Functional Recovery in Hip Fracture Patients: a Real-practice Pilot Study Comparing Different Rehabilitation Settings

Margarida Mota Freitas (✉ margaridafmfreitas@gmail.com)

Physical and Rehabilitation Medicine Department Hospital Garcia de Orta Av. Torrado da Silva | 2805-267 Almada | Portugal <https://orcid.org/0000-0001-5258-0172>

Claudio Curci

Policlinico San Marco

Diana Ascenso

Hospital Garcia de Orta EPE

Alda Silveira

Hospital Garcia de Orta EPE

Alessandro de Sire

Universita degli Studi del Piemonte Orientale Amedeo Avogadro Scuola di Medicina

Research article

Keywords: Hip Fractures, Rehabilitation, Aging, Frail Elderly, Activities of daily living, Osteoporosis

Posted Date: September 3rd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-56861/v1>

License: (cc) (i) This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Background: Hip fractures are a major source of disability in the elderly and rehabilitation is mandatory to recover pre-fracture functioning. To date, there is a big heterogeneity not only in terms of frequency and timing but also of choosing the most appropriate setting for hip fracture rehabilitation. In this real-practice pilot study we aimed at evaluating the long-term effects of rehabilitative intervention on disability status and functional outcomes in post-hip fracture elderly people.

Methods: We included patients aged 65 years or older who had undergone surgical stabilization of a hip fracture. Exclusion criteria: pathological fractures or whose comorbidities could have an impact on motor, cognitive or sensory function. The sample was divided into 3 groups according to their destination after hospital discharge: Group 1, outpatient rehabilitation; Group 2, inpatient rehabilitation; Group 3, home-based rehabilitation. All three groups underwent a specific rehabilitation protocol for 3 times/week for 2 months. At the baseline (T0), at 3 months (T1), and at 6 months after fracture (T2), we assessed as outcome measures: Barthel Index (BI), Functional Ambulation Categories, passive and active range of motion of hip flexion and abduction, Medical Research Council scale (MRC) to assess muscle strength in hip flexion, hip abduction, and knee extension.

Results: All three groups showed an average statistically significant improvement ($p < 0.05$) in all the outcome measures compared to baseline, except for MRC of knee extension in group 3 at T1. Considering the between-group analysis, BI was significantly higher in Group 1 than in Group 2 at T2 ($p = 0.018$).

Conclusions: Taken together, our findings show that rehabilitation could lead to a significant improvement in functional recovery, independently from the settings, albeit outpatient rehabilitation seems to be the best option for hip fracture patients.

Background

Hip fractures are the most common osteoporotic fractures, affecting about 18% of women and 6% of men worldwide [1], and are considered as major concern for the healthcare system and society; thus, they might lead to functional impairment, reduced independence in activities of daily living (ADL) [2–6]. At current times, we still lack proper osteoporosis screening programs covering the vast majority of population, particularly in male [7].

Rehabilitation might play a key role on the functional recovery of hip fracture patients, particularly, if combined with nutritional supplementation (i.e. vitamin D, calcium or amino acids) [8–12].

Hip fracture in common practice might show transition of patients among various settings, increasing medical costs, risk for adverse events and medical errors [13]. However, up to date, there is a big heterogeneity not only in terms of frequency and timing of rehabilitation treatment but also in terms of the choice of the most appropriate setting [14].

Timing of discharge is crucial, considering that the sooner the patient is re-integrated in his/her own environment, the better the functional outcome tends to be [15]. Moreover, it has been showed that an early return at home after hip fracture would increase the involvement of caregivers. It is mandatory to define the adequate discharge destination for hip fracture patients considering that they might undergo rehabilitation in different settings: inpatient, outpatient, or home-based [16, 17].

Inpatient rehabilitation might provide an adequate hospitalization after surgery in hip fracture patients, but they might tend to have more comorbidities and poor general condition, predicting lower rehabilitation outcomes [18, 19].

On the other hand, outpatient facilities might be considered as valid settings with attracting results in terms of improved physical function in hip fracture patients, albeit there are still a few findings in literature [20, 21].

