Int J Clin Exp Med 2017;10(12):15825-15833
www.ijcem.com /ISSN:1940-5901/IJCEM0057299

Review Article

Cost comparing home-based rehabilitation with hospital-based rehabilitation following total joint replacement: systematic review and meta-analysis

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Received May 12, 2017; Accepted October 4, 2017; Epub December 15, 2017; Published December 30, 2017

Abstract: The purpose of this research is to evaluate the effects and cost of rehabilitation in or not in a hospital in total joint arthroplasty. The study included randomized controlled trials (RCTs) on the effects or cost of home-based rehabilitation and hospital-based rehabilitation after total joint replacement. All related articles which were published up to June 2016 from Pubmed, Embaseand Web of Science were identified. Outcomes included pain, postoperativefunction, knee range of motion, 6-minutes-walking test (6-MWT) and cost. The quality of the included studies was assessed. Cochrane RevMan software version 5.3 was utilized to perform the meta-analysis. Seven RCTs that involved 820 patients were included in the meta-analysis, which were divided into two groups. The home-based rehabilitation group included 420 patients, and thehospital-based rehabilitation group included 400 patients. The meta-analysis showed that there were no differences for home-based rehabilitation compared with hospital-based rehabilitation in pain (WMD, -0.07; 95% CI, -0.17 to 0.16; P = 0.34), postoperative function (WMD, -0.11; 95% CI, -0.25 to -0.03; P = 0.12), range of motion (WMD, 0.37; 95% CI, -0.10 to 0.83; P = 0.12), 6-minutes-walking test (6-MWT) (WMD, -1.18; 95% CI, -3.19 to 0.83; P = 0.25). However, home-based rehabilitation could becost-benefitfor the patients compared with hospital-based rehabilitation (SMD 0.42 (95% CI 0.04, 0.80)). In conclusion, home-based rehabilitation has superior to hospital-based rehabilitation in cost.

Keywords: Meta-analysis, rehabilitation, economic evaluation, total knee replacement, total hip replacement

Introduction

Osteoarthritis is the most significant cause of disability and limitation in older people [1, 2] and if medical treatments do not help, joint replacement is recommended [3]. The number of total joint replacements performed each year is increasing [4]. There have been 772, 818 and 708, 311 patients who have experienced the total knee and hip replacement respectively at the end of 2015 [4]. Although a majority of patients experience marked improvement in pain, physical function, and quality of life after total knee arthroplasty (TKA) [5], there continue to be some defects in muscle strength, aerobic fitness does not recover after surgery [6-8].

Therefore, rehabilitation, with a particular emphasis on physiotherapy and exercise, is widely promoted after total joint replacement [9]. Traditionally in Canada after total joint replacement, patients were routinely sent to inpatient facilities for rehabilitation [10, 11]. More recently, there has been an increased trend to send patients directly home after total joint replacement with supporting home-care services [11, 12]. Aprevious study reviewed the rehabilitation protocol before 2012 and showed physio therapy could improve strength and gait speed after total hipreplacement [8]. Therefore, we need to reconsider whether patients could discharge earlier and rehabilitation at home, and get the same function with rehabilitation in hospital.

Methods and methods

Search strategy

Two researchers (LZY and WD) searched the electronic databases (PubMed, Embase, Web

