moderate effect size of
616 SMD 0.56 (-0.02, 1.13) for in-hospital and post discharge rehabilitation as compared to usual care
617 (Figure 3)
618
619

620
621 One trial reported on length of hospital stay with the mean LOS 10.5 days in the control group and
622 12 in the intervention group [28]. Another trial reported a seven-fold increase in readmissions in the
623 control group using a multi-variant logarithmic regression [26]. A final trial found similar
624 readmissions in both groups [24].
625
626

627
628 Deaths were reported in three trials. One study had 3 deaths in both arms [24], another had 2
629 deaths in the control arm and 3 in the intervention group [26]. The final trial reported 2 deaths in
630 the intervention group only during the intervention but by one month there were ten deaths in both
631 groups (6%) [28].
632
633

634 3.9 Usual care and post discharge rehabilitation vs Usual Care

635
636 One trial investigated the effect of high intensity group based exercise on function. [25]. Participants
637 exercised twice weekly for 3-months after discharge from hospital. They attended a hospital twice
638 weekly for 60 minutes of high intensity exercise, as compared to a home exercise programme (6
639 exercises 3x weekly) with telephone follow up from a physiotherapist once a month. The study was
640
641
642
643
644
645
646
647
648
649

650
651
652 judged to have a low risk of bias but there was no reporting on the fidelity or adherence to the
653 exercise programme. There was little difference in the SF36 (mean change 0.5) or TUG (mean change
654 -0.3) between the intervention and control groups. There was one death in the intervention group.
655 Adverse events were reported in 24% of the intervention group and 29% of the control group, these
656 included reporting feeling ill, falls, musculoskeletal pain or dizziness experienced during the exercise.
657
658
659
660

661 4. Discussion

662 4.1 Statement of Principle Findings

663
664 This systematic review of exercise-based rehabilitation interventions to improve function in older
665 patients after a hospital admission with an acute medical illness, found low quality evidence to
666 support exercise interventions which include both in-hospital and post-discharge components (3
667 trials, SMD 0.56 (95% CI -0.02, 1.13). There is inconclusive evidence for trials involving only in-
668 hospital interventions (SMD -0.04 (-0.31, 0.22)). The review is unable to make any recommendations
669 on the content or dose of an exercise programme to improve function after hospitalisation due to
670 the variation and heterogeneity of the rehabilitative interventions.
671
672
673
674
675
676
677

678 4.2 Outcome significance in relation to other research

679
680 Previous reviews of exercise interventions for older patients demonstrated the safety of physical
681 interventions for this vulnerable group but were inconclusive about any functional gain when
682 compared to usual care [8, 9]. Exercise appeared to be most beneficial when part of a multi-
683 disciplinary intervention, however, which components confer the benefit are not well understood [8,
684 29]. This is in keeping with previous research into falls prevention, where physical interventions as
685 part of a complex intervention were most effective at reducing falls [10].
686
687
688
689

690 Most rehabilitative interventions have been examined in hospital setting [7], however, out of
691 hospital interventions have been shown to have similar outcomes whilst reducing length of stay,
692 reducing hospital associated costs [16] and may be a more cost effective option [30]. This review
693 suggests that for functional gain exercise needs to start in-hospital but continue into the community.
694 This is in keeping with falls prevention interventions where the duration of effective exercise
695 programmes is between 3 and 6 months [31].
696
697
698
699

700 4.3 Strengths

701
702 This study has examined the dose, content and timing of exercise-based rehabilitative interventions
703 designed to improve the function of older patients after hospital admission for an acute medical
704
705
706
707
708

709
710
711 problem. These patients are at particularly high risk of mortality or institutionalisation after a
712 hospital admission [3] and it is important to understand which exercise-based interventions are most
713 effective at maintaining functional ability for patient autonomy. The findings of this review adds to
714 the body of evidence promoting exercise for older adults to prevent functional decline [7-9] and in
715 addition recommends that exercise is most effective if introduced in-hospital but continued after
716 discharge, in the community.
717
718
719

720 721 4.4 Limitations 722

723 The interventions showed considerable heterogeneity in the exercise provided (resistance, strength,
724 high intensity group or mobility programmes). Descriptive reporting of the exercise intervention
725 delivery was limited and few studies reported on the number of exercise sessions, programme
726 duration, and participant adherence to the programme. Due to the different functional outcome
727 measures used by the trials, it was difficult to directly compare results and the meta-analysis relies
728 on differences in standardised mean difference.
729
730
731
732

