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REVIEW

The Effect of Care Pathways for Hip Fractures: A Systematic Review

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Abstract We performed a systematic review for primary studies on care pathways (CPs) for hip fracture (HF). The online databases MEDLINE-PubMed, Ovid-EMBASE, CINAHL-EBSCO host, and The Cochrane Library (Cochrane Central Register of Clinical Trials, Health Technology Assessment Database, NHS Economic Evaluation Database) were searched. Two researchers reviewed the literature independently. Primary studies that met predefined inclusion criteria were assessed for their methodological quality. A total of 15 publications were included: 15 primary studies corresponding with 12 main investigations. Primary studies were evaluated for clinical outcomes, process outcomes, and economic outcomes. The studies assessed a wide range of outcome measures. While a number of divergent clinical outcomes were reported, most studies showed positive results of process management and health-services utilization. In terms of mortality, the results provided evidence for a positive impact of CPs on in-hospital mortality. Most studies also showed a significantly reduced risk of complications, including medical complications, wound infections, and pressure sores. Moreover, time-span process measures showed that an improvement in the organization of care was achieved through the use of CPs. Conflicting results were observed with regard to functional recovery and mobility between patients treated with CPs compared to usual care. Although our review suggests that CPs can have positive effects in patients with HF, the available evidence is insufficient for formal recommendations. There is a need for more research on CPs with selected process and outcome indicators, for in-hospital and postdischarge management of HF, with an emphasis on well-designed randomized trials.

Keywords Clinical pathway · Care pathway · Critical pathway · Hip fractures · Outcome and process assessment · Systematic review

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In 1990, epidemiological data estimated that there were 1.26 million hip fractures (HFs) in adults, with such events predicted to rise to 7.3–21.3 million by 2050 [1]. The 1-year death rate after HF is approximately 20–30 %, with about one-third of this excess mortality directly attributable to the fracture [2]. However, HF occurrence is not only associated with short-term mortality; in fact, recent data indicate that, in both genders, significant excess annual mortality persists over time, even 10 years or more following injury [3]. After HF, survivors can expect a 15–25 % decline in the ability to perform activities of daily living (ADL), and about 10–20 % of survivors will be unable to return to their previous residences, causing them to become more dependent and to seek assisted-living care [4]. In line with these findings, women who sustain HF continue to suffer from substantial functional impairment and loss in quality of life at 1 year, despite significant recovery during the initial 12-month period [5].

HFs represent the second leading cause of hospitalization in patients over 65 years of age [6], with elderly patients accounting for almost 90 % of all hospital stays due to HFs [7]. After HF, patients' health-service consumption increases for 1 year or more, with most health-care costs attributed to long-term care [8–10].

One of the main issues in managing HFs is that it is difficult to provide standard care that can reduce variations in processes of care and patient outcomes. To address this issue, care pathways (CPs) may be an appropriate response. CPs are complex interventions [11–13], designed to optimize clinical outcome and resource use [14–16], and used worldwide for a variety of patient groups [17, 18].

Although the use of CPs in the management of HF patients has been mentioned in a number of international guidelines, no conclusive systematic review evidence on their effects in HF patients is available [19–24].

In this context, the main objective of the present systematic review was to identify and analyze published primary literature studies, corresponding to original articles, on the impact of CPs for HF related to the acute and postdischarge processes of care.

Materials and Methods

Data Sources

Two reviewers (F. L. and C. L.) independently searched major electronic biomedical databases for relevant articles on CPs and HFs and checked the bibliographies of identified publications. To identify original articles, we searched MEDLINE-PubMed (1975–Jan. 2011), Ovid EMBASE (1998–2010, Jan. 2011), and CINAHL-EBSCO host (1981–Dec. 2010). Furthermore we searched in The Cochrane Library: Cochrane Central Register of Clinical Trials (CCRCT, up to fourth quarter 2010), Health Technology Assessment Database (HTA database, up to 2010 issue 4), and NHS Economic Evaluation Database (NHSEED, up to 2010 issue 4).

Search Strategy

To optimize the sensitivity of the search, we did not limit the initial search by year of publication or language. However, we only examined the full texts of relevant English, German, French, Dutch, and Italian articles. As a first strategy, the following medical subject headings (MeSH) related to CPs and HFs were used: Critical Pathways AND Hip Fractures (MEDLINE), Clinical Pathways AND Hip Fractures (EMBASE), Critical Path AND Hip Fractures (CINAHL). Subsequently, a combined non-MeSH and MeSH search was performed based on the following search string: ("care pathway" OR "clinical pathway" OR "critical pathway" OR "care map" OR "clinical path" OR "multidisciplinary approach") AND ("Hip Fractures" [MeSH]). For the three searched databases included in the Cochrane Library (CCRCT, HTA, and NHSEED), the MeSH terms "Critical Pathways" and "Hip Fractures" were used. When the full text of a relevant article was not found, the authors were contacted for further information. If the requested information was not available, the article was excluded.

Inclusion Criteria

We included only primary literature studies, representing the report of an original research study (original article) of experimental (randomized controlled trials [RCTs] and controlled clinical trials [CCTs]) and quasi-experimental (cohort studies) study designs with historical or contemporary control (Ctrl) groups, according to the inclusion criteria adopted in previous systematic reviews on CPs [25–27]. All studies concerning CPs that recruited patients of all ages who had been admitted to acute-care hospitals, post–acute care/rehabilitation, and post rehabilitation for HFs were included. All aspects of the continuum of care, from preoperative assessment through surgical management and subsequent rehabilitation, were considered for CPs and HFs. Studies reporting outcome measures on clinical parameters, process of care, and/or hospitalization costs were considered.

