Supplementary table 1: Example search string from Ovid Medline

	Search string Search team
	Free text search
1	Heart failure.mp.
2	Cardiac failure.mp.
3	Congestive heart failure.mp.
4	Ventric* dysfunction.mp.
5	Cardiac dysfunction.mp.
6	Systolic dysfunction.mp.
7	Cardiac insufficiency.mp.
8	Myocardi* insufficiency.mp.
9	Ventric* insufficiency.mp.
10	Myocardi* dysfunction.mp.
11	Myocardi* failure.mp.
12	Ventric* failure.mp.
13	HF.mp.
14	CHF.mp.
15	CCF.mp.
16	LVSD.mp.
17	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
	Medical Subject Heading search
18	exp Heart failure/
19	exp Ventricular dysfunction/ or exp Stroke Volume/ or exp Heart diseases

20	18 or 19
	Free text search
21	Advanced.mp.
22	Chronic.mp.
23	Terminal.mp.
24	End stage.mp.
25	Moderate.mp.
26	Severe.mp.
27	Progressive.mp.
28	Persisitent.mp.
29	Fatal.mp.
30	Limiting.mp.
31	Incurable.mp.
32	Unremitting.mp.
33	Decompensated.mp.
34	NYHA class III.mp.
35	NYHA class IV.mp.
36	21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35
	Free text search
37	Palliat*.mp.
38	Terminal care.mp.
39	Hospice*.mp.
40	End of life care.mp.
41	Holistic.mp.

42	Respite.mp.
43	Supportive care.mp.
44	Care of the dying.mp.
45	Patient centred care.mp.
46	Advance* care
47	Advance* directive
48	37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47
	Medical Subject Heading search
49	exp Palliative care
50	exp "Quality of Life"/ or exp Palliative Medicine/ or exp Terminal Care
51	exp Hospices/ or exp Hospice Care/
52	exp Holistic Health
53	exp Home Nursing/ or exp Respite Care/ or Home Care Services/
54	exp Patient-Centred Care/
55	exp Advance Care planning/
56	exp Advance directives/
57	49 or 50 or 51 or 52 or 53 or 54 or 55 or 56
	Drawing search terms together
58	17 or 20
59	36 and 58
60	48 or 57
61	59 and 60

Supplementary table 2: Characteristics of included studies

First author, year and country	Study setting	Participants: sample size (n), age (years), sex (%), disease characteristics (NYHA Class, LVEF)		Intervention and Comparator	Outcomes	Results
		Intervention	Comparator			
Interventional studies						
Aiken LS (20) 2006 USA	Evaluation phase RCT Community based and Hospital based	Note: Mixed population study with subset analysis of CHF patients in some outcome measures. N = 100 (patients with CHF = 67) Mean Age (SD) = 68 (14) Sex: M = 42.0; F = 58.0	N = 90 (patients with CHF = 62) Mean Age (SD) = 70 (13) Sex: M = 30.0; F = 70.0	PhoenixCare Home-based palliative care focused on disease and symptom management, patient and caregiver education on disease management, and social and psychological support. Providers: Registered nurse case manager (co-ordinator), primary care physician, health-plan case manager, and community agencies supported by a medical director, social worker, and pastoral counsellor.	1. Self-management of illness and knowledge of resources 2. Preparation for end of life 3. Physical and mental functioning a. Participation in enjoyable activities b. Symptom control c. Trajectories of mental and	1. Greater information for self-management, greater appreciation of resources available to help with their illness and initially, better preparedness for daily experiences in the intervention arm. ◈ 2. PhoenixCare participants showed a higher rate of having a living will or advance directive *vs* controls. ($p < 0.05$). ◈

Supplementary table 2: Characteristics of included studies

		No data on NYHA Class or LVEF	No data on NYHA Class or LVEF	Usual Care Medical and disease orientated care included medication and technical treatment and other support service. Providers: Managed care organisations.	4. Utilisation of medical service	3a. NSD in CHF. 3b. High symptom distress in PhoenixCare ($p < 0.05$). 3c. NSD in mental and physical functioning among CHF control. 4. Relatively unchanged over time with NSD across arms.
Bekelman DB (21) 2015 USA	Evaluation phase RCT with >80% power Community based with outpatient consultations	N = 187 Mean Age (SD) = 68.3 (9.6) Sex: M = 95.2; F = 4.8 NYHA class I = 16 (8.9%) NYHA class II = 77 (42.8%)	N = 197 Mean Age (SD) = 67.9 (10.6) Sex: M = 98.0; F = 2.0 NYHA class I = 16 (8.5%) NYHA class II = 85 (45.0%)	Patient-Centred Disease Management Multidisciplinary collaborative care of HF disease management, screening for and treatment of depression and telemonitoring with patient self-care support. Providers: Registered nurse (co-ordinator), primary care physician, psychiatrist. Usual Care	1. HF-specific health status 2. Depression 3. Mortality 4. Hospitalisation	1. NSD in KCCQ overall score. 2. Greater improvement in PHQ-9 in the intervention arm ($p = 0.01$). 3. Fewer patients died in the intervention arm ($p = 0.04$). 4. NSD in hospitalisations.

Supplementary table 2: Characteristics of included studies

		NYHA class III = 82 (45.6%) NYHA class IV = 5 (2.8%) LVEF: Normal = 78 (45.6%) Mild = 34 (19.9%) Moderate = 46 (26.9%) Severe = 13 (7.6%)	NYHA class III = 82 (43.4%) NYHA class IV = 6 (3.2%) LVEF: Normal = 84 (47.5%) Mild = 34 (19.2%) Moderate = 32 (18.1%) Severe = 27 (15.3%)	Regular care at the discretion of health care provider. Information sheets for self-care given and if patients screened positive for depression at baseline, primary care physicians were notified. Providers: Regular health care professionals and nurses.		
Brännström M (22) 2014 Sweden	Evaluation phase RCT with 80% power Community based with outpatient consultations	N = 36 Mean Age (SD) = 81.9 (7.2) Sex: M = 72.2; F = 27.8	N = 36 Mean Age (SD) = 76.6 (10.2) Sex: M = 69.4; F = 30.6	<u>Palliative advanced home care and heart failure care (PREFER) model</u> Person-centred care, total care including assessment of symptoms, quality of life, and risk, and registration into HF and palliative care registry.	1. Symptom burden 2. Health related quality of life 3. Disease-specific quality of life 4. Functional classes 5. Hospitalisation 6. Resource utilisation	1. NSD in overall score 2. Age-adjusted health related quality of life was better in PREFER group (p = 0.02). 3. NSD in overall disease specific quality of life. 4. Improved mean NYHA class (p = 0.012) and

Supplementary table 2: Characteristics of included studies

		NYHA class III = 28 (77.8%) NYHA class IV = 8 (22.2%) LVEF: 40-49% = 13 (36.1%) 30-39% = 16 (44.4%) <30% = 7 (19.4%)	NYHA class III = 23 (63.9%) NYHA class IV = 11 (30.6%) LVEF: 40-49% = 12 (33.3%) 30-39% = 21 (58.3%) <30% = 3 (8.3%)	Providers: Specialised nurses, palliative care nurses, cardiologist, palliative care physician, physiotherapist, and occupational therapist. <u>Usual care</u> No information. Providers: General practitioners or doctors and/ or the nurse-led heart failure clinic.		more experienced improved NYHA class (p = 0.015) in the PREFER arm. 5. Fewer hospitalisations in the PREFER group (p = 0.009); with fewer days spent in hospital (p = 0.0011); NSD in mortality 6. Utilisation of visits differed significantly between the two arms in favour of the intervention, but precise results are unclear.
Hopp FP (23) 2016 USA	Evaluation phase RCT with approx. 80% power Hospital based	N = 43 Mean Age (SD) = 67.0 (11.0)	N = 42 Mean Age (SD) = 68.0 (13.0)	<u>Palliative Care Consultation</u> Clinical interviews to assess for uncontrolled symptoms, goals of care, advance care planning, code status, and desired post-treatment residential setting.	1. Election vs non-election of comfort care a. Outpatient hospice b. Inpatient hospice	1. NSD in the primary end point. 2. NSD in mortality.

Supplementary table 2: Characteristics of included studies

		Sex: M = 60.5; F = 39.5 No data on NYHA Class Mean LVEF = 36.4% (16.7)	Sex: M = 42.9; F = 57.1 No data on NYHA Class Mean LVEF = 38.1% (16.8)	Providers: Physician and advanced nurse practitioner. Other professionals participated as needed – chaplains and social workers. <u>Usual Care</u> No information.	c. A "Do Not Resuscitate" order during hospitalisation d. A "Do Not Resuscitate" order at home or nursing home	
Rogers JG (24) 2017 USA	Evaluation phase RCT with <80% power Community based and Hospital based	N = 75 Mean Age (SD) = 71.9 (12.4) Sex: M = 56.0; F = 44.0 NYHA class III = 54 (72.0%) NYHA class IV = 15 (20.0%) LVEF:	N = 75 Mean Age (SD) = 69.8 (13.4) Sex: M = 49.3; F = 50.7 NYHA class III = 58 (77.3%) NYHA class IV = 5 (6.7%) LVEF:	<u>Palliative Care in Heart Failure (PAL-HF)</u> Interdisciplinary, guideline-driven, multicomponent palliative care intervention in combination with contemporary HF management, including assessment and management of physical symptoms, psychosocial and spiritual concerns and advance care planning	1. HF-specific quality of life 2. General and palliative care specific, health related quality of life 3. Spiritual wellbeing 4. Depression and anxiety	1. Greater improvements in the HF-specific quality of life (p = 0.03) in PAL-HF arm 2. Greater improvement in health related quality of life in the intervention arm (p = 0.035). 3. Spiritual wellbeing was better improved in the intervention arm (p = 0.027) 4. Depressive symptoms improved more in the

Supplementary table 2: Characteristics of included studies

		>55% = 21 (28.0%) 40-55% = 14 (18.7%) 25-40% = 17 (22.7%) <25 = 23 (30.7%)	>55% = 14 (18.7%) 40-55% = 19 (25.3%) 25-40% = 14 (18.7%) <25 = 28 (37.3%)	Providers: Palliative care nurse practitioner, palliative medicine board-certified physician, clinical cardiology team, and when required, mental health provider. <u>Usual care</u> Inpatient care focused on symptom relief with outpatient follow up. They were not denied access to inpatient palliative care consultation. Providers: Cardiologist directed team with HF expertise in inpatient setting. General practitioners , HF cardiologists, nurse practitioners in outpatient setting.		intervention arm (p = 0.02), as well as anxiety (p = 0.048).
Sahlen KG (25) 2015 Sweden	Evaluation phase RCT with 80% power	N = 36 Mean Age (SD) = 81.9 (7.2)	N = 36 Mean Age (SD) = 76.6 (10.2)	Note: Same study as Brännström *et al.* (3) <u>PREFER model</u>	1. Quality adjusted life years 2. Costs of care	1. Small but significant difference in the weight of the quality adjusted life year (p = 0.026) favouring PREFER.

