

Geriatric Interdisciplinary Home Rehabilitation After Hip Fracture in People with Dementia – A Subgroup Analysis of a Randomized Controlled Trial

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Purpose: To investigate if the effects of geriatric interdisciplinary home rehabilitation after hip fracture were different among people with dementia compared to those without dementia and to describe the overall outcome after hip fracture in people with dementia.

Patients and Methods: A post hoc subgroup analysis of a randomized controlled trial was conducted including 205 people with hip fracture, aged ≥ 70 , living in ordinary housing or residential care facilities. Early discharge followed by individually designed interdisciplinary home rehabilitation for a maximum of 10 weeks was compared to in-hospital geriatric care according to a multifactorial rehabilitation program. Outcomes were hospital length of stay (LOS), readmissions, falls, mortality, performance in activities of daily living (ADL), and walking ability.

Results: Interdisciplinary home rehabilitation vs in-hospital care had comparable effects on falls and mortality between discharge and 12 months and on ADL and walking ability at 3 and 12 months regardless of whether the participants had dementia or not ($P \geq 0.05$ for all). Among participants with dementia, postoperative LOS was a median of 18 days (interquartile range [IQR] 14–30) in the home rehabilitation group vs 23 days (IQR 15–30) in the control group ($P=0.254$) with comparable numbers of readmissions after discharge. Dementia was associated with increased risk of falling (odds ratio [OR] 3.86; 95% confidence interval [CI]: 2.05–7.27; $P < 0.001$) and increased mortality (OR 4.20; 95% CI 1.79–9.92, $P=0.001$) between discharge and 12 months and with greater dependence in ADL and walking at 3 and 12 months compared to participants without dementia ($P < 0.001$ for all).

Conclusion: The effects of geriatric interdisciplinary home rehabilitation vs in-hospital geriatric care did not differ in participants with and without dementia. However, the statistical power of this subgroup analysis was likely insufficient to detect differences between the groups. Dementia was associated with a substantial negative impact on the outcomes following the hip fracture. Our findings support offering interdisciplinary home rehabilitation after hip fracture to people with dementia.

Keywords: accidental falls, activities of daily living, cognitive impairment, length of stay, walking ability

Introduction

The number of people with dementia is growing worldwide, and according to the World Health Organization there is one new case of dementia every three seconds.¹ An individual with Alzheimer's disease is about three times more likely to sustain a hip fracture than an age- and sex-matched control who is cognitively intact,² and the outcomes are worse when compared with people without dementia. Mortality is higher,^{2–5} postoperative complications are more common,^{3,6} and the negative impact

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on mobility and performance in activities of daily living (ADL) is greater in people with dementia than in people who are cognitively intact.⁵⁻⁷ In addition, dementia is an independent risk factor for postoperative admission to long-term residential care.³

Despite dementia being common among older people with hip fracture and that the population has complex care needs,⁶ the condition has often been an exclusion criterion for participation in previous clinical trials.⁸ There is, however, growing evidence that people with hip fracture and cognitive impairment (CI) or dementia benefit from enhanced interdisciplinary rehabilitation in hospital,^{9,10} combined in-hospital and in-home rehabilitation,¹¹⁻¹⁴ and from rehabilitation in nursing homes,¹⁵ although the optimal rehabilitation strategies remain unclear.⁶

To our knowledge, no previous team-based home rehabilitation (HR) interventions after hip fracture have included people with severe CI or dementia. We have, however, in a randomized controlled trial (RCT) evaluated a Geriatric Interdisciplinary Home Rehabilitation (GIHR) intervention for older people with hip fracture, including those with dementia and those living in residential care facilities, compared with in-hospital geriatric care according to a multifactorial rehabilitation program. The results showed that functional recovery in ADL and walking ability, as well as complications and readmissions after discharge, were comparable between the GIHR and control groups,¹⁶⁻¹⁸ although the GIHR group had a significantly shorter initial postoperative length of stay (LOS) in hospital. Half of the participants in the RCT had dementia at baseline. Given this high proportion, the lack of HR studies including people with dementia, and the positive effects for people with dementia in a previous in-hospital RCT at our clinic with a multifactorial rehabilitation program,¹⁰ we considered it important to perform a subgroup analysis of the outcome in people with dementia.

The aim of the present study was to investigate if the effects of geriatric interdisciplinary home rehabilitation after hip fracture were different among people with dementia compared to those without dementia. A secondary aim was to describe the overall outcome after hip fracture in people with dementia.

Methods

Design and Participants

This post hoc subgroup analysis was part of a parallel-group RCT conducted between May 2008 and June 2011 at the Geriatric Department of the University Hospital of

Umeå in Sweden. The method of the RCT has been described in detail previously,¹⁶⁻¹⁸ and the study is registered at Current Controlled Trials Ltd. (ISRCTN 15738119). People after hip fracture surgery (cervical or trochanteric fracture), aged 70 or older, and living in the municipality of Umeå in ordinary housing or in residential care facilities were eligible. People with pathological fractures and those who fractured their hips in the hospital were excluded.

