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Strategies to Modify the Risk of Heart Failure Readmission: A Systematic Review and Meta-Analysis

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Abstract

Background: Human factors play an important role in health-care outcomes of heart failure (HF) patients. A systematic review and meta-analysis of clinical trial studies on HF hospitalization may yield positive proofs of the beneficial effect of specific care management strategies.

Purpose: To investigate how the 8 guiding principles of choice, rest, environment, activity, trust, interpersonal relationships, outlook, and nutrition reduce HF readmissions.

Basic Procedures: Appropriate keywords were identified related to the (1) independent variable of hospitalization and treatment, (2) the moderating variable of care management principles, (3) the dependent variable of readmission, and (4) the disease of HF to conduct searches in 9 databases. Databases searched included CINAHL, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, ERIC, MEDLINE, PubMed, PsycInfo, Science Direct, and Web of Science. Only prospective studies associated with HF hospitalization and readmissions, published in English, Chinese, Spanish, and German journals between January 1, 1990, and August 31, 2015, were included in the systematic review. In the meta-analysis, data were collected from studies that measured HF readmission for individual patients.

Main Findings: The results indicate that an intervention involving any human factor principles may nearly double an individual's probability of not being readmitted. Participants in interventions that incorporated single or combined principles were 1.4 to 6.8 times less likely to be readmitted.

Principal Conclusions: Interventions with human factor principles reduce readmissions among HF patients. Overall, this review may help reconfigure the design, implementation, and evaluation of clinical practice for reducing HF readmissions in the future.

Keywords
heart failure readmission, care management strategies, moderating effects of human factors in heart health care, risk reduction approach

Introduction

Heart failure (HF) is a chronic and progressive condition in which the heart muscle is unable to pump enough blood to meet the body's need for blood and oxygen.[1] Placement into class I, II, III, or IV of the New York Heart Association functional classification depends on the severity of patient symptoms and physical activity limitations.[1] Heart failure is a leading cause of hospitalization and health-care costs in the United States. Nearly 5.1 million Americans have been diagnosed with HF, and approximately half die within 5 years of diagnosis.[2,3] The total costs of HF to the nation, in terms of direct medical costs and lost productivity, are estimated to be US$32 billion annually.[2,3] Congestive HF is the most common reason for readmission among Medicare fee-for-service

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patients,[4] and up to 25% of HF patients are readmitted within 30 days.[5] An analysis of Medicare claims data from 2007 to 2009 showed that 35% of readmissions within 30 days were for HF.[5] Section 3025 of the Affordable Care Act amended the Social Security Act to establish the Hospital Readmissions Reduction Program, which requires the Centers for Medicare and Medicaid Services to decrease reimbursements to hospitals with excessive risk-standardized readmissions.[6] This program encourages hospitals to develop interventions to reduce the readmission rates for HF patients. Increasingly, care management practices incorporate human factors that can influence the relationship between therapeutic interventions and patient outcomes. These interventions commonly involve human factors, including components such as education and assessment, rest and relaxation, exercise, interpersonal relationships, outlook, and dietary recommendations.

Research Questions

In a search for the causal mechanisms for enhancing patient care outcomes, this investigation explored how scientific literature has documented the moderating influence of varying care management principles involving human factors on hospital outcomes of HF patients. A systematic review of intervention strategies was conducted, and a broad range of intervention types aimed at reducing HF readmissions was included. The selected intervention components include education and assessment, rest and relaxation, exercise, interpersonal relationships, outlook, and dietary recommendations. The systematic review and meta-analysis aimed to answer the following research questions:

1. Is there evidence that particular intervention components may modify the care management effects on HF readmission?
2. Does a single intervention component work more effectively than a combination of intervention components in care management for HF patients?
3. How can the knowledge gained from the systematic review and meta-analysis be applied in population health management for HF?

Material and Methods

Data Sources and Searches

Appropriate keywords were identified related to (1) the independent variable of hospitalization and treatment, (2) the moderating variable of intervention components, (3) the dependent variable of readmission, and (4) HF. Combinations with 1 keyword from each of the 4 categories (see Table 1) were used to conduct searches in 9 databases: CINAHL, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, ERIC, MEDLINE, PubMed, PsycInfo, ScienceDirect, and Web of Science. Although systematic reviews were not included in the meta-analysis, the Cochrane Database of Systematic Reviews was searched in case any similar studies existed.

Table 1. List of Keywords for Database Searches.