Lastly, in some cases, individualized home-based rehabilitation programs might also be effective in improving recovery after hip fracture over standard care; they can be prolonged even after completion of standard programs, with good results in terms of physical function [22, 23].

Several differences exist in care pathways after hip fracture among different countries. More in detail, taking into account the Portuguese National Health Service, rehabilitative options might differ according to a specific setting for hip fracture patients: inpatient or outpatient rehabilitation in hospitals or rehabilitation centers, or home-based care, provided by rehabilitative teams where physiatrists and physical therapists provide domiciliary treatment.

To date, to the best of our knowledge, there is still a lack of data on the role of rehabilitation for hip fracture, taking into account the setting where it was provided; moreover, considering the increasing lifespan, it is mandatory to perform an adequate rehabilitative intervention in hip fracture patients to reduce their disability.

Therefore, we sought to evaluate the long-term effects of rehabilitation in different settings on disability status and functional outcomes in a pilot sample of hip fracture patients.

Methods

Participants

In this real-practice pilot study we recruited hip fracture patients consecutively admitted to a Traumatology Unit of a Portuguese Hospital in a 3-month period (from October to December 2019).

Inclusion criteria: a) age 65 years or older; b) patients undergone surgical stabilization of the hip fracture; c) understanding of the authorizations and able to sign an informed consent.

We excluded from the study: a) patients not eligible to follow-up in appointments for geographic or social reasons; b) patients with pathological fractures; c) patients who had comorbidities with an impact on the motor, cognitive or sensory function; d) cognitive impairment, assessed by a Mini Mental Status Examination (MMSE) < 24/30.

The Hospital Garcia de Orta Ethical Committee approved this study – approval number 37/2020. All the participants were asked to carefully read and sign an informed consent, and researchers provided to protect the privacy and the study procedures according to the Declaration of Helsinki, with pertinent National and International regulatory requirements.

Intervention

The study cohort was divided into 3 groups according to their destination after hospital discharge: Group 1, including patients that had been discharged for outpatient rehabilitation treatment; Group 2, including patients referred for inpatient rehabilitation facilities; Group 3, including patients intended for undergoing home-based rehabilitation.

All patients underwent a rehabilitation protocol, consisting of multiple fitness components (aerobic, flexibility, resistance and neuromotor) based on clinical guidelines for individuals with chronic conditions or functional limitations [24]. The rehabilitation protocol consisted of a set of exercises (walking training, lower limb muscle strengthening, balance exercises, and assisted ambulation) administered for three times per week for 2 months.

Outcome Measures

At the baseline we collected demographic, anamnestic and clinical data, including MMSE [25], comorbidities, history of previous fragility fractures (hip, vertebral or non-hip non vertebral -NHNV), and the use of anti-osteoporotic drugs or supplementation with vitamin D or calcium.

At the baseline (T0), at 3 months (T1), and at 6 months after fracture (T2) we assessed as outcome measures:

- - *Barthel Index (BI)*, to evaluate the functional independence in ADL (toileting, bathing, eating, dressing, continence, transfers, and ambulation); each task receives a numerical score based on whether the patient requires physical assistance to perform it. A patient scoring 0 points would be dependent in all assessed activities of daily living, whereas a score of 100 would reflect independence in all activities [26].
- - *Functional Ambulation Categories (FAC)*, to evaluate the independence in ambulation according to six categories ranging from 0 (non-functional ambulation) to 5 (independent walking); albeit the FAC is a general ambulation test, its scores showed a positive linear relationship with such variables as gait velocity and step length [27];
- - *Passive and active range of motion (pROM and aROM)* of hip flexion and abduction;

- - *Medical Research Council (MRC) scale*, to evaluate muscle strength in hip flexion, hip abduction, and knee extension [28].

Statistical Analysis

Statistical analysis was performed using STATA v.12 (StataCorp LP, College Station, TX). A study power of 90% was assumed and the statistical significance was defined at 0.05 ($\alpha = 0.05$). At baseline, Kruskal Wallis test and ANOVA test were performed to assess the differences among groups for continuous and categorical variables, respectively. Considering the differences in outcome measures, a between-group analysis in outcome measures was performed using Wilcoxon rank sum test for between-group analysis to compare continuous variables between two groups; Wilcoxon matched-pairs signed rank test for intra-group analysis in all three groups.