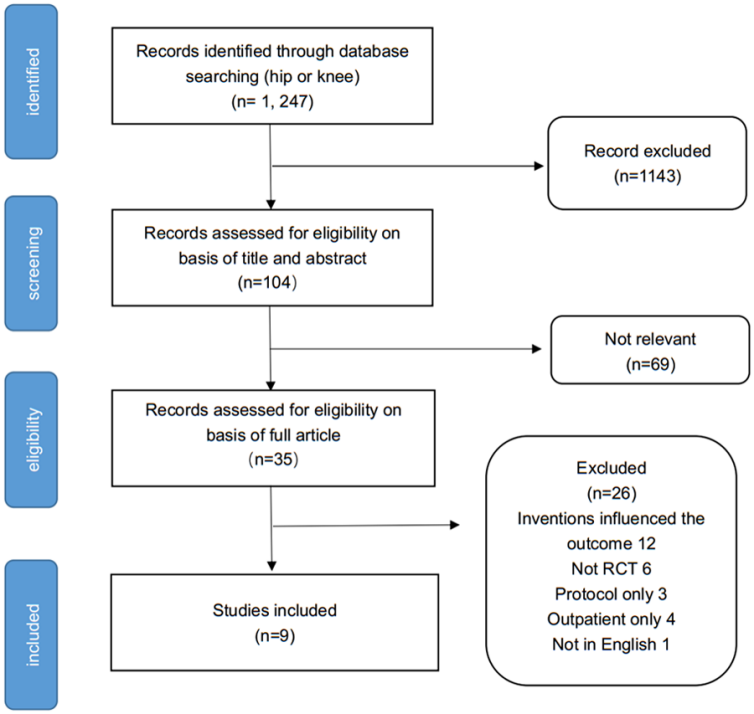

Figure 1. Flow chart summarizing the selection process of randomized control trials (RCTs).

of Science) independently, which were published up to June 2016. Search terms included: total hip and knee replacement; randomized controlled trial, rehabilitation. Reference lists of the relevant papers were also looked through for any additional relevant studies.

Eligibility criteria

The following criteria were required for inclusion: (1) patients underwent unilateral primary total knee arthroplasty (TKA) or total hip arthroplasty (THA), (2) an RCT comparing hospital-based rehabilitation with home-based rehabilitation, (3) the full text must be published in English. Review articles, case reports, meeting abstracts, comments, letters, expert opinions, along with animal and cadaver studies were ruled out.

After excluding duplicates, two investigators independently screened the titles and abstracts to exclude irrelevant studies and identify relevant articles for full-text review. Two reviewers then independently reviewed the full text of the remaining articles and evaluated them against the inclusion/exclusion criteria to select articles for final inclusion. Disagreements regarding whether an article should be included or excluded were resolved by discussion. If discrepancies remained, a third author would make an arbitration.

Risk of bias assessment

Two investigators independently assessed each included study using the Cochrane Collaboration tool forrisk of bias, including random sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting and other issues. If all of the criteria were met, the study was considered to have a low risk of bias; if one or more of the criteria were partly met, the study was deemed to have an unclear risk of bias; if one or more of the criteria were not met, then the study was considered to have a high risk of bias. A risk of bias table was completed for each eligible study. Any differences were resolved by adiscussion [13]. If discrepancies remained, a third author would make an arbitration.

Data extraction and statistics

Two authors (LZY and WD) extracted relevant data, including sample size, Gender distribution mean age, body mass index (BMI), Intervention details, Follow up, WOMAC, ROM, KOOS, SF-36, quality of life (QOF), 6-MWT, satisfaction, cost.

For outcomes reported as continuous variables, means and standard deviations were extracted. If outcomes were reported as means and confidence intervals, or medians and inter-quartile ranges, appropriate conversions were applied.

The primary author of the study was contacted for missing data if necessary. We also asked if any outcomes not reported in their publications had been collected.

The meta-analysis was conducted with Cochrane Collaboration Review Manager 5.3 software. For continuous data, a weighted mean difference (WMD) and 95% confidence interval

Table 1. Participant characteristics of the selected seven RCTs

Authors	Year	Sample size	Sample size		Gender distribution		Mean age (SD)		BMI (SD)	
			Hospital	Home	Hospital (M/F)	Home (M/F)	Hospital	Home	Hospital	Home
Moffet, H	2015	197	86	111	44/42	56/55	67 (8)	65 (8)	34 (7)	33 (6)
Kauppila, AM	2011	86	44	42	NS	NS	NS	NS	NS	NS
Sigurdsson, E	2008	50	23	27	NS	NS	66 (11.91)	69 (6.4)	NS	NS
Mahomed, NN	2008	234	119	115	NS	NS	NS	NS	NS	NS
Galea, MP	2008	23	11	12	3/8	4/8	68 (9.7)	66 (7.9)	28 (4.5)	29 (5.2)
Mitchell, C	2005	114	57	57	27/30	21/36	70 (8.2)	70 (7.2)	NS	NS
Rajan, RA	2004	120	60	56	23/37	20/36	NS	NS	NS	NS

Note: SD, standard deviation; NS, nonestatement; BMI, body mass index.