Variable	Keywords
Heart failure	Heart failure
Intervention	Medicine, medication, hospital, inpatient, outpatient, health education, behavior modification, motivational interviewing
Outcome	Rehospitalization, readmission, health-related quality of life
Education/assessment	Internal-external control, choice behavior, responsibility, goal-setting
Rest/relaxation	Relaxation, rest, sleep
Environment	Built environment, pollution
Exercise	Leisure activities, exercise, recreation, sports
Religion/spirituality	Trust, belief, higher power, religion, spirituality
Interpersonal relationships	Family relations, interpersonal relations, sibling relations, professional-family relations, professional-patient relations, social participation, social capital
Outlook	Mindfulness, control, self-efficacy, emotion*, optimism, stress*
Dietary	Food habits, meals, food preferences, food security

Study Selection, Data Extraction, and Quality Assessment

Table 2 shows the inclusion and exclusion criteria in regard to population, interventions, outcomes, timing of outcomes, time period, settings, publication language, design, and publication format. Only studies associated with HF hospitalization and readmissions, published in English, Chinese, French, German, Italian, Portuguese, and Spanish between January 1, 1990, and August 31, 2015, were compiled. Retrospective studies were excluded. Studies that evaluated interventions focused on only pharmaceuticals, surgical procedures, technology, or other therapeutic strategies and that did not incorporate any of the selected human factors were excluded. Each selected study was reviewed by a team of 5 graduate students with training in rating the quality. The detailed characteristics of cited studies are listed in Appendix A.

Data Synthesis and Analysis

Studies that focused on HF and other chronic illnesses and reported the number of readmissions for only HF patients were included if they met the inclusion criteria. All studies that reported the number of persons readmitted in each group were included in the meta-analysis. Although a study that only reported the total number of readmissions per group was included in the systematic review, it was not included in the meta-analysis. Additionally, studies in the systematic review could not be included in the meta-analysis if they evaluated multiple intervention groups and a control group rather than only 1 intervention group and 1 control group, or if the study reported numbers for only composite outcomes, such as readmission and death.

In the Comprehensive Meta-Analysis (Version 2) software,[7] a mixed-effects model was used to synthesize effect sizes from independent studies, which were also categorized into

Table 2. Inclusion and Exclusion Criteria for Studies of Intervention Patients Hospitalized for HF.

Category	Inclusion Criteria	Exclusion Criteria
Population	Adults with heart failure	Children and adolescents
Interventions	Interventions that include 1 or more of the components listed	Interventions that do not incorporate 1 or more of the components listed
Outcomes	Readmission to hospital	Only a quality of life or functional status outcome with no mention of readmission to hospital
Timing of outcome	Outcomes occurring within 24 months of hospitalization	Outcomes occurring more than 24 months after hospitalization
Time period	Studies published from January 1, 1990, to August 31, 2015	Studies published before January 1, 1990, or after August 31, 2015
Settings	Interventions occurring during hospitalization before discharge; interventions occurring in an outpatient setting after discharge from hospital; interventions bridging the transition from inpatient to outpatient care	All other settings, such as discharge from hospital to a skilled nursing facility or rehabilitation center
Publication language	English, Chinese, French, German, Italian, Portuguese, Spanish	Any other languages
Design	Original research, randomized controlled trials (RCTs), non-RCTs, prospective cohort studies with comparison group	Case reports, case–control studies, retrospective cohort studies
Publication format	Peer-reviewed articles in an academic journal	Books, book reviews, continuing education units (CEUs), conference abstracts, dissertations, nonsystematic reviews, systematic reviews, editorials, letters to the editor

subgroups based on the moderator variable of intervention components. A random-effects model was used to combine studies within each subgroup, and a fixed-effect model was used to combine subgroups and yield the overall effect. The study-to-study variance was not assumed to be the same for all subgroups. This is the method used by Review Manager (RevMan).[7] The odds ratio represented the odds of successfully avoiding HF readmissions, given exposure to an intervention involving 1 or more intervention components. A funnel plot of log odds ratio was created to test for publication bias.

Results of Systematic Review

A flow diagram of the systematic review of literature is shown in Figure 1. The characteristics of the 113 included studies are shown in Appendix A. The interventions were grouped by components. Limited biases were introduced since only studies with proven quality were included. The empirical evidence provided by the systematic review is summarized in this section.

Education and Assessment

Eleven studies incorporated education and assessment.[8-18] In 9 of these studies, readmissions were significantly lowered. These interventions included:

- Patient education during hospitalization and postdischarge telemonitoring for reinforcement of education and assessment of patients[13] or postdischarge home visits and monthly calls for reinforcement, assessment, and medication compliance[8]
- Phone calls after discharge for patient education, assessment of symptoms and compliance, and review of medication adherence[14]
- Postdischarge patient education at outpatient clinics and assessment of symptoms and compliance during clinic visits[12] or during follow-up calls every 2 to 4 weeks[16]
- Postdischarge assessments of medication adherence, symptoms/health, and compliance through a single home visit 1 week after discharge,[18] through daily telemonitoring and outpatient clinic visits every 1 to 2 weeks,[11] and through a daily telemonitoring system.[9]

Exercise

Four studies incorporated exercise.[19-22] In all 4 studies, readmissions were significantly lowered. These interventions included:

- Home-based program of light aerobic exercise and resistance training with home visits by a nurse to assess adherence for 12 months[20,21]
- Aerobic exercise training for 36 supervised sessions followed by home-based training[22]
- Exercise using a cycle ergometer 2 to 3 times per week for 1 year.[19]

Interpersonal Relationships

Two studies incorporated interpersonal relationships.[23,24] In these studies, readmissions were not significantly lowered.

