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Effectiveness of self-management interventions on mortality, hospital readmissions, chronic heart failure hospitalization rate and quality of life in patients with chronic heart failure: A systematic review

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ABSTRACT

Objective: This review examined the effectiveness of self-management interventions compared to usual care on mortality, all-cause hospital readmissions, chronic heart failure hospitalization rate and quality of life in patients with chronic heart failure.
Methods: A systematic review was performed. MEDLINE, EMBASE, CINAHL and the Cochrane Library were searched between 1996 and 2009. Randomized controlled trials were selected evaluating self-management interventions designed for patients with chronic heart failure. Outcomes of interest are mortality, all-cause hospital readmissions, chronic heart failure hospitalization rate and quality of life.
Results: Nineteen randomized controlled trials were identified. The effectiveness of heart failure management programs initiating self-management interventions in patients with chronic heart failure indicate a positive effect, although not always significant, on reduction of numbers of all-cause hospital readmitted patients and due to chronic heart failure, decrease in mortality and increasing quality of life.
Conclusion: This systematic review found that current available published studies show methodological shortcomings impairing validation of the effectiveness of self-management interventions on mortality, all-cause hospital readmissions, chronic heart failure hospitalization rate and quality of life in patients with chronic heart failure.
Practice implications: Further research should determine independent effects of self-management interventions and different combinations of interventions on clinical and patient reported outcomes.

1. Introduction

Both prevalence and incidence of people living with chronic heart failure (CHF) increases drastically worldwide, especially in individuals older than 65 years. Causes for this increase are due to the ageing of the population over time and improvement of survival in patients suffering from coronary diseases [1,2].

Being diagnosed with heart failure (HF) not only has a major impact on the persons quality of life (QoL), also usage of health care facilities is challenged [3]. Noncompliance with prescribed medical treatment and diet regimen, shortage of knowledge about deterioration of signs and symptoms and lack of professional intensive follow-up in CHF patients often result in frequent, preventable rehospitalization and emergency visits [3–8].

To achieve positive effects on clinical and patient reported outcomes, HF management programmes are developed. There is growing evidence of potential effectiveness of self-management interventions for CHF-patients [2]. Self-management interventions in HF programmes underline the importance of patient education about the disease, daily weight, blood pressure monitoring and self-medication [9]. Barlow et al. [10] described self-management as follows: *self-management refers to the individual's ability to manage symptoms, treatment, physical and psychosocial consequences and lifestyle changes inherent in living with a chronic condition, to effect the cognitive behavioural and emotional responses necessary to maintain a satisfactory quality of life, so a dynamic and continuous process of self-regulation is established.*

Abbreviations: HF, heart failure; CHF, chronic heart failure; NYHA (1–4), New York Heart Failure classification; LVEF, Left Ventricular Ejection Fraction; QoL, quality of life; MLWHFQ, Minnesota Living With Heart Failure Questionnaire; SF-36/12, Short Form 36/12; 95%CI, 95% confidence interval; RR, relative risk; HR, hazard ratio; IQR, interquartile range; SD, standard deviation; RD, risk difference; NNT, number needed to treat; RRR, relative risk reduction; CABG, Coronary Artery Bypass Grafting; PTCA, percuntaneous coronary angioplasty; PCP, primary care physician; ACE-inhibitor, angiotensine converting enzym-inhibitor.

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In 2008, the Dutch Ministry of Health started a national campaign emphasizing the need of adequate management of chronic diseases using self-management interventions. The Dutch institute for Healthcare Improvement CBO, was asked by the Dutch Ministry of Health to design a program for health care providers and patient organisations with the objective to implement effective self-management interventions for chronic patients. One of the five disorders in this program to be explored is CHF.

The objective of this study was to review randomized controlled trials (RCT) on effectiveness of self-management interventions on mortality, all-cause hospital readmissions, CHF-hospitalization rate and QoL in patients with CHF.

2. Methods

2.1. Study selection

Assisted by an information specialist, the search strategy for the systematic review was conducted in the following electronic databases: MEDLINE, EMBASE, CINAHL and the Cochrane Library from 1996 till April 23th 2009. Keywords used were: ''self-management'', ''disease management'', ''self-care'', ''self-medication'', ''self-monitoring'', ''tele-medicine'', ''tele-monitoring'', ''congestive heart failure'', ''heart failure'', ''cardiac failure''. In all searches a filter was used for systematic reviews and RCTs. Systematic reviews obtained from the search strategy were hand searched. Two reviewers (JD and HB) independently screened titles and abstracts for inclusion. Full text copies of most of the potentially relevant papers were retrieved and checked formally for eligibility (JD and HB). Any disagreement was to be resolved by discussion between the review authors or by consulting the third reviewer (JH) if required. Language restrictions did not apply.

2.2. Eligibility criteria

Studies were eligibile if they were RCTs providing the highest level of evidence in the literature.

Studies had to describe self-management interventions interpreted following the definition of self-management by Barlow et al. [10]. The definition by Barlow is the most extended definition of self-management found, not only because of addressing medical and physical aspects, but also because of the integration of psychosocial aspects and effects on daily life and QoL, therefore being a dynamic and continuous process of self-regulation.

Studies also had to compare effectiveness of self-management interventions (in any format, i.e. written, verbal, visual, audio) with standard care designed for CHF patients implemented by any health professional or lay leader. Self-management interventions could be integrated in a formal HF (disease-management) program.

Included patients of either sex had to be aged 18+ years and diagnosed with CHF, regardless severity of the disease, literacy level or ethnic group.

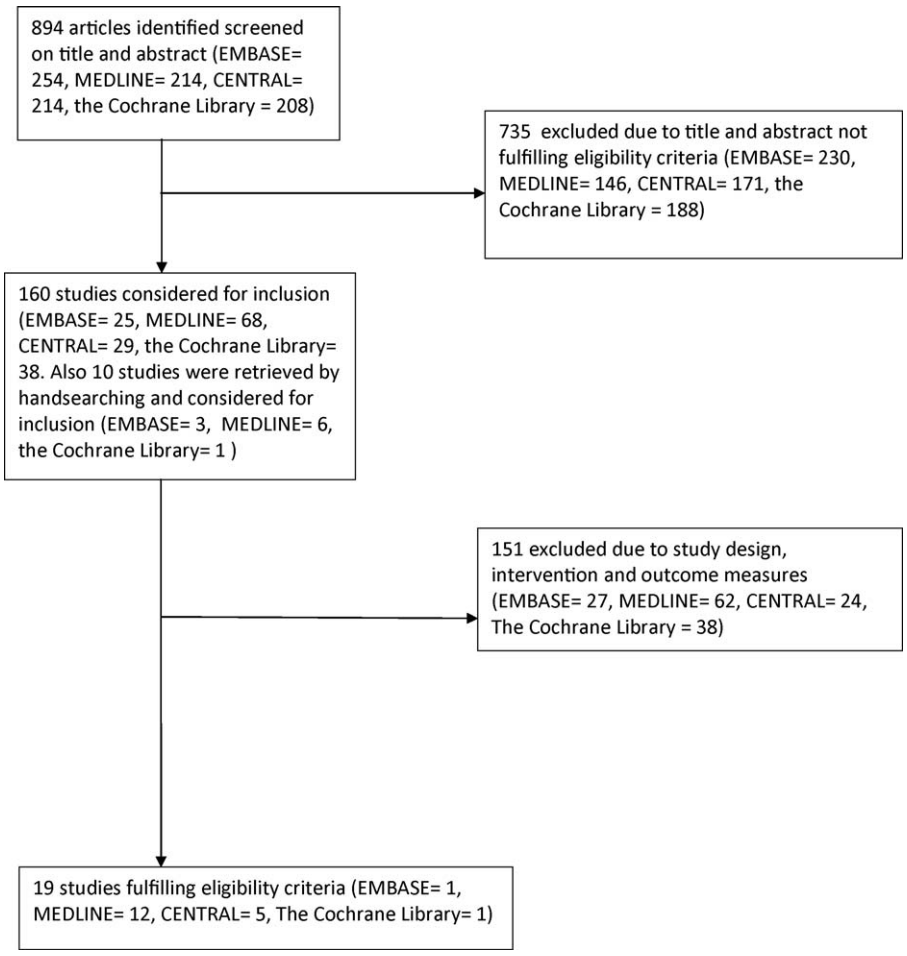

Fig. 1. Study selection flow.

Selected outcome measures were, mortality, all-cause hospital readmissions, CHF-hospitalization rate and QoL. These outcome measures were used as objective parameters (except QoL) to assess the effectiveness of self-management interventions. QoL measurement is important to assess the effect of self-management interventions on the patients well-being.

2.3. Quality assessment

Two reviewers (JD and HB) independently assessed methodological quality of included studies using the Delphi list for RCTs [11]. Items were scored using answers as "yes", "no" or "don't know". Disagreements were to be resolved by discussion. In case of persistent disagreement, JH was to be consulted.

2.4. Data extraction and analysis

From the included studies, data were abstracted on the following items; participants (age, gender, diagnosis, New York Heart Failure (NYHA) class and/or Left Ventricular Ejection Fraction (LVEF), intervention (containing a self-management principle and/or an education component) and outcome measures (mortality, all-cause hospital readmissions, CHF-hospitalization rate and QoL).

Both JD and HB extracted data from the included studies. In case of disagreement the third reviewer was to be consulted. Characteristics of included studies were examined for clinical and statistical heterogeneity. Consequently, a qualitative analysis was conducted linking results on effectiveness of self-management interventions to methodological quality.