Procedure

The participants were consecutively randomized using sequentially numbered lots in opaque, sealed envelopes drawn by a ward nurse who was not involved in the study. The randomization was stratified according to type of housing (ordinary or residential care facility) and to type of fracture (cervical or trochanteric). Participants were randomized to receive in-hospital care and rehabilitation in a geriatric ward plus GIHR after discharge, or to in-hospital geriatric care and rehabilitation. Study information was given both orally and in writing, and when CI was present the next of kin could provide written informed consent. The participants were assessed during their hospital stay, within 5 days after randomization, and at 3 and 12 months postoperatively in their homes by trained assessors, one physiotherapist, and one registered nurse who were blinded to group allocation.

Control Group

In-hospital care and rehabilitation in the geriatric ward were based on a multifactorial rehabilitation program, which was evaluated in an RCT¹⁹⁻²¹ and was implemented at the ward in 2000. In short, the program consists of interdisciplinary rehabilitation using comprehensive geriatric assessment followed by individual rehabilitation plans, participation of the whole staff in the patient's everyday activities, and a thorough discharge plan. The in-hospital program had a special focus on detection, prevention, and treatment of postoperative complications and on specific retraining provided by the physiotherapist and the occupational therapist. Participants who needed additional rehabilitation after discharge were referred to primary health care, and at 3 months after the fracture they could also receive rehabilitation at a geriatric outpatient rehabilitation unit. For participants living in residential care, physiotherapists and occupational therapists in the facilities were contacted regarding the need for continued rehabilitation after discharge.

Intervention

Participants allocated to the GIHR intervention, as described in detail earlier,^{16–18} were also initially treated according to the in-hospital multifactorial rehabilitation program, but with the aim of early discharge and continuation of rehabilitation in their homes with the support of the GIHR team for a maximum of 10 weeks. Discharge was possible when the participants had no medical obstacles, could manage basic transfers, and had the care they required at home. The team was comprised of a nurse, an occupational therapist, and two physiotherapists who visited the participants regularly and a geriatrician who was medically responsible. A social worker and a dietician were available on consultation. The rehabilitation was individually tailored, ie, team actions, length of the rehabilitation period, and number of home visits varied for each participant according to their individual rehabilitation plan. The intervention included multifactorial fall prevention, modifications of the home environment, and specific training in ADL and in the use of assistive devices. In addition, walking exercises and progressive functional strength and balance training according to the High-Intensity Functional Exercise (HIFE) Program were included.^{22,23} The medical part of the intervention focused on prevention, detection, and treatment of complications after discharge, evaluation of pain, and assessment of the participants' ability to handle their medicines safely. The participants' nutrition was also evaluated, and all team members worked together to improve the participants' nutritional status with the support of the dietician when necessary. The GIHR team worked closely with the next of kin and with the care providers in home social services or in the residential care facilities.

Outcome Measures

Data on initial postoperative LOS and readmissions, falls (numbers of participants who fell at least once and the total numbers of falls), and mortality between discharge and 12 months were registered when the study was completed using medical data from the participants' digital charts along with the assessments at the 3- and 12-month follow-ups. An experienced geriatrician not blinded to group allocation collected the data according to a pre-set protocol. Medical data and assessments were analyzed by a geriatrician, who was blinded to group allocation, to determine if the participants fulfilled the criteria for dementia, delirium, and depressive disorders (DSM-IV).²⁴ ADL performance (ie, what the participants actually did in their everyday life) before the

fracture and at the 3- and 12-month follow-ups was assessed using the Barthel ADL Index^{25,26} along with the ADL Staircase including the Katz ADL Index.^{27,28} The Barthel Index (0–20; best score 20) and the Katz Index (A to G; A indicating independence) both measure personal ADL (PADL), namely feeding, continence, transfer, toilet use, bathing, and dressing, while the Barthel Index also measures mobility. In the ADL Staircase (0–10; 0 indicating independence in all activities), the Katz Index is extended with four items that measure instrumental ADL (IADL), namely cooking, cleaning, shopping, and using public transport. Walking ability indoors and outdoors before the fracture and at 3 and 12 months was assessed on a scale from 1 to 7, where 1 indicated no functional ability or the need for the assistance of two people and 7 indicated normal function.²⁹ Data on ADL and walking ability were obtained by interviewing the participants, and, if CI was present, also the next of kin or the care staff in the facilities.

Baseline Descriptive Assessments

During the hospital stay, the participant and, when CI was present, the next of kin or a nurse in the residential care facility were interviewed about the participant's pre-fracture social situation, medical history, and prescribed drugs. In addition, the participants were assessed with the Mini Mental State Examination,³⁰ the Geriatric Depression Scale,³¹ and the Organic Brain Syndrome Scale.³²

Statistical Analysis

LOS was used for sample size calculation and was based on the number of days patients with hip fracture spent in the hospital during one year in a previous study.¹⁹ Assuming a power of 80% and a 24% reduction in hospital days, the total sample size was estimated to be 206 participants. In agreement with the intention-to-treat principle, available data from all participants were analyzed according to their original allocation and regardless of level of attendance.

Descriptive statistics were used in comparisons between participants with and without dementia and between treatment groups (GIHR vs control) among the participants with and without dementia. Student's *t*-test for independent samples was used for normally distributed continuous variables, and the Mann–Whitney *U*-test was used for ordinal data and for non-normally distributed continuous variables. Binary data were analyzed with Pearson's chi-square test (with Yates's continuity correction) or Fisher's exact test.