Supplementary table 2: Characteristics of included studies

	Community based with outpatient consultations	Sex: M = 72.2; F = 27.8 No data on NYHA Class or LVEF	Sex: M = 69.4; F = 30.6 No data on NYHA Class or LVEF	Person-centred care, total care including assessment of symptoms, quality of life, and risk, and registration into HF and palliative care registry. Providers: Specialised nurses, palliative care nurses, cardiologist, palliative care physician, physiotherapist, and occupational therapist. <u>Usual care</u> No information. Providers: General practitioners or doctors and/ or the nurse-led heart failure clinic.		2. NSD in cost of care between the two arms.
Sidebottom AC (26) 2015 USA	Evaluation phase RCT, but poor recruitment	N = 116 Mean Age (SD) = 76.0 (11.9)	N = 116 Mean Age (SD) = 70.9 (13.6)	<u>Palliative care</u> Assessment of symptom burden, emotional, spiritual and psychosocial care, coordination of care orders, recommendation for	1. Symptom burden 2. Depression 3. Quality of life 4. Readmissions 5. Hospice use	1. Difference in symptom burden favours intervention in mean change from baseline ($p < 0.001$).

Supplementary table 2: Characteristics of included studies

	resulted in 47.5% power 1 Inpatient consultation	Sex: M = 47.4; F = 52.6 No data on NYHA Class or LVEF	Sex: M = 57.8; F = 42.2 No data on NYHA Class or LVEF	change in current or future treatments. Providers: 4 physicians board certified in hospice and palliative medicine, 2 clinical nurse specialists board certified in advanced practice palliative care nursing, a social worker and a chaplain. <u>Control group</u> No information.	6. ACP 7. Mortality	2. Difference in depression favours intervention ($p < 0.001$). 3. Improvement of quality of life is better in the intervention arm ($p < 0.001$). 4. NSD in readmissions 5. NSD in hospice use between arms. 6. ACP process 2.87 times more likely in intervention. 7. NSD in mortality.
Wong FKY (27) 2016 China	Evaluation phase RCT Community based	N = 43 Mean Age (SD) = 78.3 (16.8) Sex: M = 43.9; F = 56.1	N = 41 Mean Age (SD) = 78.4 (10.0) Sex: M = 61.0; F = 39.0	<u>Transitional Care Palliative End-Stage Heart Failure</u> Pre-discharge assessment, patients' needs assessment (environmental, psychosocial, physiological and health-related behaviour) and intervention, goal setting and creating a mutually agree care plan.	1. Readmissions at 4 and 12 weeks 2. Symptom intensity 3. Functional status 4. Quality of life 5. Satisfaction with care	1. NSD in 4 week re-admission rate, however there was significantly fewer 12 week re-admissions in the intervention arm ($p = 0.001$).

Supplementary table 2: Characteristics of included studies

		NYHA class II = 6 (14.0%) NYHA class III = 31 (72.0%) NYHA class IV = 6 (14.0%) Mean LVEF = 39.0% (14.0)	NYHA class II = 3 (7.3%) NYHA class III = 22 (53.7%) NYHA class IV = 16 (39.0 %) Mean LVEF = 37.0% (17.0)	Providers: Nurse case managers (primary provider), trained volunteers, and nursing students. <u>Control group</u> Usual care – palliative care medical clinic, discharge advice on symptom management and medication, and referrals if appropriate. Also, control group received 2 attention control social calls.		2. NSD in symptom burden across groups. 3. NSD in functional status between or within groups. 4. Both heart failure specific (p = 0.01) and palliative care specific (p = 0.05) quality of life tools found significant improvement in the intervention arm. 5. The intervention group had significantly (p < 0.001) higher satisfaction with care.
Paes P (28) 2005 UK	Feasibility and pilot phase RCT Outpatient consultations	N = 6 Mean Age (SD) = 73.2 (4.2)	N = 7 Mean Age (SD) = 78.0 (7.0)	<u>Palliative care consultation</u> 1 hour of palliative care medical outpatient consultation, followed by monthly 30-minute consultation for a total of 5 months.	1. Depression 2. Quality of life 3. Clinical evaluation	1. NSD in depression between treatment arms. 2. NSD in quality of life between treatment arms.

Supplementary table 2: Characteristics of included studies

		Sex: M = 100.0; F = 0.0 NYHA class III = 3 (50.0%) NYHA class IV = 3 (50%) No data on LVEF	Sex: M = 80.0; F = 20.0 NYHA class III = 3 (60.0%) NYHA class IV = 2 (40%) No data on LVEF	Provider: Palliative care physician. <u>Control group</u> Regular cardiology care.		3. The evaluation forms were positive and found the format acceptable.
O'Donnell A (30) 2018 USA	Pilot study RCT In-patient or community consultations	N = 26 Mean Age (SD) = 74.7 (11.2) Sex: M 53.9, F = 46.1 NYHA class 1 or 2 = 10 (38.5%)	N = 24 Mean Age (SD) = 69.2 (10.2) Sex: M = 62.5, F = 37.5 NYHA class 1 or 2 = 8 (33.3%)	<u>Social Work (palliative care trained) consultation</u> <u>Conversation about goals of care and advanced care planning started in hospital and continued in the community post-discharge.</u> <u>Palliative physician assessment and management plan including outpatient palliative medicine consults as needed</u> <u>Provider: Palliative social worker and palliative physician</u>	1. % patients with ACP documentation and % aligned preferences at 6 months 2. FACIT-Sp 3. Patient and provider preferences of care questionnaire 4. KCCQ-12 5. EQ-5D VAS 6. PHQ-8 7. GAD-7	1. Higher % with ACP documentation in intervention arm (p = 0.02), and better alignment with physician assessed prognosis in intervention arm (p <0.001) NSD in any other outcome measure.

Supplementary table 2: Characteristics of included studies

		NYHA class 3 or 4 = 16 (61.5%) Mean LVEF = 30% (14)	NYHA class 3 or 4 = 16 (66.7%) Mean LVEF = 36% (17)	Control: Usual care, includes available information about palliative care and advance care planning, and access to in-patient palliative care team if needed. NB. Out patient palliative care consults NOT part of usual care.		
Johnson MJ (31) 2018 UK	Out-patient or home-based interventions	Cohort 1: palliative cardiology N = 43 Mean Age (SD) = 75.8 (12.3) Sex: M 55.8, F = 44.2 NYHA: class I = 0 class II = 0	Cohort 2: usual care N = 34 Mean Age (SD) = 78.4 (11.3) Sex: M 50.0, F = 50.0 NYHA: class I = 0 class II = 3 (8.8) class III = 30 (88.2)	Cohort 1. Palliative cardiology clinic consultations with a cardiologist and heart failure nurse consultant with a special interest in palliative care. Full holistic assessment, medication review, advance care planning, symptom management, care co-ordination, and community based follow up with liaison with primary care. Referrals to other services including specialist palliative care as needed Cohort 2. Usual care. Case-based care from heart failure nurse	1. Feasibility measures (recruitment, attrition, data quality, sample size calculation for trial) 2. AKPS 3. ESAS 4. KCCQ-12 5. HADs 6. EQ-5L-5D 7. Health service utilisation 8. Patient understanding 9. ACP documentation 10. Survival	Groups imbalanced; Cohort 1 less well, more symptomatic and worse QoL 1. Concluded a future trial was feasibility and sample size for KCCQ-12 as primary outcome calculated 2. NSD AKPS 3. Greater improvement in usual care (p = 0.046) 4. NSD KCCQ-12 5. NSD HADs 6. NSD EQ-5D-5L

Supplementary table 2: Characteristics of included studies

		class III = 40 (93.0) class IV = 3 (7.0)	class IV = 1 (2.9)	specialist in community care, with access to hospital-based cardiology physicians as needed. Specialist palliative care available if referred.		7. Fewer nights in hospital but more GP visits in cohort 1. Average costs reduced by £785 per patient. 8. Better patient understanding in Cohort 1 ($p<0.001$) 9. More ACP documentation in Cohort 1 ($p<0.001$) 10. NSD in survival
Bakitas M (29) 2017 USA	Single-arm feasibility and pilot phase trial Community based with outpatient consultations	N = 61 Mean Age (SD) = 70.59 (10.7) Sex: M = 50.8; F = 49.2 NYHA class I = 1 (1.6%) NYHA class II = 3 (4.9%) NYHA class III = 43 (70.5%) NYHA class IV = 12 (19.7%) Unknown = 2 (3.3%)		Educate, Nuture, Advise, Before Life Ends Comprehesive Heartcare for Patients and Caregivers (ENABLE CHF-PC) A telephonic early palliative care intervention for rural-dwelling, underserved HF patient and caregivers including in-person palliative care consultation, weekly semi-structured telephone palliative	1. Feasibility and acceptability 2. Patient reported outcomes a. Disease specific quality of life b. Symptom burden c. Anxiety and depression	1. Results discussed in paper – not relevant to the review. 2. Patient reported outcomes a. Significant improvement in KCCQ clinical summary ($p = 0.009$)

Supplementary table 2: Characteristics of included studies

		Mean LVEF = 37.86% (16.3)	care nurse coaching, and monthly follow-ups. Providers: Trained nurse coaches	d. General wellbeing e. Assessment of chronic illness care 3. Caregiver reported outcomes a. Caregiving outcomes measuring life changes b. Anxiety and depression c. General wellbeing d. Caregiver burden e. Positive aspects of caregiving 4. Resource use a. Number of days in hospital per month	b. Significant reduction in symptom burden (p = 0.0004) c. NSD in anxiety or depression d. NSD in physical health, however there was significant improvement in the global mental health T score of PROMIS (p = 0.04) e. NSD in PACIC summary score. 3. Caregiver reported outcomes a. NSD in caregiving outcomes. b. NSD in anxiety or depression.