(CI) was used. For dichotomous outcomes, risk ratio/relative risk (RR) and 95% CI were calculated as the summary statistics. The statistical heterogeneity was tested with the Chi-square test and I^2. The value of $I^2 < 25\%$ was considered low statistical heterogeneity; $I^2 < 50\%$, moderate statistical heterogeneity; $I^2 < 75\%$, high statistical heterogeneity. When there was no statistical evidence of heterogeneity, we adopted a fixed-effect model; otherwise, a random-effect model was chosen.

Result

Study characteristics

A flow diagram depicting the study identification is shown in **Figure 1**. We identified 1247 potential articles (843 from PubMed; 208 from Embase; 195 from Web of Science; and one from the reference lists). Of these, seven articles met inclusion criteria for final review [11, 14-19]. **Tables 1** and **2** included the summary general and rehabilitation information on the included studies, respectively.

Risk of bias

The results of the quality assessment are presented in **Figures 2** and **3**. Seven studies adequately described the correct randomization, six studies demonstrated sufficient allocation concealment, one study described the blinding of outcome assessment and two studies described the blinding of participants and personnel. Five studies retained complete outcome data and seven studies avoided selective reporting, and seven studies seemed to be free of other potential sources of bias. As a result, the overall quality of the included studies was considered adequate, except two studies that demonstrated a high risk of bias (**Figure 3**).

Outcomes

The pain was described in four studies. The pooling data showed thathospital-based rehabilitation has no difference compared with home-based rehabilitation (WMD, -0.07; 95% CI, -0.17 to 0.16; P = 0.34) (**Figure 4**).

Four papers described the postoperative function. The forest plot of postoperative function showed no significant difference between hospital-based rehabilitation and home-based rehabilitation (WMD, -0.11; 95% CI, -0.25 to -0.03; P = 0.12) (**Figure 5**).

Two studies reported the range of motion. Two trials calculated the change of the range of motion. However, there has beenno significant difference between hospital-based rehabilitation and home-based rehabilitation (WMD, 0.37; 95% CI, -0.10 to 0.83; P = 0.12) (**Figure 6**).

Two studies mentioned the result of the 6-minutes-walking test. The pooling result showed no statistical difference between the two groups (WMD, -1.18; 95% CI, -3.19 to 0.83; P = 0.25) (**Figure 7**). Four studies recorded the cost. The cost of home-based group was less than the hospital group (WMD, 0.42; 95% CI, 0.04 to 0.80; P = 0.03) (**Figure 8**).

Discussion

With the increasing number of total joint replacements being performed worldwide, there is an increasing emphasis on cost-effective

Table 2. Characteristics of included studies

Authors	Year	Intervention details		Period of intervention (month)	Time-points of Follow up (month)	Outcomes measurements
		Hospital	Home			
Moffet, H	2015	The face-to-face visit	Home-based telerehabilitation	2 m	2 m, 4 m	KOOS, Functional and strength tests, and Knee ROM
Kauppila, AM	2011	Outpatient course: the multidisciplinary rehabilitation program	Instructions for exercises	4 m	2, 6, 12 m	Cost, Womac changes
Sigurdsson, E	2008	A stay at a rehabilitation center	Education programs,	6 m	4, 6 m	Cost
Mahomed, NN	2008	Inpatient rehabilitation in one of two independent inpatient rehabilitation institutions	Home-based rehabilitation	3 m	3, 12 m	Womac, SF-36, satisfaction, Cost
Galea, MP	2008	Attended the rehabilitation centre twice a week for an exercise intervention program included 7 kinds of exercises	Illustrations of the same prescribed exercises without supervise	2 m	2 m	Womac, Quality of life, Stair climbing test and 6-MWT
Mitchell, C	2005	Usual hospital physiotherapy is post-discharge only and comprised group exercises, and individual treatment	Individual treatment: three pre-operative visits and up to six post-discharge visits	3 m	3 m	Womac, SF-36
Rajan, RA	2004	Inpatient physiotherapy and outpatient physiotherapy,	Inpatient physiotherapy only before discharge.	12 m	12 m	ROM,

Note: KOOS, the Knee Injury and Osteoarthritis Outcome Score questionnaire; WOMAC, the Western Ontario and McMaster Universities Osteoarthritis Index questionnaire; SF-36, the Short Form-36; 6-MWT, 6-minutes-walking test.