3. Results

3.1. Study selection

The initial search generated 1204 citations, after removing double articles, 894 remained. Searching EMBASE, the Cochrane Library, MEDLINE, and CINAHL resulted in 254, 217, 214, 209 citations, respectively. Of these, 160 articles were considered for inclusion (MEDLINE $n = 68$, EMBASE $n = 25$, the Cochrane Library $n = 29$, CINAHL $n = 38$). Hand searched references of identified studies and published systematic reviews yielded 10 more possibly relevant articles.

One hundred and seventy papers were collected. Hundred and fifty-one studies were excluded as they were discussion papers, editorials or otherwise did not meet the eligibility criteria. A reference-list of excluded studies can be requested by the author.

Nineteen studies met the eligibility criteria [4,6,8,9,12–26]. The flow of the inclusion process is shown in Fig. 1. There were no disagreements between reviewers on the selection of studies.

3.2. Quality assessment

An overview of the methodological quality scores concerning the internal and external validity of the included studies by using the Delphi list, is shown in Table 1. In all studies a randomization procedure was performed. Seven studies [14,17–21,22] did not report if and how concealment of allocation was certified, leading to possible selection bias regarding the

Table 1
Methodological quality scores of included studies (Delphi List).

First author (year)	1	2	3	4	5	6	7	8	9
Atienza et al., 2004 [4]	Y	Y	Y	Y	D	N	N	Y	Y
Balk et al., 2008 [12]	Y	Y	Y	N	N	N	N	N	Y
Bruggink-André de la Porte et al., 2007 [13]	Y	Y	Y	Y	Y	N	N	Y	Y
Cline et al., 1998 [8]	Y	Y	N	Y	D	N	N	Y	D
Del Sincado et al., 2007 [14]	Y	D	Y	Y	Y	N	N	Y	Y
DeWalt et al., 2006 [9]	Y	Y	Y	Y	N	N	N	Y	Y
Dunagan et al., 2005 [15]	Y	Y	Y	Y	Y	N	N	Y	Y
Giordano et al., 2009 [16]	Y	Y	Y	Y	D	N	N	Y	Y
Jaarsma et al., 1999 [17]	Y	D	N	Y	D	N	N	Y	D
Jaarsma et al., 2000 [18]	Y	D	Y	Y	D	N	N	Y	N
Krumholz et al., 2002 [19]	Y	D	Y	Y	Y	N	N	Y	Y
Mårtensson et al., 2005 [20]	Y	D	N	Y	D	N	N	N	Y
Nuciforca et al., 2006 [21]	Y	D	N	Y	N	N	N	Y	N
Ramachandran et al., 2007 [6]	Y	Y	Y	Y	D	N	N	Y	D
Riegel et al., 2002 [22]	Y	D	Y	Y	D	N	N	Y	D
Shively et al., 2005 [23]	Y	Y	Y	Y	D	N	N	Y	Y
Tsuyuki et al., 2004 [24]	Y	Y	N	Y	D	N	N	Y	Y
Varma et al., 1999 [25]	Y	Y	N	Y	D	N	N	Y	D
Wakefield et al., 2008 [26]	Y	Y	N	Y	D	N	N	Y	Y

Y = yes, N = no, D = don't know.
(1) Was a method of randomization performed?
Yes, No, Don't know
(2) Was the treatment allocation concealed?
Yes, No, Don't know
(3) Were the groups similar at baseline regarding the most important prognostic indicators?
Yes, No, Don't know
(4) Were eligibility criteria specified?
Yes, No, Don't know
(5) Was the outcome assessor blinded?
Yes, No, Don't know
(6) Was the care provider blinded?
Yes, No, Don't know
(7) Was the patient blinded?
Yes, No, Don't know
(8) Were point estimates and measures of variability presented for the primary outcome measures?
Yes, No, Don't know
(9) Did the analysis include an intention-to-treat analysis?
Yes, No, Don't know

Table 2
Characteristics of included studies (ranked in alphabetical order).

First author, year	Study design	Study details	Baseline participants characteristics	Intervention and control	Notes
Atienza et al., 2004 [4]	Multicenter randomized trial	**Intervention:** 3 phased intervention program. *Phase 2*: 2 weeks after discharge 1 visit by primary care physician. *Phase 3*: regular follow up visits every 3 months- outpatient HF clinic. Tele-monitoring: 24 h contact number (from discharge till end of follow up) **Inclusion:** Diagnose Congestive HF (presence of symptoms, signs + cardiac dysfunction at rest) **Exclusion:** Dementia, psychiatric illness, survival expectation less than 3 months, discharge to long-term care facility.	Total $n = 338$ Intervention $n = 164$ Control $n = 174$ **Intervention:** Median age (IQR), years = 69(61–74) Males, $n = 101$(62%), NYHA(%), 1/2/3/4 = 11/39/40/10, Median LVEF (IQR), %* = 36(30–53) **Control:** Median age(IQR), years = 67(58–74), Males, $n = 102$(59%), NYHA(%), 1/2/3/4 = 10/40/40/10, Median LVEF (IQR), %* = 40(30–55) *Data available for $n = 308$(91%)	**Intervention:** *Phase 1:* In hospital education – (recognition deteriorated signs of HF, self-monitoring vital signs, life style advice, treatment compliance). Individualized strategies to manage health problems (diuretic self-adjustment) *Phase 2:* Visit primary care physician-monitor clinical progress+ reinforce educational knowledge. *Phase 3:* Follow-up visits in outpatient HF clinic to reinforce knowledge and to increase the patient's ability to manage health problems. Tele-monitoring phase. (questions patient) **Control**: Routine discharge planning	
Balk et al., 2008 [12]	Randomized parallel group trial	SF-36/MLWHFQ measured baseline and every 4 months. **Inclusion:** Diagnose chronic HF(stable condition) NYHA class 1–4, received care in one of 8 Dutch hospitals(by cardiologist-HF nurse) **Exclusion:** Unknown.	Total $n = 214$ Intervention $n = 101$ Control $n = 113$ **Intervention**: Age, median (range) 68 (33–85), Female $n = 36$ (36%), LVEF (%, mean, range) = 31(9–69), LVEF <25%(n, %) = 24(31%) NYHA (n) 1 = 6(6%), 2 = 43(41%), 3 = 50(48%), 4 = 2(2%) **Control:** Age(median, range) 65(42–87), Female $n = 28$ (25%), LVEF (%, mean, range) = 31(11–71), LVEF<25%(n, %)= 27 (31%) NYHA (n) 1 = 8(7%), 2 = 44(38%), 3 = 56(48%), 4 = 3(3%)	**Intervention:** MOTIVA system (TV channel providing education, drug reminders, health related surveys, motivation messages) Nurse-led data monitoring. **Control**: Care as usual.	No power analysis was performed. 89% of the total population suffered from LV systolic dysfunction (selected group) Before enrolment both groups were already seen by HF nurses. Results may underestimated.
Bruggink-André de la Porte et al., 2007 [13]	Parallelgroup randomized controlled trial	**Intervention:** 9 scheduled patient contacts—at day 3 by telephone, and at weeks 1, 3, 5, 7 and at months 3, 6, 9 and 12 by visit at HF outpatient visit clinic. **Inclusion:** Hospitalised/visiting cardiology outpatient clinic. Diagnose HF (based on LVEF ≤45%, clinical signs/symptoms) **Exclusion:** Dementia, psychiatric illness, stay/ discharge long-term care facility, other diseases than HF, expected survival <1 year.	Total $n = 240$ Intervention $n = 118$ Control $n = 122$ **Intervention:** Mean(SD) age, y: 70(10), Male $n = 78$(66%) NYHA 3 = 98%, 4 = 2%. Mean LVEF = 31%. **Control:** Mean(SD) age, y: 71(10), Male $n = 96$(79%) NYHA 3 = 95%, 4 = 5%. Mean LVEF = 31%.	**Intervention:** In addition to usual care, intensive follow up HF outpatient clinic (HF physician, cardiovascular nurse) Verbal/written comprehensive education (dietary restrictions, lifestyle), optimise treatment, easy access to clinic, advice (exercise and rest+ symptom monitoring and self-care). Patient diary was given and a patient visit to dietician. Physician and nurse made treatment plan. Follow up: Reinforce education, physical control. **Control:** Care as usual.	No loss to follow up.