To properly include primary literature studies in a systematic review, the definition of "care pathway" according to the European Pathway Association (www.E-P-A.org) was adopted. A CP is defined as a complex intervention for mutual decision making and organization of care processes in a well-defined group of patients during a well-defined period. Defining characteristics of CPs include (1) an explicit statement of the goals and key elements of care based on evidence, best practice, and patients' expectations and characteristics; (2) facilitation of communication among the team members and with patients and families; (3) coordination of the care process by coordinating the roles and sequencing the activities of the multidisciplinary care team, patients, and their relatives; (4) documentation, monitoring, and evaluation of variances and outcomes; and (5) identification of the appropriate resources. The aim of a CP is to enhance the quality of care across the continuum by improving risk-adjusted patient outcomes, promoting patient safety, increasing patient satisfaction, and optimizing the use of resources [16, 28].

Exclusion Criteria

Articles were excluded when (1) the intervention did not fulfill the definition criteria of a CP, (2) the article did not report study results, (3) the study was not pertinent to the research question(s), (4) the study was part of duplicate publications reporting the same main outcome measures and/or it was performed as an individual component of a larger study without additional results, (5) the study lacked detailed and appropriate risk-adjusted analyses, or (6) no full text and/or no author details were available (corresponding author information missing).

Selection of Studies

Two reviewers (F. L. and C. L.) screened all the titles, abstracts, and keywords of publications identified by the searches to assess their eligibility, according to the above-mentioned inclusion and exclusion criteria (see Fig. 1). Articles that did not meet the inclusion criteria were excluded during this phase. We then obtained a paper copy of all potentially relevant studies and assessed the publications according to the prespecified selection criteria. Disagreements were resolved by discussion with two additional researchers until consensus was obtained (M. P. and K. V.).

Methodological Quality Assessment of Studies

Two reviewers (F. L. and C. L.) independently assessed the methodological quality, using (1) the Jadad scale (JS) for assessing the quality of RCTs and CCTs and (2) the Newcastle-Ottawa Quality Assessment Scale (NOS) for assessing the quality of nonrandomized studies for the cohort studies [29–31]. Finally, the two reviewers rated the studies according to the quality of study reporting, following the method developed by the NHR Centre for Review and Dissemination (CRD) [32, 33]. Disagreements were again resolved by discussion with two additional researchers (M. P. and K. V.).

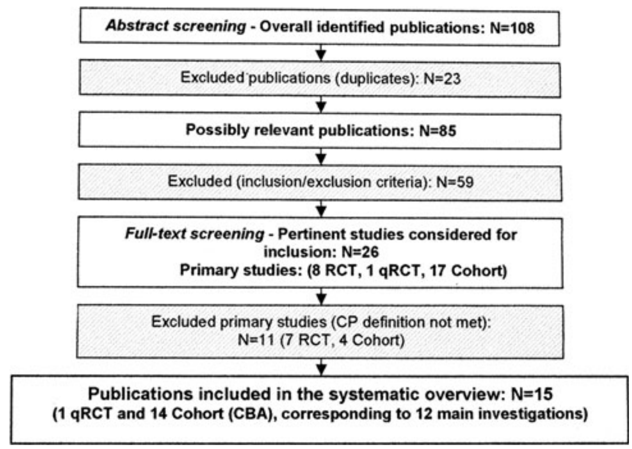

Fig. 1 Flowchart showing the results of the search strategy. *CBA* controlled before-and-after study, *Cohort* cohort controlled study; *RCT* randomized controlled trial; *qRCT* quasi-randomized controlled trial

Results

The results of the search strategy are described with a flowchart of the inclusion and exclusion of the identified publications (Fig. 1). The systematic review finally included 15 papers corresponding with 12 main investigations. In fact, of the 15 papers, three original articles arose from one main investigation and two original articles arose from another main investigation. The identified original articles were assessed for their methodological quality.

The characteristics of the included primary literature studies (5,791 patients overall) were described in detail (Table 1). Overall, baseline characteristics were well balanced in most studies, with the exception of significant differences in age [37, 41], gender [39], comorbidities [37, 42, 47], and residence at admission [37].

The methodology of protocol implementation by resident staff/interns or the presence or absence of a care coordinator was reported in three studies [35, 39, 48]. In Roberts et al. [39] the care coordinator was responsible for staff training and implementation of the CP. In Tallis and Balla [35] and Lau et al. [48] the care coordinator did the audit of the actual organization of care and the data collection.

Two of the mentioned studies described how the protocols were implemented [35, 48]. In Lau et al. [48] a specific key intervention was defined for each identified target problem and goal, and the related staff task to be implemented was developed. In Tallis and Balla [35] a general overview of the methodological process for developing and implementing CP was described.