Results

Of the 52 patients assessed for eligibility, 7 patients did not start rehabilitation treatment, 8 patients dropped out the study, 3 patients died during the follow-up. Therefore, the final sample consisted of 34 patients (12 male and 40 female), mean aged 83.12 ± 7.78 years, that could be divided according to the rehabilitation setting after discharge in 3 groups: 14 patients referred to outpatient rehabilitation facilities (Group 1), 14 patients discharged to inpatient facilities (Group 2) and 6 patients followed integrated home-based rehabilitation care (Group 3) (see the study flow-chart in Fig. 1 for further details).

At baseline (T0), there were no significant differences among groups in terms of age, MMSE, comorbidities, previous osteoporotic fractures, osteoporotic treatments (see Table 1 for further details), or functional outcome measures.

Table 1
Baseline characteristics of study population.

	Total (n = 52)	Group 1 (n = 14)	Group 2 (n = 14)	Group 3 (n = 6)	P value
Age (years)	83.12 ± 7.78	81.00 ± 2.50	84.21 ± 2.20	81.17 ± 3.90	0.490
Sex (male/female)	12/40	3/11	2/12	3/3	0.219
MMSE	27.41 ± 2.06	27.86 ± 1.83	26.93 ± 2.13	27.5 ± 2.51	0.502
Hypertension	19 (36.53)	8 (57.14)	8 (57.14)	3 (50.00)	0.950
Previous myocardial infarction	7 (13.46)	3 (21.42)	2 (14.28)	2 (33.33)	0.624
COPD	5 (9.61)	2 (14.28)	3 (21.42)	0 (0.00)	0.280
Diabetes	12 (23.07)	4 (28.57)	6 (42.85)	2 (33.33)	0.727
Previous fragility fractures	9 (17.31)	3 (21.42)	3 (21.42)	1 (16.67)	0.966
Previous hip fractures	3 (5.77)	1 (7.14)	1 (7.14)	0 (0.00)	0.796
Vertebral fractures	4 (7.69)	1 (7.14)	1 (7.14)	0 (0.00)	0.796
NHNV fractures	3 (5.77)	1 (7.14)	1 (7.14)	1 (16.67)	0.757
Anti-osteoporotic drugs or vitamin D or calcium supplementations	10 (19.23)	1 (7.14)	4 (28.57)	2 (33.33)	0.301
Bisphosphonates	8 (15.38)	1 (7.14)	4 (28.57)	1 (16.67)	0.330
Vitamin D	9 (17.31)	2 (14.29)	4 (28.57)	1 (16.67)	0.624
Calcium	7 (13.46)	1 (7.14)	3 (21.42)	1 (16.67)	0.560
Continuous variables are expressed as means ± standard deviations; ratios are expressed as x/y; categorical variables are expressed as counts (percentages). Kruskal Wallis test was performed to assess the differences among groups for continuous variables; ANOVA test was performed to assess the differences among groups for categorical variables. Abbreviations: MMSE = Mini Mental Status Examination; NHNV = non-femoral non-vertebral; COPD = chronic obstructive pulmonary disease.					

All three groups showed a statistically significant improvement ($p < 0.05$) in all the outcome measures at T1 and T2 compared to baseline, except for MRC of knee extension in group 3 at 3 months (T0-T1).

Furthermore, taking into account the between-group analysis, no statistically significant differences were found at T1; on the other hand, BI was significantly higher in Group 1 than in Group 2 at T2 (88.00 ± 9.73 vs 68.57 ± 21.70 ; $p = 0.018$). Group 1 showed also better improvement in all outcomes, at both time points, although significance level was not reached; on the opposite, Group 2 showed the lesser increase in performance and disabilities at T1 and T2. Concerning ROM and muscle strength, Group 1 had better hip aROM and pROM, both in flexion and abduction, and better muscle strength in hip flexors, hip abductors and knee extensor muscles across all time points (see Table 2 for further details).

Table 2
Outcome measures assessed in the three groups at the different points.