Cline et al., 1998 [8]	Randomized trial	**Intervention:** Education: 2 times 30 min. nurse-led in hospital visits 1 h home info visit 2 weeks after discharge. Follow up at nurse directed outpatient clinic. Prescheduled visit by nurse 8 months after discharge. Possible outpatient visits (doctor): in month 1, 4 after discharge. **Inclusion:** Diagnose HF (based clinical signs (+1 objective sign present on admission/symptoms) **Exclusion:** Drug/alcohol abuse, psychiatric illness, participation other clinical trial, inability to answer questionnaire.	Total $n = 190$ Intervention $n = 80$ Control $n = 110$ **Intervention:** Mean (SD) age (years) = 75.1 (5.1), Male $n = 44$ (55.0%), Mean (SD) LVEF(%) 31.6(8.4), Mean (SD) NYHA = 2.6(0.7) **Control:** Mean (SD) age (years) = 76.0 (5.3), Male $n = 57$ (51.8%), Mean (SD) LVEF(%) 35.7(12.3), Mean (SD) NYHA = 2.6(0.7)	**Intervention:** Education program (HF, (non) and pharmacological treatment). Self-management guidelines of diuretics (deteriorated signs HF- registration patient diary) Nurse led in hospital group education to reinforce information. Telephonic contact available. **Control:** Care as usual.	Baseline LVEF fraction significant worse in intervention-group compared to control-group, despite adequate randomization procedure. This might lead to underestimation of the effects.
Del Sincado et al., 2007 [14]	Randomized controlled trial	**Intervention:** Follow-up HF hospital clinic visits (7–14 days after discharge, at 1, 3 and each 6 months thereafter, periodical nurse's phone calls and home or office primary physician visits. Contact number available 6 h/day for questions. **Control**: Phone calls (every 6 months) **Inclusion:** Diagnose HF (European Society of Cardiology guideline) Age: $\geq$ 70 years, discharged to home after HF hospitalisation (NYHA 3–4). **Exclusion:** Psychiatric illness, dementia, noncardiac illness, reduced life expectancy, living in nursing-home/long term care facility.	Total $n = 173$ Intervention $n = 86$ Control $n = 87$ **Intervention**: Age, Mean $\pm$ SD,y 77.4 $\pm$ 5.9, Male no.(%) = 44(51.2), Mean LVEF (%) = 33.5 $\pm$ 11 NYHA (n, %) 2 = 32(37.2%), 3 = 44(51.2%), 4 = 10(11.6%) MLWHFQ tot. score = 39.5 $\pm$ 18 **Control** = Age, Mean $\pm$ SD, y 77.5$\pm$5.7, Male no.(%) = 46(52.8), Mean LVEF (%) = 32.5 $\pm$ 10 NYHA (n, %) 2 = 34(39.1%), 3 = 49(56.3%), 4 = 4(4.6%) MLWHFQ tot. score = 35.2 $\pm$ 20	**Intervention:** **DMP** (discharge planning, continuing education, therapy optimisation, improved communication healthcare providers, patients early attention of signs and symptoms, flexible diuretic regimen. Educational booklet. **Control**: Care as usual.	Inclusion: age 70 years or more. Generalization of results impaired (specialised HF clinic)
DeWalt et al., 2006 [9]	Randomized controlled trial	**Intervention:** Scheduled follow-up phone calls (days 3, 7, 14, 21, 28, 56) and monthly during months 3–6 (5–15 min). **Inclusion:** Clinical diagnose HF confirmed by LVEF <40%, chest X-ray findings. NYHA 3–4. Age 30–80. **Exclusion:** Dementia, terminal illness (less than 6 months), on dialysis, undergo cardiac surgery (or awaiting for heart transplantation)	Total $n = 123$ Intervention $n = 59$ Control $n = 64$ **Intervention:** Mean (SD) age, years = 63(9) Male % = 58, NYHA(%), 2/3/4 = 53/40/7, HFQL score, mean score (range 0–105) = 45 **Control:** Mean (SD) age, years = 62(11) Male % = 41, NYHA(%), 2/3/4 = 47/51/2, HFQL score, mean score (range 0–105) = 57	**Intervention:** Education session (1h) at clinical visit- recognition deterioration signs/symptoms) patient receive educational booklet (low literacy) and digital scale. Patient management plan; to better manage weight fluctuations and advice to self-adjust diuretic dose. Telephone calls: reinforce education and answer questions. **Control:** care as usual (primary physician and education pamphlet).	Power not optimal- lack of included patients: funding ended. Significant baseline difference results adjusted by multivariate analyses, variables: age, gender, race, co-morbidity, medication, and presence of systolic dysfunction.

Table 2 (*Continued*)

First author, year	Study design	Study details	Baseline participants characteristics	Intervention and control	Notes
Dunagan et al., 2005 [15]	Randomized trial	**Intervention:** Patients were called within 3 days after hospital discharge or program enrolment and then at least weekly for 2 weeks. **Inclusion:** Age ≥ 21 years, NYHA 2,3,4. Access primary care. Signs, symptoms of HF exacerbation, evidence of left ventricular sys/diastolic dysfunction. **Exclusion:** Predominantly right ventricular failure (chronic lung disease, pulmonary hypertension), chronic renal failure, survival less 6 months, heart transplant candidacy, cognitive/psychological impairment, discharge long term care facility.	Total *n* = 151 Intervention *n* = 76 Control *n* = 75 **Intervention:** Mean (SD) age (years) 70.5 ± (12.7), Female n (%) = 45 (59%), LVEF <25% = 29 (38%) 25–40% = 27 (36%) 41–50% = 6 (8%) >50% = 14 (18%) NYHA 2(%) = 17(22%) 3(%) = 54(71%) 4(%) = 5(7%) **Control:** Mean (SD) age (years) 69.4 ± (13.9), Female n (%) = 40 (53%), LVEF <25% = 36 (48%) 25–40% = 23 (31%) 41–50% = 5 (7%) >50% = 11 (15%) NYHA 2(%) = 13(17%) 3(%) = 54(72%) 4(%) = 8 (11%)	**Intervention:** Educational packet (HF, treatment, patient role in care and monitoring condition, strategies to manage exacerbation of HF). Nurse-led additional education (phone calls)-self-management skills, treatment adherence, dietary restrictions, assessment by nurse on potential HF exacerbations (if so nurse advised diuretics or contacted physician). Telephone-contact possible for questions patient. **Control:** Educational packet (HF, treatment, patient-role in care and monitoring, strategies to manage exacerbation of HF)	Multivariable analyses controlled for severe impaired LVEF, NYHA class, ACE inhibitor, did not significantly alter estimates of treatment effects.
Giordiano et al., 2009 [16]	Multicenter randomized trial	**Intervention:** Cardiologist supervised: weekly calls. **Control:** Visit to PCP within 2 weeks after discharge+ structured follow-up (by cardiologist) at 12 mth in the hospital outpatient department. **Inclusion:** Confirmed diagnose CHF, LVEF <40%, at least 1 hospitalisation for acute HF in previous year, clinical stable (optimized oral therapy. **Exclusion:** Noncardiac debilitating illness, planned coronary revascularization, heart transplantation, cognitive impairment.	Total *n* = 460 Intervention (HBT) *n* = 230 Control *n* = 230 **Intervention:** Age (Mean ± SD) 58 ± 10, >65 years, *n* = 9(73%) Female = 16% NYHA 2 *n* = 124(54%) NYHA 3/4 *n* = 106(46%) Mean LVEF (%) = 28 ± 7 **Control:** Age (Mean ± SD) 56 ± 10,> 65 years, *n* = 189(82%) Female = 14% NYHA 2 *n* = 150(65%) NYHA 3/4 *n* = 80(35%) Mean LVEF (%) = 26 ± 8	**Intervention:** HBT (telephone device-care available 24/7): Nurse scheduled appointments; assess patients knowledge on (dietary restrictions, self-measurement on physical variables) Reinforce education and compliance. Tele-assistance: Patient called nurse (decompensation signs and symptoms of HF). **Control:** All patients discharge education. (HF- advice on daily self measurements on physical variables, dietary restrictions, signs and symptoms HF decompensation)	Limitation generalisation of results: CHF patients discharged from settings with comprehensive HF programs. Multivariable analyses performed to adjust for baseline differences: Use of digitalis and beta blockers.
Jaarsma et al., 1999 [17]	Randomized trial	**Intervention**: Lasted from hospital admission till 10 days after discharge from hospital. **Inclusion:** Diagnose HF (Boston scoring system), NYHA 3,4, at least 3 months HF diagnose, Age ≥ 50 years. **Exclusion:** Suffer from coexisting chronic debilitating disease, discharged to nursing home, psychiatric diagnoses, had a CABG, PTCA or have one in the future.	Total *n* = 179 Intervention *n* = 84 Control *n* = 95 **Intervention:** Mean (SD) age (years) 73 (9), Male *n* = 47 (56%), Mean (SD) LVEF(%) 34.3(12), NYHA 3/3,4/4 (%) =12(14), 13(16), 59(70). **Control:** Mean (SD) age (years) 73 (9), Male *n* = 56 (59%), Mean (SD) LVEF(%) 34.5(14), NYHA 3/3,4/4 (%) =19(20), 24(26), 51(54).	**Intervention:** Once in hospital education by study nurse (HF, dietary restrictions and compliance) Patient received a warning symptom card. Telephonic contact (1 week after discharge) assess possible problems. Home visit (nurse) Reinforce personalised education. Advice to call GP, cardiologist, ER heart centre if problems occur. **Control:** Care as usual.	A trend towards increased severity of symptoms (NYHA 4) at baseline in the intervention group was reported, therefore possible underestimation of the effect.