Binary logistic regression was used to evaluate the associations (odds ratio [OR]) between dementia and the risk of falling and mortality after discharge and between dementia and performance in ADL and walking ability at 3 and 12 months. Analysis using Cox regression was considered for the outcomes related to falls and mortality, but this was considered inappropriate because the proportional hazard assumptions were not fulfilled. The regression models were unadjusted, except for the analysis of falling after discharge, which was adjusted for observation time. Observation time was registered as the time from discharge until the end of the study or until the participant died, declined participation, or for other reasons left the study. The total score on the Barthel ADL Index was dichotomized at the median value ($<18, \geq 18$), and category A in the Katz ADL Index was considered as independent PADL performance. To investigate if the treatment effect on the outcomes was different among people with dementia, we also used binary logistic regression in separate models where an interaction term was added to each model between dementia (yes/no) and type of treatment

(GIHR or control), and the P -value of the interaction was reported.

Analyses were performed using SPSS version 25.0 (IBM SPSS Statistics for Windows, Armonk, NY: IBM Corp.). All statistical tests were 2-tailed, and $P < 0.05$ was considered statistically significant.

Results

Of the 205 participants included in the study, 103 (50.2%) were diagnosed with dementia, 57 in the GIHR group and 46 in the control group ($P=0.444$) (Figure 1). The baseline characteristics of the participants included in the study are presented in Table 1. The most common dementia type was Alzheimer's disease ($n=49, 47.6\%$). Fourteen (13.6%) had vascular dementia, while 40 (38.8%) had other types of dementia such as mixed Alzheimer and vascular, frontotemporal, Parkinson, Lewy body, alcohol-related, or unspecified dementia. Among those with dementia, a larger proportion in the control group were prescribed analgesics compared with the GIHR group ($P=0.048$).

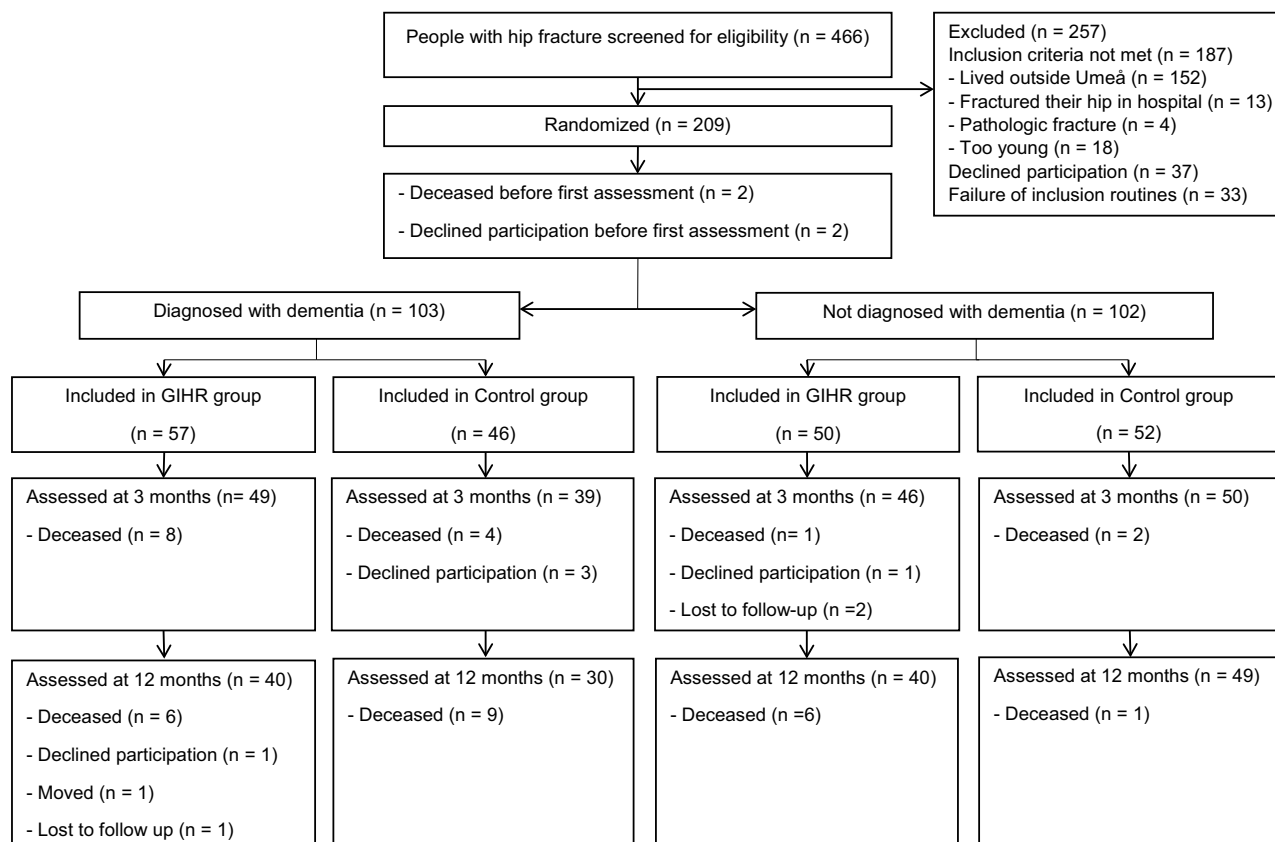


Figure 1 Flow of participants through the study.