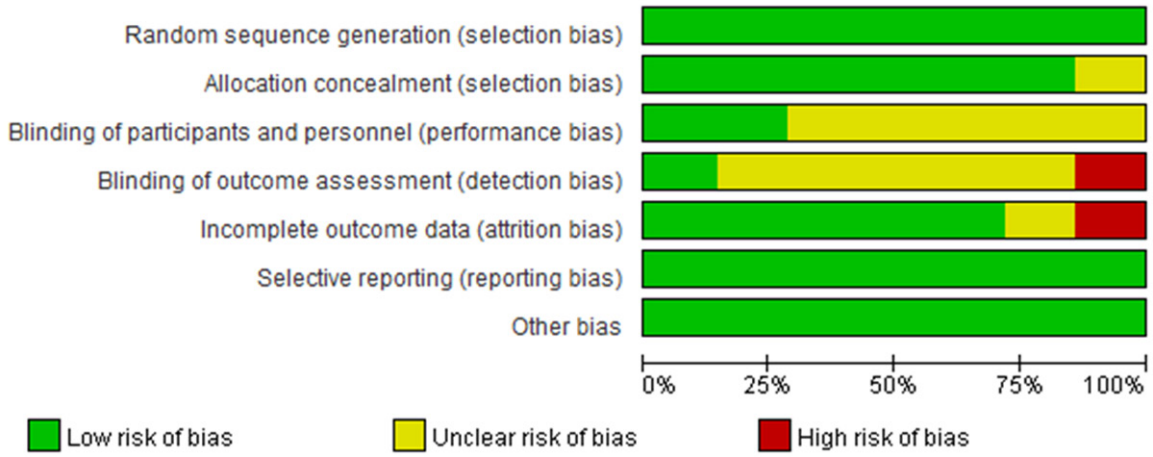

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

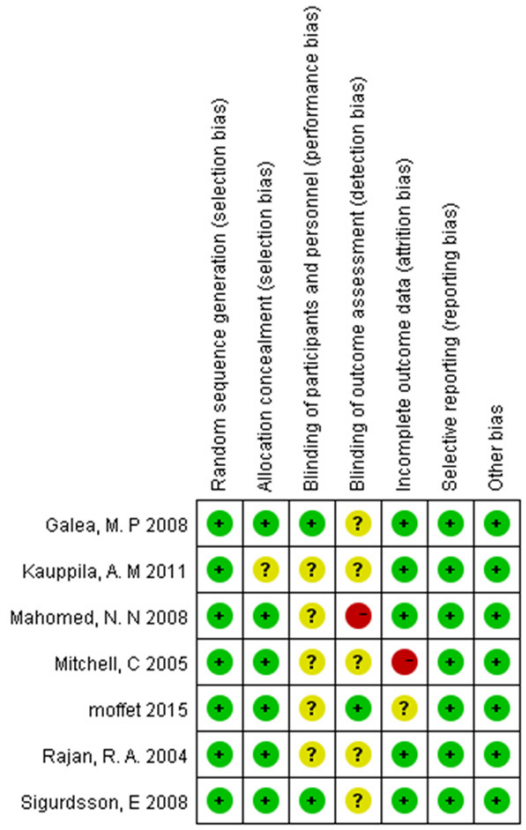

Figure 3. Risk of bias summary: review authors' judgements about each risk-of-bias item for each included study.

delivery of care [20]. A prior study had reviewed the rehabilitation protocols before 2012 and concluded that physio therapy could improve strength and gait speed after total hipreplacement [8]. In recent years, the assumption that postoperative inpatient rehabilitation results in improved outcomes for patients receiving a total joint replacement has been challenged, and there has been an increasing trend toward discharging patients who have had a total joint replacement directly to home from the acute care facility with home-based rehabilitation support. Decreasing costs and improving the efficiency of care are important goals in enhancing any health-care delivery system; however, these must not come at the cost of reduced quality of care [11].