733
734 Usual care varied considerably; some groups receiving physiotherapy up to 5x weekly and one trial
735 providing one month of physiotherapy at home in the routine care group. The two in-hospital trials
736 showing a negative SMD, may be explained by extensive physiotherapy in the usual care groups.
737
738 Previous authors have acknowledged the difficulties of 'usual care' as control groups, in particular
739 highlighting the difficulties of "active" controls who are receiving an exercise intervention as usual
740 care [16, 32].
741
742
743
744

745 746 4.5 Clinical implications 747

748 This review has highlighted the resource intensity required for effective rehabilitative interventions.
749 In most of the trials healthcare professionals were involved over long periods of time to provide
750 intensive exercise interventions. Further research is needed to decide how effective rehabilitation
751 interventions can be provided within healthcare budget restraints.
752
753
754

755 The in-hospital group had shorter duration of intervention, with patients staying between 4-28 days,
756 as compared to a 4-8 week intervention time for the in-hospital and post discharge groups. This
757 increased contact time with the physiotherapist may explain the differences between the groups
758 [33]. In addition in-hospital rehabilitation has been shown to have less noticeable effects on long
759 term patient outcomes [7].
760
761
762
763
764
765
766
767

768
769
770 4.5 Recommendations for improving future research
771

772 Further research is recommended to understand the most effective approach to restoring function
773 to older patients after an acute hospital admission for a medical illness. None of the trials recruited
774 more than 500 patients and larger studies are needed to understand the size of any intervention
775 effect. Standardisation in reported outcome measures are needed to aid comparison between trials.
776 Finally, improved reporting describing the intervention and usual care would allow conclusions to be
777 made on the optimal dose and content of any rehabilitative measure.
778
779
780
781

782
783 5. Conclusions
784

785 There is low quality evidence to suggest that exercise based rehabilitation for older patients after
786 emergency hospitalisation improves functional ability, if the exercise component includes both in-
787 hospital and post-discharge components. No conclusions can be made on the effective dose or
788 content of exercise.
789
790

791
792 With limited healthcare resources, understanding what entails an effective exercise intervention will
793 improve service planning and delivery for these vulnerable older patients at risk of functional decline
794 and an inability to return to independent living. Further studies are urgently needed to understand
795 the effectiveness of exercise for older adults hospitalised after an acute medical illness.
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826