Outlook

Two studies incorporated outlook.[25,26] In these studies, readmissions were not significantly lowered.

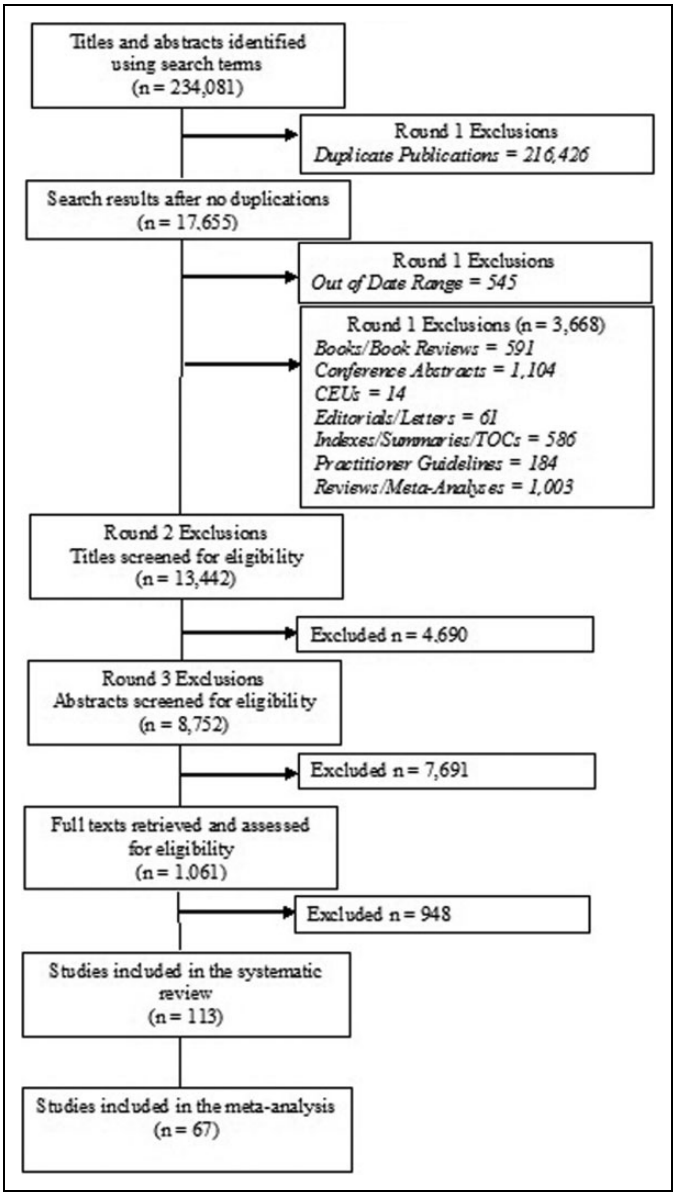

Figure 1. Flowchart of the systematic review of literature.

Dietary Recommendations

Three studies incorporated dietary recommendations.[27-29] In 2 of these studies, readmissions were significantly lowered. These interventions included:

- A comparison of 2 groups, one with a low-sodium diet and the other with a medium-sodium diet. Both groups had 1000 mL/d fluid restriction and a high diuretic dose. The group with the medium-sodium diet showed a significant reduction in readmissions[28]
- Eight different combinations of levels of fluid intake restriction, sodium intake, and diuretic dosages. A normal sodium diet with high diuretic doses and fluid intake restriction was most effective in reducing readmissions.[29]

Education and Assessment Combined With Exercise

Two studies incorporated these 2 components.[30,31] In 1 of these studies, readmissions were significantly lowered. This intervention included:

- Patient education during hospitalization and postdischarge assessment of symptoms and compliance with emphasis on activity and treatment through Internet-based monitoring 3 times per week.[30]

Education and Assessment Combined With Interpersonal Relationships

Four studies incorporated these 2 components.[32-35] In 2 of these studies, readmissions were significantly lowered. These interventions included:

- Postdischarge education and counseling for patients and families to influence medication adherence through clinic visits and phone calls focused on incorporating significant others and building positive medication-taking behaviors.[35]

Education and Assessment Combined With Outlook

One study incorporated these 2 components.[36] In this study, readmissions were not significantly lowered.