Table 1 Included primary literature studies ($n = 15$ original articles corresponding with 12 main investigations)

Ref.	Study design	Control type	Location and setting	Patients (*N*, Ctrl, CP)	Length[a] of study (months)	Patient demographics characteristics	Patient medical and other baseline characteristics	Outcome measures assessed	Quality assessmentscore
[34]	CBA monocenter	Prospective/ concurrent (preintervention) of usual care	Canada	$N = 106$ Ctrl $n = 51$ CP $n = 55$	Not stated	Age, sex, marital status, preoperative accommodation	Preoperative ambulation, mental status, number of preexisting medical conditions, number of medications before injury, fracture type, fracture treatment	Complications, LOS in hospital, accommodation, ambulation, overall outcome	9/9(NOS)
[35]	CBA monocenter	Historical of usual care	Australia,Box Hill Hospital, medium-sized teaching hospital with a large emergency department and 2 orthopedic units	$N = 178$ Ctrl $n = 90$ CP $n = 88$	7 + 6	Age, sex, marital status, residence type	Comorbidity number and type	LOS, distance walked just before discharge from hospital, discharge destination, unplanned readmission, wound infection rate	8/9(NOS)
[36]	qRCT monocenter	Prospective/ concurrent (preintervention) of usual care	Australia,St. Vincent's Hospital, Melbourne, Victoria (a tertiary referral, university teaching hospital)	$N = 111$ Ctrl $n = 56$CP $n = 55$	14	Age, sex	Number of premorbid conditions, confused on admission, number of patients who did not speak English	Total LOS, hospital readmission, time to mobilization	1/5(JS)
[37]	CBA multicenter (Ctrl 4 hosp., CP 2 hosp.)	Prospective/ concurrent (preintervention) of usual care	Australia	$N = 481$ Ctrl $n = 286$ in 4 hosp.CP $n = 195$ in 2 hosp.	12 + 6	Age, sex, prefracture residential status	Prefracture mental state, number of comorbidities	Level of function, mortality, nursing home status (in-hospital, at 4 months)	7/9(NOS)
[38]	CBA monocenter	Prospective/ concurrent (preintervention) of usual care	USA,Hospital for Joint diseases New York, NY	$N = 1{,}065$ Ctrl $n = 747$CP $n = 318$	30 + 132	Age, sex	ASA score, prefracture functioning, prefracture ambulatory ability, prefracture living situation, cause and place of fracture, number of prefractures	Hospital LOS, discharge status (home or skilled nursing facility), in-hospital mortality, mortality and ambulatory abilities 6 months and 1 year before and after CP	8/9(NOS)
[39]	CBA monocenter	Prospective/ concurrent (preintervention) of usual care	UK,Southampton General Hospital, 1 orthopedic unit teaching hosp. (and 3 Ctrl units)	$N = 764$ Ctrl $n = 395$CP $n = 369$	12 + 12	Age, sex, admission residence	Ambulation score, history of dementia, confused on admission, type of fracture (intra, extra), type of treatment (Thompson's hemiarthroplasty, Austin-Moore hemiarthoplasty, dynamic screw, Asnis screw, bipolar hemiarthroplasty), grade of surgeon, grade of anesthetist	Primary: LOS. Secondary: ambulation at discharge, discharge destination, in-hospital complications, 30-day mortality, readmission within 30 days of discharge, and postoperative days on which the patient first sat out of bed and walked	8/9(NOS)

Table 1 continued

Ref.	Study design	Control type	Location and setting	Patients (N, Ctrl, CP)	Length[a] of study (months)	Patient demographics characteristics	Patient medical and other baseline characteristics	Outcome measures assessed	Quality assessmentscore
[40]	CBA multicenter (two tertiary hosp.)	Prospective/ concurrent (preintervention) of usual care	Canada,urban health region	$N = 919$Ctrl $n = 468$CP $n = 451$	15 + 16	Age, sex, social contact, marital status	Charlson Comorbidity Index, known dementia on admission, mean baseline MBI score, fracture type, preadmission residence	Function at time of fracture and 3 and 6 months postfracture, institutionalization status at time of fracture and 3 and 6 months postfracture, LOS	9/9(NOS)
[41]	CBA monocenter	Historical audit of fast track system (FTS)	UK,orthopedic unit, Airedale General Hospital	$N = 294$ Ctrl $n = 143$CP $n = 151$	10 + 10	Age, sex	Type of fracture, operative treatment vs. no operative treatment, type of treatment	Time to surgery, cancellations, in-hospital LOS, 30- and 90-day mortality	8/9(NOS)
[42]	CBA multicenter (two tertiary hosp.)	Prospective (preintervention) of usual care	Canada,large urban health region	$N = 1{,}341$ Ctrl $n = 678$CP $n = 663$	24 + 24	Age, sex	Charlson Comorbidity Index, preexisting cardiac disease, fracture type, admitted from	In-hospital complications, postoperative delirium, in-hospital mortality/risk-adjusted in-hospital mortality, overall LOS, hospital LOS, rehabilitation LOS, costs	8/9(NOS)
[43]	CBA monocenter	Prospective (preintervention) of usual care	Sweden,Orthopedic Department, Sahlgrenska University Hospital/Östra, Göteborg	$N = 112$ Ctrl $n = 56$CP $n = 56$	17 + 17	Age, sex, living, type of living, need of home help services, place of accident	Prefracture independence, type of walking aid, gait capacity, general medical health, type of fracture, type of treatment, cognitive functioning at admission	Primary: LOS. Secondary: amount of time from emergency room to ward, to surgery and to first ambulation; in-hospital complications; 30-day readmission rate	8/9(NOS)
[44][b]see [43]	CBA monocenter	Prospective (preintervention) of usual care	SwedenOrthopedic Department, Sahlgrenska University Hospital/Östra, Göteborg	$N = 112$ Ctrl $n = 56$CP $n = 56$	17 + 17	Age, sex, living, type of living, need of home help services, place of accident	Prefracture independence, type of walking aid, gait capacity, general medical health, type of fracture, type of treatment, cognitive functioning at admission	Activities of daily living to level A (independent) at discharge, activities of daily living level F (dependent), time span (days) within contact with the community social worker and discharge planning meetings took place, returned to prefracture living status, readmissions related to hip fracture within 30 days from time of discharge, 1-year mortality after surgery	8/9(NOS)
[45][b]see [43]	CBA monocenter	Prospective (preintervention) of usual care	SwedenOrthopedic Department, Sahlgrenska University Hospital/Östra, Göteborg	$N = 112$ Ctrl $n = 56$CP $n = 56$	17 + 17	Age, sex, living, type of living, need of home help services, place of accident	Prefracture independence, type of walking aid, gait capacity, general medical health, type of fracture, type of treatment, cognitive functioning at admission	Average total cost of treatment A vs. treatment B,cost-effectiveness ratio	NA

