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Review Article

The influence of inpatient comprehensive geriatric care on elderly patients with hip fractures: a meta-analysis of randomized controlled trials

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Abstract: Objective: To evaluate the efficacy of in-patient comprehensive geriatric care for elderly patients with hip fracture. Methods: Relevant literatures were searched using the following databases including PubMed, OVID, Web of science, Scopus, ClinicalTrials.gov, and the Cochrane Central Register of Controlled Trails until August 1, 2015. Eligible studies were restricted to randomized controlled trials (RCTs). The available data was extracted by two independent authors and pooled through using Review manager version 5.2. For data deemed not appropriate for synthesis, a narrative overview was conducted. Results: 15 trials evaluating 3458 participants were identified in our meta-analysis. Our findings indicated patients who underwent comprehensive geriatric cares showed no significant greater improvement than control in in-patient mortality (Odds risk (OR) 0.73, 95% confidence interval (CI) 0.51 to 1.05, P=0.09), 3-(OR 0.96, 95% CI 0.51 to 1.81, P=0.90), 6-(OR 1.03, 95% CI 0.73 to 1.45, P=0.86) and 12-months mortality (OR 0.93, 95% CI 0.77 to 1.12, P=0.30). The proportion of patients who were discharged from hospital to the same place of residence as before the fracture was higher in intervention group than control (OR 1.67, 95% CI 0.80 to 3.37, P=0.0003). In addition, the pooled results showed that the number of patients in intervention group who had regained the same level of activities of daily living (ADL) (43.9% vs 30.2%, 46.0% vs 29.1%) and walking ability (71.3% vs 53.2%, 68.9% vs 56.3%) as before the fracture was higher than control at 3 and 12 months after discharge, respectively. Conclusion: Comprehensive geriatric care promoted the functional improvement for elderly patients with hip fracture. Meanwhile, the proportion of patients who were discharged from hospital to the same place as before fracture in intervention group was higher as compared to control. However, our finding showed no significant difference on in-patients mortality, follow-up mortality and length of stay between both groups.

Keywords: Comprehensive geriatric care, elderly, meta-analysis, inpatient

Introduction

Hip fracture is one of the most frequent causes of mortality and disability for elderly patients and constitutes a major public health problem worldwide [1]. As the population aging, the incidence of hip fracture rises in the last years [2]. Almost all hip fractures require surgical correction for preservation of function [2, 3]. Although most patients benefit from hip-replacement surgery, less than half of patients could regain their previous ambulatory abilities and functional status [4]. A considerable proportion of patients suffer from continuous loss of ability to live independently and require a long-term nursing home care with attendant high medical costs [5].

Elderly patients are typically high-risk for surgery because they have pre-existing functional deficits that must be managed concomitantly with their fractures [1]. A hip fracture in elderly patient represents a geriatric problem rather than an orthopaedic disorder, and thus new clinical approaches are needed to achieve better functional recovery and prevent potential complications [6, 7]. Comprehensive geriatric care as an alternative form of care has been developed [8, 9]. The original geriatric-orthopaedic intervention focusing on the post-dis-

charge rehabilitation showed positive results in length of stay, functional level and mortality [8]. For inpatient comprehensive geriatric care in the vulnerable period prior to surgery, individual studies showed conflicting results on the benefits in elderly patients with hip fractures [10-14].

Earlier meta-analyses focusing on the outpatient showed favorable effects of geriatric rehabilitation as compared to usual hospital care [15]. Recently reviews and meta-analyses demonstrated a well-designed inpatient rehabilitation program had a potential effect to promote functional recovery and reduce in-patient and long-term mortality for elderly patients [16, 17]. Ellis et al published their study [18] based on 22 trials focusing on the elderly patients who were admitted acutely and showed that comprehensive geriatric care increased patients' likelihood of being alive and in their own homes after an emergency admission to hospital. A study by Bachmann et al. [19] included 17 studies that assessed the effects of inpatient rehabilitation for geriatric patients with acute surgical illnesses, in which 9 studies as a subgroup evaluated the usage of inpatient interdisciplinary care for patient with acute hip fracture. Their results showed that orthopaedic geriatric rehabilitation programs resulted in a beneficial effect for functional improvement, nursing home admission and morality. Grigoryan et al. [20] performed a meta-analysis with 17 studies including 8 prospective randomized trials and demonstrated that inpatient ortho-geriatric collaboration could improve in-hospital mortality and long-term mortality for elderly patients with hip fracture. Buecking et al. [21] published their study with 5 randomized trials showed comprehensive geriatric care leaded to a slightly decrease in hospital mortality and one-year mortality but these decrease were not statistically significant. However, their findings remained of limited value because of the few and small clinical studies, which might be making premature conclusion about the effectiveness of comprehension geriatric care. In addition, several meta-analyses included trials that evaluated elderly patients who suffered acute surgical illness rather than hip fracture [19, 20].

Given the newly emerging evidence, we perform the meta-analysis with all the up-to-date RCTs to determine whether inpatient comprehensive geriatric care more is effective than routine or general orthopedics care for elderly patients with hip fracture.

Material and methods

Search strategy

Relevant studies that compared the efficacy of inpatient comprehensive geriatric care with the usual orthopaedic care for elderly patients with hip fracture were searched by using PubMed, OVID, Web of science, Scopus, ClinicalTrials.gov, and the Cochrane Central Register of Controlled Trails. No language restrictions were applied. The following search terms were used: hip fracture, femur fracture, femoral fracture, humerus fracture, humeral fracture, multidisciplinary, comanagement, co-management, interdisciplinary, comprehensive care, ortho-geriatric and orthogeriatric. In addition, the reference lists of all identified articles were examined to gain studies not captured by electronic searches. The electronic search and the eligibility of the studies were independently assessed by the two authors (HC. W and CB. L). Differences were resolved by discussion with a third author (YW. L).

Study selective

The studies were selected by screening the abstracts of all citations and retrieved studies according to the following criteria: the design must be randomized controlled trials; the population was geriatric patients (age >65) with hip fracture, including femoral neck, intertrochanteric, and subtrochanteric fractures; intervention group included interdisciplinary team approach in which a geriatrician and an orthopedic surgeon must be selected; control group included routine orthopedic care; the outcome of interest must include main outcome measurements: length of stay, mortality or functional recovery.