Table I Characteristics of the Study Population and Baseline Measures

	Total n = 205	D n = 103	ND n = 102	D in GIHR n = 57	D in Control n = 46	ND in GIHR n = 50	ND in Control n = 52
Age, mean ± SD	82.9 ± 6.7	83.9 ± 6.8	81.9 ± 6.6*	84.5 ± 7.1	83.2 ± 6.4	81.7 ± 6.8	82.1 ± 6.5
Females, n (%)	147 (71.7)	72 (69.9)	75 (73.5)	43 (75.4)	29 (63.0)	36 (72.0)	39 (75.0)
Dementia type, n (%)							
Alzheimer	49 (47.6)	49 (47.6)		26 (45.6)	23 (50.0)		
Vascular	14 (13.6)	14 (13.6)		6 (10.5)	8 (17.4)		
Other	40 (38.8)	40 (38.8)		25 (43.9)	15 (32.6)		
Cervical fracture, n (%)	148 (72.2)	79 (76.7)	69 (67.6)	44 (77.2)	35 (76.1)	34 (68.0)	35 (67.3)
Trochanteric fracture, n (%)	57 (27.8)	24 (23.3)	33 (32.4)	13 (22.8)	11 (23.9)	16 (32.0)	17 (32.7)
Operative methods, n (%)							
Internal fixation	48 (23.4)	27 (26.2)	21 (20.6)	15 (26.3)	12 (26.1)	11 (22.0)	10 (19.2)
Hemiarthroplasty	86 (42.0)	44 (42.7)	42 (41.2)	24 (42.1)	20 (43.5)	19 (38.0)	23 (44.2)
Sliding hip screw	41 (20.0)	20 (19.4)	21 (20.6)	12 (21.1)	8 (17.4)	11 (22.0)	10 (19.2)
Other methods	30 (14.6)	12 (11.7)	18 (17.6)	6 (10.5)	6 (13.0)	9 (18.0)	9 (17.3)
Living in ordinary home, n (%)	142 (69.3)	46 (44.7)	96 (94.1)*	25 (43.9)	22 (47.8)	46 (92.0)	49 (94.2)
Living in residential care facilities, n (%)	63 (30.7)	57 (55.3)	6 (5.9)*	32 (56.1)	24 (52.2)	4 (8.0)	3 (5.8)
Living alone, n (%)	147 (71.7)	81 (78.6)	66 (64.7)*	48 (84.2)	33 (71.7)	30 (60.0)	36 (69.2)
Diagnoses and medical conditions							
Previous hip fracture, n (%)	35 (17.1)	22 (21.4)	13 (12.7)	14 (24.6)	8 (17.4)	6 (12.0)	7 (13.5)
Depressive disorders, n (%), (n = 102), ^a (n = 101) ^b	77 (37.9)	55 (53.9)	22 (21.8)*	35 (61.4)	20 (44.4)	12 (24.5)	10 (19.2)
Delirium during hospitalization, n (%)	153 (74.6)	100 (97.1)	53 (52.0)*	56 (98.2)	44 (95.7)	28 (56.0)	25 (48.1)
Stroke, n (%)	45 (22.0)	21 (20.4)	24 (23.5)	10 (17.5)	11 (23.9)	11 (22.0)	13 (25.0)
Heart disease, n (%)	105 (51.2)	59 (57.3)	46 (45.1)	30 (52.6)	29 (63.0)	23 (46.0)	23 (44.2)
Impaired vision, ^c n (%), (n = 92), ^a (n = 99) ^b	31 (16.2)	22 (23.9)	9 (9.1)*	11 (21.6)	11 (26.8)	6 (12.2)	3 (6.0)
Number of comorbidities ≥ 3, n (%)	120 (58.5)	82 (79.6)	38 (37.3)*	45 (78.9)	37 (80.4)	21 (42.0)	17 (32.7)
Number of prescribed drugs, mean ± SD	8.5 ± 3.1	8.6 ± 3.1	8.5 ± 3.2	8.7 ± 2.8	8.5 ± 3.4	8.8 ± 3.2	8.1 ± 3.2
Medications at discharge, n (%)							
Analgesics (not ASA)	177 (86.3)	90 (87.4)	87 (85.3)	46 (80.7)	44 (95.7)*	41 (82.0)	46 (88.5)
Antidepressants	75 (36.6)	56 (54.4)	19 (18.6)*	36 (63.2)	20 (43.5)	13 (26.0)	6 (11.5)
Benzodiazepines	27 (13.2)	17 (16.5)	10 (9.8)	9 (15.8)	8 (17.4)	6 (12.0)	4 (7.7)
Beta-blockers	76 (37.1)	30 (29.1)	46 (45.1)*	16 (28.1)	14 (30.4)	26 (52.0)	20 (38.5)
Diuretics	70 (34.1)	35 (34.0)	35 (34.3)	18 (31.6)	17 (37.0)	18 (36.0)	17 (32.7)
Neuroleptics	23 (11.2)	15 (14.6)	8 (7.8)	7 (12.3)	8 (17.4)	3 (6.0)	5 (9.6)
Parkinson medications	11 (5.4)	7 (6.8)	4 (3.9)	6 (10.5)	1 (2.2)	4 (8.0)	0 (0.0)*
Assessments							
Geriatric Depression Scale (0–15), ^d median (IQR), (n = 75), ^a (n = 99) ^b	4 (2–6)	5 (2–8)	3 (2–5)*	5 (2–7)	5 (2–9)	3 (2–4)	4 (2–5)
Mini Mental State Examination (0–30), ^e median (IQR), (n = 97) ^a	19 (11–25)	11 (6–17)	24 (21–26)*	12 (7–17)	11 (4–16)	25 (21–27)	24 (20–26)
Independent in PADL, ^f n (%)	92 (44.9)	16 (15.5)	76 (74.5)*	8 (14.0)	8 (17.4)	37 (74.0)	39 (75.0)
Independent in both PADL and IADL, ^g n (%)	35 (17.1)	4 (3.9)	31 (30.4)*	3 (5.3)	1 (2.2)	19 (38.0)	12 (23.1)
Barthel ADL-index (0–20), ^e median (IQR)	18 (13–20)	15 (10–18)	20 (18–20)*	14 (11–18)	15 (9–18)	20 (18–20)	19 (17–20)