Table 1 continued

Ref.	Study design	Control type	Location and setting	Patients (N, Ctrl, CP)	Length[a] of study (months)	Patient demographics characteristics	Patient medical and other baseline characteristics	Outcome measures assessed	Quality assessmentscore
[46][b]see [47]	CBA monocenter	Prospective (preintervention) of usual care	SwedenDepartment of Orthopedics, Lund University Hospital, (referral area)	$N = 420$ Ctrl $n =$ first 210CP $n =$ last 210	6 + 5	Age, gender, prefracture residence, living alone, prefracture walking aids, discharge destination	Number of medicines prescribed before admittance, smoking, lucidity, ASA grade, fall outdoors or indoors, fracture type, pathological fracture, concomitant fractures, development of pressure ulcer(s)	Incidence rate of pressure ulcers from admission (excluded patients with same pressure ulcers at admission and discharge)	9/9(NOS)
[47]	CBA monocenter	Prospective (preintervention) of usual care	SwedenDepartment of Orthopedics, Lund University Hospital (referral area)	$N = 420$ Ctrl $n =$ first 210CP $n =$ last 210	6 + 5	Age, gender, prefracture residence, living alone, prefracture walking aids, discharge destination	Number of medicines prescribed before admittance, smoking, lucidity, ASA grade, fall outdoors or indoors, fracture type, pathological fracture, concomitant fractures, development of pressure ulcer(s)	In-hospital acute mortality, 4-month mortality, 12-month mortality, acute LOS, total institutionalized LOS, 12-month reoperation, delay to operation, early surgery within 24 hours	9/9(NOS)
[48]	CBAmonocenter	Historical of usual care	People's Republic of China,Queen Mary Hospital, The University of Hong Kong	$N =$ NRCP $n = 964$ Ctrl $n =$ NR	12 + 36	Age, sex, ASA score,comorbidities, place of living	Type of fracture, type of surgery, postoperative blood transfusion, walking ability, MMSE, MBI	Preoperative and total LOS in acute hospital, surgical site infection, 30- day mortality, incidence of pressure sores, 28-day readmission rate after discharge	7/9(NOS)

[a] Length of study (measured in months): for CBA, length of the usual care period of study (Ctrl) + length of the care pathway–development period of study (CP); for qRCT, length of the study. Quality assessment score: methodological quality of studies was assessed by a nine-point scale for cohort studies (NOS) and by a five-point scale for qRCT (JS); thus, the scores of the two scales are not directly comparable

[b] Authors of articles corresponding to the main investigation study are indicated in parentheses

ASA American Society of Anesthesiologists' physical status classification system, *CBA* controlled before-and-after study, *Ctrl* control group(s), *JS* Jadad scale, *MBI* modified Barthel Index, *MMSE* Mini Mental State Examination, *NA* not applicable, *NR* not reported, *hosp.* hospital(s), *NOS* Newcastle-Ottawa Quality Assessment Scale, *qRCT* quasi-randomized clinical trial

Fourteen studies assessed clinical outcomes, and one study measured cost-effectiveness [45]. Due to the wide range of clinical outcomes and process and economic outcome measures evaluated in the studies, we grouped the studies according to the following major end-point measures: mortality, functional recovery and mobility, medical complications, hospital readmission, discharge location/destination, length of stay (LOS), other time-span measures, and costs (Tables 2, 3).

Ten studies assessed mortality. Koval et al. [38] and Ogilvie-Harris et al. [34] reported a significant reduction in in-hospital mortality when CPs were implemented. Both Beaupre et al. [42] and Tallis and Balla [35] reported nonsignificant effects. For 30-day mortality, Lau et al. [48] did not report any significance levels for their results; the findings of Gholve et al. [41] were bordeline significant, while those of Roberts et al. [39] and Choong et al. [36] were not. No significant differences were observed by March et al. [37] for 4-month mortality. By contrast, Koval et al. [38] reported reduced 6-month and 1-year mortality rates when CPs were implemented. Olsson et al. [44], on the other hand, reported no differences.

Six studies assessed functional recovery and mobility with different scales of functional status. In general, better outcomes were observed in patients treated according to CPs. Olsson et al. [44] found that CPs improved ADL ("level A or independent at discharge" [49]) when compared to control patients. None of their patients who were independent before their HF remained at ADL "level F or dependent" [49] after treatment with CPs. Roberts et al. [39] also observed better outcomes with CPs when measuring the rates at which a patient could walk unassisted upon discharge from the orthopedic unit. In a study by Beaupre et al. [40], CP did not affect postoperative function or institutionalization in elderly patients with HFs. However, after risk adjusting the outcomes measured with the Modified Barthel Index [50–53], they found that the CP improved postoperative function in patients with low social support. Furthermore, these patients were significantly more likely to tolerate weight bearing postoperatively. In the study by Ogilvie-Harris et al. [34], better outcomes were observed in the CP group, with more of these patients returning "to their prefracture status with regard to accommodation and ambulation." Koval et al. [38] did not find any significant differences in ambulation decline 6 months and 1 year after CP implementation. No differences were found by Tallis and Balla [35] for acceptable walked distance prior to discharge rates and for mean longest distance walked prior to discharge. Ogilvie-Harris et al. [34] did not find an improvement in patients subjected to CPs with regard to "returning to prefracture ambulation status" or with regard to "change in ambulation."