Exclusion criteria constituted the following items: studies that were not randomized controlled trials or published as abstract, letter or case report; studies in which the interventions focusing on rehabilitation or post-discharge not inpatient patients care in a designated unit; studies that did not include a comprehensive geriatrician care; studies in which intervention examined other surgical illness rather than acute hip fracture. If multiple manuscripts

based on the same data, the results of the most recent manuscript were utilized. For the outcomes of interest were presented in different manuscripts, we included those findings.

Data abstraction

All data from the included studies were screened and extracted by two authors independently (HC. W and CB. L). The extracted information included authors, year of publication, country, age, number of patient, characteristics of patients, length of stay, intervention procedure, control, and duration of follow-up for outcome evaluation. To ensure completeness and accuracy of the extracted data, the two investigators abstracted data from included studies and then cross-checked their tasks. At these stages, if there was any disagreement between the two reviewers, a final decision was made by discussion with a third author (YW. L). If necessary, the authors of the eligible trials were contacted by phone, fax, or e-mail to obtain missing information. The characteristics of eligible studies were presented in **Table 1**.

Study quality

The risk of bias in each included study was assessed by two independent authors (HC. W and CB. L) in accordance with the Cochrane Handbook for systematic reviews of interventions [22]. The following seven domains related to risk of bias were evaluated for each trial, including (1) random sequence generation; (2) concealment of treatment allocation; (3) blinding of participants and personnel; (4) blinding of outcome assessment; (5) incomplete outcome data; (6) selective reporting; (7) other bias. For each criterion, a score of "+" (low risk of bias), "-" (high risk of bias), or "?" (risk of bias is unclear from the article) was assigned. Disagreement was resolved by discussion with a third author (YW. L).

Statistical analysis

The data analysis was completed by two independent authors through using Review Manager software (RevMan Version 5.2, Nordic Cochrane Centre). Continuous data were recorded in terms of mean, standard deviation (SD) and the treatment effect was calculated in term of the weighted mean difference (WMD) and 95% confidence interval (CI). In respect to dichotomous data, the data was expressed as proportions or risks and the treatment effect was calculated in term of odds ratio (OR) with 95% CI. The heterogeneity for included studies was assessed with the use of a standard Chi square test with a significance set at a p values, and the quantity of heterogeneity was measured by using the I^2 index. An I^2 statistic value more than 50% was considered to indicate substantial heterogeneity, which promoted the use of a random effects model. Otherwise, a fixed effects model was used for the analysis. We also performed a narrative review for outcomes that could not be pooled due to differences in outcome measure. Funnel plots were presented to assess for potential publication bias.

Results

Study selection

A total of 5431 relevant citations were identified by searching the above-mentioned databases, and then 4847 records were excluded due to duplication. On the basis of the articles' titles and abstracts, it was determined that 131 articles were relevant for further reviews. Following that, 104 articles that did not meet the inclusion criteria were further, resulting in a total of 27 articles for more-detailed evaluation. After referring to the full texts, 27 articles [10-14, 23-41] describing 15 trials met the predefined inclusion criteria and were included in our study. The process of the study selection is presented in **Figure 1**.

These studies were prospective randomized trials published between 1988 and 2015. Within the 15 selected studies, a total of 3458 were allocated to intervention (n=1728) or control group (n=1730). All studies reported the effects of comprehensive geriatric care on elderly patients with hip fracture. There was high variability in terms of the type and duration of comprehensive in-hospital care before the trial, the reason for the initial hospital admission, and the criteria for the selection of patients among the included studies. All included studies stated that the procedure of comprehensive care for elderly was performed effectively. Study follow-up duration was between 3 and 12 months. No significant differences in baseline characteristics including age, sex, body mass index, fracture type, surgical treatment and type of anesthesia, were found between the interven-

Table 1. The characteristic of studies included in our meta-analysis

Study	Year	Country	Age (year)	Study population (n)	Admission to surgery	Main criteria for selection	Length of stay (day)	Intervention method	Control	Follow-up period
Gilchrist	1988	UK	EXP: 82 (65-98)	EXP: 97	Within 48 hours of admission	Patients with femoral neck fractures; age ≥65; female.	EXP: 41.7±3.7	Term members: a geriatrician, an orthopaedic senior registrar, a senior ward nurse, a physiotherapist, an occupational therapist and a social worker.	No case conference; patients did not transfer between the orthopaedic geriatric unite and the orthopaedic wards.	Six months
			CON: 80.6 (65-98)	CON: 125			CON: 52.1±9.7	Term organization: a weekly combined ward round; multidisciplinary meeting; any advises on medical problem by consultation with the geriatrician.		
Kennie	1989	UK	EXP: 79 (65-94)	EXP: 54	EXP: 1 (1-15)	Patients with proximal femoral fractures; age ≥65; female.	EXP: 41 (9-365)	Term members: a general practitioner, a consultant physician in geriatric, and an orthopaedic specialist.	Patients remained in the orthopaeduc admission ward and received regular attention on orthopaedic ward rounds.	One year
			CON: 84 (66-94)	CON: 54	CON: 1 (0-21)		CON: 24 (8-197)	Term organization: a combined ward round; multidisciplinary meeting weekly.		
Cameron	1993	Australia	EXP: 79 (65-94)	EXP: 127	NR	Patients with femoral neck fractures; surgical intervention within 7 days	EXP: 19.5 (median 13 days)	Term member: A physiotherapist, an occupational therapist, an orghopaedic surgeon, and a social worker.	Patients remained in the orthopaeduc admission ward and received regular attention on orthopaedic ward rounds.	Four months
			CON: 84 (66-94)	CON: 125			CON: 28 (median 15 days)	Term organization: multidimensional geriatric rounds; intervention term meeting.		
Galvard	1995	Sweden	EXP: W: 79.6±8.2	EXP: 192	NR	Patients with hip fractures; age ≥65; both males and female.	EXP: 28±24.2	Term member: A physiotherapist, an occupational therapist, and an orghopaedic surgeon	Usual postoperative surgical care	One year
			M: 73.6±10.0	CON : 179			CON: 53.3±47.7	Term organization: NR		
			CON: W: 80.9±9.2							
			M: 79.1±8.6							
Swanson	1998	Australia	EXP: 78.5 (75.3-81.7)	EXP: 38	EXP: 1 (1-9)	Patients with femoral neck fractures; age ≥55; both males and female.	EXP: 32.5 (95% CI 24.2-41.1)	Term member: a full-time physiotherapist, an occupational therapist, a clinical nurse consultant and a half-time social worker. A geriatrician and an orthopaedic surgeon completed the multidisciplinary term.	Usual postoperative surgical care	Six months
			CON: 77.8 (74-81.6)	CON: 33	CON: 2 (2-15)		CON: 21 (95% CI 17.2-24.4)	Term organization: multidimensional geriatric rounds; intervention term meeting.		
Huusko	2000	Finland	EXP: 80 (67-92)	EXP: 120	Median time=1 in both groups	Patients with femoral neck fractures; age ≥64; both males and female.	EXP: 34 (95% CI 28-38)	Term member: a geriatric unit, an occupational therapist, and a physician.	Usual postoperative surgical care	One year
			CON: 80 (66-97)	CON: 123			CON: 42 (95% CI 35-48)	Term organization: multidimensional geriatric rounds; intervention term meeting.		