Supplementary table 2: Characteristics of included studies

				b. Number of days in ICU per month c. Number of visits to ED per month d. Hospice use	c. NSD in the carer's general wellbeing. d. Significant reduction in burden on the carer (p = 0.002) e. NSD in the positive aspects of caregiving. 4. Resource use a. Significant reduction in number of days in hospital per month (p = 0.002) b. NSD in number of days in ICU per month c. NSD in number of visits to ED per month d. NSD in hospice use.

Supplementary table 2: Characteristics of included studies

Tadwalkar R (32) 2014 USA	Quasi-experimental trial Inpatient visits	N = 14 Mean Age (SD) = 58 (11) Sex: M = 42.9; F = 57.1 No data on NYHA Class or LVEF	N = 9 Mean Age (SD) = 57 (10) Sex: M = 55.6; F = 44.4 No data on NYHA Class or LVEF	<u>Religious support</u> Prayer, reading of religious text, religion-specific rituals, and other pastoral care. Provider: member of the chaplaincy. <u>Non-religious support</u> Personal discussions, recreational activities, undertaking social and spiritual support. Provider: in-house volunteer.	1. Depression 2. Spirituality 3. Symptom burden 4. Enjoyment and life satisfaction	1. Significant reduction in depression over time but there was NSD between the two groups. 2. NSD in spirituality between the two groups or over time. 3. NSD in symptom burden between groups or over time. 4. NSD in enjoyment and life satisfaction between groups or over time.
Observational studies						
Connor SR (33) 2007 USA	Retrospective Cohort Study Hospice care	N = 2095 (patients with CHF = 83) Mean Age = 73.5	N = 2260 (patients with CHF = 457) Mean Age = 73.9	<u>Intervention</u> Hospice care <u>Comparator</u> No claims for hospice care	1. Survival	1. Increase in survival period in those who received hospice care (p = 0.0540).

Supplementary table 2: Characteristics of included studies

		Sex: M = 55; F = 45 No data on NYHA Class or LVEF	Sex: M = 59; F = 41 No data on NYHA Class or LVEF			
Enguidanos SM (34) 2005 USA	Prospective Cohort Study Community based with outpatient consultations	Note: Mixed population study with subset analysis of CHF patients N = 159 (patients with CHF = 31) Mean Age (SD) = 70 (13.92) Sex: M = 49.1; F = 50.9	N = 139 (patients with CHF = 51) Mean Age (SD) = 73 (13.29) Sex: M = 44.6; F = 55.4	<u>Kaiser Permanente Home-based Palliative Care Program</u> Extensive patient and family education on the disease/ condition; training in symptom control; psychosocial support aimed at assisting in making care choices in advance. Providers: Physicians, nurses, social workers, and other health care professionals. <u>Usual Care</u> Standard Kaiser Permanente TriCentral Service Area care.	1. Severity of illness 2. Service use 3. Site of death 4. Days on service 5. Costs of care	1. Intervention group had significantly ($p < 0.001$) more severe illness at enrolment. ◈ 2. NSD in obtaining hospice care between groups. ◈ 3. Palliative care arm were significantly more likely to die at home ($p < 0.001$). 4. Significantly fewer days on service ($p < 0.001$) in the intervention arm. 5. Palliative care group on

Supplementary table 2: Characteristics of included studies

		No data on NYHA Class or LVEF	No data on NYHA Class or LVEF	Standard health care in response to needs and home care only when Medicare certified criteria are fulfilled. Access to psychosocial support and social services is very limited.		average cost less than those in the control group.
Pattenden JF (35) 2013 UK	Prospective Cohort Study Community based	N = 99 Mean Age (SD) = 81.7 Sex: M = 60.6; F = 39.4 No data on NYHA Class or LVEF	N = 98 Mean Age (SD) = 78.85 Sex: M = 62.0; F = 37.8 No data on NYHA Class or LVEF	<u>Better Together Intervention</u> Self-management education and advice to patients and their carers, clinical assessment and regular monitoring and review, palliative nursing e.g. medication for symptoms and psychological support, respite care. Providers: British Heart Failure (BHF) Heart Failure Specialist Nurses (HFSN); Marie Curie Cancer Care Nurses (MCN), Marie Curie Cancer Care Healthcare Assistants (MCHCAs); district nurses and other support services.	1. Resource use – admissions, length of stay 2. Costs of care 3. Benefits of care – death in preferred place of care 4. Cost-effectiveness	1. Smaller proportion of patients in the intervention group in Bradford was admitted to hospital ($p < 0.01$), and fewer admissions per patient in the intervention arm in Poole ($p < 0.05$). NSD in LOS. 2. Fewer costs of care in the intervention in both sites (significant in Bradford).

Supplementary table 2: Characteristics of included studies

				Control patients 'Convenience sample' historical sample.		3. Significantly different distribution of place of death ($p < 0.0001$). 4. Uncertainty around incremental cost-effectiveness.
Evangelista LS† (36) 2014 USA	Prospective Single-arm Cohort Study Outpatient consultations	N = 29 Mean Age (SD) = 53.3 (7.3) Sex: M = 75.9; F = 24.1 NYHA class II = 20 (69.0%) NYHA class III = 9 (31.0%) Mean LVEF = 23.1% (4.3)	N = 13 Mean Age (SD) = 52.5 (7.6) Sex: M = 61.5; F = 38.5 NYHA class II = 9 (69.2%) NYHA class III = 4 (30.8%) Mean LVEF = 30.5% (9.7)	Palliative Care Intake summary with current health status and treatment regimen, assessment of physical and psychological symptoms, determine illness understanding, establish goals of care, assist with treatment decision making and coordination of care. Providers: Palliative care specialist (e.g. physician or advance practice nurse). 'Intervention group' Participants receiving > 2 palliative care consultations.	1. Perceived control 2. Patient activation 3. Symptom distress	1. Greater improvement in perceived control ($p < 0.001$). 2. Greater improvement in activation ($p < 0.001$). 3. Greater reduction in symptom distress ($p < 0.001$).

Supplementary table 2: Characteristics of included studies

				'Comparator group' Participants receiving ≤ 1 palliative care consultations.		
Evangelista LS* (37) 2014 USA	Prospective Single-arm Cohort Study Outpatient consultations	N = 29 Mean Age (SD) = 54.1 (8.4) Sex: M = 75.9; F = 24.1 NYHA class II = 20 (69.0%) NYHA class III = 9 (31.0%) Mean LVEF = 25.9% (5.3)	N = 7 Mean Age (SD) = 52.7 (6.3) Sex: M = 57.1; F = 42.9 NYHA class II = 5 (71.4%) NYHA class III = 2 (28.6%) Mean LVEF = 23.1% (4.3)	Palliative Care Comprehensive physical and psychosocial assessment, discussions about advance care planning, developed a treatment plan (with participants) and listing goals of care. Providers: Palliative care specialist (e.g. physician or advance practice nurse). 'Intervention group' Participants receiving palliative care consultation and follow up. 'Comparator group' Participants receiving initial palliative care consultation only.	1. Symptom rating 2. Type of palliative care, focus of care, medication use	1. Improvement in symptom burden in those who were followed up ($p < 0.001$). 2. Patients who chose to have additional palliative care input were referred to: • Pharmacist for new medication (69%) or changes to their medication (24% • social work support (69%) • physical and occupational therapists (66%)

Supplementary table 2: Characteristics of included studies

						• psychiatrists (55%) • chaplain (45%) • home health (83%) • support groups (31%) and • hospice (7%).
Taylor GJ (38) 2017 USA	Retrospective Single-arm Cohort Study Community based	N = 32 Age Range (Median) = 48-94 (70) Sex: M = 100; F = 0 NYHA class III = 2 (6.7%) NYHA class IV = 28 (93.3%) No specific data on LVEF, but 23 patients had HFrEF (LVEF <30%) and 7 had HFpEF.	<u>Intervention</u> Home-delivered palliative care with intensive guidelines-directed medical therapy using the standard hospice approach to psychosocial and spiritual aspects of end-of-life care, optimising the drug therapy, and laboratory evaluation when clinically indicated. Providers: Home-hospice nurses, cardiologists, social workers, chaplains, and volunteers. No control	1. Re-hospitalisations 2. Death at home 3. NYHA functional class 4. BNP levels	1. Drop in hospital admissions from 110 admissions in the 6 months prior to enrolment to 26 admissions after enrolment. 2. 18 out of the 21 patients who died, did so at home. 3. Improvement in pre-post NYHA class IV versus NYHA class III ($p < 0.001$). 4. Improvement in BNP levels following

Supplementary table 2: Characteristics of included studies

					treatment with L-dopa (p = 0.014).
Wong RC (39) 2013 Singapore	Prospective Single-arm Cohort Study Community based	N = 44 Mean Age (SD) = 79 (9) Sex: M = 38.6; F = 61.4 NYHA class III = 31 (70.0%) NYHA class IV = 13 (30.0%) No data on LVEF		<u>Home Palliative Care Program</u> Measure patient's physiological parameters, physical examination to elicit relevant signs and symptoms, medication modification or initiation to palliate patient's symptoms. Providers: Doctor, nurse and/ or counsellor. No control	1. HF hospitalisation 2. All cause hospitalisation 3. Time to death	1. Mean HF hospitalisation improved from baseline (p < 0.0001). 2. Mean all-cause hospitalisation improved from baseline (p < 0.0001). 3. Mean time to death was 5.5 months.
Cassel JB (40) 2016 USA	Retrospective Case-Control Study Community based	N = 174 Mean Age (SD) = 87.5 (6.6) Sex: M = 44.3; F = 55.7	N = 499 Mean Age (SD) = 87.1 (6.4) Sex: M = 43.7; F = 56.3	<u>Transitions</u> Concurrent care home-based program including in home medical consultation, ongoing prognostication, caregiver support, advance healthcare planning, symptom management, education,	1. Costs: a. Costs per month for hospital care b. Costs per month for other care c. All costs per month 2. Hospitalisation	1. Improvement in costs per month for hospital care (p < 0.001) and all costs per month (p < 0.001) in the Transitions participants. NSD in costs per month for other care.