Nine studies assessed the effects of CP implementation on postoperative medical complications. Ogilvie-Harris et al. [34] and Olsson et al. [43] found that, in general, patients subjected to CPs experienced fewer complications. Choong et al. [36], however, found no differences in the occurrence of in-hospital or after-discharge complications between CP and control groups. Tallis and Balla [35] and Roberts et al. [39] did not report complication rates.

Several studies assessed the effects of CPs on various complications. Pressure ulcers/sores were significantly reduced by the use of CPs in publications by Lau et al. [48], Roberts et al. [39], Olsson et al. [54], and Hommel et al. [46]. Choong et al. [36] on the other hand, found no differences. Beaupre et al. [42] observed that patients receiving CP-directed care experienced fewer complications for postoperative congestive heart failure, postoperative cardiac arrhythmias, and postoperative delirium. Roberts et al. [39] observed fewer complications for wound infection, urinary tract infection, cardiac events, and caregiver-related events; Tallis and Balla [35] observed fewer wound infections; and Lau et al. [48] observed fewer surgical site infections after internal fixation or hemiarthroplasty. Choong et al. [36] could not document an effect of CPs on a number of in-hospital complications, including chest infection, urinary tract infection, and deep vein thrombosis. They also found no differences between the CP and control groups for after-discharge complications like wound infection and failure to cope [36]. Koval et al. [38] observed no differences for the need for revision surgery.

Six studies evaluated readmission rates at 28 or 30 days, but none found differences between CP and control groups [35, 36, 39, 42, 43, 48; see also 44].

Six studies examined the destination after discharge. Beaupre et al. [43] found that significantly more CP patients were discharged to home or to long-term care. Ogilvie-Harris et al. [34] and Olsson et al. [44], however, observed no significant differences between CP and non-CP groups with respect to likelihood of returning to their previous housing situation. Moreover, three studies observed no differences when comparing discharge to skilled nursing facilities, institutional care, or long-term care [35, 38, 39].

All of the studies assessed LOS but used different time-span measures. Several studies found that CP patients experienced a shorter in-hospital LOS [34–38, 41, 43, 48; see also 45]. However, some studies observed that CP patients experienced a longer LOS [39, 40, 42, 47]. Roberts et al. [39] also found extended LOS for the CP group after excluding deaths and discharge to nursing homes or residential care. March et al. [37] reported no difference in LOS for non-nursing home patients.

Beaupre et al. [40] reported reduced "mean time to initial postoperative rehabilitation" in CP patients, and

Table 2 Results of primary literature studies related to clinical outcome measures