Naglie	2002	Canada	EXP: 83.8±6.9	EXP: 141	NR	Patients with hip fractures; age ≥70; both males and females.	EXP: 29.2±22.6	Term member: a physiotherapist, an occupational therapist, a clinical nurse specialist, a social worker, an internist and orthopedic residents.	Usual postoperative surgical care	Six months
			CON: 84.6±7.3	CON: 138			CON: 20.9±18.8	Term organization:		
Vidan	2005	Spain	EXP: 81.1±7.8	EXP: 155	EXP: 75.8±43 h	Patients with acute hip fractures; age ≥65; both males and females.	EXP: 16 (25th-75th percentile=13-19)	Term members: a geriatrician, a rehabilitation specialist, a social worker, an orthopedic.	Usual postoperative surgical care	One year
			CON: 82.6±7.4	CON: 164	CON: 78.5±53 h		CON: 18 (25th-75th percentile=13-24)	Term organization: interdisciplinary meeting weekly; a comprehensive therapeutic plan		
Shyu	2005	Taiwan	EXP: 77.6±8.3	EXP: 68	NR	Patients with single-side hip fractures; age ≥60; both males and females	NR	Term members: a geriatrician and geriatric nurses, a physical therapist, a rehabilitation physician, and an orthopedic	Usual postoperative surgical care	Three months
			CON: 77.7±7.1	CON: 69				Term organization: geriatric consultation service, rehabilitation program, and discharge-planning service		
Shyu	2008	Taiwan	EXP: 77.4±8.2	EXP: 80	NR	Patients with single-side hip fractures; age ≥60; both males and females.	EXP: 10.1±3.7	Term members: a geriatrician and geriatric nurses, a physical therapist, a rehabilitation physician, and an orthopedic.	Usual postoperative surgical care	One year
			CON: 78.9±7.3	CON: 82			CON: 9.72±4.96	Term organization: geriatric consultation service, rehabilitation program, and discharge-planning service.		
Shyu	2012	Taiwan	EXP: 77.6±7.14	EXP: 99	EXP: 2.18±1.9 d	Patients with single-side hip fractures; age ≥60; both males and females.	EXP: 8.34±4.39	Term members: a geriatrician and geriatric nurses, a physical therapist, a rehabilitation physician, and an orthopedic.	Usual postoperative surgical care	One year
			CON: 76.91±8.20	CON: 99	CON: 2.3±1.2 d		CON: 8.47±4.51	Term organization: geriatric consultation service, rehabilitation program, and discharge-planning service.		
Deschodt	2012	UK	EXP: 80.4±7.0	EXP: 94	NR	Patients with hip fractures; age ≥65; both males and females.	EXP: 11.51±5.1	Term members: a geriatrician, three nurses, a social workers, two occupational therapists, and a physiotherapist.	Usual postoperative surgical care	One year
			CON: 81.1±7.2	CON: 77			CON: 12.4±8.5	Term organization: in-depth multidisciplinary evaluation, formal clinical advice, and recommendations, and in-hospital follow-up upon request.		
Stenvall	2012	Sweden	EXP: 82.3±6.6	EXP: 102	NR	Patients with femoral neck fractures; age ≥70; both males and females.	EXP: 30.0±18.1	Term members: registered nurses, physiotherapists, occupational therapists, a dietician and geriatricians besides surgeon.	No corresponding termworks; usual postoperative surgical care	One year
			CON: 82.0±5.9	CON: 97			CON: 40.0±40.6	Term organization: all term members assessed each patient within 24 hours; Term planning of rehabilitation process and goals twice a week.		

Watne	2014	Norway	EXP: 84 (55-99) CON: 85 (46-101)	EXP: 163 CON: 166	EXP: 26.2 h (interquartile range15.9 to 42.7 h) CON: 23.9 h (interquartile range16.5 to 38.1 h)	Patients with femoral neck fractures	EXP: 11 (interquartile range 4.8 to 15) CON: 8 (interquartile range 4.8 to 11)	Term members: geriatrician, nurse, physiotherapist and occupational therapistbesides surgeon. Term organization: comprehensive geriatric assessment as a basis for treatment planning; all term members assessed patients during the first day; intervention term meeting daily.	No multidisciplinary meeting and no geriatric assessments; usual postoperative surgical care	One year
Prestmo	2015	Norway	EXP: 83.4±5.4 CON: 83.2±6.4	EXP: 198 CON: 199	NR	Patients with femoral neck fractures; age ≥70; both males and females.	NR	Term members: geriatrician, nurse, physiotherapist and occupational therapistbesides surgeon. Term organization: structured, systematic interdisciplinary comprehensive geriatric assessment and care.	Following of routines of department of orthopaedic surgery.	One year

EXP: comprehensive geriatrical care; CON: control group; NR: no report.