(Continued)

Table 1 (Continued).

	Total n = 205	D n = 103	ND n = 102	D in GIHR n = 57	D in Control n = 46	ND in GIHR n = 50	ND in Control n = 52
ADL Staircase (0–10), ^d median (IQR), (n = 100), ^a (n = 98) ^b	5 (1–7)	7 (5–8)	2 (0–4)*	6 (5–8)	7 (5–8)	1 (0–4)	2 (1–4)
Walking independently indoors, n (%)	180 (87.8)	83 (80.6)	97 (95.1)*	46 (80.7)	37 (80.4)	49 (98.0)	48 (92.3)

Notes: Numbers reported after covariates indicate number of measurements available when values were missing; ^aParticipants with dementia in GIHR and control groups; ^bParticipants with no dementia in GIHR and control groups; ^cNot able to read 5-mm capital letters at reading distance, with or without glasses; ^dLower scores indicate better status; ^eHigher scores indicate better status; ^fCategory A according to Katz ADL Index; ^gAccording to ADL Staircase; *Indicates a significant difference between groups.

Abbreviations: ADL, activities of daily living; D, participants with dementia; GIHR, geriatric interdisciplinary home rehabilitation; IADL, instrumental ADL; IQR, interquartile range; ND, participants with no dementia; PADL, personal ADL.

Effects of the GIHR Intervention

No statistically significant interaction was found between dementia (yes/no) at baseline and type of treatment (GIHR or control) on the risk of falling at least once during the year after discharge ($P=0.100$) or on measures of ADL or walking ability at 3 and 12 months (Table 2). In relation to mortality, however, a statistically significant interaction was found ($P=0.035$). Further analysis showed that for participants with dementia allocated to the GIHR group (compared with the control group) the OR for death after discharge was 0.67; 95% CI: 0.27–1.66 ($P=0.392$), whereas the OR for participants without dementia in the GIHR group was 8.14; 95% CI: 0.96–68.81 ($P=0.054$).

When analyzing the effects of the GIHR intervention solely among the participants with dementia, we found no significant differences between the GIHR and control groups in postoperative LOS, readmissions, falls, or

mortality between discharge and 12 months or in ADL or walking ability at 3 and 12 months (Tables 3 and 4).

Overall Outcome in People with Dementia

Between-group comparisons based on whether the participants had dementia or not, and irrespective of type of treatment, showed significantly worse results in most of the outcomes for the participants with dementia (Tables 3 and 4). The postoperative LOS was comparable between participants with and without dementia, but the GIHR intervention was significantly shorter and involved less frequent home visits for the participants with dementia than their counterparts without dementia (Table 3). No significant differences were seen for readmissions or total days in hospital during the year after discharge between participants with and without dementia (Table 3). Binary logistic regression analyses revealed a higher risk for falls

Table 2 Odds Ratios of Functional Performance at the 3- and 12-Month Follow-Ups for Participants with Dementia Compared to Those Without Dementia, and Interaction Effects Between Dementia (Yes/No) and Type of Treatment (GIHR or Control)

	N	3 Months Unadjusted OR	95% CI	P-value for Interaction	N	12 Months Unadjusted OR	95% CI	P-value for Interaction
ADL performance								
Barthel ADL Index, ^a (median ≥ 18)	184	0.08	0.04–0.17	0.878	159	0.11	0.05–0.23	0.564
Recovery of Barthel ADL Index	184	0.22	0.12–0.42	0.826	159	0.23	0.12–0.46	0.989
Independent in PADL	184	0.06	0.02–0.16	0.379	159	0.09	0.04–0.21	0.662
Recovery of independent PADL ability	90	0.28	0.09–0.91	0.255	84	0.33	0.11–1.04	0.435
Walking ability								
Walking independently indoors	183	0.15	0.08–0.29	0.593	158	0.08	0.04–0.19	0.147
Walking independently outdoors	183	0.17	0.09–0.32	0.376	158	0.08	0.04–0.17	0.786
Recovery of indoor walking ability	183	0.20	0.10–0.37	0.943	158	0.10	0.05–0.20	0.668

Notes: Recovery was defined as a score at least as high or at the same level as before the fracture; ^aScore of ≥ 18 indicates better status.

Abbreviations: ADL, activities of daily living; CI, confidence interval; OR, odds ratio; PADL, personal activities of daily living.