Supplementary table 2: Characteristics of included studies

		No data on NYHA Class or LVEF	No data on NYHA Class or LVEF	and psychosocial and spiritual support. Providers: Doctors, nurses, spiritual care providers, and social workers. <u>Comparator</u> No information.	a. Percentage hospitalised at least once b. Number of hospitalisations per month c. Number of hospital days per month d. 30-day readmission rate e. ICU stay during admission within 30 days of death 3. Admission within 30 days of death and death in hospital	2. Lower percentage of patients hospitalised at least once, fewer number of hospitalisations per month, fewer number of hospital days per month, lower rate of 30-day readmission and lower rate of ICU stay prior to death ($p < 0.001$) in the intervention arm. 3. Lower percentage of patients from the Transitions arm were admitted within 30 days of death and dying in hospital ($P < 0.001$)
Evangelista LS (41) 2012	Prospective Case-Control Study	N = 36 Mean Age (SD) = 53.9 (8.0)	N = 36 Mean Age (SD) = 53.3 (8.7)	<u>Palliative care consultation</u> Assessment of current medical status and screening intake, evaluation of patient's goals and	1. Symptom burden 2. Depression 3. Quality of life	1. Lower symptom burden following intervention ($p = 0.031$).

Supplementary table 2: Characteristics of included studies

USA	1 Outpatient consultation	Sex: M = 72.2; F = 27.8 NYHA class II = 25 (69.4%) NYHA class III = 11 (30.6%) Mean LVEF = 25.4% (5.2)	Sex: M = 69.4; F = 30.6 NYHA class II = 26 (72.2%) NYHA class III = 10 (27.8%) Mean LVEF = 26.0% (6.2)	preferences, assessment of areas of perceived needs and establish a treatment plan with co-ordination of care. Providers: Palliative care physician or advance practice nurse. <u>Control</u> No information.		2. Lower depression following intervention (p = 0.034). 3. Quality of life significantly improved following intervention (p = 0.015).
Blecker S (42) 2011 USA	Cross-Sectional Study Hospice Care	N = 6,436 Mean Age (SD) = 85.0 (7.6) Sex: M = 39.5; F = 60.5 No data on NYHA Class or LVEF	N = 10,177 Mean Age (SD) = 83.6 (7.9) Sex: M = 44.5; F = 55.5 No data on NYHA Class or LVEF	<u>Intervention</u> Hospice care <u>Comparator</u> No claims for hospice care	1. Costs 2. Resource use – hospitalisations, ICU admission, length of stay in hospital and ICU	1. Higher total adjusted expenditures in hospice care. 2. Hospice care patients were less likely to be admitted to hospital or have ICU stay during this time, and spent significantly less time in hospital or ICU.

Note: Evangelista LS 2014† is titled: On-going palliative care enhances perceived control and patient activation and reduces symptom distress in patients with symptomatic heart failure: A pilot study and Evangelista LS 2014 is titled: Does the Type and Frequency of Palliative Care Services Received by Patients with Advanced Heart Failure Impact Symptom Burden?*

◇ *is used where there is no subset analysis of CHF population in mixed population studies.*

Abbreviations: NYHA = New York Heart Association; LVEF = Left Ventricular Ejection Fraction; RCT = Randomised Controlled Trial; CHF = Congestive Heart Failure; SD = Standard Deviation; HF = Heart Failure; KCCQ = Kansas City Cardiomyopathy Questionnaire; PHQ-9 = Patient Health Questionnaire-9; ACP = Advance Care Planning; NSD = no significant difference; LOS = length of stay.

Supplementary table 3: Breakdown of palliative care components delivered in the included studies

Study	Components of palliative care	Assessment of current status	Assessment of need	Assessment of quality of life	Symptom management	Psychological support	Social support	Spiritual support	Medication review and monitoring	Tele-health and monitoring	Patient education	Goal setting	Advance care planning	Coordination of care	Multidisciplinary involvement	Carer/ family support
Aiken LS (20		✓	✓		✓	✓	✓		✓		✓		✓	✓	✓	✓
Bekelman DB (21)		✓	✓	✓	✓	✓			✓	✓	✓				✓	
Brännström M (22)		✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
Hopp FP (23)			✓									✓	✓		✓	
Rogers JG (24)		✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	
Sahlen KG (25)		✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
Sidebottom AC (26)		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	
Wong FKY (27)		✓	✓	✓	✓					✓		✓	✓		✓	
Paes P (28)		✓	✓	✓	✓	✓			✓		✓		✓		✓	
Bakitas M (29)		✓	✓	✓	✓					✓	✓	✓			✓	✓
O'Donnell A (30)		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Johnson MJ (31)		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Tadwalkar R (32)			✓	✓		✓		✓							✓	
Connor SR (33)		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Enguidanos SM (34)		✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	
Pattenden JF (35)		✓	✓		✓	✓			✓		✓				✓	✓
Evangelista LS† (36)		✓	✓		✓	✓				✓	✓	✓	✓	✓	✓	
Evangelista LS* (37)		✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	
Taylor GJ (38)		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	✓	
Wong RC (39)		✓	✓		✓				✓	✓			✓		✓	
Cassel JB (40)		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Evangelista LS (41)		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓	
Blecker S (42)		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Supplementary table 4: Results of risk of bias assessment with the Cochrane Risk of Bias tool

Study	Adequate sequence generation?	Allocation concealment?	Blinding (participants and personnel)	Blinding (outcome assessors)	Incomplete outcome data addressed?	Free of selective reporting?
Aiken LS 2006 (20)	☑	☑	☒	☑	☒	☑
Bekelman DB 2015 (21)	☑	☑	☒	☑	☑	☑
Brännström M 2014 (22)	☑	☑	☒	☒	?	☑
Hopp FP 2016 (23)	?	?	☒	☒	☑	☒
Rogers JG 2017 (24)	☑	?	☒	☒	☑	☑
Sahlen KG 2015 (25)	☑	☑	☒	☒	☑	☑
Sidebottom AC 2015 (26)	?	?	☒	☒	☑	☑
Wong FKY 2016 (27)	☑	☑	☒	☑	☑	☑
Paes P 2005* (28)	☑	☒	☒	☒	☒	☑
Bakitas M 2017 (290)	**N/A**	**N/A**	☒	☒	☑	☑
Tadwalkar R 2014 (32)	**N/A**	**N/A**	☒	☒	?	☑
O'Donnell A 2018 (30)	☑	?	☒	?	☑	☑

* *Derived from the full thesis on which the letter was based and not from the limited information in the published letter.*

N/A = not applicable

Key: ☑ = low risk of bias, ☒ = high risk of bias, ? = risk of bias unclear

Supplementary table 5: Results of NOS risk of bias assessment for cohort studies

Study	Representativeness of exposed cohort	Selection of non-exposed cohort	Ascertainment of exposure	Outcome of interest not present at start of study	Comparability of cohorts	Assessment of outcome	Length of follow up	Adequacy of follow up
Connor SR 2007 (33)	★	★	★	★	★	★	★	★
Enguidanos SM 2005 (34)	★	★	★	★	★	★	★	★
Pattenden JF 2013 (35)	★	★	★	★	★	★	★	★
Evangelista LS 2014† (36)	★	★	★	★	★	★	★	★
Evangelista LS 2014* (37)	★	★	★	★	★	★	★	★
Taylor GJ 2017 (38)	★	★	★	★	★	★	★	★
Wong RC 2013 (39)	★	★	★	★	★	★	★	★
Johnson MJ 2018* (31)	★	★	★	★	★	★	★	★

Key: ★ = low risk of bias, ★ = high risk of bias, ★ = risk of bias unclear

* Designed as a nonrandomised feasibility study rather than to examine outcomes, but methods more suited to quality appraisal as observational data.