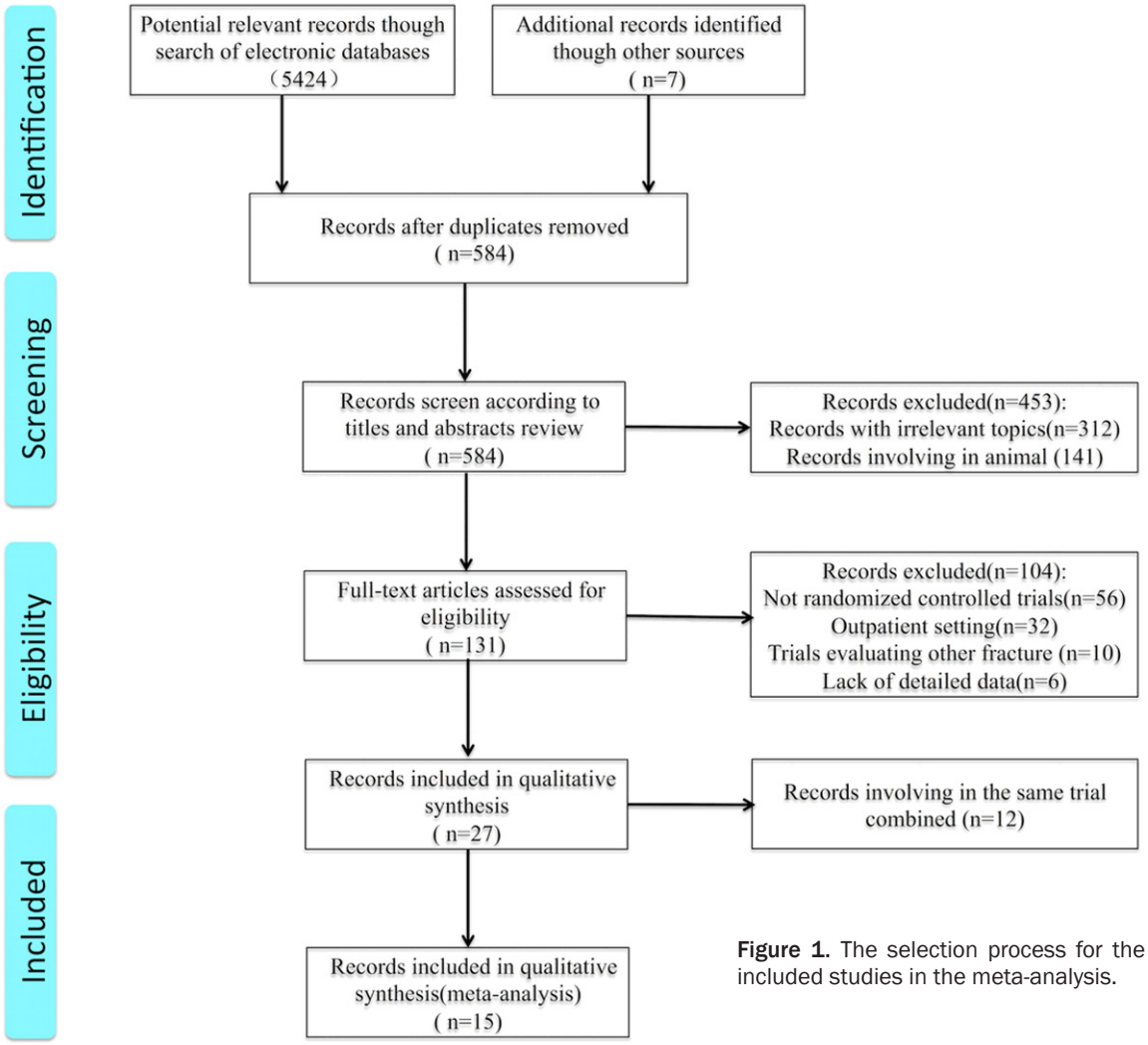

Figure 1. The selection process for the included studies in the meta-analysis.

tion and control in any study. The main characteristics of the 15 studies included in the meta-analysis were shown in **Table 1**.

Risk of bias in included studies

The studies identified were heterogeneous in quality (**Figure 2**). Of the 15 trials, 13 trials had a detailed description of method for individual patient randomization, though reporting of key issues such as allocation concealment varied. Adequate allocation concealment was performed in 6 out of 15 studies. 2 studies did not clearly describe the method of randomization and 9 trials used a block randomization of two causing allocation concealment less effective. No studies blinded participants or outcome assessors. Attrition and selective reporting bias was specified in 2 trials. 14 studies had an adequate handing of incomplete outcome data, which were also free of suggestion of selective outcome reporting. All studies appeared to be free of other sources of bias. In addition, the majority of the included trials were small studies with sample sized ranging from 50 to 200 patients. However, they were relatively well designed and well implemented.

Synthesis of results

A total of 10 studies [10-14, 23, 24, 34, 35, 37] including 2538 patients reported data on in-patients mortality. Pooled results showed no significant differences between intervention group and control group (OR 0.73, 95% CI 0.51 to 1.05, P=0.09). Heterogeneity tests for the ten outcomes were not significant difference (I^2=5%, P=0.39) (**Figure 3A**).

For mortality at 3 months, 6 months and 1 year after surgery, combined results did not demonstrate any beneficial effect on mortality

Figure 2. The methodological quality of included studies.

between intervention and control group at 3 months (OR 0.96, 95% CI 0.51 to 1.81, P=0.90), 6 months (OR 1.03, 95% CI 0.73 to 1.45, P=0.86) or 12 months (OR 0.93, 95% CI 0.77 to 1.12, P=0.30) after discharge. There was no significant heterogeneity for the follow-up mortality at 3 months (I^2=0%, P=0.75), 6 months (I^2=0%, P=0.62) and 1 year (I^2=0%, P=0.78) (**Figure 3B**).