827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885

References

1. Bardsley, M.B., Ian; Davies, Sian; Dixon, Jennifer;, *Is secondary preventive care improving? Observational study of 10-year trends in emergency admissions for conditions amenable to ambulatory care.* *BMJ Open*, 2013. **3**(1): p. e002007.
2. Purdy, S. *Avoiding Hospital Admissions.* 2010.
3. Kortebein, P., *Rehabilitation for hospital-associated deconditioning.* *Am J Phys Med Rehabil*, 2009. **88**(1): p. 66-77.
4. Zisberg, A., et al., *Low mobility during hospitalization and functional decline in older adults.* *J Am Geriatr Soc*, 2011. **59**(2): p. 266-73.
5. Stott, D.J. and T.J. Quinn, *Principles of rehabilitation of older people.* *Medicine*, 2013. **41**(1): p. 1-4.
6. Ellis, G., et al., *Comprehensive geriatric assessment for older adults admitted to hospital.* *Cochrane Database Syst Rev*, 2011(7): p. CD006211.
7. Bachmann, S., et al., *Inpatient rehabilitation specifically designed for geriatric patients: systematic review and meta-analysis of randomised controlled trials.* *BMJ*, 2010. **340**: p. c1718.
8. de Morton, N.A., J.L. Keating, and K. Jeffs, *The effect of exercise on outcomes for older acute medical inpatients compared with control or alternative treatments: a systematic review of randomized controlled trials.* *Clin Rehabil*, 2007. **21**(1): p. 3-16.
9. Kosse, N.M., et al., *Effectiveness and feasibility of early physical rehabilitation programs for geriatric hospitalized patients: a systematic review.* *BMC Geriatrics*, 2013. **13**(1): p. 107.
10. Gillespie, L.D., et al., *Interventions for preventing falls in older people living in the community.* *Cochrane Database Syst Rev*, 2012(9): p. CD007146.
11. Hoffmann, T.C., et al., *Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide.* *BMJ*, 2014. **348**: p. g1687.
12. Moher, D., et al., *Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement.* *Syst Rev*, 2015. **4**: p. 1.
13. Higgins, J.P., et al., *The Cochrane Collaboration's tool for assessing risk of bias in randomised trials.* *BMJ*, 2011. **343**: p. d5928.
14. Mant, D., *The problem with usual care.* *Br J Gen Pract*, 2008. **58**(556): p. 755-6.
15. Cohen, L., L. Manion, and K. Morrison, *Research methods in education.* 2013, Routledge,; Place of publication not identified. p. 1 online resource (784 pages).
16. Forster, A., J. Young, and P. Langhorne, *Systematic review of day hospital care for elderly people.* *The Day Hospital Group.* *BMJ*, 1999. **318**(7187): p. 837-41.
17. Shepperd, S., et al., *Early discharge hospital at home.* *Cochrane Database of Systematic Reviews*, 2009: p. N.PAG.
18. Beswick, A.D., et al., *Complex interventions to improve physical function and maintain independent living in elderly people: a systematic review and meta-analysis.* *Lancet*, 2008. **371**(9614): p. 725-35.
19. Guyatt, G., et al., *GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables.* *J Clin Epidemiol*, 2011. **64**(4): p. 383-94.
20. Blanc-Bisson, C., et al., *A randomized controlled trial on early physiotherapy intervention versus usual care in acute car unit for elderly: Potential benefits in light of dietary intakes.* *Journal of Nutrition, Health and Aging*, 2008. **12**(6): p. 395-399.
21. Brown, C.J., et al., *Comparison of posthospitalization function and community mobility in hospital mobility program and usual care patients a randomized clinical trial.* *JAMA Internal Medicine*, 2016. **176**(7): p. 921-927.
22. Raymond, M.J.M., et al., *The effects of a high-intensity functional exercise group on clinical outcomes in hospitalised older adults: an assessor-blinded, randomised-controlled trial.* *Age & Ageing*, 2016. **07**: p. 07.

886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944

23. Tibaek, S., et al., *Does progressive resistance strength training as additional training have any measured effect on functional outcomes in older hospitalized patients? A single-blinded randomized controlled trial.* *Clinical Rehabilitation*, 2014. **28**(4): p. 319-28.
24. Brovold, T., D.A. Skelton, and A. Bergland, *The efficacy of counseling and progressive resistance home-exercises on adherence, health-related quality of life and function after discharge from a geriatric day-hospital.* *Archives of Gerontology & Geriatrics*, 2012. **55**(2): p. 453-9.
25. Brovold, T., D.A. Skelton, and A. Bergland, *Older Adults Recently Discharged from the Hospital: Effect of Aerobic Interval Exercise on Health-Related Quality of Life, Physical Fitness, and Physical Activity.* *Journal of the American Geriatrics Society*, 2013. **61**(9): p. 1580-1585.
26. Courtney, M., et al., *Fewer emergency readmissions and better quality of life for older adults at risk of hospital readmission: a randomized controlled trial to determine the effectiveness of a 24-week exercise and telephone follow-up program.* *Journal of the American Geriatrics Society*, 2009. **57**(3): p. 395-402.
27. de Morton, N.A., et al., *Additional exercise does not change hospital or patient outcomes in older medical patients: a controlled clinical trial.* *Australian Journal of Physiotherapy*, 2007. **53**(2): p. 105-11.
28. Siebens, H., et al., *A randomized controlled trial of exercise to improve outcomes of acute hospitalization in older adults.* *Journal of the American Geriatrics Society*, 2000. **48**(12): p. 1545-52.
29. Puts, M.T., et al., *Interventions to prevent or reduce the level of frailty in community-dwelling older adults: a scoping review of the literature and international policies.* *Age Ageing*, 2017.
30. Brusco, N.K., et al., *Economic evaluation of adult rehabilitation: a systematic review and meta-analysis of randomized controlled trials in a variety of settings.* *Arch Phys Med Rehabil*, 2014. **95**(1): p. 94-116 e4.
31. Brown, A., *Reducing falls in elderly people: A review of exercise interventions.* *Physiotherapy Theory and Practice*, 1999. **15**(2): p. 59-68.
32. Somerville, S., et al., *Content and outcome of usual primary care for back pain: a systematic review.* *Br J Gen Pract*, 2008. **58**(556): p. 790-7, i-vi.
33. Brusco, N.K., et al., *Factors that predict discharge destination for patients in transitional care: a prospective observational cohort study.* *Aust Health Rev*, 2012. **36**(4): p. 430-6.