Jaarsma et al., 2000 [18]	Randomized trial	**Intervention:** Patients received an average of 4 hospital visits, 1 telephone call, and 1 home visit. **Inclusion:** Diagnose HF (Boston scoring system), NYHA 3,4, at least 3 months HF diagnose, Age $\geq$ 50 years. **Exclusion:** Suffer from co-existing chronic debilitating disease, discharged to nursing home, psychiatric diagnoses, had a CABG, PTCA or have one in the future.	Total $n = 132$ Intervention $n = 58$ Control $n = 74$ **Intervention:** Age (Mean $\pm$ SD) 72 ± 9, Male $n = 32(55\%)$ NYHA 3, 3/4, 4, $n = 7(12\%)$, 12(21%), 39(67%) LVEF (%) (Mean $\pm$ SD) 36 ± 13. **Control:** Age (Mean $\pm$ SD) 72 ± 10, Male $n = 47(64\%)$. NYHA 3, 3/4, 4, $n = 15(20\%)$, 17(20%), 42(52%) LVEF (%) (Mean $\pm$ SD) 34 ± 14.	**Intervention:** Systematic planned education by a study nurse (HF, recognition of symptom decompensation, dietary restrictions, compliance) 1 wk after discharge; telephone call to assess possible problems. During the home visit the nurse reinforced personalised education. **Control:** Care as usual.	A per-protocol analysis was performed on functional capabilities and psychosocial adjustment. Higher drop out rates in the intervention-group(NS) (older, more severly ill, died earlier state of the study compared to control-group).
Krumholz et al., 2002 [19]	Randomized trial	**Intervention:** Phase 2: first 4 weeks once, next 8 weeks once every 2 weeks, once a month for 1 year follow up. **Inclusion:** Age$\geq$ 50 years, HF admission diagnose or radiologic signs of HF. **Exclusion:** Patients transformed other hospitals, patients from nursing home, terminal illness in addition of HF with less 6 month expected survival.	Total $n = 88$ Intervention $n = 44$ Control $n = 44$ **Intervention:** Age = 75.9 ± 8.7, LVEF(%) = 38 ± 17, Male gender=21(48) **Control:** Age = 71.6 ± 10.3, LVEF(%) = 37 ± 16, Male gender = 29(66)	**Intervention:** 2 phases intervention. Phase 1: provide education about disorder, symptom/decompensation, medication treatment, healthy behaviour according to disorder, treatment of disorder. Initial phase: 30 min. in hospital education 2 weeks after discharge by cardiac nurse. Phase 2: Telephonic contact with nurse, to empower education. Patient experienced deterioration of HF, nurse helps patient how and when to seek and access care. **Control:** Care as usual.	Correction was performed for baseline differences on calcium channel blockers, betablockers at discharge or presence of coronary artery disease. The hazard estimates did not significantly change.
Mårtensson et al., 2005 [20]	Cluster-randomized design	Eligible study patients recruited through Diagnoses Related Groups(DRG) registry available in 8 primary health care centres. (Sweden) Cluster-randomization was performed on the basis of primary health care settings. **Inclusion:** Diagnose HF(based on echocardiography, signs/ symptoms of HF, Age > 18 years, NYHA class 2,3,4. **Exclusion:** Psychiatric disease, suffer life threatening disease, follow up at hospital HF clinic, inability to speak Swedish.	Total $n = 153$ Intervention $n = 78$ Control $n = 75$ **Intervention:** Age (Mean $\pm$ SD) 79 ± 7, Female $n = 36(46\%)$ NYHA 2/3/4(%)= 30(38), 40(51), 8(10) **Control:** Age (Mean $\pm$ SD) 79 ± 7, Female $n = 34(45\%)$ NYHA 2/3/4(%)= 33(44), 41(55), 1(1)	**Intervention:** Education session 3 times(3 h each): HF, treatment and evaluation of HF, non pharmacological treatment(self-management regarding lifestyle and regulation of symptoms). Education session (2 h) given by a nurse at home to empower the other education sessions. Telephone follow up (coaching, support self-management) in the months 1–2, 4 till 11 (month 3–12 questionnaires). **Control:** According to the characteristics of primary care in Sweden.	Results: Only p values are defined. The significant effect seen at 3 months in the intervention-group compared to control-group could be underestimated. Baseline characteristics at role functioning due to physical and emotional limitations and social functioning were significant better for the control-group (an effect over time on deterioration).

Table 2 (*Continued*)

First author, year	Study design	Study details	Baseline participants characteristics	Intervention and control	Notes
Nuciforca et al., 2006 [21]	Preliminary randomized trial	Patients recruitment: tertiary hospital (part of university medical centre) **Inclusion:** Age: ≤85 year, diagnose: congestive HF (confirmed by Framingham criteria) **Exclusion**: Chronic corpulmonale, terminal illness in addition to HF, dementia, psychiatric illness, indication for surgical therapy in next 6 months.	Total *n* = 200 Intervention *n* = 99 Control *n* = 101 **Intervention:** Age (Mean ± SD) 73 ± 9, Male *n* = 61(62%) NYHA 1/2/3/4= 0,33(33%),63(64%),3(3%) LVEF>45% = 32(42%) LVEF<45%=44(58%) **Control:** Age(Mean ± SD) 73 ± 8, Male *n* = 62(62%) NYHA 1/2/3/4= 2(2%),37(37%),61(61%), 1(1%) LVEF>45% = 29(40%) LVEF<45%=43(60%)	**Intervention:** 1. Pre-discharge education (30 min) Causes HF and treatment of HF, recognition symptoms/signs deteriorated HF, treatment adherence, weight control, lifestyle using teaching booklet. 2. Telephone contact 3–5 days after discharge: reinforce education, treatment adherence, promote self-management. 3. Outpatient visits by internal medicine doctors planned at 15 days, 1 and 6 months after discharge: assess clinical progress since discharge and patient's adherence to prescribed therapeutic regimen. **Control:** Care as usual	A per protocol analysis was performed (loss to follow up not described, short follow up period). May lead to overestimation of effects.
Ramachandran et al., 2007 [6]	Randomized clinical trial	Patient recruitment: Heart failure Institute India. **Inclusion:** Age: 16–65 years. Symptoms/signs of CHF, LVEF score < 40% based on echocardiography, treated in outpatient centre. **Exclusion:** Dementia, psychiatric illness, renal failure, presence of valvular heart disease, hypertrophic obstructive cardiomyopathy. Patients on transplant list only included if they stabilized enough to receive outpatient care.	Total *n* = 50 Intervention *n* = 25 Control *n* = 25 **Intervention:** Mean (SD) age, years = 43.4(11.5), Women, *n* (%) = 5 (20%) NYHA *n* (%)1,2/3/4 = 19(76)/4(16)/2(8), LVEF Mean (SD) = 21.2(7.5) Echocardiography 1–10% 2(8%) 11–20% 13(52%) 21–30% 8(32%) 31–40% 2(8%) **Control:** Mean (SD) age, years = 45.8(12.5), Women, *n*(%) = 6 (24%) NYHA *n* (%) 1,2/3/4 = 18(72)/3(12)/4(16), LVEF Mean (SD) = 22.4(7) Echocardiography 1–10% 0 11–20% 11(48%) 21–30% 10(40%) 31–40% 3(12%)	**Intervention:** Education/counselling (patients/family) Information (HF, signs and symptoms, medications, patient role in management of the disease- daily weight, lifestyle advice, dietary restrictions, drug treatment (education about flexible diuretic regimen.) Intensive monitoring: Once weekly phone calls Telephone helpline. **Control:** Care as usual (heart failure clinic, seen on a monthly or SOS basis. Cardiologist gave also principles of self-management based on own judgement)	Generalisation impaired due to Indian population. Control patients received self- management interventions (not structured). Results might underestimated.
Riegel et al., 2002 [22]	Randomized controlled trial	**Intervention:** Frequency of telephone calls was based on patient personal situation (average of 17 phone calls during 6 month follow up). **Inclusion:** Confirmed HF clinical diagnose as primary reason admission. English/Spanish speaking. **Exclusion:** Cognitive impairment, psychiatric illness, renal failure (dialysis) terminal disease, discharge to long term care facility, previous enrolment in HF disease management program.	Total *n* = 358 Intervention *n* = 130 Control *n* = 228 **Intervention:** Age(Mean ± SD) 72.52 ± 13.05, Female n(%) = 60(46.2) NYHA(%) 2/3/4= 2.3/35.9/61.7 EF, Mean ± SD, %(*n* = 204)= 41.91 ± 17.01 **Control:** Age (Mean ± SD) 74.63 ± 12, Female (%) = 123(53.9) NYHA(%) 2/3/4= 3.6/38.4/58.0 EF, Mean ± SD, %(*n* = 204)= 43.21 ± 19.07	**Intervention:** Telephone management (nurse) 5 days after discharge (software programme used to empower knowledge HF, lifestyle factors, treatment adherence, dietary regime). Education material on mail, monthly. Case managers managed care around the patient (contact with several health professionals, gave information to patient, contact with family). **Control:** Care as usual.	Analyses were conducted to adjust for beta blocker use and chronic lung disease.