Main end point/specific measure	
Mortality	
In-hospital mortality	CP+: CP 1.5 % vs. Ctrl 5.3 %, $p < 0.001$ [38]
	CP 9.1 % vs. Ctrl 15.7 %, $p = 0.01$ [34]
	Ctrl+/p-NR: CP 3.4 % vs. Ctrl 2.2 %, p-NR [35]
	NS: CP 7 % vs. Ctrl 8 %, $p = 0.83$ [42]
30-day mortality	CP+/p-NR: From 1.7 % (year 2007–2008) to 1.67 % (year 2009) in the CP, p-NR [48]
	NS: CP 8 % vs. Ctrl 13 %, $p = 0.056$ [41]
	CP 12 % vs. Ctrl 13 %, $p = 0.341$ [39]
	CP=Crtl/p-NR: CP 0.018 % vs. Ctrl 0.0 %, p-NR [36]
4-month mortality	NS: CP 17.6 % vs. Ctrl 16.8 %, $p = 0.826$ [37]
6-month mortality	NS: CP 5.9 % vs. Ctrl 9.1 %, $p = 0.06$ [38]
1-year mortality	CP+: CP 8.8 % vs. Ctrl 14.1 %, $p < 0.01$ [38]
	CP=Ctrl/p-NR: CP 16 % vs. Ctrl 16 %, p-NR [44]
Functional recovery and mobility	
Multiple measurements (ADL level; walking ability and status; weight bearing; MBI)	CP+: Restored to ADL level A (independent) at discharge, CP 21 % vs. Ctrl 5 %, $p = 0.003$; patients, admitted as independent, remained at ADL level F (dependent): CP 0 % vs. Ctrl 16 %, $p = 0.003$ [44]
	Able to walk alone at discharge from orthopedic unit: Ctrl 36 % vs. CP 73 %, $p = 0.033$ [39]
	Social support did not affect 3-month function in the CP; after risk adjustment, MBI for patients with low social support: CP 69.6 % vs. Ctrl 58.7 %, $p < 0.05$; weight bearing as tolerated: CP 81 % vs. Ctrl 71 %, $p = 0.001$ [40]
	Ambulation decline at 6 months: CP 60.2 % vs. Ctrl 65.8 %, $p =$ NS; recovery of ambulatory ability declined at 1 year: CP 52.1 % vs. Ctrl 56.3 %, $p =$ NS [38]
	Walked prior to discharge: CP 75.0 % vs. Ctrl 73.3 %; mean longest distance walked prior to discharge: CP 20.3 vs. Ctrl 23.0 m, $p = 0.17$ [35]
	Ambulation status at 6 months postoperation, $p =$ NS; returned to prefracture ambulation status: CP 55 vs. Ctrl 51, $p = 0.07$; change in ambulation: trend in favor of CP, $p = 0.09$ [34]
Overall functional outcome	CP+: 4 grades of return to prefracture function and accommodation/ambulation: CP 28 vs. Ctrl 17, resulting as grade 1, of best outcome $p = 0.036$ [34]
Medical complications	
Pressure ulcers	CP+: CP 9 % vs. Ctrl 19 %, $p < 0.007$ [46]
	Pressure wounds: CP 8 vs. Ctrl 19, $p = 0.02$ [43]
	CP 7 % vs. Ctrl 11 %, $p = 0.041$ [39]
	CP+/p-NR: From 4.3 to 0.3 % in the CP (year 2007–2009), p-NR [48]
	NS: Pressure area: CP 4% vs. Ctrl 2 %, $p = 0.97$ [37]
Multiple complications	CP+: Postoperative congestive heart failure: 1 % CP vs. 5 % Ctrl, $p < 0.001$; postoperative cardiac arrhythmias: CP 1 % vs. Ctrl 5 %, $p < 0.001$; postoperative delirium: 22 % CP vs. 51 % Ctrl, $p < 0.001$ [42]
	Wound infection: CP 3 % vs. Ctrl 7 %, $p = 0.022$; urinary tract infection: CP 6 % vs. Ctrl 10 %, $p = 0.038$; cardiac events: CP 14 % vs. Ctrl 19 %, $p = 0.019$ [39]
	Number of wound infections: CP 0.0 % vs. Ctrl 6.7 %, $p = 0.029$ [35]
	CP+/p-NR: SSI: internal fixation: Ctrl 0.81 % vs. CP 0.0 %, p-NR; hemiarthroplasty: CP 0.98 % vs. 2.61 % Ctrl, p-NR [48]
	NS: Other in-hospital complications: chest infection CP 4 % vs. Ctrl 5 %, $p = 0.97$; urinary tract infection CP 4 % vs. Ctrl 4 %, $p = 0.62$; deep vein thrombosis CP 0.0 % vs. Ctrl 2 %, $p = 0.95$; multiple complications CP 4 % vs. Ctrl 5 %, $p = 0.97$; other CP 4 % vs. Ctrl 7 %, $p = 0.69$. Other after-discharge complications: wound infection CP 4 % vs. Ctrl 5 %, $p = 0.97$; failure to cope CP 0.0 % vs. Ctrl 2 %, $p = 0.95$; other CP 2 % vs. Ctrl 4 %, $p = 0.97$ [36]
	Need for revision surgery: CP 1.2 % vs. Ctrl 2.6 %, $p = 0.1$ [38]
	Caregiver-related events: CP 13 % vs. Ctrl 18 %, $p = 0.068$ [39]

Table 2 continued

Main end point/specific measure	
Overall complications	CP+: Postoperative minor and major complications: CP 18.2 % vs. Ctrl 33.3 %, $p = 0.01$ [34]
	Medical complications: CP 8.9 % vs. Ctrl 25 %, $p = 0.003$ [43]
	NS: Other in-hospital complications: CP 18.2 % vs. Ctrl 25.0 %, $p = 0.5$; other after-discharge complications: CP 5 % vs. Ctrl 11 %, $p = 0.5$ [36]
	Associated-illness complications: $p =$ NS [35]
	CP=Ctrl/p-NR: Overall complication rate similar in CP and Ctrl, rate NR, p-NR [39]
Hospital readmission	
Readmission at 28–30 days	CP+/p-NR: CP 4.5 % vs. Ctrl 5.5 %, p-NR [35]
	CP=Ctrl/NS: CP 8.0 % vs. Ctrl 7.0 %, $p = 0.167$ [39]
	CP 3.6 % (2/55) vs. Ctrl 10.7 % (6/56), $p = 0.28$ [36]
	Readmissions to hospital or rehabilitation: 100 (16 %) CP vs. 94 (16 %) Ctrl, $p = 0.76$; median (IQR) readmission LOS 13 (5–26) days CP vs. 10 (5–22) days Ctrl, $p = 0.33$ [42]
	CP 0.0 % vs. Ctrl 0.0 % [43, 44]
	15 % (year 2007–2008) and 15 % (year 2009) in the CP, p-NR [48]
Discharge location/destination	
Discharged to home	CP+: CP 7.7 % vs. Ctrl 3.8 %; to long-term care CP 27.6 % vs. Ctrl 24.5 %, $p = 0.001$ [42]
Discharged to prefracture living	NS: CP 75 % vs. Ctrl 66 %, $p =$ NS [44]
Discharged to skilled nursing facility/institutional care	CP=Ctrl/NS: CP 5.3 % vs. Ctrl 5.2 %, $p =$ NS [38]
	Institutionalization care: Ctrl 19 % vs. CP 13 %, $p = 0.058$; discharged to nursing homes: CP 36.5 % vs. Ctrl 30.7 %, $p =$ NS [39]
	Admitted from place other than a nursing home and discharged to a nursing home: CP 6.8 % vs. Ctrl 7.8 %, $p =$ NS [35]
New nursing home placement 4 months postdischarge	NS: NS difference [37]
Accommodations at home 6 months postoperation	NS: CP 30.9 % vs. Ctrl 17.7 %, $p = 0.06$ [34]