Outcomes	Groups	T ₀	T ₁	T ₂	P value T ₀ -T ₁	P value T ₀ -T ₂
BI						
	1 (n = 14)	52.14 ± 8.71	82.86 ± 13.26	88.00 ± 9.73*	0.001	0.001
	2 (n = 14)	50.36 ± 9.29	70.30 ± 19.56	68.57 ± 21.70*	0.002	0.007
	3 (n = 6)	54.17 ± 7.36	76.67 ± 16.30	82.50 ± 12.94	0.027	0.026
FAC						
	1 (n = 14)	0.00 ± 0.00	3.71 ± 0.94	4.07 ± 0.92	0.001	0.001
	2 (n = 14)	0.00 ± 0.00	2.86 ± 1.23	3.14 ± 1.41	0.001	0.001
	3 (n = 6)	0.00 ± 0.00	3.17 ± 1.17	3.33 ± 1.03	0.027	0.026
Hip flexion						
<i>p</i> ROM (°)						
	1 (n = 14)	28.93 ± 14.17	99.29 ± 10.54	107.14 ± 8.48	0.001	0.001
	2 (n = 14)	31.79 ± 17.17	100.36 ± 6.64*	106.43 ± 9.08	0.001	0.001
	3 (n = 6)	28.33 ± 16.66	92.50 ± 6.89*	107.50 ± 4.18	0.027	0.027
<i>a</i> ROM (°)						
	1 (n = 14)	3.57 ± 3.63	93.57 ± 10.64	99.29 ± 12.07	0.001	0.001
	2 (n = 14)	5.00 ± 5.55	93.93 ± 7.38	98.93 ± 9.44	0.001	0.001
	3 (n = 6)	4.17 ± 4.92	90.00 ± 8.94	99.17 ± 6.65	0.028	0.026
Hip abduction						
<i>p</i> ROM (°)						
	1 (n = 14)	19.29 ± 10.89	35.71 ± 7.81	36.07 ± 8.13	0.003	0.003

Outcomes	Groups	T ₀	T ₁	T ₂	P value T ₀ -T ₁	P value T ₀ -T ₂
	2 (n = 14)	13.93 ± 5.94	29.29 ± 11.24	30.00 ± 12.09	0.001	0.001
	3 (n = 6)	11.67 ± 4.08	35.00 ± 8.94	35.83 ± 9.70	0.027	0.027
<i>aROM (°)</i>						
	1 (n = 14)	3.21 ± 3.72	27.14 ± 8.93	29.64 ± 8.43	0.001	0.001
	2 (n = 14)	3.93 ± 4.01	20.00 ± 9.81	23.57 ± 12.47	0.001	0.002
	3 (n = 6)	4.17 ± 3.76	27.50 ± 11.73	34.17 ± 8.61	0.028	0.026
MRC scale						
<i>Hip flexion</i>						
	1 (n = 14)	1.43 ± 0.65	4.14 ± 0.66	4.71 ± 0.47	0.001	0.001
	2 (n = 14)	1.86 ± 0.86	3.86 ± 1.03	4.64 ± 0.50	0.001	0.001
	3 (n = 6)	1.33 ± 0.52	3.67 ± 0.82	4.83 ± 0.41	0.026	0.024
<i>Hip abduction</i>						
	1 (n = 14)	0.86 ± 0.36	3.50 ± 0.85	4.71 ± 0.47*	0.001	0.001
	2 (n = 14)	0.86 ± 0.36	3.14 ± 1.10	4.00 ± 0.96*	0.001	0.001
	3 (n = 6)	0.83 ± 0.41	3.33 ± 0.52	4.33 ± 0.52	0.024	0.024
<i>Knee extension</i>						
	1 (n = 14)	2.64 ± 0.63	4.07 ± 0.73	4.79 ± 0.43	0.001	0.001
	2 (n = 14)	3.00 ± 0.68	3.71 ± 0.73	4.21 ± 0.80	0.008	0.004
	3 (n = 6)	3.33 ± 0.82	3.83 ± 0.75	4.83 ± 0.41	0.180	0.024