Randomized controlled trials of rehabilitation interventions provide some evidence that home-based rehabilitation is as efficient as rehabilitation in hospital. In the analysis comparing patients who received home-based rehabilitation with those receiving rehabilitation in hospital. There was no difference in postoperative function, (WMD, -0.11; 95% CI, -0.25 to -0.03; P = 0.12), and pain, (WMD, -0.07; 95% CI, -0.17 to 0.16; P = 0.34). However, these effects were based on only four studies with 254 patients, and 2 studies with 103 patients randomized, respectively. For ROM and 6-MWT, this observation based on only 2 studies shows that there was no difference in ROM (WMD, 0.37; 95% CI, -0.10 to 0.83; P = 0.12) and 6-MWT (WMD, 0.42; 95% CI, 0.04 to 0.80; P = 0.03). As for the cost, there was a significant difference between the two groups. The cost of home-based group was less than the hospital group (WMD, 0.42; 95% CI, 0.04 to 0.80; P = 0.03).

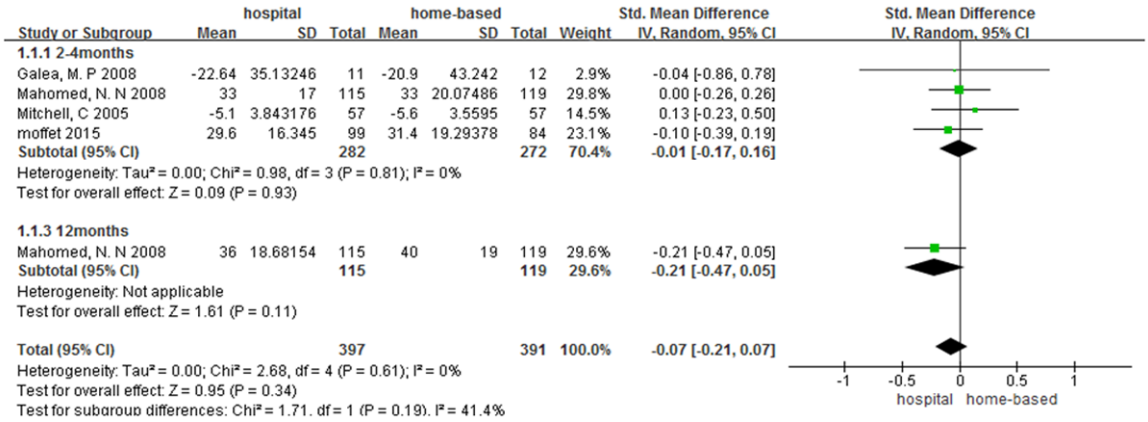

Figure 4. No significant difference comparing the pain of home-based rehabilitation with hospital-based.