Education and Assessment Combined With Dietary Recommendations

Thirty studies incorporated these 2 components.[37-65] In 16 of these studies, readmissions were significantly lowered. These interventions included:

- Patient education during hospitalization and weekly or biweekly phone calls postdischarge to reinforce education and assess symptoms, compliance,[62,63] and medication adherence[45,58]
- Diet and self-care education during hospitalization and reinforcement of education and assessment of symptoms and compliance after discharge through weekly calls for 2 weeks,[42] weekly calls for 12 weeks and 2 clinic visits,[53] or calls and clinic visits tailored to individual patient needs[55]
- Diet, disease, and drug therapy education at discharge and after discharge on monthly phone calls, clinic assessments, and using a pill counter[43]
- Postdischarge phone calls weekly or biweekly for patient education[39,40]
- Telemonitoring to assess diet, weight, symptoms,[57] and medication adherence, along with home visits[38]
- Patient education about symptoms and diet at discharge and after discharge over the phone, monthly home visits,

and a daily diary for assessment of symptoms and compliance[52]

- Postdischarge patient education on HF and diet at outpatient clinics, assessment of symptoms and compliance during clinic visits, and monitoring diet and/or medication adherence on calls[47,64] or through the use of a diary and printed guide.[50]

Rest and Relaxation Combined With Outlook

One study incorporated these 2 components.[66] In this study, readmissions were significantly lowered. This intervention included:

- Relaxation therapy consisting of relaxation training and music therapy for 1 hour daily and basic psychological care lasting 4 weeks.[66]

Exercise Combined With Outlook

One study incorporated these 2 components.[67] In this study, readmissions were not significantly lowered.

Education and Assessment Combined With Exercise and Interpersonal Relationships

One study incorporated these 3 components.[68] In this study, readmissions were significantly lowered. This intervention included:

- A cardiac rehabilitation program for 12 weeks with individualized exercise plans and group-based educational session for patients and families.[68]

Education and Assessment Combined With Exercise and Dietary Recommendations

Twenty-two studies incorporated these 3 components.[69-90] In 12 of these studies, readmissions were significantly lowered. These interventions included:

- Comprehensive patient education during hospitalization and a follow-up call 1 to 2 weeks after discharge[76] and at 90 days for high-risk patients[72]
- Patient education during hospitalization and postdischarge assessment of symptoms and compliance with emphasis on diet, activity, and treatment through biweekly phone calls[74]
- Comprehensive patient education during hospitalization and postdischarge reinforcement and assessment of symptoms and compliance emphasizing diet, activity, and treatment through home visits at least once weekly for 6 weeks[70]
- Postdischarge clinic visits and phone calls at 6-month intervals to provide patient education and assess symptoms and compliance[86]
- Patient education postdischarge during 2 to 5 clinic visits and assessment of symptoms, compliance, and medication use through follow-up phone calls[77] or through the use of a diary and/or pill counter,[73] as well as motivational interviewing,[81] or during monthly home visits with follow-up phone calls every 10 to 15 days[89]
- One home visit during the first 2 weeks after discharge to provide patient education on self-management, diet, and physical activity and assess medication adherence and/or symptoms[69] and follow-up phone calls at 3 and 6 months for assessment[85]
- Education on self-care management, diet, and exercise delivered by a multidisciplinary team weekly for 6 weeks with a 1-hour exercise component.[78]

Education and Assessment Combined With Interpersonal Relationships and Dietary Recommendations

Six studies incorporated these 3 components.[91-96] In 4 of these studies, readmissions were significantly lowered. These interventions included:

- Postdischarge education on diet and sodium restriction for patients and caregivers through weekly outpatient clinic visits[92] or coaching phone calls[96]
- Education on HF, diet, and drug therapy for patients and caregivers at discharge and postdischarge on monthly phone calls, clinic assessments, and medication checklist[94]
- Development of care plan and patient and caregiver education by a multidisciplinary team during hospitalization and weekly home visits to reinforce education and assess symptoms and compliance for 9 weeks postdischarge.[95]

Education and Assessment Combined With Outlook and Dietary Recommendations

Two studies incorporated these 3 components.[97,98] In these studies, readmissions were not significantly lowered.