Figures

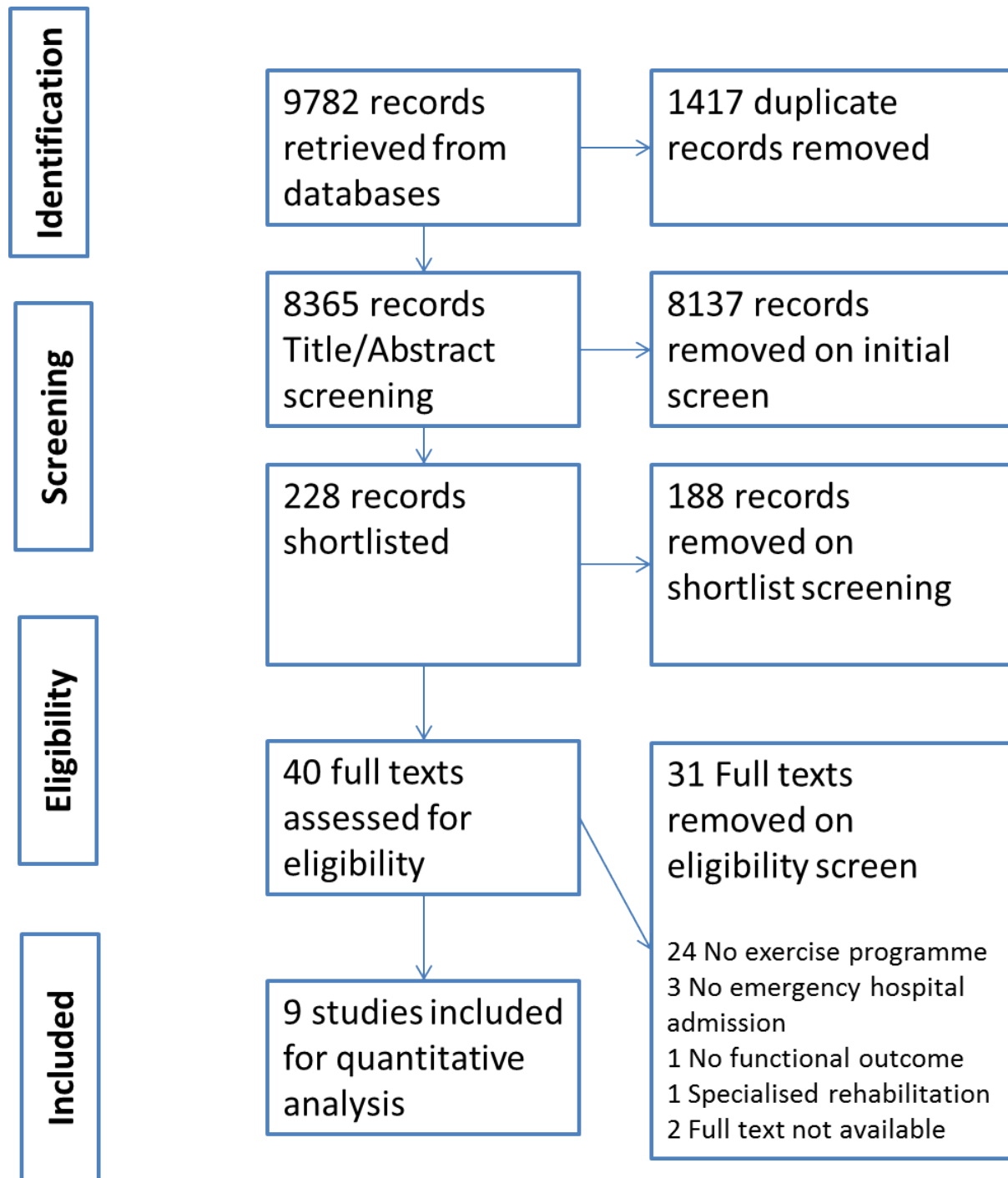


Figure 1: PRISMA Flow Chart

1004
 1005
 1006
 1007
 1008
 1009
 1010
 1011
 1012
 1013
 1014
 1015
 1016
 1017
 1018
 1019
 1020
 1021
 1022
 1023
 1024
 1025
 1026
 1027
 1028
 1029
 1030
 1031
 1032
 1033
 1034
 1035
 1036
 1037
 1038
 1039
 1040
 1041
 1042
 1043
 1044
 1045
 1046
 1047
 1048
 1049
 1050
 1051
 1052
 1053
 1054
 1055
 1056
 1057
 1058
 1059
 1060
 1061
 1062