Outcomes	Groups	T ₀	T ₁	T ₂	P value T ₀ -T ₁	P value T ₀ -T ₂
Continuous variables are expressed as means $\pm$ standard deviations. Wilcoxon matched-pairs signed rank test was performed for intra-group analysis; Wilcoxon rank sum test was performed for between-group analysis. Group 1: outpatient rehabilitation; Group 2: inpatient rehabilitation; Group 3: home-based rehabilitation. Abbreviations: T ₀ : baseline; T ₁ : after 3 months; T ₂ : after 6 months; FAC: Functional Ambulation Category; pROM: passive Range Of Motion; aROM: active Range Of Motion; MRC: Medical Research Council. *= $p < 0.05$ in the between-group analysis.						

Discussion

Taken together, our results showed that all patients achieved a better functional status and lower disability after rehabilitative treatment in all three settings.

Community-dwelling hip fracture subjects treated in outpatient rehabilitation settings are more likely to obtain better long-term effects from a rehabilitation protocol in terms of functional status, hip ROM, and lower limb muscle strength. However, our findings might be influenced by the generally worse condition afflicting patients that are commonly enrolled in inpatient settings. Patients destined to home-based rehabilitation showed intermediate results, closer to outpatient settings, however they were the fastest to achieve rehabilitation treatment after hospital discharge.

According to our findings, the time between discharge and the start of rehabilitation treatment was usually long in the Portuguese National Health Service. Nonetheless, all patients started passive mobilization and gait training as soon as possible during their hospitalization in Traumatology Unit. Nonetheless, in our opinion, a strict cooperation between orthopedic surgeons and physiatrists is needed, as a challenge in caring hip fracture patients worldwide [29, 30].

Indeed, an adequate evaluation of these patients after surgery might provide the adequate rehabilitation setting. According to our findings, outpatient rehabilitation should be encouraged instead of inpatient rehabilitation setting, albeit safer in a sanitary facility, considering that older people could have alteration in mental status due to a long hospitalization, with a negative influence on functional outcomes [31]. At the same time, home-based patients started rehabilitation treatment as soon as possible in their environment, contributing to better time-space orientation and greater collaboration.

We are aware that the present pilot study has as some limitations: first, the small sample size that might be justified by the study design of a real-practice pilot study that aims to give a point-of-view of the Portuguese Rehabilitation settings; second, the lack of data on other factors might influence recovering in hip fracture patients, such as vitamin D, calcium or amino acids supplementation, that have a well-known role in improving muscle function and reducing disability in combination with an adequate rehabilitation treatment [8–12]; third, the lack of data on cognitive status that might influence the functional recovery.

The difference in functional outcomes among different rehabilitation settings in hip fracture patients is not well studied in literature [32]. Our findings might help the discharge planning team to determine the adequate destination for older people undergoing hip fracture rehabilitation after surgical stabilization.

Conclusions

Taken together, our findings showed that rehabilitation leads to a significant improvement in functional recovery independently from the settings, albeit outpatient rehabilitation seems to be the best option for hip fracture older people.

This real-practice pilot study reported only a cross-section of Portuguese Rehabilitation settings and could be considered as a starting point for further prospective studies on this topic, clarifying that patients' destination after hospital discharge should be adequately tailored by the rehabilitation professionals.

Abbreviations

ADL - Activities of Daily Living

aROM - Active Range of Motion

BI - Barthel Index

FAC - Functional Ambulation Categories

MMSE - Mini Mental Status Examination

MRC scale - Medical Research Council Scale

pROM – Passive Range of Motion

Declarations

Ethics approval and consent to participate

The Hospital Garcia de Orta Ethical Committee approved this study. The committee's reference number is 37/2020. This research was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article and its additional files.

Competing interests

The authors declare that they have no competing interests.

Funding

The study was not funded.

Authors' contributions

Margarida Freitas was responsible for study design, data collection, statistical analysis and manuscript writing. Claudio Curci contributed with manuscript writing. Diana Ascenso participated in the study design and data collection. Alda Silveira participated in the study design, data acquisition and revision. Alessandro de Sire revised and corrected the manuscript, worked on the statistical analysis and table creation.