Education and Assessment Combined With Rest and Relaxation, Exercise, and Dietary Recommendations

One study incorporated the 4 components.[99] In this study, readmissions were significantly lowered. This intervention included:

- Pharmaceutical care, education about self-care, drugs, and medication, and 1 month of self-monitoring diary cards to record medication use, physical activity, diet, and symptoms.[99]

Education and Assessment Combined With Exercise, Interpersonal Relationships, and Dietary Recommendations

Eight studies incorporated these 4 components.[100-107] In 6 of these studies, readmissions were significantly lowered. These interventions included:

- Educational programs in clinics for patients and families[102,103]
- Predischarge education on self-monitoring, diet, exercise, and medication and interview of patients and caregivers by nurse and postdischarge outpatient clinic visits every 3 months to review performance and introduce strategies to improve treatment adherence and response[100]
- Comprehensive patient education with families/caregivers during hospitalization and postdischarge reinforcement and assessment of symptoms and compliance emphasizing diet, activity, and treatment through clinic visits every 3 months[106] or clinic visits and phone calls every 2 to 8 weeks[101]
- Home visit once during the first month after discharge for education on self-management, diet, physical activity, and vaccinations for the patient and caregiver, and pill organizers provided for medication adherence.[104]

Education and Assessment Combined With Exercise, Outlook, and Dietary Recommendations

Three studies incorporated these 4 components.[108-110] In 1 of these studies, readmissions were significantly lowered. This intervention included:

- A multidisciplinary disease management program to provide in-person education to patients when enrolled in the intervention and through follow-up, which included outpatient clinic visits and monthly telephone calls and then visits every few months beginning at 6 months if patients had stabilized.[110]

Education and Assessment Combined With Exercise, Interpersonal Relationships, Outlook, and Dietary Recommendations

Nine studies incorporated these 5 components.[111-119] In 2 of these studies, readmissions were significantly lowered. These interventions included:

- A telehealth system that combined self-monitoring and motivational support tools in addition to a comprehensive, multidisciplinary HF care program[112]
- Patient education about HF, medication, diet, and activity during hospitalization, at discharge, or after discharge during home visits and phone calls, which also included assessment of diet, weight, and medication checklist[117]

Education and Assessment Combined With Rest and Relaxation, Exercise, Interpersonal Relationships, Outlook, and Dietary Recommendations

One study incorporated these 6 components.[120] In this study, readmissions were not significantly lowered.

Results of Meta-Analysis

A meta-analysis allowed for the combination of data from 67 studies to determine the impact of single or combined intervention components aiming to reduce HF readmissions. Studies included in the systematic review could not be included in the meta-analysis if only the total number of readmissions per group was reported, if multiple intervention groups were assessed, or if only composite outcomes were reported. Figure 2 shows the forest plot of the effect sizes and confidence intervals for each study in the fixed-effect and random-effects models. In the mixed-effects model, the overall odds of being readmitted were 1.79 times lower among participants of interventions that involved any of these intervention components. The funnel plot of log odds ratio was symmetrical, which indicates that publication bias was unlikely.[121]

Discussion and Conclusions

This analysis yields robust results that are based on a systematic review and meta-analysis of published studies that evaluate interventions involving particular components aimed at reducing HF readmissions. Intervention strategies incorporating certain human factors or combinations of such factors have the potential to enhance therapeutic outcomes for HF patients following hospitalization. The implications of the key findings are as follows:

1. The independent and combined effects of education and assessment are the most beneficial strategies to yield a positive benefit to avoid or reduce readmissions of HF patients. A care management or disease management team could consider a person-centered approach to enhance individual choice or self-efficacy for the patients.
2. Exercise combined with education and assessment or rest and relaxation shows greater benefits than exercise alone. A clinical team could examine how activities were prescribed, implemented, and evaluated. Lack of adherence to or uncertainty about prescribed activities for the therapeutic outcomes may have prevented activities from demonstrating their beneficial effects on readmissions.
3. Nutrition combined with other intervention components reveals a clear positive effect. Dietary interventions should be combined with other strategies in order to maximize their benefit in the reduction of risk for HF readmissions.
4. Interventions with the aforementioned components increase the likelihood of not being readmitted to the hospital for HF. The meta-analysis results indicate that an intervention involving 1 or more of these components doubles an individual's probability of not being readmitted.

This study is not without limitations. Potential limitations include the risk of bias at the study level and the possibility of