ADL activities of daily living, *MBI* modified Barthel Index, *SSI* surgical site infection, *CP+* positive effect in favor of CP group, *Ctrl+* positive effect in favor of control group, *CP=Ctrl* equal effect for CP and Ctrl; *NS* no significant difference between CP and Ctrl; *p-NR* not reported if the observed difference was significant; *p=NS* no significant difference, *NR* not reported value or data

Choong et al. [36] observed a reduction in the "time between surgery and the patient first walking with the use of aids." In Hommel et al. [46], the "time from hospital admission until the patient arrived at the ward" was reduced with CP. In Olsson et al. [43], similar results were observed for the "time waiting at the emergency room before receiving care in the ward." No significance level was reported for the differences observed by Lau et al. [48] for "preoperative LOS." In Gholve et al. [41] a better "rate of surgery within 24 h" was observed, but the authors considered this difference not to be significant. No significance level was reported by Hommel et al. [47]. Tallis and Balla [35] found significant differences in "days after operation first seen by geriatric medical unit" and in "days between geriatric assessment and discharge." Olsson et al. [44] observed that CP patients were visited by a community social worker 10 days sooner than non-CP patients. Discharge-planning meetings also took place 5 days earlier for CP patients [44]. Olsson et al. [43] observed a shorter "time between surgery to first ambulation" and "time from arrival to hospital to first ambulation." Tallis and Balla [35] reported fewer "days after operation patient first sat out of bed" and fewer "days after operation patient first walked."

In the study of Olsson [45] a 40 % reduction in the average total cost in the CP group and in terms of a cost–effectiveness ratio was observed. Beaupre et al. [42], on the other hand, found no significant difference in overall costs.

Discussion

The included studies assessed a wide range of outcome measures and reported inconsistent results. The magnitude of risk difference for some outcome measures, including mortality was very small and its clinical significance unclear. It would seem, therefore, that CPs need to be further evaluated with well-designed studies and well-selected

Table 3 Results of primary literature studies related to process and economic outcome measures

Main end point/specific measure	
LOS	
Acute LOS	CP+: CP 12.2 vs. Ctrl 26.3 days, $p < 0.0001$ [51, see also 45]
	CP 13.7 vs. Ctrl 21.6 days, $p < 0.001$ [38]
	CP 6.6 vs. Ctrl 8.0 days, $p = 0.03$ [36]
	For nursing home patients: CP 5 vs. Ctrl 6 days, $p = 0.038$ [37]
	CP 15.3 vs. Ctrl 19.2, $p < 0.001$ [41]
	CP 11.0 vs. Ctrl 19.3 days, $p < 0.0001$ [35]
	For discharged <14 days, CP had significant difference, $p = 0.047$; for discharged <28 days, CP 13.6 vs. Ctrl 15.3 days, p-NR [34]
	CP+/p-NR: CP 6.66 vs. Ctrl 12.07 days, p-NR [48]
	Ctrl+: CP 11.0 vs. Ctrl 9.0 days, $p < 0.001$ [40]
	CP 10 vs. Ctrl 8.5, $p < 0.001$ [42]
	CP 11.8 vs. Ctrl 10.8; patients coming from their own home: CP 13.2 vs. Ctrl 11.5 days ($p = 0.034$) [47]
	CP 22.5 vs. Ctrl 16.4, $p < 0.0005$; excluding deaths and those discharged to nursing homes or residential care: CP 19.6 vs. Ctrl 14.8 days, $p < 0.0005$ [39]
	NS: For non-nursing home patients: CP 9 vs. Ctrl 10 days, $p = 0.2$ [37]
Rehabilitation LOS	CP+: CP 22 vs. Ctrl 28 days, $p = 0.04$ [42]
	CP+/p-NR: Ctrl 40 (year 2006) vs. CP 22.8 (year 2009) days, p-NR [48]
	Ctrl+: CP 26 vs. Ctrl 21 days, $p = 0.011$ [37]
	NS: CP 9 vs. Ctrl 12 days, $p = 0.12$ [40]
Total LOS	NS: CP 24 vs. 22 Ctrl, $p = 0.33$ [42]
	CP 23.0 vs. Ctrl 21.0 days, $p = 0.29$ [40]
	CP 40.6 vs. Ctrl 37.2, $p =$ NS [39]
Total days institutionalized	CP+/p-NR: CP 27.5 vs. Ctrl 28.3 days; p-NR [47]
Other time span measures	
Time from hospital admission to acute-care ward	CP+: CP 3.2 vs. Ctrl 4.0 h, $p < 0.001$ [46]
	CP 4.0 vs. Ctrl 5.0 h, $p = 0.02$ [43]
	NS: CP 3.6 vs. Ctrl 4.1 h, $p = 0.11$ [36]
Early surgery	CP+/p-NR: CP 27.4 h vs. Ctrl 26.5 h, p-NR [47]
Surgery within 24 h	NS: CP 79 % vs. Ctrl 71 %, $p = 0.05$ [41]
Preoperative LOS	CP+/p-NR: CP 1.42 vs. Ctrl 6.1 days, p-NR [48]
Time waiting for surgery	NS: CP 22 vs. Ctrl 23 h, $p = 0.6$ [43]
	CP 17.5 vs. Ctrl 16.9 h, $p = 0.72$ [36]
Postoperative LOS	CP+/p-NR: Ctrl 6.6 vs. CP 5.24 days, p-NR [48]
Days postoperation first seen by geriatric medical unit	CP+: CP 3.0 vs. Ctrl 4.3, days $p < 0.0001$ [35]
Days between geriatric assessment and discharge	CP+: CP 10.1 vs. Ctrl 16.7 days, $p < 0.018$ [35]
Days of contact with community social worker	CP+: Contact with the community social worker was made 10 days earlier in the CP vs. Ctrl, $p = 0.001$ [44]
Time span of discharge planning meeting	CP+: Discharge planning meetings took place 5 days earlier in the CP vs. Ctrl, $p = 0.003$ [44]
Time span proxy for mobility	CP+: Time between surgery to first ambulation: CP 20 vs. Ctrl 28 h, $p < 0.0005$; time from arrival to hospital to first ambulation: CP 41 vs. Ctrl 49 hours, $p = 0.01$ [43]
	Days after operation first sat out of bed: CP 1.7 vs. Ctrl 2.8, $p < 0.0005$; days after operation first walked: CP 3.0 vs. Ctrl 4.3, $p < 0.0005$ [35]