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias): Other	Blinding of outcome assessment (detection bias): Patient reported	Incomplete outcome data (attrition bias): Short term (2-6 weeks)	Incomplete outcome data (attrition bias): Long term (more than 6 weeks)	Selective reporting (reporting bias)	Other bias
Blanc-Bisson 2008	?	?	-	?	-	-	-	?	-
Brovold 2012	+	+	-	+	-	?	+	?	-
Brovold 2013	+	?	-	+	-	?	+	?	-
Brown 2016	+	+	-	?	?	+	+	+	+
Courtney 2009	+	+	?	?	?	?	-	?	-
DeMorton 2007	+	+	+	+	+	-	?	?	+
Raymond 2017	+	+	-	+	?	+	?	?	+
Siebens 2000	+	+	-	+	-	+	?	?	-
Tibaek 2014	?	+	-	+	-	+	?	?	-

Figure 2: GRADE Risk of Bias

1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121

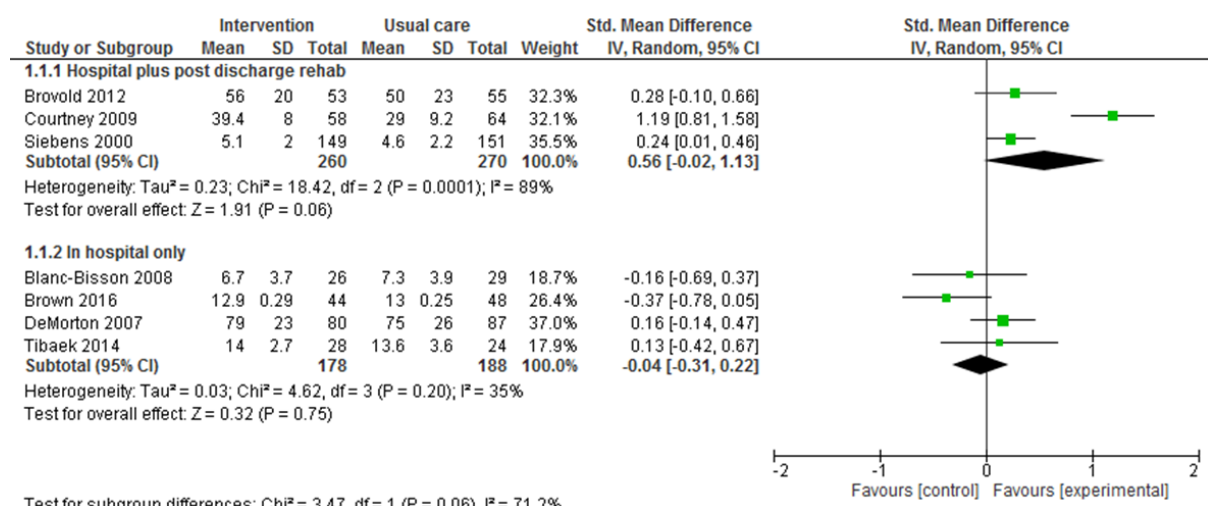


Figure 3: Random Effects Meta-analysis Forest Plot

Appendices

Appendix 1: Rehabilitation after Emergency Admission of Older Adults: Inclusion-Exclusion Criteria	
Inclusion criteria	
Age	80% Participants aged over 60 years
Population	Admitted to a hospital ward as an emergency/unplanned way for urgent care
Intervention	Exercise Based Rehabilitation intervention to improve function
Timing of intervention	Patients are admitted to hospital as an emergency/or in an unplanned way Hospital admission lasts greater than 4 hours Intervention takes place during or after the hospital admission
Study Design	Randomised control trials
Outcome measured	Measures of functional ability (Activities of Daily Living): Barthel's ADL Index (BI), Functional Independence Measure (FIM), Katz ADL, Lawton's Instrumental ADL (IADL), Nottingham extended ADL (EADL), Physical functioning aspect of the Health Related Quality of Life Short Form 36 (HRQOL SF-36)
Language	English
Exclusion Criteria	
Age	<60 years
Population	Patients living in residential or nursing homes Patients recruited from the Community without an emergency hospital admission
Intervention	Interventions designed solely to reduce the incidence of falls Complementary or Alternative Therapies Exercise is not the main component of the intervention