Acknowledgements

Not applicable.

References

1. Veronese N, Maggi S. Epidemiology and social costs of hip fracture. *Injury*. 2018;49(8):1458–60. doi:10.1016/j.injury.2018.04.015.
2. Magaziner J, Fredman L, Hawkes W, et al. Changes in functional status attributable to hip fracture: a comparison of hip fracture patients to community-dwelling aged. *Am J Epidemiol*. 2003;157(11):1023–31.
3. Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. *Osteoporos Int*. 2006;17:1726–33. doi:10.1007/s00198-006-0172-4.
4. Gimigliano F, de Sire A, Moretti A, Curci C, Iolascon G. (2018) Rehabilitation Therapy After Surgery in Osteoporotic Patients. In: *Multidisciplinary Approach to Osteoporosis: From Assessment to Treatment*. Springer International Publishing. P.313–324. ISBN: 978-331975110-8;978-331975108-5. doi: 10.1007/978-3-319-75110-8_19.
5. Toro G, Calabrò G, Toro A, de Sire A, Iolascon G. Locking plate fixation of distal femoral fractures is a challenging technique: a retrospective review. *Clin Cases Miner Bone Metab*. 2015;12:55–8. doi:10.11138/ccmbm/2015.12.3s.054.

6. Peeters CM, Visser E, Van de Ree CL, et al. Quality of life after hip fracture in the elderly: A systematic literature review. *Injury*. 2016;47(7):1369–82. doi:10.1016/j.injury.2016.04.018.
7. Marx KA, Quinn CC. Commentary: male osteoporosis-policy gaps in prevention and treatment. *J Aging Soc Policy*. 2009;21(2):119–29. doi:10.1080/08959420902728421.
8. Landi F, Calvani R, Tosato M, et al. (2016) Protein Intake and Muscle Health in Old Age: From Biological Plausibility to Clinical Evidence. *Nutrients*; 8(5).pii:E295. doi:10.3390/nu8050295.
9. Artaza-Artabe I, Sáez-López P, Sánchez-Hernández N, Fernández-Gutierrez N, Malafarina V. The relationship between nutrition and frailty: Effects of protein intake, nutritional supplementation, vitamin D and exercise on muscle metabolism in the elderly. A systematic review. *Maturitas*. 2016;93:89–99. doi:10.1016/j.maturitas.2016.04.009.
10. Iolascon G, Moretti A, de Sire A, Calafiore D, Gimigliano F. Effectiveness of Calcifediol in Improving Muscle Function in Post-Menopausal Women: A Prospective Cohort Study. *Adv Ther*. 2017;34(3):744–52. doi:10.1007/s12325-017-0492-0.
11. Invernizzi M, de Sire A, D'Andrea F, et al. Effects of essential amino acid supplementation and rehabilitation on functioning in hip fracture patients: a pilot randomized controlled trial. *Aging Clin Exp Res*. 2019;31(10):1517–24. doi:10.1007/s40520-018-1090-y.
12. de Sire A, Baricich A, Renò F, Cisari C, Fusco N, Invernizzi M. Myostatin as a potential biomarker to monitor sarcopenia in hip fracture patients undergoing a multidisciplinary rehabilitation and nutritional treatment: a preliminary study. *Aging Clin Exp Res*. 2020;32(5):959–62. doi:10.1007/s40520-019-01436-8.
13. Antonova E, Boye ME, Sen N, O'Sullivan AK, Burge R. Can bundled payment improve quality and efficiency of care for patients with hip fractures? *J Aging Soc Policy*. 2015;27(1):1–20. doi:10.1080/08959420.2015.970844.
14. Siebens HC, Sharkey P, Harriet U, et al. Variation in Rehabilitation Treatment Patterns for Hip Fracture Treated with Arthroplasty. *PM R*. 2016;8(3):191–207. doi:10.1016/j.pmrj.2015.07.005.
15. Pryor G, Williams D. Rehabilitation after hip fractures: home and hospital management compared. *J Bone Joint Surg Br*. 1989;71(3):471–4.
16. Donohue K, Hoevenaars R, McEachern J, Zeman E, Mehta S. Home-Based Multidisciplinary Rehabilitation following Hip Fracture Surgery: What Is the Evidence? *Rehabil Res Pract*. 2013;2013:875968. doi:10.1155/2013/875968.
17. Pitzul KB, Wodchis WP, Carter MW, Kreder HJ, Voth J, Jaglal SB. Post-acute pathways among hip fracture patients: a system-level analysis. *BMC Health Serv Res*. 2016;16:275. doi:10.1186/s12913-016-1524-1.
18. Levy C, Ocampo-Chan S, Huestis L, Renzetti D. Early Rehabilitation for Patients with Hip Fractures: Spreading Change Across the System. *Healthc Q*. 2017;20(1):29–33. doi:10.12927/hcq.2017.25088.
19. Cecchi F, Pancani S, Antonioli D, et al. Predictors of recovering ambulation after hip fracture inpatient rehabilitation. *BMC Geriatr*. 2018;18(1):201. doi:10.1186/s12877-018-0884-2.