Table 3 Postoperative Use of Health Care and Falls and Mortality Between Discharge and 12 Months

	D n = 103	ND n = 102	P	D in GIHR n = 57	D in Control n = 46	P	ND in GIHR n = 50	ND in Control n = 52	P
LOS, admission geriatric ward-discharge, median (IQR)	20 (14–29)	21 (13–32)	0.928	18 (14–30)	23 (15–30)	0.254	15 (11–26)	24 (18–34)	0.004
Days in GIHR, median (IQR), (n = 106)	17 (7–30)	29 (22–43)	<0.001						
Visits from GIHR team, median (IQR), (n = 106)	10 (4–17)	16 (10–22)	<0.001						
Number of readmissions after discharge, (n = 199)	40	71	0.059	26	14	0.373	32	39	0.631
Number of days in hospital after discharge, (n = 199)	389	673	0.086	235	154	0.330	325	348	0.556
Sustained one or more falls after discharge, n (%), (n = 199)	53 (54.1)	31 (30.7)	0.001	28 (50.0)	25 (59.5)	0.465	18 (36.0)	13 (25.5)	0.353
Number of falls, (n = 199)	225	51	<0.001	131	94	0.434	32	19	0.239
Deceased in hospital, n, (n = 199)	2	1	1.000	1	1	1.000		1	1.000
Deceased after discharge, n (%), (n = 199)	26 (26.5)	8 (7.9)	0.001	13 (23.2)	13 (31.0)	0.530	7 (14.0)	1 (2.0)	0.031

Note: Numbers reported after covariates indicate number of measurements available when values were missing.

Abbreviations: D, participants with dementia; GIHR, geriatric interdisciplinary home rehabilitation; IQR, interquartile range; LOS, length of stay; ND, participants with no dementia.

after discharge (OR 3.86; 95% CI: 2.05–7.27, $P < 0.001$) and increased mortality (OR 4.20; 95% CI 1.79–9.82, $P = 0.001$) for participants with dementia compared to those without dementia. Additionally, dementia was associated with impaired performance in ADL (OR between 0.06 and 0.23, $P < 0.001$ for all) and with impaired walking ability (OR between 0.08 and 0.20, $P < 0.001$ for all) at the 3- and 12-month follow-ups compared with participants without dementia (Table 2). However, for recovery of independent PADL performance there was a significant difference between participants with and without dementia at 3 months (OR 0.28; 95% CI 0.09–0.91, $P = 0.034$), but not at the 12-month follow-up (OR 0.33; 95% CI 0.11–1.04, $P = 0.059$).

Discussion

This study showed that a GIHR intervention compared with in-hospital geriatric care according to a multifactorial rehabilitation program had comparable effects on falls and mortality between discharge and 12 months and on ADL and walking ability at 3 and 12 months regardless of whether the participants had dementia or not. Among the participants with dementia, the postoperative LOS was 5 days shorter in the GIHR group compared with controls, but this was not a significant reduction, and there were comparable numbers

of readmissions. However, the study did show a substantial negative impact of dementia on the outcomes after hip fracture compared with participants without dementia.

The findings of the present study suggest that GIHR can be a complement to in-hospital rehabilitation after hip fracture for older people with dementia, which is an important clinical implication because severe CI or dementia and residing in residential care have been exclusion criteria in previous team-based HR interventions.^{33–37} Two previous subgroup analyses of RCTs have reported on the effects of an HR intervention after the postoperative hospital stay for people with CI.^{13,14} Shyu et al¹³ found that in people with mild to moderate CI, 3 months of interdisciplinary HR after the hip fracture resulted in better ADL performance and recovery of walking ability than controls who received routine care in hospital. The other study evaluated an intensive team-based in-hospital intervention that also included 10 home visits from a physiotherapist.¹⁴ This HR intervention showed that participants with mild to moderate CI, but not those with severe CI or normal scores, had shorter LOS and that fewer needed institutional care one year after the hip fracture compared with those who had rehabilitation in local hospitals. In contrast to the present study, CI in these studies was based on the Mini Mental State

Table 4 ADL Performance and Walking Ability Before Fracture and at the 3- and 12-Month Follow-Ups