1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239

Timing of intervention	During an elective planned admission e.g. for a planned surgical procedure Hospital admission lasts less than 4 hours
Diagnosis	Disease processes which require specialized rehabilitation: Pulmonary rehab for COPD Cardiac rehabilitation after Myocardial Infarction, Acute Coronary Syndrome or Heart Failure Rehabilitation after Stroke Rehabilitation after Orthopaedic Injury such as hip fractures Rehabilitation for Spinal Injuries or Traumatic Brain Injury (TBI) Rehabilitation after Intensive care treatment, Psychological disorders, Cancer
Study Design	Cohort, Case Control, Pilot, Feasibility, Cost Analysis and Review articles
Outcome measured	No specific measures of function

Appendix 2: Search Strategy for Embase

exp Aged/

(older adj2 (adult? or person? or people? or patient?)).ti,ab.

(elder? or elderly or old age or seniors).ti,ab.

Geriatrics/

elderly care/ or geriatric care/

geriatric*.ti,ab.

1 or 2 or 3 or 4 or 5 or 6

hospital admission/ or hospitalization/

(hospitali?ation? or hospitali?ed or (hospital adj2 (admit* or admission?))).ti,ab.

((emergenc* or acute* or unplanned) adj2 (admission? or admitted?)).ti,ab.

hospital patient/

inpatient?.ti.

transitional care.ti,ab.

8 or 9 or 10 or 11 or 12 or 13

rehabilitation/ or geriatric rehabilitation/

rh.fs.

physiotherapy/

Physical Activity/

Occupational Therapy/

rehabilitat*.ti,ab.

(physical therap* or physiotherap*).ti,ab.

occupational therap*.ti,ab.

exp Exercise/ or kinesiotherapy/

exercise?.ti,ab.

(physical adj2 (activity or train*)).ti,ab.

(aerobic adj2 (train* or activit*)).ti,ab.

(strengthening or (strength adj2 train*)).ti,ab.

(fall? adj2 (prevent* or program* or intervention?)).ti,ab.

15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28

1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357

daily life activity/ or independent living/
((activit* adj2 daily living) or adl or iadl*).ti,ab.
(bathing or dressing).ti,ab.
(barthel or whodas or functional reach).ti,ab.
Fitness/
convalescence/
immobility/ or limited mobility/ or walking difficulty/
unsteadiness/
(function* adj2 (capacity or outcome? or status or performance or decline or recovery)).ti,ab.
(physical* adj2 (function* or capacity or outcome? or status or performance or decline or recovery)).ti,ab.
(aerobic adj2 (function* or capacity or outcome? or status or performance or decline or recovery)).ti,ab.
(mobility or debility or disability).ti,ab.
body equilibrium/ or walking speed/ or gait/ or muscle strength/
((muscle or hand or grip) adj2 (strength or weakness)).ti,ab.
(gait or (walk* adj3 (test* or speed* or distance))).ti,ab.
walking.ti,ab.
(standing or balance or stand test*).ti,ab.
"get up and go".ti,ab.
falling/
(falls or falling).ti,ab.
hospital discharge/ or hospital readmission/ or hospital utilization/
((patient? or hospital) adj2 (discharge or readmission or transfer)).ti,ab.
(discharg* adj5 (home? or nursing home? or residential home? or nursing care or residential care)).ti,ab.
30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52
7 and 14 and 29 and 53

1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416

limit 54 to "reviews (maximizes specificity)"
54 not 55
(review or comment or letter or editorial).pt.
56 not 57
conference*.pt.
58 not 59
58 nd 59

Table 1. Study Characteristics: Rehabilitation after Emergency Admission for Older Adults