Supplementary table 6: Results of NOS risk of bias assessment for case-control studies

Study	Adequate case definition	Representativeness of cases	Selection of controls	Definition of controls	Comparability of cases and controls	Ascertainment of exposure	Same method of ascertainment for cases and controls	Non-response rate
Cassel JB 2016 (40)	★	★	★	★	★	★	★	★
Evangelista LS 2012 (41)	★	★	★	★	★	★	★	★

Key: ★ = low risk of bias, ★ = high risk of bias, ★ = risk of bias unclear

Supplementary table 1: Example search string from Ovid Medline

	Search string	Search team
	Free text search	
1	Heart failure.mp.	
2	Cardiac failure.mp.	
3	Congestive heart failure.mp.	
4	Ventric* dysfunction.mp.	
5	Cardiac dysfunction.mp.	
6	Systolic dysfunction.mp.	
7	Cardiac insufficiency.mp.	
8	Myocardi* insufficiency.mp.	
9	Ventric* insufficiency.mp.	
10	Myocardi* dysfunction.mp.	
11	Myocardi* failure.mp.	
12	Ventric* failure.mp.	
13	HF.mp.	
14	CHF.mp.	
15	CCF.mp.	
16	LVSD.mp.	
17	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16	
	Medical Subject Heading search	
18	exp Heart failure/	
19	exp Ventricular dysfunction/ or exp Stroke Volume/ or exp Heart diseases	

20	18 or 19
	Free text search
21	Advanced.mp.
22	Chronic.mp.
23	Terminal.mp.
24	End stage.mp.
25	Moderate.mp.
26	Severe.mp.
27	Progressive.mp.
28	Persisitent.mp.
29	Fatal.mp.
30	Limiting.mp.
31	Incurable.mp.
32	Unremitting.mp.
33	Decompensated.mp.
34	NYHA class III.mp.
35	NYHA class IV.mp.
36	21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35
	Free text search
37	Palliat*.mp.
38	Terminal care.mp.
39	Hospice*.mp.
40	End of life care.mp.
41	Holistic.mp.

42	Respite.mp.
43	Supportive care.mp.
44	Care of the dying.mp.
45	Patient centred care.mp.
46	Advance* care
47	Advance* directive
48	37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47
	Medical Subject Heading search
49	exp Palliative care
50	exp "Quality of Life"/ or exp Palliative Medicine/ or exp Terminal Care
51	exp Hospices/ or exp Hospice Care/
52	exp Holistic Health
53	exp Home Nursing/ or exp Respite Care/ or Home Care Services/
54	exp Patient-Centred Care/
55	exp Advance Care planning/
56	exp Advance directives/
57	49 or 50 or 51 or 52 or 53 or 54 or 55 or 56
	Drawing search terms together
58	17 or 20
59	36 and 58
60	48 or 57
61	59 and 60

Supplementary table 2: Characteristics of included studies

First author, year and country	Study setting	Participants: sample size (n), age (years), sex (%), disease characteristics (NYHA Class, LVEF)		Intervention and Comparator	Outcomes	Results
		Intervention	Comparator			
Interventional studies						
Aiken LS (~~21~~20) 2006 USA	Evaluation phase RCT Community based and Hospital based	Note: Mixed population study with subset analysis of CHF patients in some outcome measures. N = 100 (patients with CHF = 67) Mean Age (SD) = 68 (14) Sex: M = 42.0; F = 58.0	N = 90 (patients with CHF = 62) Mean Age (SD) = 70 (13) Sex: M = 30.0; F = 70.0	PhoenixCare Home-based palliative care focused on disease and symptom management, patient and caregiver education on disease management, and social and psychological support. Providers: Registered nurse case manager (co-ordinator), primary care physician, health-plan case manager, and community agencies supported by a medical director, social worker, and pastoral counsellor. Usual Care	1. Self-management of illness and knowledge of resources 2. Preparation for end of life 3. Physical and mental functioning a. Participation in enjoyable activities b. Symptom control c. Trajectories of mental and	1. Greater information for self-management, greater appreciation of resources available to help with their illness and initially, better preparedness for daily experiences in the intervention arm. ◈ 2. PhoenixCare participants showed a higher rate of having a living will or advance directive *vs* controls. ($p < 0.05$). ◈

Supplementary table 2: Characteristics of included studies

		No data on NYHA Class or LVEF	No data on NYHA Class or LVEF	Medical and disease orientated care included medication and technical treatment and other support service. Providers: Managed care organisations.	physical functioning 4. Utilisation of medical service	~~1.~~3a. NSD in CHF. ~~2.~~3b. High symptom distress in PhoenixCare ($p < 0.05$). ~~3.~~3c. NSD in mental and physical functioning among CHF control. 4. Relatively unchanged over time with NSD across arms.
Bekelman DB (~~22~~21) 2015 USA	Evaluation phase RCT with >80% power Community based with outpatient consultations	N = 187 Mean Age (SD) = 68.3 (9.6) Sex: M = 95.2; F = 4.8 NYHA class I = 16 (8.9%) NYHA class II = 77 (42.8%)	N = 197 Mean Age (SD) = 67.9 (10.6) Sex: M = 98.0; F = 2.0 NYHA class I = 16 (8.5%) NYHA class II = 85 (45.0%)	Patient-Centred Disease Management Multidisciplinary collaborative care of HF disease management, screening for and treatment of depression and telemonitoring with patient self-care support. Providers: Registered nurse (co-ordinator), primary care physician, psychiatrist. Usual Care	1. HF-specific health status 2. Depression 3. Mortality 4. Hospitalisation	1. NSD in KCCQ overall score. 2. Greater improvement in PHQ-9 in the intervention arm ($p = 0.01$). 3. Fewer patients died in the intervention arm ($p = 0.04$). 4. NSD in hospitalisations.

Supplementary table 2: Characteristics of included studies

		NYHA class III = 82 (45.6%) NYHA class IV = 5 (2.8%) LVEF: Normal = 78 (45.6%) Mild = 34 (19.9%) Moderate = 46 (26.9%) Severe = 13 (7.6%)	NYHA class III = 82 (43.4%) NYHA class IV = 6 (3.2%) LVEF: Normal = 84 (47.5%) Mild = 34 (19.2%) Moderate = 32 (18.1%) Severe = 27 (15.3%)	Regular care at the discretion of health care provider. Information sheets for self-care given and if patients screened positive for depression at baseline, primary care physicians were notified. Providers: Regular health care professionals and nurses.		
Brännström M (~~23~~22) 2014 Sweden	Evaluation phase RCT with 80% power Community based with outpatient consultations	N = 36 Mean Age (SD) = 81.9 (7.2) Sex: M = 72.2; F = 27.8	N = 36 Mean Age (SD) = 76.6 (10.2) Sex: M = 69.4; F = 30.6	Palliative advanced home care and heart failure care (PREFER) model Person-centred care, total care including assessment of symptoms, quality of life, and risk, and registration into HF and palliative care registry.	1. Symptom burden 2. Health related quality of life 3. Disease-specific quality of life 4. Functional classes 5. Hospitalisation 6. Resource utilisation	1. NSD in overall score 2. Age-adjusted health related quality of life was better in PREFER group (p = 0.02). 3. NSD in overall disease specific quality of life. 4. Improved mean NYHA class (p = 0.012) and

Supplementary table 2: Characteristics of included studies

		NYHA class III = 28 (77.8%) NYHA class IV = 8 (22.2%) LVEF: 40-49% = 13 (36.1%) 30-39% = 16 (44.4%) <30% = 7 (19.4%)	NYHA class III = 23 (63.9%) NYHA class IV = 11 (30.6%) LVEF: 40-49% = 12 (33.3%) 30-39% = 21 (58.3%) <30% = 3 (8.3%)	Providers: Specialised nurses, palliative care nurses, cardiologist, palliative care physician, physiotherapist, and occupational therapist. <u>Usual care</u> No information. Providers: General practitioners or doctors and/ or the nurse-led heart failure clinic.		more experienced improved NYHA class (p = 0.015) in the PREFER arm. 5. Fewer hospitalisations in the PREFER group (p = 0.009); with fewer days spent in hospital (p = 0.0011); NSD in mortality 6. Utilisation of visits differed significantly between the two arms in favour of the intervention, but precise results are unclear.
Hopp FP (~~24~~23) 2016 USA	Evaluation phase RCT with approx. 80% power Hospital based	N = 43 Mean Age (SD) = 67.0 (11.0) Sex: M = 60.5; F = 39.5	N = 42 Mean Age (SD) = 68.0 (13.0) Sex: M = 42.9; F = 57.1	<u>Palliative Care Consultation</u> Clinical interviews to assess for uncontrolled symptoms, goals of care, advance care planning, code status, and desired post-treatment residential setting.	1. Election vs non-election of comfort care a. Outpatient hospice b. Inpatient hospice	1. NSD in the primary end point. 2. NSD in mortality.

Supplementary table 2: Characteristics of included studies

		No data on NYHA Class Mean LVEF = 36.4% (16.7)	No data on NYHA Class Mean LVEF = 38.1% (16.8)	Providers: Physician and advanced nurse practitioner. Other professionals participated as needed – chaplains and social workers. <u>Usual Care</u> No information.	c. A "Do Not Resuscitate" order during hospitalisation d. A "Do Not Resuscitate" order at home or nursing home	
Rogers JG (~~25~~24) 2017 USA	Evaluation phase RCT with <80% power Community based and Hospital based	N = 75 Mean Age (SD) = 71.9 (12.4) Sex: M = 56.0; F = 44.0 NYHA class III = 54 (72.0%) NYHA class IV = 15 (20.0%) LVEF:	N = 75 Mean Age (SD) = 69.8 (13.4) Sex: M = 49.3; F = 50.7 NYHA class III = 58 (77.3%) NYHA class IV = 5 (6.7%) LVEF:	<u>Palliative Care in Heart Failure (PAL-HF)</u> Interdisciplinary, guideline-driven, multicomponent palliative care intervention in combination with contemporary HF management, including assessment and management of physical symptoms, psychosocial and spiritual concerns and advance care planning Providers: Palliative care nurse practitioner, palliative medicine board-certified physician, clinical	~~a.~~1. HF-specific quality of life ~~b.~~2. General and palliative care specific, health related quality of life ~~c.~~3. Spiritual wellbeing ~~d.~~4. Depression and anxiety	1. Greater improvements in the HF-specific quality of life (p = 0.03) in PAL-HF arm 2. Greater improvement in health related quality of life in the intervention arm (p = 0.035). 3. Spiritual wellbeing was better improved in the intervention arm (p = 0.027) 4. Depressive symptoms improved more in the intervention arm (p =

Supplementary table 2: Characteristics of included studies

		>55% = 21 (28.0%) 40-55% = 14 (18.7%) 25-40% = 17 (22.7%) <25 = 23 (30.7%)	>55% = 14 (18.7%) 40-55% = 19 (25.3%) 25-40% = 14 (18.7%) <25 = 28 (37.3%)	cardiology team, and when required, mental health provider. Usual care Inpatient care focused on symptom relief with outpatient follow up. They were not denied access to inpatient palliative care consultation. Providers: Cardiologist directed team with HF expertise in inpatient setting. General practitioners , HF cardiologists, nurse practitioners in outpatient setting.		0.02), as well as anxiety (p = 0.048).
Sahlen KG (~~26~~25) 2015 Sweden	Evaluation phase RCT with 80% power Community based with outpatient consultations	N = 36 Mean Age (SD) = 81.9 (7.2) Sex: M = 72.2; F = 27.8	N = 36 Mean Age (SD) = 76.6 (10.2) Sex: M = 69.4; F = 30.6	Note: Same study as Brännström *et al.* (3) PREFER model Person-centred care, total care including assessment of symptoms, quality of life, and risk, and registration into HF and palliative care registry.	1. Quality adjusted life years 2. Costs of care	1. Small but significant difference in the weight of the quality adjusted life year (p = 0.026) favouring PREFER. 2. NSD in cost of care between the two arms.