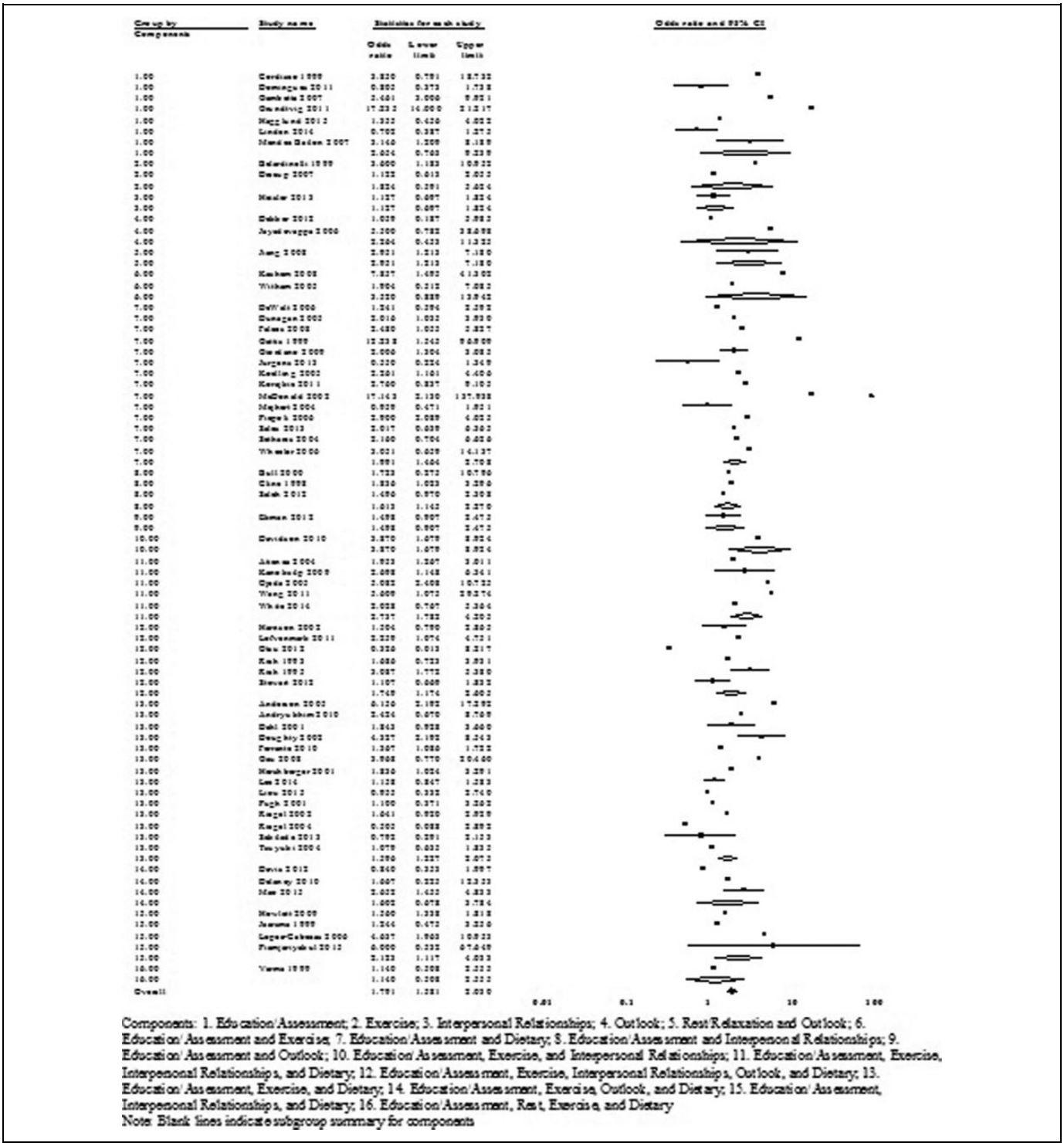

Figure 2. Forest plot of odds ratios for heart failure (HF) readmission in included studies.

incomplete retrieval of studies that meet the criteria. Furthermore, consideration should be given to other human factors and information technology that may facilitate patient–provider communications and coordinated care for chronic conditions as effective care modalities are developed and implemented for HF care management. This study focused on therapeutic interventions that incorporated certain human factors; therefore, comparison of these interventions to those not incorporating human factors was beyond the scope of this analysis. Overall, this research may help reconfigure the design, implementation, and evaluation of clinical practice for reducing HF readmissions in the future.

Appendix A

Table A1. Characteristics of Included Studies.