Shively et al., 2005 [23]	Randomized controlled trial	Measurements: baseline, 4, 10, 16 months **Inclusion:** Age: ≥18 years, access to primary care provider, stable HF symptoms (at least 1 month), be able to walk. **Exclusion:** Unstable angina, myocardial infarction or cardiac surgery within 3 past months, major surgery within 3 last months, life expectancy less 2 years, acute psychiatric problems.	Total $n = 116$ Intervention $n = 58$ Control $n = 58$ **Intervention:** Age, Mean ± SD = 65.8 ± 10.74 Male sex No. (%) = 55(94.8) NYHA class at discharge(n, %) I = 21(36.2) II = 29(50.0 III = 8(13.8 IV = 0 (0) Mean LVEF (%) = 43.2 ± 16.16 ($n = 36$) **Control:** Age, Mean ± SD = 69.0 ± 9.09 Male sex No. (%) = 55(94.8) NYHA class at discharge (n, %) I = 22(37.9) II = 26(44.8) III = 10(17.2) IV = 0(0) Mean LVEF (SD) = 40.3 ± 15.88 ($n = 36$)	**Intervention:** Usual care and a 4 month behavioural management program (four classes and three phone calls, classes were 2 h in length.) Focus: goal setting and individualized health life-style changes. Cognitive and behavioural skills to manage symptoms and change health behaviours. Self-monitoring techniques +positive verbal feedback. **Control**: Informal teaching about HF and treatment. Clinic visits every 3 months.	
Tsuyuki et al., 2004 [24]	Randomized trial	**Intervention:** Telephone contact: 2 weeks, 4 weeks, then monthly thereafter for 6 months after discharge. **Inclusion:** Age > 18 years, admission on hospital (primary, secondary, complicating diagnose of HF) **Exclusion:** Secondary causes of HF, preserved systolic dysfunction, cognitive impairment, intolerance or contraindication to ACE inhibitors, terminal illness (less 6 months), Stage 2: Contra-indication ACE inhibitors, patients not responsible administration of own medication.	Baseline Stage 1 $n = 766$. Stage 2= Intervention $n = 140$ Control $n = 136$ Stage 2: **Intervention**: Mean (SD) age, years = 71(12), Males, n (%) = 81(58), NYHA(%) 1/2/3/4= 12/48/35/5, LVEF %(± SD) = 32 ± 12 **Control:** Mean (SD) age, years = 72(12), Males, n (%) = 79(58), NYHA(%) 1/2/3/4= 14/52/30/3, LVEF %(± SD) = 31 ± 11	**Intervention:** Stage 1:Optimized pharmalogical treatment (In hospital) Stage 2: Patient Support program: education (dietary restrictions, daily weighing, exercise advice, medication use, and knowing when to call their physician (early recognition of worsening symptoms). Medication resources were provided. Telephone contact (research coordinator) to reinforce education and self-care and assessment of medical information. **Control:** Stage 1:Optimized pharmacological treatment (in hospital) Care as usual (primary physician and education pamphlet). Monthly telephone contact (6 months)	Baseline stage 2 Ischemic aetiology significant worse in intervention group despite adequate randomization procedure ($P = 0.03$) Therefore results on outcome measures might be overestimated.
Varma et al., 1999 [25]	Randomized controlled trial	Multicenter trial in Nothern Ireland. **Inclusion**: Age ≤65 years, confirmed HF diagnose, cognitive status score above 6(Clifton Assessments Procedures for the Elderly (CAPE) survey. **Exclusion:** Suffered from pulmonary disease, severe mobility problems (osteoarthritis)	Total $n = 83$ Intervention A $n = 42$ Control B $n = 41$ **Intervention:** Mean Age (years) 75.50 ± 6.44. Male/Female = 19/23. Mean NYHA class: 2.12 ± 0.9. **Control:** Mean Age (years) 76.36 ± 7.12. Male/Female = 15/26. Mean NYHA class: 2.21 ± 0.9.	**Intervention group A:** Structured education (HF, management of symptoms and medication) by research pharmacist. Teaching booklet was given. Also information on missed medication doses was given. Self-monitoring programme: Signs and symptoms of HF, compliance with medication. Patients filled in diary cards (daily weight). Instruction was given if weight increased by half a stone (7 lbs) in 48 ours, of symptoms of HF deteriorated, patients could take diuretics by themselves and contact the physician. Also advice for daily exercise was given. **Control group B:** Care as usual. **Both groups:** Outpatient hospital clinic visits (3 months interval)	Generalization of results impaired, inclusion of patients ≥65 years. Minimization randomization procedure is performed. Baseline intervention-group had a tendency towards better health compared to control group (2 min walk test, mean MLWHFQ (significant difference:SF-36 physical function domain and drug knowledge score), therefore results might be overestimated.

Table 2 (*Continued*)

First author, year	Study design	Study details	Baseline participants characteristics	Intervention and control	Notes
Wakefield et al., 2008 [26]	Randomized trial	Intervention patients were contacted three times in week 1 after discharge, and then weekly for 11 weeks (14 contacts over 3 months) 3 months intervention **Inclusion:** Exacerbation of HF as reason for admission. Absence of impaired vision, hearing, telephone line, English speaking. **Exclusion:** Cognitive impaired, living in or were discharged at long term care facility.	Total $n=148$ Control $n=49$ Telephone $n=47$ Videophone $n=52$ **Control** = Age (Mean, SD) = 67.2 (8.5) Males (%, n) = 98(48), LVEF(mean, range) 43%(12–81%) ≥41% = 40.4% ($n=23$) 26–40% = 31.9% ($n=15$) ≥ 25% = 19.2% ($n=9$) Admission NYHA class (%, n): 1 = 0, 2 = 35% (17), 3 = 59% (29) 4 = 6% (3) **Telephone** = Age (Mean, SD) = 1.8(10.2) Males(%, n) = 100(47) LVEF (mean, range) 43.5%(13–75%) ≥41% = 52.2% ($n=24$) 26–40% = 30.4% ($n=14$) ≥25% = 17.4% ($n=8$) Admission NYHA class (%, n): 1 = 0, 2 = 30%(14), 3 = 64% (30), 4 = 6% (3) **Videophone** = Age (Mean, SD) = 69.0(9.6) Males (%, n) = 98(51) LVEF (mean, range) 38%(6–73), ≥41% = 36.5% ($n=19$) 26–40% = 32.7% ($n=17$)≥ 25% = 30.8%($n=16$) Admission NYHA class (%, n): 1 = 0, 2 = 21%(11) 3 = 71%(37), 4 = 8%(4)	**Usual care:** Usual discharge teaching and contact to primary care nurse case manager if needed. **Telephone and Videophone:** Usual discharge teaching and patients received a symptom review checklist to report HF-related symptoms, a scale, blood pressure cuff, and tape measure to measure daily weights, blood-pressure and ankle circumference to monitor fluid accumulation. Behavioural skill training strategies to empower several self-management strategies(improve compliance). During all intervention contacts, study nurses assessed subjects using the symptom review checklist. **Telephone:** All contacts were conducted using personal telephone. **Videophone:** Videophone group used a system that consisted of a television monitor and a camera kit with a microphone and video camera.	Patients in video-group were more severely ill compared to control- and telephone group. Therefore results in the video-group could be underestimated.

Table 3
Effectiveness of self-management interventions in reducing mortality in patients with chronic heart failure.

First author, year	Total number of subjects (*N*)	*N* = Intervention (I) and Control-group (C)	Follow-up period (days)	Outcome mortality					*p*-Value
Atienza et al., 2004 [4]	*N* = 338	(I) *N* = 164 (C) *N* = 174	365	**Mortality (rate of deaths per observation year)** **C(51/174)** 0.24	**I(30/164)** 0.14	Difference 0.10	(95% CI) 0.02–0.18		0.006
Bruggink-Andre de la Porte et al., 2007 [13]	*N* = 240	(I) *N* = 118 (C) *N* = 122	365	**Mortality**: I 12 (10.8 per 100 pat. years) C 23 (20.6 per 100 pat. years) RR 0.52, 95% CI 0.26–1.05 RD(NNT) = 0.098(10)					NS
Cline et al., 1998 [8]	*N* = 190	(I) *N* = 80 (C) *N* = 110	365	**Mortality**: No difference between the groups (I; 24 (30%) vs. C; 31 (28%))					
Del Sincado et al., 2007 [14]	*N* = 173	(I) *N* = 86 (C) *N* = 87	730	**Mortality**: *N* (%)	C 32(36.8)	I 27(31.4)	RRR 0.146	95% CI −0.295 to 0.437	NS
Dunagan et al., 2005 [15]	*N* = 151	(I) *N* = 76 (C) *N* = 75	365	**Mortality**: 6 months: *N* (%) 12 months: *N* (%)	C 5 (7) 11 (15)	I 6 (8) 13 (17)	HR (95% CI) 1.17 (0.36–3.84) 1.15 (0.52–2.58)		0.79 0.73
Giordiano et al., 2009 [16]	*N* = 460	(I) (HBT) *N* = 230 (C) *N* = 230	365	**Mortality**: One-year total mortality was 9% HBT group vs. 14% in UC group					
Krumholz et al., 2002 [19]	*N* = 88	(I) *N* = 44 (C) *N* = 44	365	**Mortality**: *N* (%)	C 13 (29.5)	I 9 (20.4)	RR (95% CI) 0.69 (0.33–1.45)		0.33
Nuciforca et al., 2006 [21]	*N* = 200	(I) *N* = 99 (C) *N* = 101	183	**Mortality**: No. of deaths	C 8 (8%)	I 14 (14%			NS
Wakefield et al., 2008 [26]	*N* = 148	(I) Telephone *N* = 47 (I) Videophone *N* = 52 (C) *N* = 49	365	**Mortality**: No statistically significant difference between groups on mortality rates at 12 months Cox proportional hazards model (age, mean LVEF, NYHA) comparing usual care with the combined intervention-group, not significant for mortality at 12 months (HR 1.04; 95% CI 0.49–2.24)					0.91

recruitment of patients. In seven [8,17,20,21,24–26] studies both the control-group as well as the intervention-group were not similar at baseline regarding the most important prognostic indicators, despite an adequate randomization procedure. No statistical analysis was described in these studies to adjust for the unequal distribution. As a result, effects can be under- or overestimated or falsely show no difference. In three studies [9,12,21] blinding of the outcome assessor was not performed and in 12 studies [4,6,8,16–18,20,22–26] this procedure was not clearly described. For this reason it is imaginable that the results found regarding the outcome measures can be influenced due to detection bias, resulting in a possible overestimation of the effects found in the intervention-group. Two included studies performed a per protocol analysis instead of an intention to treat analysis [18,21]. This can lead to overestimated results, because the analysis is performed without accounting for selective loss to follow-up patients.

3.3. Data extraction and analysis

In all studies, the main component of self-management interventions consisted of education. Patients were particularly educated about early recognition of signs and symptoms due to HF, the importance of pharmacological treatment adherence, daily weighing and changing lifestyle.