Study	Brief Description of Intervention	Usual Care	Intervention	Control	Mean Age	Function Measures	Secondary Measures	Assessment time points
	<i>Type of exercise and programme description</i>	<i>Type and frequency of exercise</i>	n	n	years	ADL, Barthel Index, Katz ADL, IADL, FIM, TUG, SF36, SF12, EMS	Length of stay, Readmissions, Mortality	Wks/months
In Hospital Exercise Interventions								
Blanc-Bisson 2008	Early intensive physiotherapy focused on dynamic leg extension exercise with nutritional support	Walking and physiotherapy 3x/week, continues at home for 1 month after discharge	38	38	85.4 (6.6)	Katz ADL	Not assessed	Baseline, Clinical stability (normal vital signs, mental status and independent with feeding) and 1 month after stabilisation
Brown 2016	Mobility programme (MP) - began with assisted sitting, then standing, progressing to weight shifting, stepping in place, and then ambulation as tolerated with the assistance of the research assistant.	Research assistant visits for 15-20 minutes twice daily 7x/week 34% have extra physio	50	50	73.9 (6.96)	ADLs	Length of stay	Baseline, hospital discharge and by telephone at 1 month after discharge
DeMorton 2007	Individually prescribed exercise programme in addition to UC, ranging from Level 1 Bed based exercise programme, Level 2 Sitting, Level 3 Standing and Level 4 Stairs. Including resistance training where possible	Usual care	110	126	UC 78(7) Int 80(8)	Barthel Index, TUG	Length of stay, readmission	Baseline (within 48 hrs of admission) and at discharge (within 48 hrs of discharge)
Tibaek 2014b	Progressive resistance strength training in addition	Regular physiotherapy	36	35	UC 79 Int 80	Barthel Index, TUG	Length of stay	Baseline and after intervention but

	to usual physiotherapy							before discharge
Raymond 2017	High-intensity functional exercise (HIFE). Exercise group 3x/week and physiotherapy 2x/week. Exercises were lower limb progressive resistance strength exercises in supported and unsupported positions and balance exercises.	Individual physiotherapy balance, strength or aerobic exercise 5x/week	236	232	Control 84.05 (6.88) HIFE 84.51 (7.30)	Elderly Mobility Scale, TUG	Length of stay	Prior to randomisation and within 48 hours of discharge
In hospital and Post Discharge Exercise Interventions								
Brovold 2012	Combined counselling and exercise programme including balance and progressive resistance training.	45 minutes balance exercise 2x/week.	53	55	80 (6.1)	SF36, TUG	Not assessed	Baseline, after discharge from hospital, and after 3 months
Courtney 2009	Discharge planning and in-home follow-up care including an individually tailored exercise programme, including muscle stretching, walking, balance and resistance training	Usual care	64	64	78.8 (6.9)	SF12, TUG	Hospital readmissions	Baseline and 4,12, and 24 weeks after discharge
Siebens 2000	Hospital based general exercise programme and encouragement to continue to exercise at home. Combination of strength, flexibility exercises and walking.	Usual care	149	151	UC 78.2 (5.6) Int 78.5 (5.6)	IADL	Length of stay	Baseline and at 1 month after discharge
Post discharge Exercise Interventions								
Brovold 2013	High intensity group-based aerobic interval training programme.	Low intensity home exercise 3x/week	59	56	78 (5.2)	SF36, TUG	Not assessed	Baseline (2-4 weeks post discharge) and at 3 months after discharge

Table 2. Primary and Secondary Outcomes: Function, Length of Stay, Readmissions and Mortality