7 studies [11, 14, 26, 31, 34, 37, 38] with 1403 patients reported the data on length of stay. However, only six studies that showed the detailed data with mean (SD) were pooled. The pooled results comprehensive geriatric care had no significant effect on the length of hospital stay as compared to control (MD 1.60, 95% CI -2.18 to 6.01). As there was significant heterogeneity (I^2=96%, P<0.01), the results should be interpreted with caution (**Figure 4A**).

6 studies [11, 14, 24, 34, 35, 37] reported the proportion of patients who were discharged from hospital to the same place of residence as before the fracture between both groups. The pooled results showed there were a significant greater proportion of patients in intervention group as compared to control (OR 1.67, 95% CI 0.80 to 3.37, P=0.0003). No significant heterogeneity bias was found (**Figure 4B**).

The functional improvement including independent ADL performance and walking ability performance during the follow-up as before the fracture was evaluated. For the ADL performance, the pooled results from 5 trials [13, 23, 25, 35, 41] showed that the proportion of patients in intervention group who had regained the same ADL performance level as before the fracture was higher than control group at the 3 months (OR 2.34, 95% CI 1.53 to 3.29, P<0.01) and 12 months (OR 1.76, 95% CI 1.11 to 2.78, P<0.01) follow-up (**Figure 5A**). The pooled results from 4 [11, 26, 28, 31] trials showed that the proportion of patients in intervention group who had regained the same level of walking ability as before the fracture was higher than control group at the 3 months (OR 1.84, 95% CI 1.42 to 2.39, P<0.01) and 12 months (OR 2.17, 95% CI 1.52 to 3.10, P<0.01) follow-

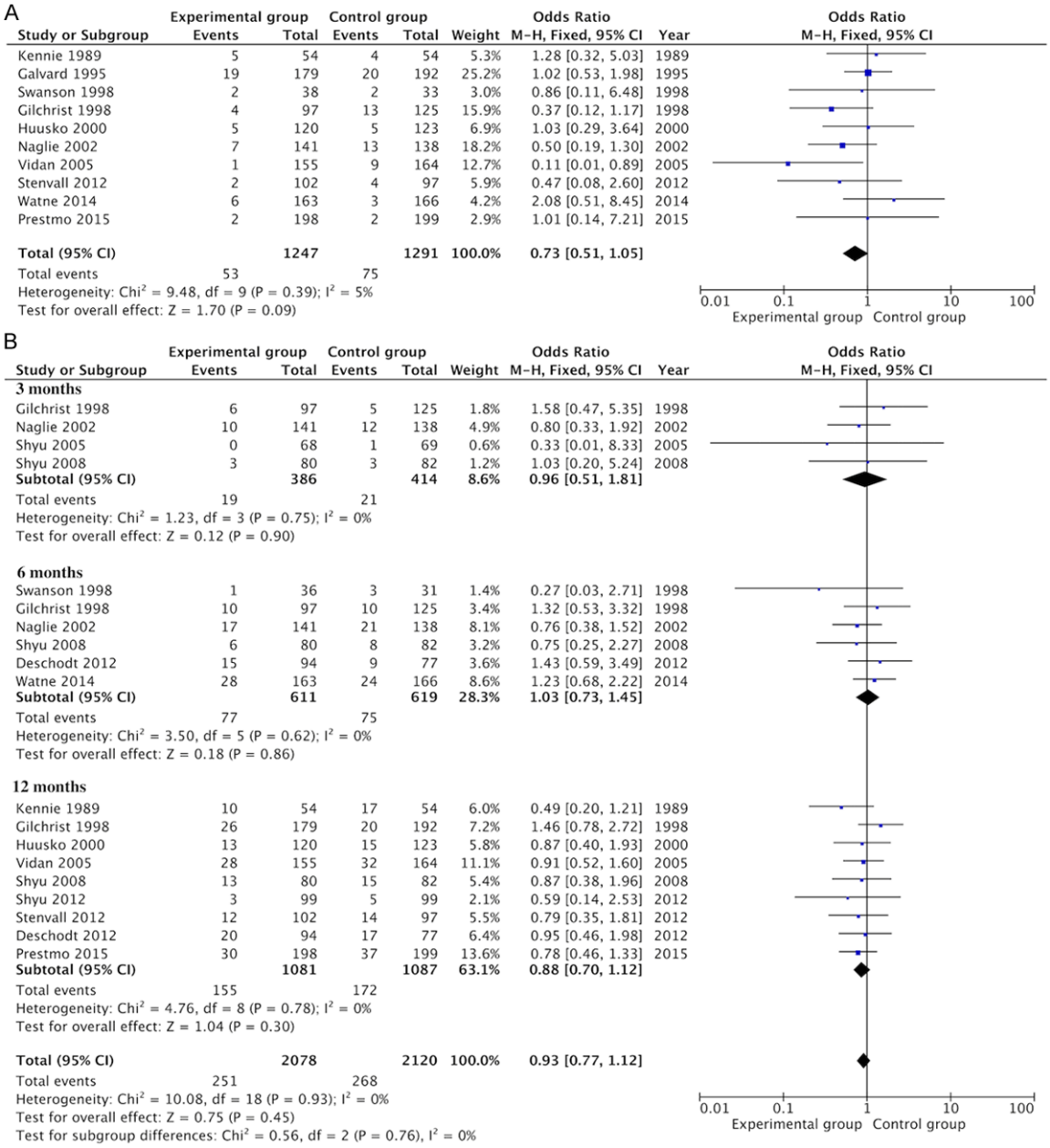

Figure 3. Effect of inpatient comprehensive geriatric care specifically designed for elderly patients on mortality at hospital (A) and 3-, 6- and 12 months follow up (B).

up (**Figure 5B**). No significant heterogeneity and publication bias were found for the both results.