	D n = 103	ND n = 102	P	D in GIHR n = 57	D in Control n = 46	P	ND in GIHR n = 50	ND in Control n = 52	P
ADL performance									
Independent in PADL, n (%)									
Before fracture	16 (15.5)	76 (74.5)		8 (14.0)	8 (17.4)		37 (74.0)	39 (75.0)	
At 3 months	5 (5.7)	49 (50.5)	<0.001	4 (8.2)	1 (2.6)	0.381	24 (52.2)	25 (49.0)	0.915
At 12 months	8 (11.4)	52 (58.4)	<0.001	6 (14.6)	2 (6.9)	0.455	25 (64.1)	27 (54.0)	0.458
Recovery of independent PADL, n (%)									
At 3 months, (n = 15), ^a (n = 75) ^b	5 (33.3)	48 (64.0)	0.055	4 (50.0)	1 (14.3)	0.282	24 (66.7)	24 (61.5)	0.825
At 12 months, (n = 15), ^a (n = 69) ^b	7 (46.7)	50 (72.5)	0.069	5 (62.5)	2 (28.6)	0.315	24 (77.4)	26 (68.4)	0.575
Barthel ADL Index, ^c median (IQR)									
Before fracture	15 (10–18)	20 (18–20)		14 (11–18)	15 (9–18)		20 (18–20)	19 (17–20)	
At 3 months	10 (6–14)	19 (16–20)	<0.001	9 (6–14)	11 (6–14)	0.466	19 (15–20)	18 (16–20)	0.078
At 12 months	9 (4–16)	19 (17–20)	<0.001	8 (4–17)	9 (5–16)	0.862	19 (17–20)	19 (16–20)	0.188
Recovery of Barthel ADL Index, n (%)									
At 3 months	20 (23.0)	56 (57.7)	<0.001	11 (22.4)	9 (23.7)	1.000	27 (58.7)	29 (56.9)	1.000
At 12 months	16 (22.9)	50 (56.2)	<0.001	10 (24.2)	6 (20.7)	0.941	23 (59.0)	27 (54.0)	0.800
ADL Staircase, ^d median (IQR)									
Before fracture	7 (5–8)	2 (0–4)		6 (5–8)	7 (5–8)		1 (0–4)	2 (1–4)	
At 3 months, (n = 85), ^a (n = 91) ^b	9 (7–9)	4 (2–6)	<0.001	9 (7–9)	8 (6–9)	0.481	4 (2–6)	4 (2–6)	0.663
At 12 months, (n = 69), ^a (n = 81) ^b	9 (6–10)	4 (1–5)	<0.001	9 (5–10)	8 (6–9)	0.394	2 (1–5)	4 (2–5)	0.140
Recovery of ADL Staircase, n (%)									
At 3 months, (n = 83), ^a (n = 91) ^b	27 (32.5)	33 (37.5)	0.603	14 (30.4)	13 (35.1)	0.827	13 (31.0)	20 (43.5)	0.321
At 12 months, (n = 67), ^a (n = 80) ^b	22 (32.8)	41 (51.2)	0.038	9 (23.7)	13 (44.8)	0.118	18 (51.4)	23 (51.1)	1.000
Walking ability									
Walking independently indoors, n (%)									
Before fracture	83 (80.6)	97 (95.1)		46 (80.7)	37 (80.4)		49 (98.0)	48 (92.3)	
At 3 months, (n = 86) ^a	33 (38.4)	78 (80.4)	<0.001	17 (34.7)	16 (43.2)	0.560	37 (80.4)	41 (80.4)	1.000
At 12 months, (n = 69) ^a	29 (42.0)	80 (89.9)	<0.001	16 (39.0)	13 (46.4)	0.716	37 (94.9)	43 (86.0)	0.289
Walking independently outdoors, n (%)									
Before fracture	55 (53.4)	86 (84.3)		28 (49.1)	27 (58.7)		42 (84.0)	44 (84.6)	
At 3 months, (n = 86) ^a	19 (22.1)	61 (62.9)	<0.001	10 (20.4)	9 (24.3)	0.864	31 (67.4)	30 (58.8)	0.508
At 12 months, (n = 69) ^a	12 (17.4)	65 (73.0)	<0.001	8 (19.5)	4 (14.3)	0.749	31 (79.5)	34 (68.0)	0.332
Recovery indoor walking ability, n (%)									
At 3 months, (n = 86) ^a	28 (32.6)	69 (71.1)	<0.001	16 (32.7)	12 (32.4)	1.000	33 (71.7)	36 (70.6)	1.000
At 12 months, (n = 69) ^a	19 (27.5)	71 (79.8)	<0.001	12 (29.3)	7 (25.0)	0.908	33 (84.6)	38 (76.0)	0.460

Notes: Numbers reported after covariates indicate the number of measurements available when values were missing; Recovery was defined as a score at least as high or at the same level as before the fracture; ^aParticipants with dementia in GIHR and control groups; ^bParticipants with no dementia in GIHR and control groups; ^cHigher scores indicate better status; ^dLower scores indicate better status.

Abbreviations: ADL, activities of daily living; D, participants with dementia; GIHR, geriatric interdisciplinary home rehabilitation; IQR, interquartile range; ND, participants with no dementia; PADL, personal ADL.

Examination scores and not on a physician-based dementia diagnosis. Furthermore, the samples in those studies were healthier because people were excluded if no consent to participate could be provided, eg, in the case of severe dementia, or if people had severe functional limitations before the fracture. The contents of the control

interventions were also different from our study. In the present study the control group received rehabilitation according to a multifactorial rehabilitation program, which could be considered as best practice.

Falls post-discharge were more common in participants with dementia than in those without dementia, which

highlights the importance of fall prevention in this population, although the evidence for the effectiveness of fall prevention interventions in people with dementia is limited.^{38–40} The GIHR intervention included multifactorial actions to prevent falls with exercise as one component as recommended.^{39,40} The exercise was individually adapted and included balance, strength, and functional exercises and was supervised in order to be safe to perform and to achieve as high intensity as possible. The results showed, however, that participants with dementia had a similar risk of falls as well as mortality after discharge, irrespective of the type of intervention. Surprisingly, among the participants without dementia, mortality was higher in the GIHR than in control groups because 7 participants in the GIHR group vs only 1 in the control group died between discharge and the 12-month follow-up. We believe, however, that this should be interpreted with caution and should be further evaluated in future research. Another unexpected finding was a trend for fewer readmissions and total days in hospital during the year after discharge among the participants with dementia compared with those without dementia. This might be explained by the fact that a large number of the participants with dementia lived in residential care where many medical conditions could be treated, and thus the number of hospital admissions was reduced. Additionally, this could also have contributed to the GIHR intervention being shorter with less frequent home visits for participants with dementia than for those without dementia. The facilities have established ways of working with their own rehabilitation staff. The GIHR team might have found it challenging to accomplish and maintain a continuous, successful team work with the care staff because of the different organizational routines. It is also possible that some of the participants in the facilities could receive a shorter home rehabilitation intervention because of dedicated staff contributing to their rehabilitation.