20. Binder EF, Brown M, Sinacore DR, et al. Effects of extended outpatient rehabilitation after hip fracture: a randomized controlled trial. *JAMA*. 2004;292(7):837–46. doi:10.1001/jama.292.7.837.
21. Pan PJ, Lin PH, Tang GJ, et al. Comparisons of mortality and rehospitalization between hip-fractured elderly with outpatient rehabilitation and those without: A STROBE-compliant article. *Medicine*. 2018;97(19):e0644. doi:10.1097/MD.00000000000010644.
22. Salpakoski A, Törmäkangas T, Edgren J, et al. Effects of a multicomponent home-based physical rehabilitation program on mobility recovery after hip fracture: a randomized controlled trial. *J Am Med Dir Assoc*. 2014;15(5):361–8. doi:10.1016/j.jamda.2013.12.083.
23. Latham NK, Harris BA, Bean JF, et al. Effect of a home-based exercise program on functional recovery following rehabilitation after hip fracture: a randomized clinical trial. *JAMA*. 2014;311(7):700–8. doi:10.1001/jama.2014.469.
24. Pescatello LS. American College of Sports Medicine. ACSM's Guidelines for Exercise Testing and Prescription. 9th ed. Philadelphia: Wolters Kluwer-Lippincott Williams & Wilkins; 2014.
25. Folstein M, Folstein S, McHugh P. Mini-Mental State: A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1965;12:189–98. doi:10.1016/0022-3956(75)90026-6.
26. Mahoney FB, Barthel DW. Functional evaluation: the Barthel index. *Md State Med J*. 1965;14:61–5.
27. Holden MK, Gill KM, Magliozzi MR, Nathan J, Piehl-Baker L. Clinical gait assessment in the neurologically impaired. *Phys Ther*. 1984;64(1):35–40. doi:10.1093/ptj/64.1.35.
28. John J. Grading of muscle power: comparison of MRC and analogue scales by physiotherapists. Medical Research Council. *Int J Rehabil Res*. 1984;7(2):173–81.
29. Cameron ID, Handoll H, Finnegan TP, et al. Coordinated multidisciplinary approaches for inpatient rehabilitation of older patients with proximal femoral fractures. *Cochrane Database Syst Rev*. 2001;3:CD000106. doi:10.1002/14651858.CD000106.
30. Hung WW, Egol KA, Zuckerman JD, et al. Hip fracture management: Tailoring care for the older patient. *JAMA*. 2012;307:2185–94. doi:10.1001/jama.2012.4842.
31. Daly N, Fortin C, Jaglal S, MacDonald S. Predictors of Exceeding Target Inpatient Rehabilitation Length of Stay after Hip Fracture. *Am J Phys Med Rehabil*. 2020. doi:10.1097/PHM.0000000000001386.
32. Beaupre LA, Jones CA, Saunders LD, Johnston DW, Buckingham J, Majumdar SR. Best practices for elderly hip fracture patients. A systematic overview of the evidence. *J Gen Intern Med*. 2005;20(11):1019–25.

Figures

Figure 1

Study flow chart

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [databasehipfracture.xlsx](#)
- [DatabaseROMStrength.xlsx](#)