As trials presented the costs of comprehensive geriatric assessment differently and with differing outcome measures, we did not carry out a meta-analysis. Of the included studies, only four trials [12, 13, 37, 40] by Cameron et al, Galvard et al, Huusko et al, and Prestmo et al reported the adequate data about the cost. Most costs reported are those incurred by the trial hospital and only rarely have the costs of nursing home care been taken into consideration. Most of the differences in cost are attributed to differences in length of stay or differences in the type and number of investigations requested between the groups. Some trials [12] reported greater costs for in-patient costs but a significant reduction in post-surgery costs in the treatment group. If nursing home costs are taken into consideration, the potential ben-

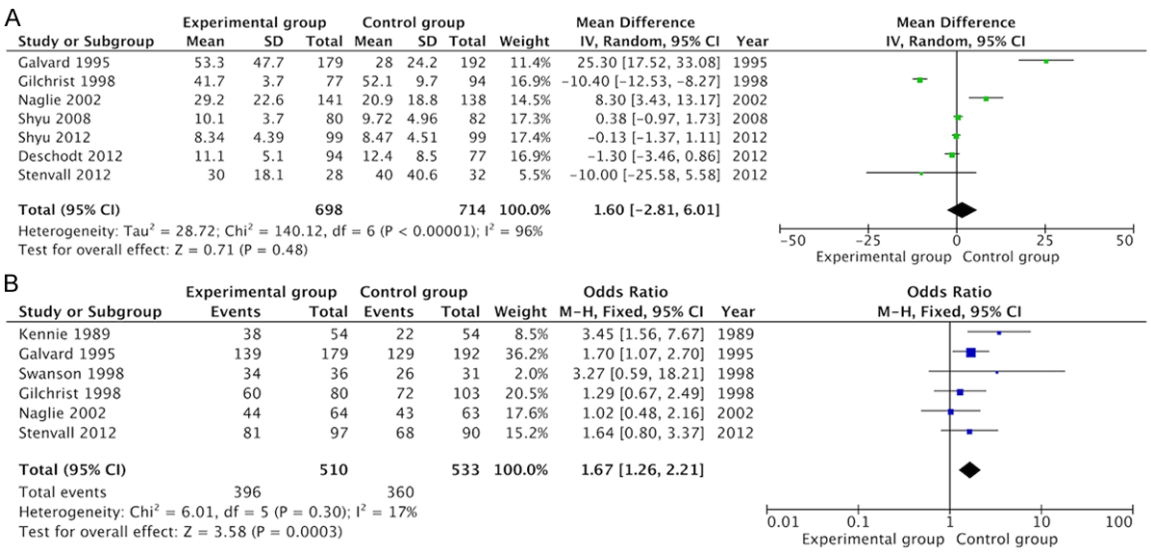

Figure 4. Effect of inpatient comprehensive geriatric care specifically designed for elderly patients on length of stay (A) and place of residence after discharge (B).

efit of comprehensive geriatric care might be greater.

Publication bias and sensitive analysis

Publication bias involving in all outcomes of interest was evaluated by using funnel plot in this meta-analysis. Our results showed that all studies lie inside the funnel with symmetric distribution indicating no obvious publication bias, which were showed in **Figure 6**. Even though sensitivity analysis was conducted by repeating the whole analysis after excluding several studies with a high risk of bias, the results remained unchanged.

Discussion

Our meta-analysis of inpatient comprehensive geriatric care specifically designed for elderly patients with hip fracture shows significant beneficial effects over usual care in functional improvement. Meanwhile, comprehensive geriatric care increases the number of patients who are discharged to their previous residence as before the fracture. However, our findings show that comprehensive geriatric care is not associated with the in-patients and long-term mortality. Insufficient data is available for defining characteristics and cost effectiveness.

Limitations

Our meta-analysis presented several limitations, and its results must be interpreted within the context. The main limitation was the heterogeneous way that comprehensive geriatric care was organized and put into practice, with different approaches in different studies. An important element in the organization of care was the involvement of a multidisciplinary term. The exact composition of the term and the frequency with which it met varied greatly. In addition, a detailed description of the content of the comprehensive geriatric care was not provided. Thus, it was impossible to compare different forms of comprehensive geriatric care with each other nor to evaluate the benefit if combining different model. That was why only articles evaluating and testing the whole concept without differentiating the model of care. Another limitation was the poor methodological quality of some of the included studies, and all had difficulties with regard to blinding of patients, assessment term, or both, which resulted in a significant potential for bias especially for some of outcomes. However, we must stress that it is difficult to meet all criteria of high methodological quality in this research area. In addition, several studies did not report results of important outcome measures or detailed statistical variables, including standard deviations of length of stay and cost. Thus, our meta-analysis may be underpowered for such outcomes.

Mortality

In-patient mortality is a common outcome parameter reported in the medical literature. It