Authors	Year	Country	Sample (Intervention)	Sample (Control)	Setting	Timing
Brotons et al.[8]	2009	Spain	144	139	After discharge	12 months
Cordisco et al.[9]	1999	US	30	51	After discharge	1 year
Domingues et al.[10]	2011	Brazil	48	63	During hospitalization After discharge 3 months	
Gambetta et al.[11]	2007	US	158	124	After discharge	7 months
Grundtvig et al.[12]	2011	Norway	1169	N/A	After discharge	12 months
Hagglund et al.[13]	2015	Sweden	32	40	After discharge	3 months
Hudson et al.[14]	2005	US	91	N/A	After discharge	6 months
Linden et al.[15]	2014	US	128	129	During hospitalization After discharge **30**, 90 days	
Bailón et al.[16]	2007	Spain	51	131	During discharge	90 days
Miller & Cox[17]	2005	US	68	N/A	After discharge	90 days, 1 year
Stewart et al.[18]	1998	Australia	49	48	After discharge	6 months
Belardinelli et al.[19]	1999	US	50	49	After discharge	14 months
Dracup et al.[20]	2007	US	86	87	After discharge	3, 6, **12** months
Evangelista et al.[21]	2006	US	48	51	After discharge	6 months
Zeitler et al.[22]	2015	US	1159	1172	After discharge	Every 3 months for 2 years
Heisler et al.[23]	2013	US	135	131	During hospitalization After discharge 12 months	
Li et al.[24]	2012	US	202	205	During hospitalization 60 days	
Dekker et al.[25]	2012	US	21	20	During hospitalization After discharge 3 months	
Jayadevappa et al.[26]	2006	US	13	10	After discharge	6 months
Albert et al.[27]	2013	US	20	26	After discharge	60 days
Parrinello et al.[28]	2009	Italy	A=87 B=86	N/A	After discharge	12 months
Paterna et al.[29]	2009	Italy	A=52, B=51, C=51, D=51, E=52, F=50, G=52, H=51	N/A	After discharge	6 months
Kashem et al.[30]	2008	US	24	24	After discharge	12 months
Witham et al.[31]	2005	UK	41	41	After discharge	6 months
Bull et al.[32]	2000	US	40	71	During hospitalization After discharge **2 weeks**, 2 months	
Cline et al.[33]	1998	Sweden	80	110	During hospitalization After discharge 12 months	
Saleh et al.[34]	2012	US	173	160	During discharge After discharge	12 months
Wu et al.[35]	2012	US	A=27 B=27	28	After discharge	9 months
Ekman et al.[36]	2012	Sweden	125	123	During hospitalization 6 months	
Aldamiz-Echevarria Iraúrgui et al.[37]	2007	Spain	137	142	After discharge	12 months
Benatar et al.[38]	2003	US	108	108	After discharge	3 months
Brandon et al.[39]	2009	US	10	10	After discharge	12 weeks
Chen et al.[40]	2010	Taiwan	275	275	After discharge	6 months
DeWalt et al.[41]	2006	US	59	64	After discharge	12 months
Dunagan et al.[42]	2005	US	76	75	After discharge	**6**, 12 months
Falces et al.[43]	2008	Spain	53	50	During discharge	**6**, 12 months
Gattis et al.[44]	1999	US	90	91	After discharge	2, 12, **24** weeks

(continued)

Table A1. (continued)

Authors	Year	Country	Sample (Intervention)	Sample (Control)	Setting	Timing
Giordano et al.[45]	2009	Italy	230	230	During After discharge	hospitalization 12 months
Goldberg et al.[46]	2003	US	138	142	During After discharge	discharge 6 months
Ho et al.[47]	2007	Taiwan	247	N/A	After discharge	139 ± 96 days
Jaarsma et al.[48]	2008	Netherlands	A=340 B=344	339	After discharge	18 months
Jurgens et al.[49]	2013	US	48	51	During After discharge	discharge 90 days
Korajkic et al.[50]	2011	Australia	35	35	After discharge	3 months
Koelling et al.[51]	2005	US	107	116	During	discharge 180 days
Lee et al.[52]	2013	US	23	21	After discharge	3 months
McDonald et al.[53]	2002	Ireland	51	47	During After discharge	hospitalization 3 months
Mejhert et al.[54]	2004	Sweden	103	105	After discharge	18 months
Piepoli et al.[55]	2006	Italy	509	N/A	After discharge	12 months
Roig et al.[56]	2006	Spain	61	N/A	After discharge	11±10 months
Roth et al.[57]	2004	Israel	118	N/A	After discharge	12 months
Sales et al.[58]	2013	US	70	67	During After discharge	hospitalization 30 days
Sethares & Elliott[59]	2004	US	33	37	During After discharge	hospitalization 3 months
Shao & Yeh[60]	2010	Taiwan, China	93	N/A	After discharge	1 month
Sisk et al.[61]	2006	US	203	203	After discharge	12 months
Slater et al.[62]	2008	US	612	N/A	During After discharge	hospitalization 6 months
Wang et al.[63]	2014	China	32	34	During After discharge	hospitalization 6 months
West et al.[64]	1997	US	51	N/A	After discharge	94-182 days
Wheeler & Waterhouse[65]	2006	US	20	20	After discharge	14 weeks
Jiang[66]	2008	China	101	89	During After discharge	hospitalization 6 months
Tully et al.[67]	2014	Australia	A=15 B=14	N/A	After discharge	6 months
Davidson et al.[68]	2010	Australia	52	53	After discharge	12 months
Aguado et al.[69]	2010	Spain	42	64	After discharge	24 months
Anderson et al.[70]	2005	US	44	77	During 6 months After discharge	hospitalization During discharge
Andryukhin et al.[71]	2010	Russia	44	41	After discharge	**6**, 18 months
Dahl & Penque[72]	2001	US	381	203	During After discharge	hospitalization 90 days
Doughty et al.[73]	2002	New Zealand	100	97	After discharge	12 months
Ferrante et al.[74]	2010	Argentina	760	758	After discharge	**1**, 3 years
Gámez-López et al.[75]	2012	Spain	A=25 B=28 C=28	35	After discharge	10.8 ± 3.2 months
Gau et al.[76]	2008	Taiwan, China	30	30	During After discharge	hospitalization 1 month
Hershberger et al.[77]	2001	US	108	N/A	After discharge	6 months
Houchen et al.[78]	2012	UK	17	N/A	After discharge	12 months