Supplementary table 2: Characteristics of included studies

		No data on NYHA Class or LVEF	No data on NYHA Class or LVEF	Providers: Specialised nurses, palliative care nurses, cardiologist, palliative care physician, physiotherapist, and occupational therapist. Usual care No information. Providers: General practitioners or doctors and/ or the nurse-led heart failure clinic.		
Sidebottom AC (~~27~~26) 2015 USA	Evaluation phase RCT, but poor recruitment resulted in 47.5% power 1 Inpatient consultation	N = 116 Mean Age (SD) = 76.0 (11.9) Sex: M = 47.4; F = 52.6	N = 116 Mean Age (SD) = 70.9 (13.6) Sex: M = 57.8; F = 42.2	Palliative care Assessment of symptom burden, emotional, spiritual and psychosocial care, coordination of care orders, recommendation for change in current or future treatments. Providers: 4 physicians board certified in hospice and palliative medicine, 2 clinical nurse specialists	1. Symptom burden 2. Depression 3. Quality of life 4. Readmissions 5. Hospice use 6. ACP 7. Mortality	1. Difference in symptom burden favours intervention in mean change from baseline ($p < 0.001$). 2. Difference in depression favours intervention ($p < 0.001$). 3. Improvement of quality of life is better in the

Supplementary table 2: Characteristics of included studies

		No data on NYHA Class or LVEF	No data on NYHA Class or LVEF	board certified in advanced practice palliative care nursing, a social worker and a chaplain. Control group No information.		intervention arm (p < 0.001). 4. NSD in readmissions 5. NSD in hospice use between arms. 6. ACP process 2.87 times more likely in intervention. 7. NSD in mortality.
Wong FKY (~~28~~27) 2016 China	Evaluation phase RCT Community based	N = 43 Mean Age (SD) = 78.3 (16.8) Sex: M = 43.9; F = 56.1 NYHA class II = 6 (14.0%) NYHA class III = 31 (72.0%) NYHA class IV = 6 (14.0%)	N = 41 Mean Age (SD) = 78.4 (10.0) Sex: M = 61.0; F = 39.0 NYHA class II = 3 (7.3%) NYHA class III = 22 (53.7%) NYHA class IV = 16 (39.0 %)	Transitional Care Palliative End-Stage Heart Failure Pre-discharge assessment, patients' needs assessment (environmental, psychosocial, physiological and health-related behaviour) and intervention, goal setting and creating a mutually agree care plan. Providers: Nurse case managers (primary provider), trained volunteers, and nursing students. Control group	1. Readmissions at 4 and 12 weeks 2. Symptom intensity 3. Functional status 4. Quality of life 5. Satisfaction with care	1. NSD in 4 week re-admission rate, however there was significantly fewer 12 week re-admissions in the intervention arm (p = 0.001). 2. NSD in symptom burden across groups. 3. NSD in functional status between or within groups. 4. Both heart failure specific (p = 0.01) and

Supplementary table 2: Characteristics of included studies

		Mean LVEF = 39.0% (14.0)	Mean LVEF = 37.0% (17.0)	Usual care – palliative care medical clinic, discharge advice on symptom management and medication, and referrals if appropriate. Also, control group received 2 attention control social calls.		palliative care specific (p = 0.05) quality of life tools found significant improvement in the intervention arm. 5. The intervention group had significantly (p < 0.001) higher satisfaction with care.
Paes P (~~29~~28) 2005 UK	Feasibility and pilot phase RCT Outpatient consultations	N = 6 Mean Age (SD) = 73.2 (4.2) Sex: M = 100.0; F = 0.0 NYHA class III = 3 (50.0%) NYHA class IV = 3 (50%)	N = 7 Mean Age (SD) = 78.0 (7.0) Sex: M = 80.0; F = 20.0 NYHA class III = 3 (60.0%) NYHA class IV = 2 (40%)	Palliative care consultation 1 hour of palliative care medical outpatient consultation, followed by monthly 30-minute consultation for a total of 5 months. Provider: Palliative care physician. Control group Regular cardiology care.	1. Depression 2. Quality of life 3. Clinical evaluation	1. NSD in depression between treatment arms. 2. NSD in quality of life between treatment arms. 3. The evaluation forms were positive and found the format acceptable.

Supplementary table 2: Characteristics of included studies

		No data on LVEF	No data on LVEF			
O'Donnell A (30) 2018 USA	Pilot study RCT In-patient or community consultations	N = 26 Mean Age (SD) = 74.7 (11.2) Sex: M 53.9, F = 46.1 NYHA class 1 or 2 = 10 (38.5%) NYHA class 3 or 4 = 16 (61.5%) Mean LVEF = 30% (14)	N = 24 Mean Age (SD) = 69.2 (10.2) Sex: M = 62.5, F = 37.5 NYHA class 1 or 2 = 8 (33.3%) NYHA class 3 or 4 = 16 (66.7%) Mean LVEF = 36% (17)	Social Work (palliative care trained) consultation Conversation about goals of care and advanced care planning started in hospital and continued in the community post-discharge. Palliative physician assessment and management plan including outpatient palliative medicine consults as needed Provider: Palliative social worker and palliative physician Control: Usual care, includes available information about palliative care and advance care planning, and access to in-patient palliative care team if needed. NB. Out patient palliative care consults NOT part of usual care.	% patients with ACP documentation and % aligned preferences at 6 months FACIT-Sp Patient and provider preferences of care questionnaire KCCQ-12 EQ-5D VAS PHQ-8 7. GAD-7	Higher % with ACP documentation in intervention arm (p = 0.02), and better alignment with physician assessed prognosis in intervention arm (p <0.001) NSD in any other outcome measure.

Supplementary table 2: Characteristics of included studies

Johnson MJ (31) 2018 UK	Out-patient or home-based interventions	Cohort 1: palliative cardiology N = 43 Mean Age (SD) = 75.8 (12.3) Sex: M 55.8, F = 44.2 NYHA: class I = 0 class II = 0 class III = 40 (93.0) class IV = 3 (7.0)	Cohort 2: usual care N = 34 Mean Age (SD) = 78.4 (11.3) Sex: M 50.0, F = 50.0 NYHA: class I = 0 class II = 3 (8.8) class III = 30 (88.2) class IV = 1 (2.9)	Cohort 1. Palliative cardiology clinic consultations with a cardiologist and heart failure nurse consultant with a special interest in palliative care. Full holistic assessment, medication review, advance care planning, symptom management, care co-ordination, and community based follow up with liaison with primary care. Referrals to other services including specialist palliative care as needed Cohort 2. Usual care. Case-based care from heart failure nurse specialist in community care, with access to hospital-based cardiology physicians as needed. Specialist palliative care available if referred.	Feasibility measures (recruitment, attrition, data quality, sample size calculation for trial) AKPS ESAS KCCQ-12 HADs EQ-5L-5D Health service utilisation Patient understanding ACP documentation Survival	Groups imbalanced; Cohort 1 less well, more symptomatic and worse QoL Concluded a future trial was feasibility and sample size for KCCQ-12 as primary outcome calculated NSD AKPS Greater improvement in usual care (p = 0.046) NSD KCCQ-12 NSD HADs NSD EQ-5D-5L Fewer nights in hospital but more GP visits in cohort 1. Average costs reduced by £785 per patient. Better patient understanding in Cohort 1 (p<0.001)

Supplementary table 2: Characteristics of included studies

						More ACP documentation in Cohort 1 ($p<0.001$) NSD in survival
Bakitas M (~~30~~29) 2017 USA	Single-arm feasibility and pilot phase trial Community based with outpatient consultations	N = 61 Mean Age (SD) = 70.59 (10.7) Sex: M = 50.8; F = 49.2 NYHA class I = 1 (1.6%) NYHA class II = 3 (4.9%) NYHA class III = 43 (70.5%) NYHA class IV = 12 (19.7%) Unknown = 2 (3.3%) Mean LVEF = 37.86% (16.3)	Educate, Nuture, Advise, Before Life Ends Comprehesive Heartcare for Patients and Caregivers (ENABLE CHF-PC) A telephonic early palliative care intervention for rural-dwelling, underserved HF patient and caregivers including in-person palliative care consultation, weekly semi-structured telephone palliative care nurse coaching, and monthly follow-ups. Providers: Trained nurse coaches	1. Feasibility and acceptability 2. Patient reported outcomes • a. Disease specific quality of life • b. Symptom burden • c. Anxiety and depression • d. General wellbeing • e. Assessment of chronic illness care 3. Caregiver reported outcomes • a. Caregiving outcomes	1. Results discussed in paper – not relevant to the review. 2. Patient reported outcomes a. Significant improvement in KCCQ clinical summary ($p = 0.009$) b. Significant reduction in symptom burden ($p = 0.0004$) c. NSD in anxiety or depression d. NSD in physical health, however there was significant improvement in the global mental health