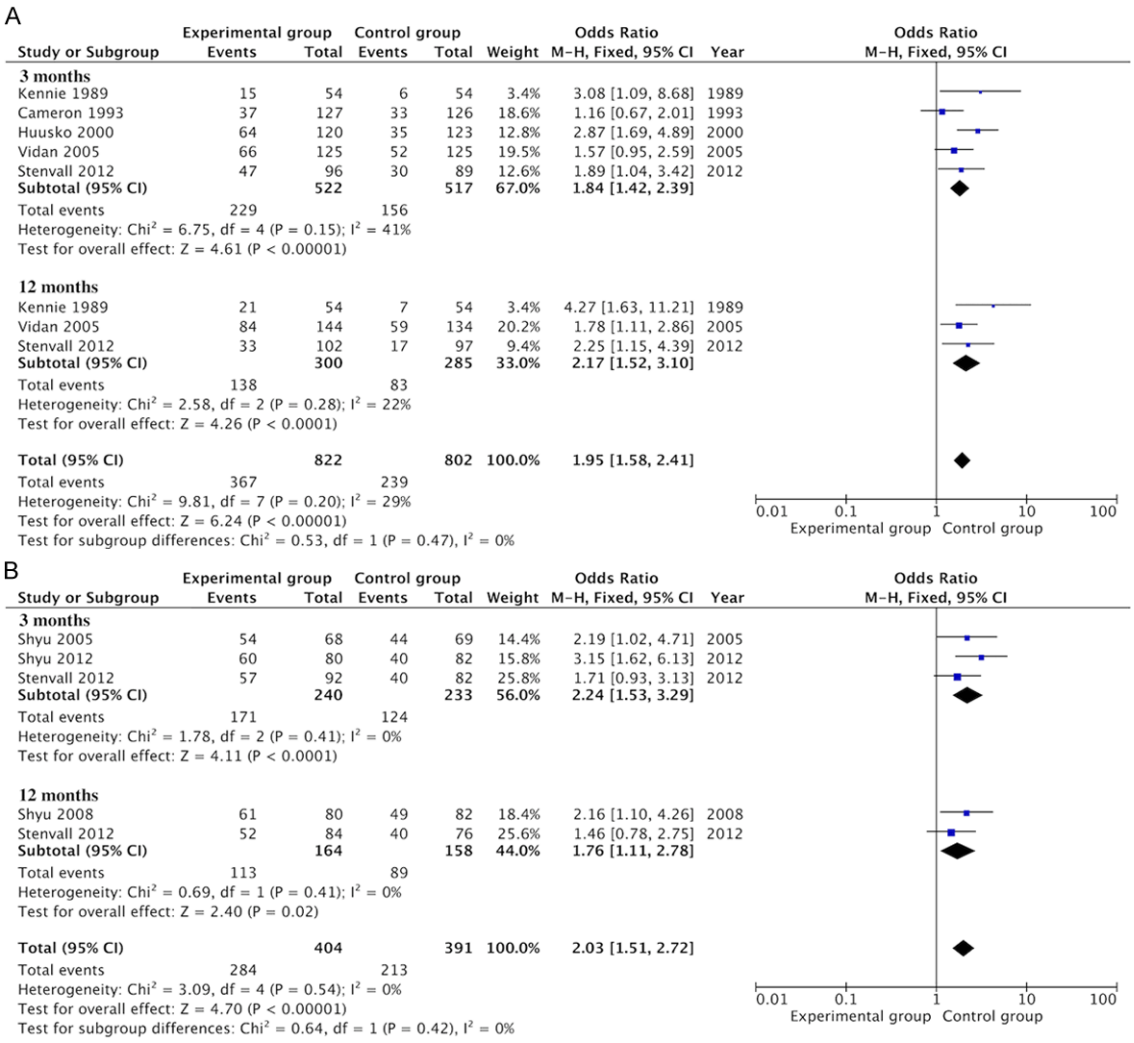

Figure 5. Effect of inpatient comprehensive geriatric care specifically designed for elderly patients on ADL (A) and walking ability (B) at 3- and 12 months follow up.

is known that mortality after hip fractures in elderly people is increased as compared to the age-matched polulation [42]. The most striking finding in our meta-analysis was that patients in intervention group presented no significant decrease in hospital morality than usual care, which was consistent with most studies that showed no effect on hospital mortality [20, 21]. A study by Vidan et al showed a significant reduction on hospital mortality in intervention group [23]. The possible reason for the reduction might be that patients in intervention group were associated with a reduction in the incidence of non-predefined major complication, which accounted for most of deaths during hospitalization. In addition, because of the differences in length of stay between countries, the pooled results of in-patient mortality should be interpreted with caution. As described in other studies, hip fracture is related to considerable long-term mortality. To reduce the bias due to the varying follow-up times, we assessed the mortality at 3, 6 and 12 months after discharge. Surprisingly, patients in intervention group did not regain a reduction in 3, 6 and 12 months mortality after discharge as compared to control. These findings indicated that comprehensive geriatric care has no significant effects on long-term mortality.

Length of hospital stay

The most frequently reported outcome parameter is the length of stay. In the present study, it