Because dementia is the leading cause of dependence in ADL⁴¹ and is a progressive disease, we expected to find poorer ADL performance and walking ability among the participants with dementia than those without, particularly from the long-term perspective. At 12 months, 23% of the participants with dementia had recovered their pre-fracture Barthel Index and 28% had recovered their pre-fracture indoor walking ability, and the corresponding numbers for those without dementia were 56% and 80%. According to the ADL Staircase, which measures both PADL and IADL, a significant difference in recovery between

participants with and without dementia was found only at 12 months. This result may reflect that recovery of IADL activities tends to be slower than PADL with possible improvements during the first year following the fracture.⁴²

Current recommendations regarding post hip fracture rehabilitation for people with dementia involve interdisciplinary person-centered approaches in settings that are adapted to the needs of this vulnerable population,⁴³ where family and caregivers should also be involved.⁴⁴ The interventions should address comorbidities and post-operative complications as well as behavioral problems connected to the dementia diagnosis.^{6,43} Education is also needed to change attitudes among care staff and health-care management.⁴³ The present study was pragmatic and not tailored specifically for people with dementia, but towards old and vulnerable people with multi-comorbidity, including dementia. The clinical experience of the GIHR team is that the intervention is possible to carry out among people with dementia, although it is more challenging because complicating symptoms connected with the disease have to be considered. The feasibility of the intervention was, however, not systematically evaluated, and this should be further explored. Receiving rehabilitation in the home setting might be beneficial for common problems among people with dementia, such as an impaired ability to transfer skills,⁴⁵ apathy, anxiety about upcoming events,⁴⁶ and low motivation to participate in activities such as exercise programs.⁴¹ The familiar environment may increase the motivation for functional activities, and next of kin and caregivers may be able to participate more actively in the rehabilitation. Moreover, there is no need for transport, which could otherwise be a barrier.⁴⁶

A strength of the study is that we included a representative sample of older people with hip fracture, including those with severe CI and dementia and people in residential care facilities, which increases the external validity of the study. These are groups in which the evidence of the optimal rehabilitation strategies is most insufficient.⁶ Moreover, dementia at baseline was diagnosed according to the DSM-IV criteria, and 3- and 12-month follow-ups were performed in the participants' homes to make it easier for the participants and thereby reduce the number of drop-outs.

There are some limitations to consider. Subgroup analyses are known to have low statistical power to detect differences in subgroup effects, although we

used interaction analyses, which is the recommended method.⁴⁷ Moreover, the RCT was not designed to be a non-inferiority study, which means that it was likely underpowered to show equivalence. The lack of difference between the groups may therefore be a consequence of insufficient power. Additionally, the analysis of people with dementia was not pre-specified in the trial protocol. Despite this, we considered it to be of clinical importance to evaluate the GIHR intervention in this subpopulation because half of the study participants were diagnosed with dementia at baseline and they differed significantly from those without dementia in a number of baseline characteristics. Consequently, the randomization of the study was not stratified according to dementia, but to type of fracture and place of residence. Because a majority of the participants with dementia resided in residential care, which was one of the study stratifications, there were no baseline differences between the GIHR and control group among those with dementia, except for analgesics being more common in the control group. Lastly, we had no access to the written documentation in the residential care facilities, and therefore only had limited information about possible additional rehabilitative actions besides the GIHR intervention. This makes it more difficult to evaluate the effects of the intervention, although it is likely that any such actions would have influenced the study outcomes randomly.

Conclusions

The effects of a GIHR intervention after hip fracture compared with in-hospital geriatric care according to a multifactorial rehabilitation program did not differ in participants with and without dementia. However, the statistical power of this subgroup analysis was likely insufficient to detect differences between the groups. Dementia was associated with a substantial negative impact on the outcomes following the hip fracture. Our findings support that interdisciplinary HR after hip fracture should be offered to older people with dementia in clinical practice, but more research on the effectiveness of interdisciplinary HR after hip fracture in people with dementia is needed.

Abbreviations

ADL, activities of daily living; CI, cognitive impairment; 95% CI, confidence interval; GIHR, geriatric interdisciplinary home rehabilitation; HR, home rehabilitation;

IADL, instrumental ADL; LOS, length of stay; OR, odds ratio; PADL, personal ADL; RCT, randomized controlled trial.

Data Sharing Statement

Participant data are not available in accordance with the General Data Protection Regulation (European Union Regulation).

Ethics Approval

The original study was conducted in accordance with the Declaration of Helsinki and approved by the Regional Ethical Review Board in Umeå, Sweden, in 2008 (DNR 08-053M).

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Disclosure

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