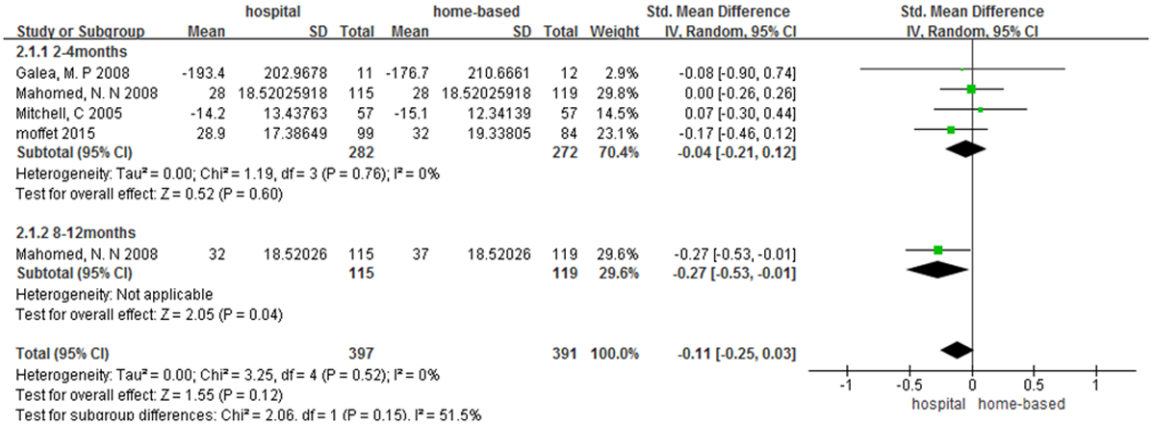

Figure 5. Regarding postoperative function, the two rehabilitation routes were not significantly different.

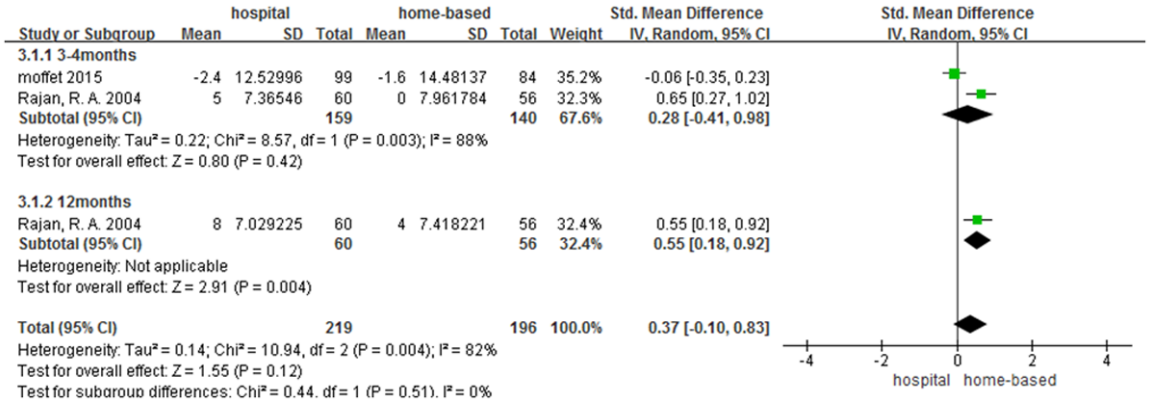

Figure 6. Regarding ROM, similarly, the two rehabilitation routes were not significantly different.

There is no current national guidance to support the early discharge and home-based rehabilitation. Rehabilitation should also address patient expectations [21], since the key expectations of patients undergoing joint replacement relate to long-term functional and pain outcomes [22, 23]. It is needed to be considered before surgery that gives the patients a

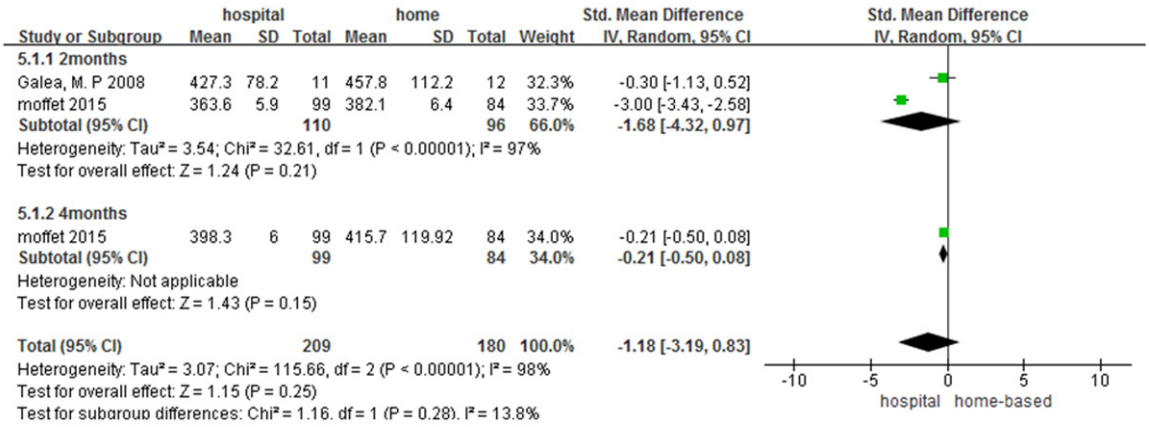

Figure 7. Regarding 6-minutes-walking test, the pooling result showed no statistical difference between the two groups.