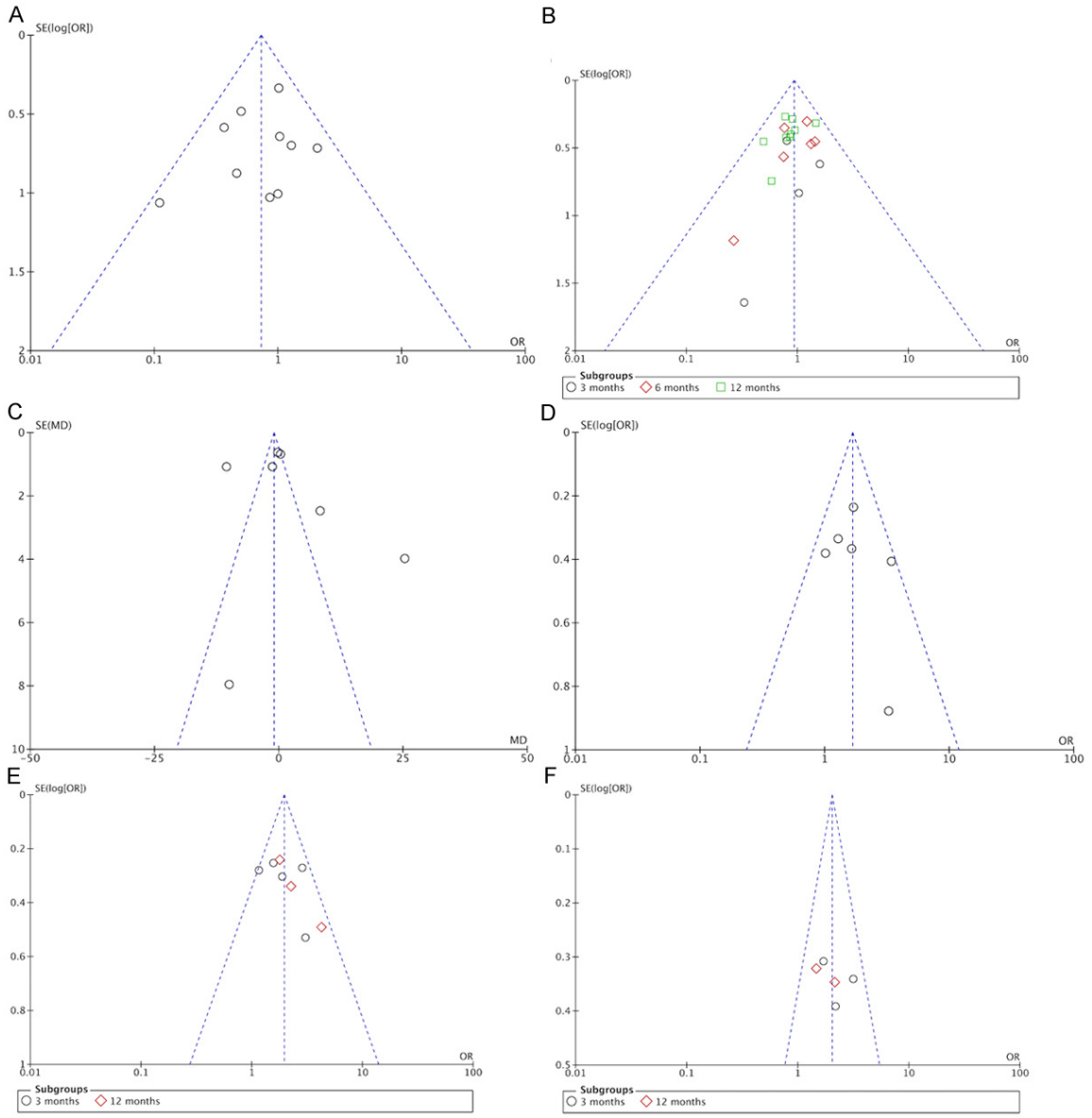

Figure 6. Funel plot of in-patient mortality (A), mortality at follow up period (B), length of stay (C), place of residence after discharge (D), ADL (E) and walking ability (F) assess publication bias.

was found to be no significant difference between intervention group and control group. Not surprisingly, it is very difficult to pool the results of length of hospital stay among the different studies since there can be major differences in the organization of health care, surgical methods and rehabilitation. A study by Galvard et al [37] was noteworthy for its significantly longer length of stay, 53.3 days in intervention group (control: 28 day). One explanation for this might be that patients in intervention group were significantly older than the patient in control, a different that was more than five year. Another factor contributing to the prolonged stay in intervention group was the lack of nursing home beds in the municipality of Malmo and the fact that orthopedic department had first priority to home help service. The difference of length of stay between two groups in Naglie et al [34] was due to the shortage of geriatric internist, which might have prolonged inpatient stay. Other studies not included in the meta-analysis also yielded heterogeneous regarding length of stay. Therefore, length of hospital stay in the different framework conditions would itself be problematic as a quality

criterion for evaluating patient care, as it provided limited information on quality of treatment.

Place of residence

Place of residence, as an indirect indicator to evaluate the efficacy of comprehensive geriatric care for functional recovery, suggests that patients have the ability for independent living [43]. One of the primary goals of orthogeriatric co-management is help the patients to achieve their pre-fracture living status. Thus, it is important to evaluate whether patients can return to their pre-fracture living situation. In the present study, six studies evaluated the place of residence at admission and the discharge destination from the acute hospital. Our findings indicated that the proportion of patients who were discharged directly to previous place rather than nursing home was significantly higher in the group receiving comprehensive geriatric care as compared to control. The results suggested a high probability of comprehensive geriatric care being more effective than orthopaedic care for patients with hip fracture. Although differences were found between the treatment groups with respect to discharge destinations, these should be interpreted cautiously because they are probably due, at least in part, to the different lengths of hospital stay or the complex family-related factors. A study by Naglie et al [34] showed no significant differences in residential status were found at 3 or 6 months after discharge. Another explanation for the discharge policy could be that comprehensive geriatric care and discharge planning are time-consuming. Also, some extra days in hospital might have been sufficient for some patients to discharge directly home.

Functional improvement

Functional improvement for patients in intervention group was achieved in most studies. In the present study, we evaluated the effect of comprehensive geriatric care on function recovery regarding the more frequent recovery of the activities of daily living and walking ability. Our findings indicated about 43.9% and 71.3% of patients in intervention group (control: 30.2% and 53.2%) achieved the same level of ADL and walking ability at three months as before the fracture, respectively. At follow-up visit six months after discharge, about 46% and 68.9% of patients in intervention group (control: 29.1% and 56.3%) achieved the same level of ADL and walking ability as before the fracture, respectively. Although comparison with outcomes achieved in other health care systems is complex, our findings are broadly consistent with previous studies [20]. These findings suggested patient receiving comprehensive geriatric care could achieve a higher level of functional recovery than patients in conventional care.

Cost

It is difficult to compare direct costs between intervention and control group since there can be major differences in the organization of health care, surgical methods and rehabilitation. In addition, few studies evaluated the cost of comprehensive geriatric care for elderly with hip fracture. The differences in cost are attributed to difference in length of stay or the type and number of investigations requested. In addition, any reduction in independence can result in extra health-care costs and is essential for cost-effectiveness analysis. A study by Cameron et al [40] reported comprehensive geriatric care released resources equivalent to approximately 17% of total cost including inpatient hospital care and post-surgery cost for treatment per patient. Prestmo et al also presented a significant reduction of cost for patients receiving comprehensive geriatric care than routine orthopaedic care because the latter resulted in a more cost of rehabilitation stay and nursing home stay after discharge in spite of less inpatient cost [12]. Galvard et al showed a slightly higher cost for patients receiving geriatric care than control because patients in intervention group had a significantly longer stay in hospital (53.3 vs 28.0), which was associated with more inpatient cost [37]. Huusko et al found the cost of geriatric-orthopaedic management to be more per patient than ordinary orthopaedic management [13]. They found no difference in the lengths of hospital stay between the two groups, and much of the additional cost was in the servicing of long-term institutional care of demented hip fracture patients unit. Based on the data, we could draw a premature conclusion that comprehensive geriatric care resulted in more in-patient cost but a significant reduction in post-discharge cost. Further economic evaluation is worthwhile considering the demographic changes and potential societal costs from healthcare for an ageing population.

Conclusion

Significantly more elderly patients with hip fracture are likely to achieve functional recovery if they undergo comprehensive geriatric assessment while they are inpatients. However, inpatient interdisciplinary care did not result in significantly reduction in in-hospital mortality and follow-up mortality. Designated orthopaedic geriatric units can provide such care, but we believe that the collaborative approach should be administered within the existing facilities of orthopaedic and geriatric services and additional costs should not be incurred.

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Disclosure of conflict of interest

None.

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