Study	Brief Description of Intervention	Assessment time point	Functional Measures used	Functional Outcome	Length of stay	Readmissions	Mortality
In Hospital Exercise Interventions							
Blanc-Bisson 2008	Early intensive physiotherapy focused on dynamic leg extension exercise with nutritional support	Baseline (T0), at clinical stability (T1), and 1 month later (T2)	Katz ADL Score 0 independent 12 dependent	Change in mean ADL score T0 to T2 Intervention 2.2 Control 3	Time to clinical stability 12.6 days both groups	Not assessed	Not assessed
Brown 2016	Mobility programme (MP) - began with assisted sitting, then standing, progressing to weight shifting, stepping in place, and then ambulation as tolerated with the assistance of the research assistant.	Baseline (T0), hospital discharge (T1) and by telephone at 1 month after discharge (T2)	ADL Score 7 independent 21 dependent	Both groups similar ADLs (p=0.62) No change over time (p=0.77)	INT 4.6 days UC 3.6 days P=0.13	Not assessed	INT 2 deaths UC 1 death
DeMorton 2007	Individually prescribed exercise programme in addition to UC, ranging from Level 1 Bed based exercise programme, Level 2 Sitting, Level 3 Standing and Level 4 Stairs. Including resistance training where possible	Baseline (within 48 hrs of admission, T0) and at discharge (within 48 hrs of discharge, T1)	Barthel Index 0 dependent 20 independent TUG Time in seconds	Change in mean ADL score T0 to T2 INT 12 UC 10 Reduction in time T0 to T1 INT -10 seconds UC -5 seconds	Median LOS INT 5 days UC 6 days P=0.45	28 days readmission rate INT 20% UC 19%	INT 2% UC 2% RR 1.15 (0.16-8)
Tibaek 2014b	Progressive resistance strength training in addition to usual physiotherapy	Baseline (T0) and after intervention but before	Barthel Index 0 dependent - 20 independent	Change in Mean ADL score Transfers	Mean LOS INT 28 days UC 24 days P=0.23	Not assessed	Not assessed

		discharge (T1)	Divided into transfer, walking and stairs	INT 1.8 UC 0.3 Walking INT 2 UC 1.2 Stairs INT 3.8 UC 3.9			
			TUG Time in seconds	Reduction in time T0 to T1 INT -7 seconds UC -6 seconds P=0.29			
Raymond 2017	High-intensity functional exercise (HIFE). Exercise group 3x/week and physiotherapy 2x/week. Exercises were lower limb progressive resistance strength exercises in supported and unsupported positions and balance exercises.	Prior to randomisation (T0) and within 48 hours of discharge (T1)	Elderly Mobility Scale 0 independent 20 dependent	Change in mean ADL score T0 to T1 INT 5 UC 5 P=0.446	Median LOS INT 12.3 days UC 12.2 days	Not assessed	Not assessed
			TUG Time in seconds	No significant difference p=0.819			
In Hospital and Post Discharge Exercise Interventions							
Brovold 2012	Combined counselling and exercise programme including balance and progressive resistance training.	Baseline (T0), after discharge from hospital (T1), and after 3 months (T2)	SF36 0 dependent 100 independent	Change in mean ADL T0 to T2 INT 6.0 UC 6.5 Time effect p=0.0001 Treatment effect p= 0.5	Not assessed	INT 5 UC 7	INT 3 deaths UC 3 deaths

			TUG Time in seconds	Reduction in time T0 to T2 INT -1.9 seconds US -1.3 seconds			
Courtney 2009	Discharge planning and in-home follow-up care including an individually tailored exercise programme, including muscle stretching, walking, balance and resistance training	Baseline (T0) and 4 (T1), 12 (T2), and 24 weeks after discharge (T4)	SF12 Physical component score 0 dependent 100 independent TUG Time in seconds	Change in mean score T0 to T4 INT 11.2 UC -8.5 P=<0.001 Not reported	Not assessed	INT 21 UC 49 UC 7.2x more likely to be readmitted (multi-variant log regression)	INT 3 deaths UC 2 deaths
Siebens 2000	Hospital based general exercise programme and encouragement to continue to exercise at home. Combination of strength, flexibility exercises and walking.	Baseline (T0) and at 1 month after discharge (T1)	IADL Average number of independent ADLs T0 to T1 0 dependent 7 independent	Change in mean score T0 to T1 INT -0.2 UC -0.7	Mean LOS INT 12 days UC 10.5 days P=0.23	Not assessed	At T0 INT 2 deaths UC 0 deaths At T1 10 deaths both groups
Post discharge exercise interventions							
Brovold 2013	High intensity group-based aerobic interval training programme.	Baseline (2-4 weeks post discharge) and 3 months after discharge	SF36 0 dependent 100 independent TUG Time in seconds	Change mean score 0.5 INT & UC Reduction in time -0.3 seconds INT & UC	N/A	Not assessed	Not assessed (Adverse events INT 23% UC 29%)

Conflicts of Interest Declaration:

There are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Funding Source Declaration:

This research was funded by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care Oxford at Oxford Health NHS Foundation Trust. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

Dr Sara McKelvie

8.1.18