Supplementary table 2: Characteristics of included studies

				measuring life changes b. Anxiety and depression c. General wellbeing d. Caregiver burden e. Positive aspects of caregiving 4. Resource use a. Number of days in hospital per month b. Number of days in ICU per month c. Number of visits to ED per month d. Hospice use	T score of PROMIS (p = 0.04) e. NSD in PACIC summary score. 3. Caregiver reported outcomes a. NSD in caregiving outcomes. b. NSD in anxiety or depression. c. NSD in the carer's general wellbeing. d. Significant reduction in burden on the carer (p = 0.002) e. NSD in the positive aspects of caregiving. 4. Resource use ~~1.~~a. Significant reduction in number of days in hospital per month (p = 0.002)

Supplementary table 2: Characteristics of included studies

						~~2.~~b. NSD in number of days in ICU per month ~~3.~~c. NSD in number of visits to ED per month ~~4.~~d. NSD in hospice use.
Tadwalkar R (~~31~~32) 2014 USA	Quasi-experimental trial Inpatient visits	N = 14 Mean Age (SD) = 58 (11) Sex: M = 42.9; F = 57.1 No data on NYHA Class or LVEF	N = 9 Mean Age (SD) = 57 (10) Sex: M = 55.6; F = 44.4 No data on NYHA Class or LVEF	Religious support Prayer, reading of religious text, religion-specific rituals, and other pastoral care. Provider: member of the chaplaincy. Non-religious support Personal discussions, recreational activities, undertaking social and spiritual support. Provider: in-house volunteer.	1. Depression 2. Spirituality 3. Symptom burden 4. Enjoyment and life satisfaction	1. Significant reduction in depression over time but there was NSD between the two groups. 2. NSD in spirituality between the two groups or over time. 3. NSD in symptom burden between groups or over time. 4. NSD in enjoyment and life satisfaction between groups or over time.
Observational studies						

Supplementary table 2: Characteristics of included studies

Connor SR (~~32~~33) 2007 USA	Retrospective Cohort Study Hospice care	N = 2095 (patients with CHF = 83) Mean Age = 73.5 Sex: M = 55; F = 45 No data on NYHA Class or LVEF	N = 2260 (patients with CHF = 457) Mean Age = 73.9 Sex: M = 59; F = 41 No data on NYHA Class or LVEF	<u>Intervention</u> Hospice care <u>Comparator</u> No claims for hospice care	~~3a.~~1. Survival	1. Increase in survival period in those who received hospice care (p = 0.0540).
Enguidanos SM (~~33~~34)	Prospective Cohort Study	Note: Mixed population study with subset analysis of CHF patients		<u>Kaiser Permanente Home-based Palliative Care Program</u> Extensive patient and family	1. Severity of illness 2. Service use 3. Site of death	1. Intervention group had significantly (p < 0.001) more severe illness at

Supplementary table 2: Characteristics of included studies

2005 USA	Community based with outpatient consultations	N = 159 (patients with CHF = 31) Mean Age (SD) = 70 (13.92) Sex: M = 49.1; F = 50.9 No data on NYHA Class or LVEF	N = 139 (patients with CHF = 51) Mean Age (SD) = 73 (13.29) Sex: M = 44.6; F = 55.4 No data on NYHA Class or LVEF	education on the disease/ condition; training in symptom control; psychosocial support aimed at assisting in making care choices in advance. Providers: Physicians, nurses, social workers, and other health care professionals. <u>Usual Care</u> Standard Kaiser Permanente TriCentral Service Area care. Standard health care in response to needs and home care only when Medicare certified criteria are fulfilled. Access to psychosocial support and social services is very limited.	4. Days on service 5. Costs of care	enrolment. ◈ 2. NSD in obtaining hospice care between groups. ◈ 3. Palliative care arm were significantly more likely to die at home ($p < 0.001$). 4. Significantly fewer days on service ($p < 0.001$) in the intervention arm. 5. Palliative care group on average cost less than those in the control group.
Pattenden JF (~~34~~35) 2013	Prospective Cohort Study	N = 99 Mean Age (SD) = 81.7	N = 98 Mean Age (SD) = 78.85	<u>Better Together Intervention</u> Self-management education and advice to patients and their carers, clinical assessment and regular	1. Resource use – admissions, length of stay 2. Costs of care	1. Smaller proportion of patients in the intervention group in Bradford was admitted

Supplementary table 2: Characteristics of included studies

UK	Community based	Sex: M = 60.6; F = 39.4 No data on NYHA Class or LVEF	Sex: M = 62.0; F = 37.8 No data on NYHA Class or LVEF	monitoring and review, palliative nursing e.g. medication for symptoms and psychological support, respite care. Providers: British Heart Failure (BHF) Heart Failure Specialist Nurses (HFSN); Marie Curie Cancer Care Nurses (MCN), Marie Curie Cancer Care Healthcare Assistants (MCHCAs); district nurses and other support services. <u>Control patients</u> 'Convenience sample' historical sample.	3. Benefits of care – death in preferred place of care 4. Cost-effectiveness	to hospital ($p < 0.01$), and fewer admissions per patient in the intervention arm in Poole ($p < 0.05$). NSD in LOS. 2. Fewer costs of care in the intervention in both sites (significant in Bradford). 3. Significantly different distribution of place of death ($p < 0.0001$). 4. Uncertainty around incremental cost-effectiveness.
Evangelista LS† (~~35~~36) 2014 USA	Prospective Single-arm Cohort Study Outpatient consultations	N = 29 Mean Age (SD) = 53.3 (7.3)	N = 13 Mean Age (SD) = 52.5 (7.6)	<u>Palliative Care</u> Intake summary with current health status and treatment regimen, assessment of physical and psychological symptoms, determine illness understanding, establish goals	1. Perceived control 2. Patient activation 3. Symptom distress	1. Greater improvement in perceived control ($p < 0.001$). 2. Greater improvement in activation ($p < 0.001$).

Supplementary table 2: Characteristics of included studies

		Sex: M = 75.9; F = 24.1 NYHA class II = 20 (69.0%) NYHA class III = 9 (31.0%) Mean LVEF = 23.1% (4.3)	Sex: M = 61.5; F = 38.5 NYHA class II = 9 (69.2%) NYHA class III = 4 (30.8%) Mean LVEF = 30.5% (9.7)	of care, assist with treatment decision making and coordination of care. Providers: Palliative care specialist (e.g. physician or advance practice nurse). 'Intervention group' Participants receiving > 2 palliative care consultations. 'Comparator group' Participants receiving ≤ 1 palliative care consultations.		3. Greater reduction in symptom distress ($p < 0.001$).
Evangelista LS* (~~36~~37) 2014 USA	Prospective Single-arm Cohort Study Outpatient consultations	N = 29 Mean Age (SD) = 54.1 (8.4) Sex: M = 75.9; F = 24.1	N = 7 Mean Age (SD) = 52.7 (6.3) Sex: M = 57.1; F = 42.9	Palliative Care Comprehensive physical and psychosocial assessment, discussions about advance care planning, developed a treatment plan (with participants) and listing goals of care.	1. Symptom rating 2. Type of palliative care, focus of care, medication use	1. Improvement in symptom burden in those who were followed up ($p < 0.001$). 2. Patients who chose to have additional palliative care input were referred to:

Supplementary table 2: Characteristics of included studies

		NYHA class II = 20 (69.0%) NYHA class III = 9 (31.0%) Mean LVEF = 25.9% (5.3)	NYHA class II = 5 (71.4%) NYHA class III = 2 (28.6%) Mean LVEF = 23.1% (4.3)	Providers: Palliative care specialist (e.g. physician or advance practice nurse). 'Intervention group' Participants receiving palliative care consultation and follow up. 'Comparator group' Participants receiving initial palliative care consultation only.		a. Pharmacist for new medication (69%) or changes to their medication (24% b. social work support (69%) c. physical and occupational therapists (66%) d. psychiatrists (55%) e. chaplain (45%) f. home health (83%) g. support groups (31%) and h. hospice (7%).
Taylor GJ (~~37~~38) 2017 USA	Retrospective Single-arm Cohort Study Community based	N = 32 Age Range (Median) = 48-94 (70) Sex: M = 100; F = 0 NYHA class III = 2 (6.7%)		Intervention Home-delivered palliative care with intensive guidelines-directed medical therapy using the standard hospice approach to psychosocial and spiritual aspects of end-of-life care, optimising the drug therapy, and	1. Re-hospitalisations 2. Death at home 3. NYHA functional class 4. BNP levels	1. Drop in hospital admissions from 110 admissions in the 6 months prior to enrolment to 26 admissions after enrolment.

Supplementary table 2: Characteristics of included studies

		NYHA class IV = 28 (93.3%) No specific data on LVEF, but 23 patients had HFrEF (LVEF <30%) and 7 had HFpEF.	laboratory evaluation when clinically indicated. Providers: Home-hospice nurses, cardiologists, social workers, chaplains, and volunteers. No control		2. 18 out of the 21 patients who died, did so at home. 3. Improvement in pre-post NYHA class IV versus NYHA class III ($p < 0.001$). 4. Improvement in BNP levels following treatment with L-dopa ($p = 0.014$).
Wong RC (~~38~~39) 2013 Singapore	Prospective Single-arm Cohort Study Community based	N = 44 Mean Age (SD) = 79 (9) Sex: M = 38.6; F = 61.4 NYHA class III = 31 (70.0%) NYHA class IV = 13 (30.0%) No data on LVEF	Home Palliative Care Program Measure patient's physiological parameters, physical examination to elicit relevant signs and symptoms, medication modification or initiation to palliate patient's symptoms. Providers: Doctor, nurse and/ or counsellor. No control	1. HF hospitalisation 2. All cause hospitalisation 3. Time to death	1. Mean HF hospitalisation improved from baseline ($p < 0.0001$). 2. Mean all-cause hospitalisation improved from baseline ($p < 0.0001$). 3. Mean time to death was 5.5 months.