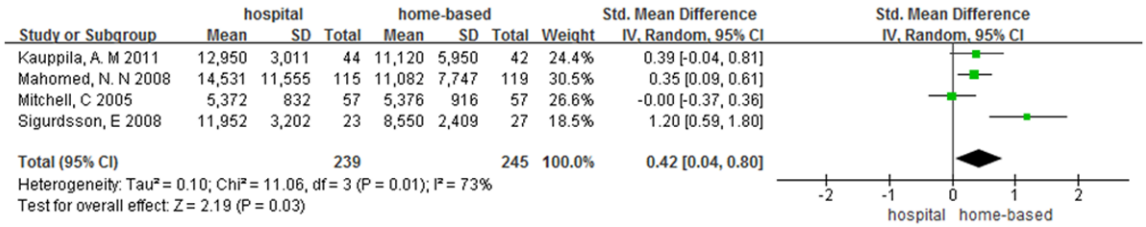

Figure 8. Home-based rehabilitation compared with rehabilitation in hospital, the cost of home-based group was less than the hospital group (WMD, 0.42; 95% CI, 0.04 to 0.80; P = 0.03).

better communication and understanding of realistic expectations after joint replacement.

Knee range of motion is commonly measured after knee replacement and is a component of clinician-based outcomemeasures such as the Knee Society Clinical Rating System [24]. While the range of joint motion is crucial, its usefulness as an outcome measure of physiotherapy interventions is limited as other factors, such as prosthetic design, preoperative knee motion, and surgical technique also influencesthe postoperative range of joint motion [25]. Therefore, it is thought to be a poor marker of implant success [26, 27], and may not influence patient satisfaction with their replacement [28]. As with all the results of our meta-analyses, the conclusions are limited by the small number of small studies that we identified.

There were insufficient studies with adequate patient numbers to provide conclusive evidence on costs. Rehabilitation provided at home is an appealing approach with the possibility of wider acceptability and uptake. On the one hand, it is more comfortable and convenient to rehabilitation at home, on the other hand, rehabilitation at home could save a lot for the patients. This study has shown that the cost of delivery of care following total hip or knee replacement can be significantly reduced by using home-based rehabilitation programs without compromising the quality of care as evidenced by comparable functional outcomes and patient satisfaction rates for up to one year after surgery [11]. However, equivalence or non-inferiority trials need larger numbers of patients and have yet to be undertaken. Our meta-analysis included only 484 patients for the cost outcome. Therefore, more similar study to invest the cost for rehabilitation were needed.

The limitations of this analysis are the following: Firstly, the study was limited to the literature published in English. Selection bias in language must have existed. Secondly, only seven RCTs published before were included. The only significant finding of that meta-analysis was

that the home-based group was significantly cost less than another group. The overall quality of these studies was sufficient, suggesting that these studies are comparable. Yet, studies were relatively small, with 832 participants included overall in the review.

The content and duration of rehabilitation need further research to evaluate. Whether early discharge and rehabilitation at home are as efficient as hospital-based rehabilitation also needs more research. The appropriate way to rehabilitation can be offered to each patient with an appropriate assessment before discharge. Future studies should include evaluation of methods, cost, complications with well-designed.

In conclusion, no difference in function and pain was found between the home-based and in hospital rehabilitation. Home-based rehabilitation iscost-benefitcomparing with the hospital-basedrehabilitation.

Acknowledgements

We thank Hao-Yang Wang for providing language help and writing assistance.

Disclosure of conflict of interest

None.

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