(continued)

Table A1. (continued)

Authors	Year	Country	Sample (Intervention)	Sample (Control)	Setting	Timing
Lee et al.[79]	2014	US	473	475	During	hospitalization
30 days						
Liou et al.[80]	2015	Taiwan	56	75	During	hospitalization
After discharge					**30**, 90 days	
Pugh et al.[81]	2001	US	27	31	During	hospitalization
After discharge					12 months	
Riegel et al.[82]	2002	US	126	226	After discharge	**3**, 6 months
Riegel & Carlson[83]	2004	US	45	43	After discharge	**30 days**, 3 months
Smith et al.[84]	2015	US	92	106	After discharge	12 months
Stewart et al.[85]	1999	Australia	100	100	After discharge	6 months
Sun et al.[86]	2013	China	433	288	After discharge	4 years
Szkiladz et al.[87]	2013	US	86	94	During	30 days
					discharge	
					After discharge	
Tsuyuki et al.[88]	2004	Canada	140	136	During	hospitalization
After discharge					6 months	
Vavouranakis et al.[89]	2003	Greece	28	N/A	After discharge	12 months
Wright et al.[90]	2003	New Zealand	100	97	After discharge	12 months
Dracup et al.[91]	2014	US	A=200 B=193	209	After discharge	2 years
Howlett et al.[92]	2009	Canada	990	7741	After discharge	12 months
Jaarsma et al.[93]	1999	Netherlands	84	95	During	hospitalization
After discharge					9 months	
López Cabezas et al.[94]	2006	Spain	70	64	During	12 months
					discharge	
					After discharge	
Naylor et al.[95]	2004	US	118	121	During	hospitalization
After discharge					52 weeks	
Piamjariyakul et al.[96]	2015	US	20	N/A	After discharge	6 months
Jerant et al.[97]	2001	US	A=12 B=13	12	After discharge	6 months
Shao et al.[98]	2013	Taiwan	47	46	After discharge	12 weeks
Varma et al.[99]	1999	UK	42	41	After discharge	12 months
Atienza et al.[100]	2004	Spain	164	174	During	hospitalization
12 months						
Fonarow et al.[101]	1997	US	214	N/A	During	hospitalization
After discharge					6 months	
Holst et al.[102]	2001	Australia	42	N/A	During	hospitalization
After discharge					6 months	
Kanoksilp et al.[103]	2009	Thailand	50	50	After discharge	12 months
Morcillo et al.[104]	2005	Spain	34	36	After discharge	6 months
Ojeda et al.[105]	2005	Spain	76	77	After discharge	16 $\pm$ 8 months
Wang et al.[106]	2011	Taiwan, China	14	13	During	hospitalization
					3 months	
After discharge						
White & Hill[107]	2014	US	59	N/A	During	hospitalization
After discharge					2 months	
Davis et al.[108]	2012	US	63	62	During	hospitalization
After discharge					30 days	
Delaney & Apostolidis[109]	2010	US	12	12	After discharge	90 days
Mao et al.[110]	2015	Taiwan	174	175	After discharge	Median 2 years
Byszewski et al.[111]	2010	Canada	45	46	After discharge	6 weeks
Domingo et al.[112]	2011	Spain	A=48 B=44	N/A	After discharge	12 months
Harrison et al.[113]	2002	Canada	92	100	After discharge	12 weeks
Löfvenmark et al.[114]	2011	Sweden	65	63	After discharge	18 months
Otsu & Moriyama[115]	2012	Japan	47	47	After discharge	**7-12**, 24 months

(continued)

Table A1. (continued)

Authors	Year	Country	Sample (Intervention)	Sample (Control)	Setting	Timing
Rich et al.[116]	1993	US	63	35	During hospitalization 90 days After discharge	During hospitalization During discharge
Rich et al.[117]	1995	US	142	140	During hospitalization 90 days After discharge	During hospitalization During discharge
Stewart et al.[118]	2012	Australia	143	137	After discharge	18 months
Stewart et al.[119]	2014	Australia	137	143	After discharge	12-18 months
Sullivan et al.[120]	2009	US	108	100	After discharge	12 months

Abbreviation: NA, not available.

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