In 16 studies, patients were specifically emphasized to self-monitor their physical condition, supported by education, self-monitoring programmes, patient diary cards or devices [4,6,8,9,12–16,20–26]. In 7 studies, patient were also given the opportunity to self-adjust diuretics, when weight increased [4,6,8,9,14,20,25].

The intervention used by Shively et al. [23] delivered besides education, a behavioural management program focussed on goal setting and problem solving.

Delivery of self-management interventions was provided by health care professionals active in primary or secondary health care.

Table 4
Effectiveness of self-management interventions in reducing all-cause hospital readmissions in patients with chronic heart failure.

First author, year	Total number of subjects (*N*)	*N* = Intervention-group (I) and Control-group (C)	Follow-up period (days)	Outcome all-cause hospital readmissions				*p*-Value
Atienza et al., 2004 [4]	*N* = 338	(I) *N* = 164 (C) *N* = 174	365	**All-cause hospital readmissions: (rate of readmitted patients per observation year)**:				
				C	I	Difference	95% CI	
				0.47	0.31	0.16	0.04–0.028	0.004
Cline et al., 1998 [8]	*N* = 190	(I) *N* = 80 (C) *N* = 110	365	**All-cause hospital readmissions (in survivors at one year)**:				
					C (*n* = 79)	I (*n* = 56)	Difference (%)	
				N (%)	43 (54)	22 (39)	−15	0.08
Giordiano et al., 2009 [16]	*N* = 460	(I) (HBT) *N* = 230 (C) *N* = 230	365	**All-cause hospital readmissions**: I *n* = 67 patients C *n* = 96 patients (RR = 0.57, 95% CI: 0.39–0.84) Multivariate analysis (use of digitalise and beta-blockers): (HR = 0.50, 95% CI: 0.34–0.73) (NNT of 4 95% CI: 3–9)				0.03 0.0001
Jaarsma et al., 1999 [17]	*N* = 179	(I) *N* = 84 (C) *N* = 95	274	**All-cause hospital readmissions**:				
					C, No. (%)	I, No. (%)		
				Patients readmitted				
				Within 1 month	14 (15%)	11 (13%)		
				Within 3 months	29 (31%)	22 (26%)		
				Within 9 months	47 (50%)	31 (37%)	Chi-square = 2.8	0.061
Nuciforca et al., 2006 [21]	*N* = 200	(I) *N* = 99 (C) *N* = 101	183	**All-cause hospital readmissions**:				
					I	C		
				No. readm. pat.				NS
				0 time	51 (52%)	58 (57%)		
				1 time	32 (32%)	25 (25%)		
				≥2 times	16 (16%)	18 (18%)		
Riegel et al., 2002 [22]	*N* = 358	(I) *N* = 130 (C) *N* = 228	183	**All-cause hospital readmissions (% of patients readmitted at least once)**				
					I	C	% change	
				3 m:	33.8	41.2	−18	U: 0.17; A: 0.40
				6 m:	43.1	50.0	−13.8	U: 0.21; A: 0.49
								U = Unadjusted; A = Adjusted
Tsuyuki et al., 2004 [24]	*N* = 276	(I) *N* = 140 (C) *N* = 136	365	**All-cause hospital readmissions: (Pat. with at least 1 hospital readmission, n (%))**				
				1 year:	51 (37.5)	59 (42.1)		0.431
Wakefield et al., 2008 [26]	*N* = 148	(I) Telephone *N* = 47 (I) Videophone *N* = 52 (C) *N* = 49	365	**All-cause hospital readmissions**: No significant difference among the three groups, or between the control and combined intervention-groups in the proportion of subjects readmitted at either 3 or 6 months following study enrolment At 12 months a significant lower proportion of combined intervention subjects were readmitted C = 59% vs. I = 41%; [OR] = 0.49; [95% CI]: 0.24–0.98				0.04

Given the clinical heterogeneity among studies in nature of intervention, study population, duration of follow-up and outcomes assessed, we did not attempt to summarize data statistically.

3.4. Outcomes

The extensive characteristics of all included studies are presented in Table 2.

3.4.1. The effect of self-management interventions on mortality

Nine studies, including a total number of 1988 participants with a mean follow-up period of 385 days, assessed mortality as an outcome measurement (Table 3).

Only one study [4] reported a significant reduction in favour of the intervention-group on the rate of deaths per observation year.

Eight studies described no significant difference in all-cause mortality between the intervention-group and the control-group [8,13–15,16,19,21,26].

In one study [8], however, patients in the intervention-group suffered from a significant more severe mean LVEF, which might have lead to underestimation of the effects. In another study [21] more patients died in the intervention-group despite the fact that the control-group consisted of more severely ill patients at baseline. The outcome might be explained by generalists providing care for the intervention-group and specialist providing care for the control-group.

A third study [26] described that patients in one of the intervention-groups were more severely ill at baseline, which can result in underestimation of results compared to the other groups.

3.4.2. The effect of self-management interventions on all-cause hospital readmission

Eight studies, including a total number of 2248 participants with a mean follow-up period of 308 days, assessed all-cause hospital readmissions as an outcome measurement (Table 4).

Two studies [4,16] reported significant reductions on all-cause hospital readmitted patients in favour of the intervention-group. In one of these studies [16], a multivariate analysis was performed due to baseline inequalities on use of digitalis and beta-blockers. This analysis did not significantly change the results.

The other six studies [8,17,21,22,24,26] described no significant differences between the intervention-group and the control-group in patients readmitted to the hospital during follow-up. One of these studies, Wakefield et al. [26] reported that at 12 months a significant lower proportion of combined intervention subjects were readmitted. Only, patients in the video-group were more severely ill compared to control- and telephone group. Therefore results in the video-group could be underestimated.

Two studies might have underestimated the effect because of the following: despite an adequate randomization procedure, patients in the intervention-group suffered from a significant more severe mean LVEF [8] and a trend towards increased severity of symptoms (NYHA IV) at baseline in the intervention-group [17].

The effects in two other studies might be overestimated because of a relative short follow-up period, and respectively, an unequal distribution of patients having an ischemic aetiology between both groups [24] and differences found in numbers for baseline and follow-up and no proper description of loss to follow-up, suggesting a per protocol analysis [21].

3.4.3. The effect of self-management interventions on CHF-hospitalization rate

Four studies, including a total number of 1304 participants with a mean follow-up period of 320 days, assessed CHF-hospitalization rate as an outcome measurement (Table 5).

Two studies [4,16] described significant reductions in favour of the intervention-group on readmitted patients for CHF. In one study [16] a multivariate analysis was performed due to inequalities on baseline, which might have lead to overestimated effects. Unfortunately the results of the analysis were not presented in the article.

Two studies [22,26] described no significant reductions on both groups on the number of readmitted patients for CHF. In one study [26] patients in one of the intervention-groups were more severely ill at baseline, which can result in underestimation of results compared to the other groups.

3.4.4. The effect of self-management interventions on QoL

Fourteen studies, including a total number of 2311 participants with a mean follow-up period of 362 days, assessed QoL as an outcome measurement (Table 6).

Eleven studies [4,9,12–15,20,21,23,25,26] used the disease specific MLWHFQ to measure the outcome QoL. Four studies [13,14,23,25] showed significant improvements on the MLWHFQ in favour of the intervention-group during the follow-up period. One study however described that, despite equal distribution of

Table 5
Effectiveness of self-management interventions in reducing the CHF-hospitalization rate in patients with chronic heart failure.

First author, year	Total number of subjects (*N*)	*N* = Intervention-group (I) and Control-group (C)	Follow-up period (days)	Outcome **CHF-hospitalization rate**				*p*-Value
Atienza et al., 2004 [4]	*N* = 338	(I) *N* = 164 (C) *N* = 174	365	C (79/174)	I (39/164)	Difference	95% CI	
				0.37	0.18	0.19	0.09–0.29	<0.001
Giordiano et al., 2009 [16]	*N* = 460	(I) (HBT) *N* = 230 (C) *N* = 230	365	**CHF-hospitalization rate**: I: *n* = 43 (19%) C: *n* = 73 (32%) RR = 0.49; 95% CI: 0.31–0.76				0.0001
Riegel et al., 2002 [22]	*N* = 358	(I) *N* = 130 (C) *N* = 228	183	**CHF-hospitalization rate (% of patients readmitted at least once)**				
					I	C	% change	
				3 m:	14.6	22.8	−36	U: 0.06; A: 0.06
				6 m:	17.7	27.6	−35.9	U: 0.06; A: 0.04 U: unadjusted; A: adjusted
Wakefield et al., 2008 [26]	*N* = 148	(I) Telephone *N* = 47 (I) Videophone *N* = 52 (C) *N* = 49	365	**CHF-hospitalization rate (treated for HF (primary or secondary))** I: *n* = 23 of 41; 56% (both groups) C: *n* = 20 of 29; 69% (OR = 0.58, 95% CI: 0.21–1.56)				0.28

Table 6
Effectiveness of self-management interventions in improving QoL in patients with chronic heart failure.