Supplementary table 2: Characteristics of included studies

Cassel JB (~~39~~40) 2016 USA	Retrospective Case-Control Study Community based	N = 174 Mean Age (SD) = 87.5 (6.6) Sex: M = 44.3; F = 55.7 No data on NYHA Class or LVEF	N = 499 Mean Age (SD) = 87.1 (6.4) Sex: M = 43.7; F = 56.3 No data on NYHA Class or LVEF	<u>Transitions</u> Concurrent care home-based program including in home medical consultation, ongoing prognostication, caregiver support, advance healthcare planning, symptom management, education, and psychosocial and spiritual support. Providers: Doctors, nurses, spiritual care providers, and social workers. <u>Comparator</u> No information.	1. Costs: a. Costs per month for hospital care b. Costs per month for other care c. All costs per month 2. Hospitalisation a. Percentage hospitalised at least once b. Number of hospitalisations per month c. Number of hospital days per month d. 30-day readmission rate e. ICU stay during admission within 30 days of death	1. Improvement in costs per month for hospital care ($p < 0.001$) and all costs per month ($p < 0.001$) in the Transitions participants. NSD in costs per month for other care. 2. Lower percentage of patients hospitalised at least once, fewer number of hospitalisations per month, fewer number of hospital days per month, lower rate of 30-day readmission and lower rate of ICU stay prior to death ($p < 0.001$) in the intervention arm. 3. Lower percentage of patients from the Transitions arm were

Supplementary table 2: Characteristics of included studies

					3. Admission within 30 days of death and death in hospital	admitted within 30 days of death and dying in hospital (P <0.001)
Evangelista LS (4041) 2012 USA	Prospective Case-Control Study 1 Outpatient consultation	N = 36 Mean Age (SD) = 53.9 (8.0) Sex: M = 72.2; F = 27.8 NYHA class II = 25 (69.4%) NYHA class III = 11 (30.6%) Mean LVEF = 25.4% (5.2)	N = 36 Mean Age (SD) = 53.3 (8.7) Sex: M = 69.4; F = 30.6 NYHA class II = 26 (72.2%) NYHA class III = 10 (27.8%) Mean LVEF = 26.0% (6.2)	<u>Palliative care consultation</u> Assessment of current medical status and screening intake, evaluation of patient's goals and preferences, assessment of areas of perceived needs and establish a treatment plan with co-ordination of care. Providers: Palliative care physician or advance practice nurse. <u>Control</u> No information.	1. Symptom burden 2. Depression 3. Quality of life	1. Lower symptom burden following intervention (p = 0.031). 2. Lower depression following intervention (p = 0.034). 3. Quality of life significantly improved following intervention (p = 0.015).
Blecker S (4142) 2011	Cross-Sectional Study	N = 6,436 Mean Age (SD) = 85.0 (7.6)	N = 10,177 Mean Age (SD) = 83.6 (7.9)	<u>Intervention</u> Hospice care <u>Comparator</u>	Costs Resource use – hospitalisations, ICU admission,	Higher total adjusted expenditures in hospice care.

Supplementary table 2: Characteristics of included studies

USA	Hospice Care	Sex: M = 39.5; F = 60.5 No data on NYHA Class or LVEF	Sex: M = 44.5; F = 55.5 No data on NYHA Class or LVEF	No claims for hospice care	length of stay in hospital and ICU	Hospice care patients were less likely to be admitted to hospital or have ICU stay during this time, and spent significantly less time in hospital or ICU.

Note: Evangelista LS 2014† is titled: On-going palliative care enhances perceived control and patient activation and reduces symptom distress in patients with symptomatic heart failure: A pilot study and Evangelista LS 2014 is titled: Does the Type and Frequency of Palliative Care Services Received by Patients with Advanced Heart Failure Impact Symptom Burden?*

◈ is used where there is no subset analysis of CHF population in mixed population studies.

Abbreviations: NYHA = New York Heart Association; LVEF = Left Ventricular Ejection Fraction; RCT = Randomised Controlled Trial; CHF = Congestive Heart Failure; SD = Standard Deviation; HF = Heart Failure; KCCQ = Kansas City Cardiomyopathy Questionnaire; PHQ-9 = Patient Health Questionnaire-9; ACP = Advance Care Planning; NSD = no significant difference; LOS = length of stay.

Supplementary table 3: Breakdown of palliative care components delivered in the included studies

Study	Components of palliative care	Assessment of current status	Assessment of need	Assessment of quality of life	Symptom management	Psychological support	Social support	Spiritual support	Medication review and monitoring	Tele-health and monitoring	Patient education	Goal setting	Advance care planning	Coordination of care	Multidisciplinary involvement	Carer/ family support
Aiken LS (21)0		✓	✓		✓	✓	✓		✓		✓		✓	✓	✓	✓
Bekelman DB (2221)		✓	✓	✓	✓	✓			✓	✓	✓				✓	
Brännström M (2322)		✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
Hopp FP (2423)			✓									✓	✓		✓	
Rogers JG (2524)		✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	
Sahlen KG (2625)		✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓
Sidebottom AC (2726)		✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	
Wong FKY (2827)		✓	✓	✓	✓					✓		✓	✓		✓	
Paes P (2928)		✓	✓	✓	✓	✓			✓		✓		✓		✓	
Bakitas M (3029)		✓	✓	✓	✓					✓	✓	✓			✓	✓
O'Donnell A (30)		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Johnson MJ (31)		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Tadwalkar R (3132)			✓	✓		✓		✓							✓	
Connor SR (3233)		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Enguidanos SM (3334)		✓	✓		✓	✓	✓	✓				✓	✓	✓	✓	
Pattenden JF (3435)		✓	✓		✓	✓			✓		✓				✓	✓
Evangelista LS† (3536)		✓	✓		✓	✓				✓	✓	✓	✓	✓	✓	
Evangelista LS* (3637)		✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	✓	
Taylor GJ (3738)		✓	✓		✓	✓	✓	✓	✓	✓			✓	✓	✓	
Wong RC (3839)		✓	✓		✓				✓	✓			✓		✓	
Cassel JB (3940)		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Evangelista LS (4041)		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓	
Blecker S (4142)		NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Supplementary table 4: Results of risk of bias assessment with the Cochrane Risk of Bias tool

Study	Adequate sequence generation?	Allocation concealment?	Blinding (participants and personnel)	Blinding (outcome assessors)	Incomplete outcome data addressed?	Free of selective reporting?
Aiken LS 2006 (~~21~~20)	☑	☑	☒	☑	☒	☑
Bekelman DB 2015 (~~22~~21)	☑	☑	☒	☑	☑	☑
Brännström M 2014 (~~23~~22)	☑	☑	☒	☒	?	☑
Hopp FP 2016 (~~24~~23)	?	?	☒	☒	☑	☒
Rogers JG 2017 (~~25~~24)	☑	?	☒	☒	☑	☑
Sahlen KG 2015 (~~26~~25)	☑	☑	☒	☒	☑	☑
Sidebottom AC 2015 (~~27~~26)	?	?	☒	☒	☑	☑
Wong FKY 2016 (~~28~~27)	☑	☑	☒	☑	☑	☑
Paes P 2005* (~~29~~28)	☑	☒	☒	☒	☒	☑
Bakitas M 2017 (~~30~~290)	**N/A**	**N/A**	☒	☒	☑	☑
Tadwalkar R 2014 (~~31~~32)	**N/A**	**N/A**	☒	☒	?	☑
O'Donnell A 2018 (30)	☑	?	☒	?	☑	☑

* *Derived from the full thesis on which the letter was based and not from the limited information in the published letter.*

N/A = not applicable

Key: ☑ = low risk of bias, ☒ = high risk of bias, ? = risk of bias unclear

Supplementary table 5: Results of NOS risk of bias assessment for cohort studies

Study	Representativeness of exposed cohort	Selection of non-exposed cohort	Ascertainment of exposure	Outcome of interest not present at start of study	Comparability of cohorts	Assessment of outcome	Length of follow up	Adequacy of follow up
Connor SR 2007 (~~32~~33)	★	★	★	★	★	★	★	★
Enguidanos SM 2005 (~~33~~34)	★	★	★	★	★	★	★	★
Pattenden JF 2013 (~~34~~35)	★	★	★	★	★	★	★	★
Evangelista LS 2014† (~~35~~36)	★	★	★	★	★	★	★	★
Evangelista LS 2014* (~~36~~37)	★	★	★	★	★	★	★	★
Taylor GJ 2017 (~~37~~38)	★	★	★	★	★	★	★	★
Wong RC 2013 (~~38~~39)	★	★	★	★	★	★	★	★
Johnson MJ 2018* (31)	★	★	★	★	★	★	★	★

Key: ★ = low risk of bias, ★ = high risk of bias, ★ = risk of bias unclear

* Designed as a nonrandomised feasibility study rather than to examine outcomes, but methods more suited to quality appraisal as observational data.

Supplementary table 6: Results of NOS risk of bias assessment for case-control studies

Study	Adequate case definition	Representativeness of cases	Selection of controls	Definition of controls	Comparability of cases and controls	Ascertainment of exposure	Same method of ascertainment for cases and controls	Non-response rate
Cassel JB 2016 (~~39~~40)	★	★	★	★	★	★	★	★
Evangelista LS 2012 (~~40~~41)	★	★	★	★	★	★	★	★

Key: ★ = low risk of bias, ★ = high risk of bias, ★ = risk of bias unclear

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1,2,5
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2, 3-4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	2,5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5-6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supple table 1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6-7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6-7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7 - 8
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	19, 20 and supple tables 3 &4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	20 -22
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	19, 20 and supple tables 3 &4
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	23-24
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	24-25
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	26-27

PRISMA 2009 Checklist

FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	28

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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