First author, year	Total number of subjects (*N*)	*N* = Intervention-group (I) and Control-group (C)	Follow-up period (days)	Outcome QoL				*p*-Value
Atienza et al., 2004 [4]	*N* = 338	(I) *N* = 164 (C) *N* = 174	365	**(MLWHFQ)** Baseline: No difference 1 year: Score intervention-group improved significant				0.01
Balk et al., 2008 [12]	*N* = 214	(I) *N* = 101 (C) *N* = 113	288	**(SF-36 & MLWHFQ)** Baseline: No difference 288 days: No difference				
Bruggink-Andre de la Porte et al., 2007 [13]	*N* = 240	(I) *N* = 118 (C) *N* = 122	365	**(MLWHFQ)** Total score baseline: Total score 3 months: Total score 12 months: **(Rand SF36)** Total score baseline: Total score 3 months: Total score 12 months:	I 42.5 28.8 30.2 45.12 49.63 49.23	C 42.6 36.3 34.5 46.77 46.41 41.92		 0.958 0.001 0.038 0.506 0.131 0.021
Cline et al., 1998 [8]	*N* = 190	(I) *N* = 80 (C) *N* = 110	365	**QoL in HF questionnaire, Nottingham health profile and a patient global self-assessment**: No difference at baseline and after 1 year follow-up between groups in all 3 instruments				
Del Sincado et al., 2007 [14]	*N* = 173	(I) *N* = 86 (C) *N* = 87	730	**(MLWHFQ)** Total score: Physical dimension: Emotional dimension:	 Baseline (39.5 ± 17.8) (19.9 ± 8.8) (9.5 ± 5.6)	 Follow-up (27.7 ± 16.6) (14.9 ± 8.6) (5.6 ± 4.4)		 <0.0001 0.001 <0.0001
DeWalt et al., 2006 [9]	*N* = 123	(I) *N* = 59 (C) *N* = 64	365	**(MLWHFQ)**: Unadjusted analysis: C = improved 5 points I = improved 1 point. Difference 3.5 points (95% CI 11, −4) Adjusted analysis between the groups: Difference 2 points (95% CI 9, −5)				 0.36 0.59
Dunagan et al., 2005 [15]	*N* = 151	(I) *N* = 76 (C) *N* = 75	365	**(SF-12)** mean ± SD Physical scale Mental scale **(MLWHFQ)** mean ± SD Physical scale Emotional scale	C −2.7 ± 10.7 5.5 ± 11.7 5.2 ± 10.4 2.4 ± 6.8	I 1.2 ± 9.9 7.3 ± 12.7 9.3 ± 8.9 2.7 ± 6.0		 0.028 0.20 0.33 0.90
Jaarsma et al., 2000 [18]	*N* = 132	(I) *N* = 58 (C) *N* = 74	274	**Heart Failure Functional Status Inventory (functional capabilities), a non-validated questionnaire (symptoms) and the Psychosocial Adjustment to Illness Scale (psychosocial perceptions)** **Functional capabilities**: No differences between the 2 groups in functional capabilities at baseline and follow-up **Within groups symptoms**: (number) (C) (I) **Within groups symptoms**: (severity) (C) (I)	 Baseline 3.9 ± 1.3 3.9 ± 1.7 6.7 ± 2.4 7.6 ± 2.2	 3 months 1.9 ± 1.5 2.2 ± 1.6 5.9 ± 2.3 5.4 ± 2.8	 9 months 5.8 ± 2.8 5.3 ± 2.8	 <0.001 <0.001 <0.001 <0.001

Jaarsma et al., 2000 [18]				*Additional analyses on the change scores from baseline between groups: (−2.7 vs. −0.6; t = 2.4)*				0.02
				After correction for bias: (−1.2 vs. −0.4; t = 1.8)				0.07
				Within groups symptoms:				
				(distress)				
				(C)	6.7 ± 2.8	5.5 ± 3.1	5.9 ± 2.7	<0.001
				(I)	7.5 ± 2.6	5.2 ± 3.2	5.3 ± 2.9	<0.001
				Intervention-group reported a larger decrease in symptom distress than the control-group (−2.6 vs. −0.8; t = 2.1)				0.04
				After correction for multiple testing (−1.3 vs. −0.5; t = 1.6)				0.11
				Within groups				
				PIAS:	Baseline	3 months	9 months	
				C:	35.3 ± 19.4	30.4 ± 20.3	29.2 ± 21.3	
				I:	36.2 ± 16.0	31.9 ± 20.7	28.4 ± 21.6	
				In both groups, significant improvement from baseline to 9 months				
				(C): t = 2.3				0.03
				(I): t = 2.3				0.03
Mårtensson et al., 2005 [20]	*N* = 153	(I) *N* = 78 (C) *N* = 75	365	**SF-36**:				
				Differences within groups:				
				No significant improvement in any of the dimensions for both groups				
				(I): HRQoL preserved in all dimensions				
				(C): Significant impairment at 3 months compared to baseline in the domains:				
				Role functioning due to physical limitations				0.035
				Vitality				0.029
				(C): At both 3 and 12 months deterioration occurred in the domains:				(3m) (12m)
				Physical functioning				0.035 0.001
				Role functioning due to emotional limitations				0.001 0.022
				Mental component summary (MCS)				0.017 0.047
				Differences between groups:				
				(I) At 3-month follow-up significant improvement regarding:				
				Role functioning due to physical limitations				0.008
				(I) A tendency toward improved:				
				Vitality				0.051
				Social functioning				0.056
				The differences disappeared at the 12-month follow-up				
				MLWHFQ: No significant mean differences between or within groups at baseline or at the 3- and 12-month follow-up in total scores, or in emotional or physical scores				
Nuciforca et al., 2006 [21]	*N* = 200	(I) *N* = 99 (C) *N* = 101	183	**(MLWHFQ, mean ± SD)**				**P group effect**
					Baseline:		6 months:	Total: NS
					I	C	I	C	Physical: NS
					(*n* = 98)	(*n* = 98)	(*n* = 74)	(*n* = 75)	Emotional: NS
				Score:					**P time effect**
				Total	36 ± 18	34 ± 19	14 ± 20	10 ± 16	<0.0001
				Physical	19 ± 10	18 ± 10	7 ± 10	5 ± 7	<0.0001
				Emotional	8 ± 6	7 ± 6	3 ± 5	2 ± 4	<0.0001
Ramachandran et al., 2007 [6]	*N* = 50	(I) *N* = 25 (C) *N* = 25	183	**(Kansas City Cardiomyopathy questionnaire)**				
				Significant changes were evaluated within groups				
					Baseline	6months		
				Mean HRQOL score:				
				Control:	62.2(22.6)	63.4(21.9)		0.69
				Intervention:	60.0(23.6)	76.3(17.3)		0.05
				Physical impairment:				
				Control:	55.7(21)	56.0(18.8)		0.90
				Intervention:	53.9(21.3)	63.3(16.2)		0.05

Table 6 (*Continued*)

First author, year	Total number of subjects (*N*)	*N* = Intervention-group (I) and Control-group (C)	Follow-up period (days)	Outcome QoL			*p*-Value
Ramachandran et al., 2007 [6]				**Symptoms**:			
				Control:	63.3(26.1)	66.4(26.4)	
				Intervention:	60.2(30.1)	76.7(18.8)	0.05
				Score between C & I			0.02
				Understanding/self-efficacy:			
				Control:	35.0(25.3)	37.0(22.9)	
				Intervention:	50.5(26.9)	75.0(22.8)	0.05
				Psychosocial impact:			
				Control:	53.3(21.8)	54.9(21.3)	0.66
				Intervention:	49.3(22.8)	64.5(17.3)	0.05
				Score between C & I at follow-up			0.01
Shively et al., 2005 [23]	*N* = 116	(I) *N* = 58 (C) *N* = 58	487	**SF-36V**: No significant differences on components of the SF-36V over time between groups			
				MLWHFQ: physical dimension score: significant improvement in intervention-group vs. control-group over time.			
				group by time interaction: log transformed scores, $F(3,291) = 3.27$			0.03
				linear interaction contrast, $F(1,97) = 7.04$			0.009
				Missing data analyses:			
				group by time interaction with log transformed scores, $F(3,342) = 3.42$			0.02
				linear interaction contrast, $F(1,114) = 7.05$			0.009
Varma et al., 1999 [25]	*N* = 83	(I) *N* = 42 (C) *N* = 41	365	**MLWHFQ (Mean ± SD)**:			
				Scores for Group A&B			
				Baseline:	(I) 23.7 ± 16.3 vs. (C) 27.1 ± 17.3		NS
				9 m:	(I) 15.6 ± 14.6 vs. (C) 25.7 ± 18.5		0.04
				12 m:	(I) 12.7 ± 9.9 vs. (C) 19.1 ± 10.2		NS
				SF-36 (Mean ± SD):			
				Physical functioning:			
				Baseline:	(I) 44.0 ± 27.9 vs. (C) 30.8 ± 19.7		0.04
				9 m:	(I) 52.8 ± 23.2 vs. (C) 34.1 ± 27.4		0.009
				12 m:	(I) 56.0 ± 23.8 vs. (C) 36.3 ± 26		0.03
				Vitality:			
				12 m:	(I) 58.3 ± 22.1 vs. (C) 38.3 ± 27.2		0.04
				Social functioning:			
				12 m:	(I) 91.8 ± 21.4 vs. (C) 57.7 ± 41.9		0.015
				Mental health:			
				9 m:	(I) 87.5 ± 21.9 vs. (C) 76.9 ± 23.8		0.014
				12 m:	(I) 88.2 ± 18.3 vs. (C) 73.5 ± 20.6		0.014
Wakefield et al., 2008 [26]	*N* = 148	(I) Telephone *N* = 47 (I) Videophone *N* = 52 (C) *N* = 49	365	**(MLWHFQ)** Significant improvement in all groups (first telephone than video and control-group), over time ($F = 8.90$) No significant differences among the groups at baseline, 3 or 6 months.			0.0002

baseline characteristics on disease severity, more deaths occurred in the control-group compared to the intervention-group, but that difference was not significant [14].

Two studies [4,26] found significant improvements in both groups during follow-up, but the scores in the intervention-groups were significantly higher. However, the study of Wakefield reported that patients in the video-group were more severely ill at baseline, which can result in underestimation of outcomes compared to the telephone-group and the control-group.

Two studies [9,21] reported a general improvement on QoL in both groups, but the results were not significant.

Three studies [12,15,20] showed no differences in scores between baseline and follow-up in both the control as well as the intervention-group.

Five studies [10,12,13,20,23,25] used the generic SF-36 instrument to measure QoL. Both Shively et al. [23] as well as Balk et al. [12], reported no differences in scores between both groups at follow-up compared to baseline parameters. One study [13] described that the intervention-group had significant better results than the control-group during follow-up using the Rand SF-36. Though, despite equal distribution of baseline characteristics on disease severity, more deaths occurred in the control-group compared to the intervention-group, but that difference was not significant.

Varma et al. [25], reported that the intervention-group had better scores in general compared to the control-group. Significant scores were observed on physical functioning at baseline, at 9 and at 12 months, on domain vitality at 12 months, on social functioning at 12 months and on mental health at 9 and 12 months.

In the study of Mårtensson et al. [20], a significant impairment was shown in the control-group on the domains of role functioning due to physical limitations and vitality at 3 months follow-up. Significant deterioration in the control-group was reported on physical functioning, role functioning due to emotional limitations and the mental component summary at 3 and 12 months. The intervention-group preserved QoL in all dimensions. A significant improvement was seen in the intervention-group at 3 months follow-up regarding role function due to physical limitations as well as a tendency toward improved vitality and social functioning. This effect could be underestimated because baseline characteristics at role functioning due to physical and emotional limitations and social functioning were significant better for the control-group, suggesting an effect over time on deterioration.

However, differences disappeared at 12 months between both groups [20].

One study [15] used the Short Form-12 (SF-12) and reported a significant improvement on QoL after 6 months in favour of the intervention-group on the physical functioning domain. This effect, however, did not remain at 12 months follow-up. Multivariable analyses for severely impaired LV function, NYHA class and use of high doses ACE-inhibitors did not significantly alter estimates of treatment effects.

Another study [8], evaluated QoL using a disease specific questionnaire (QoL in HF questionnaire), a generic questionnaire (Nottingham health profile) and a patient global self-assessment. For all three measurements QoL did not differ between the intervention-group and the control-group comparing baseline to 1 year of follow-up. Despite an adequate randomization procedure, patients in the intervention-group suffered from a significant more severe mean LVEF which might have lead to underestimation of the effects.

Ramachandran et al. [6], measured QoL using the Kansas City Cardiomyopathy questionnaire, containing five domains. A significant change in the intervention-group was reported between baseline and follow-up, on mean HRQL, physical impairment, symptoms, understanding and self-efficacy and psychosocial impact. The results can be underestimated, because usual care seems to be contaminated with education on diet modification, adjustment for beta-blockers and ACE-inhibitors and self-adjustment on diuretics.

Jaarsma et al. [18], used three instruments evaluating QoL, focusing on symptoms (questionnaire not validated), psychosocial perceptions (Psychosocial Adjustment to Illness Scale-PIAS) and functional capabilities (HF Functional Status Inventory).

Symptoms: significant decreases were reported on the average number of symptoms in both groups at 3 months of follow-up compared to baseline and the average severity of symptoms ($p < 0.001$). Between baseline and 9 months follow-up the intervention-group reported a larger decrease in symptom severity compared to the control-group. After correction for possible attrition bias (due to a large number of missing values in the intervention-group) the trend remained, however not significant. Significant decreases were also seen in the average symptom distress in both groups at follow-up and in symptom distress in the intervention-group. After correction for multiple testing and possible bias for missing values, the trend remained but was not significant. Results should be interpreted with caution as measurements were performed using a non-validated questionnaire and therefore might not be reliable because incorrect reflection of the reality can occur.

The total PAIS score on psychosocial perceptions decreased for both groups compared with baseline indicating better psychosocial adjustment to illness. In both groups, improvement from baseline till 9 months was significant.

Measurements on functional capabilities showed no significant difference between the two groups at baseline and follow-up after correction for multiple testing. It seems that a per-protocol analysis was performed on functional capabilities and psychosocial adjustment. Higher drop out rates were observed in the intervention-group compared to the control-group (NS) and defined as older and severely ill patients who died in an early stage of the study [18].

Overall, QoL assessment may be susceptible for overestimated effects. Eight studies described a significant improvement in QoL [4,6,13–15,23,25,26], six studies described no significant changes neither improvement nor maintenance or deterioration in QoL [9,8,12,18,20,21]. Two studies performed a per protocol analysis, not accounting for selective loss to follow-up and might have lead to overestimated effects [18,21].

Unequal distribution of baseline patient characteristics was seen in 7 studies of the included 19 studies [8,17,20,21,24,25,26]. No statistical analysis was described to adjust for these unequal distributions. As a result, effects can be under- or overestimated or falsely show no difference.

4. Discussion and conclusion

4.1. Discussion

In this systematic review, we found that effectiveness of self-management interventions in patients with CHF shows a positive effect, although not always significant, on the reduction of numbers of all-cause hospital readmitted patients and due to CHF, decrease in mortality and increasing QoL. We considered a substantial amount of published literature and found 19 studies that met the eligibility criteria. Currently available published studies show methodological shortcomings which impairs validation of the effectiveness of self-management interventions. Other systematic reviews describing self-management interventions in different chronic conditions have reported that these interventions seem to be a promising self-management approach, empowering

patients resulting in an improvement on morbidity and mortality, but lack long-term studies with sufficient sample sizes, used selected study-populations, recruiting from diverse medical settings and did not report evaluation of the effectiveness of single self-management interventions [10,27–29].

Positive trends on effectiveness are described according to several authors but methodological detail is often impaired to such a degree that the validation and generalisation of these findings is limited by the deficiencies [10,27–29].

This systematic review of studies showed that self-management interventions are part of multifaceted HF-programs and only the effect of the whole program on outcome measures is assessed. Determination of possible beneficial effects reported in the studies used in this systematic review on clinical and patient reported outcome measures of single interventions is difficult, because it is not possible to estimate and specify which elements of the intervention are responsible for beneficial results. None of the included studies defines the concept of self-management (interventions) used in HF management programs which leads to no uniformity concerning the content of used self-management interventions. Patient education was used as one of the main components of self-management in all included studies, in order to gain awareness of signs and symptoms, to accomplish lifestyle changes and treatment adherence. The importance of HF patient education to accomplish self-management behaviour was also emphasized by Stromberg [3], Gonseth et al. [29], Gwadry-Sridhar et al. [30] and McAllister et al. [31]. However, patients providing with information, does not guarantee they gain knowledge. Besides, increased knowledge may not directly lead to increased self-management behaviour [17].

In 10 of the included studies other self-management interventions as performing self-adjustment on diuretics when weight increased and empowering patients to perform self-monitoring skills of physical signs were reported [4,6,8,9,15,16,23–26]. Empowering patients to perform self-monitoring skills of physical signs like weight and blood pressure is one of the interventions seen in HF management programs [30].

The association of inadequate or unclear allocation concealment and lack of blinding with biased estimates of intervention effects varies with the nature of the intervention or outcome [32]. Overestimated effects were found in trials partly using subjective outcomes when there was inadequate or unclear allocation concealment and lack of blinding. In trials using objective outcomes, there was little evidence of bias. Blinding of patients and caregivers is difficult in self-management interventions. Lack of blinding can thus lead to overestimated effects in case of subjective outcome measures. Moreover, blinding of outcome assessment was not or not clearly described. It can be assumed that studies using objective outcomes, like hospital readmissions or mortality, may be safeguarded from bias.

Although there is a lot of literature to be found on this topic, the included studies have relatively short follow-up periods, used diverse medical settings and selected patient populations (i.e. excluding severe comorbidities, cognitive impairment and psychological disorders). Furthermore QoL was assessed using different instruments and no evaluation on the effectiveness of single self-management interventions was performed.

This systematic review has several limitations. Despite an extensive electronic and hand search, it is possible that eligible studies were missed due to inconsistent terminology used in self-management research. Furthermore, there was no search for unpublished studies. It is known that publication bias can form a threat to internal validity of systematic reviews and may result in an overestimated effect [33].

4.2. Conclusion

In this systematic review it was found that current available published studies show methodological shortcomings which might impair validation of the effectiveness of self-management interventions on mortality, all-cause hospital readmissions, CHF hospitalization and QoL in patients with CHF. There is a need for well-designed studies, including patient populations with severe co-morbidity, cognitive impairment and psychological disorders, besides recruiting from combined healthcare facilities (primary as well as secondary).

4.3. Practice implications

We propose the following for future research:

- Enhancement of methodological quality by designing and performing (multicenter) RCTs recruiting from combined healthcare facilities (primary as well as secondary) avoiding as much bias as possible knowing that blinding is not feasible with this type of intervention.
- Research aiming at the independent primary effects of self-management interventions and different combinations of interventions on clinical and patient reported outcomes.
- Properly define terms like self-management or the conceptual framework used behind the self-management interventions, to accomplish consistency in the interpretation of the results of self-management interventions in CHF-patients.
- Adequate duration of follow-up and consideration on what extent the intervention must be empowered and supported by care providers and/or technology devices on the long run.
- Research aiming to understand the effects of self-management interventions regarding selected patients populations with severe co-morbidity, cognitive impairment and psychological disorders.

Conflict of interest

There are no conflicts of interest with this review.

Acknowledgments

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