Table 3 continued

Main end point/specific measure	
Economic outcome	
Average total cost	CP+: CP € 9,685 vs. Ctrl € 15,984 [45]
	CP=Ctrl: Mean costs/patient CP US$ 19,925 vs. Ctrl US$ 20,466; median costs/patient US$ 13,543 for both CP and Ctrl groups [42]
Cost–effectiveness ratio	CP+: CP € 14,840 vs. Ctrl € 31,908 [45]

CP+ positive effect in favor of care pathway group, *Ctrl+* positive effect in favor of control group, *CP=Ctrl* equal effect for CP and Ctrl, *NS* not significant difference between CP and Ctrl, *p-NR* not reported if the observed difference was significant, *p=NS* not significant difference, *NR* not reported value or data

outcome measures [16, 54]. This review was primarily focused upon the hospital admission processes rather than, for example, issues around future fracture risk. Further studies should evaluate also the rate of osteoporosis treatment on admission and discharge because of the relevance of this outcome measure in HF-management studies. Overall, the studies included in this systematic review failed to explore all the domains of a CP compass, which corresponds to clinical, service, team, process, and financial outcome. The investigation of every one of these five compass domains is a requirement to fully interpret the effects of any CP [55].

In terms of mortality, the results provided evidence that CPs can have a positive impact on in-hospital mortality [35, 36]. However, CPs generally failed to have a significant effect on after-discharge mortality, both short and long term. It remains unclear if and to what extent these results may have been biased by the inclusion of different populations and settings—of 12 studies, three were conducted in Australia, three in Canada, two in Sweden, two in the United Kingdom, one in the United States, and one in Hong Kong and about half were conducted in teaching hospitals.

From a clinical perspective, almost all studies showed significantly reduced complication rates with CPs, including fewer medical complications, wound infections, pressure sores, etc. Moreover, time-span process measures suggested that CPs do improve the organization of care: surgery rates within 24 h were higher in the CP groups [41], time between hospital admission and ward admission was shorter in the CP groups [43, 46], waiting time for geriatric medical assessment was shorter in patients treated according to CPs [35], and CP patients were contacted by social workers sooner [44]. Taken together, these findings suggest that the organization of the care process does improve clinical outcome, in line with previous findings in patients undergoing elective hip surgery [56].

Overall, results for functional recovery and mobility in patients treated with CPs compared with those on usual care were inconsistent and inconclusive [34, 35, 38–40, 44]. In general, however, recent studies tended to show better functional outcomes with CPs [39, 40, 44]. This may reflect the fact that, in recent years, CPs have progressed from a pioneer tool to a better-understood complex intervention comprising more structured, evidence-based medicine adapted to local standards and multidisciplinary care [11–13, 57].

With regard to the after-discharge location and hospital readmission rates, nearly all of the included studies failed to find differences between CP and non-CP patients. A possible explanation may be that the CPs used were mainly hospital-based with no explicit link to primary care, a key component in the continuum of care of HF patients. In line with these findings, LOS was shorter in hospital settings where CPs were implemented, with less of an effect when tracking the patients' post-hospital stay through the continuum of care. It is important to note that the studies did not investigate health-related quality of life for HF, a potentially relevant outcome measure to be assessed along with functional outcome [5].

From a methodological perspective, the selected studies showed an acceptable quality, even if we take into account some limits when interpreting the results. In fact, as with similar studies, certain key aspects were not always clear, such as some of the selection criteria for patients, the representativeness of the CP cohort, the selection of the non-CP cohort, the ascertainment of exposure/intervention, and the demonstration of outcomes of interest. Adjustment for confounding factors was also limited, with the majority of studies based on an observational design. Moreover, in many of the studies outcome assessment was based on a nonindependent and nonblinded observation of medical records.

The main limitation of our review lies in design issues of the selected studies. In addition to selection bias, the use of historical controls (instead of prospective controls) in the studies with a controlled before-and-after (CBA) design, based on retrospective medical records review, may have caused some distortion due to historical trends. Approximately half of the studies had a small sample size of participants in both arms, which may have negatively affected statistical power. Also, most studies were single-center trials. In CBA studies with only one control site and one intervention site, the intervention is often confounded by the study site, limiting the ability to attribute changes specifically to the CP intervention and not to other site-specific variables [58]. Also, because of the nonrandomized nature of most studies, differences in baseline characteristics may have confounded the findings and limited the interpretation of the data. However, overall, baseline characteristics were well balanced in most studies, with the exception of significant differences in age [37, 41], gender [39], comorbidities [37, 42, 47], and residence at admission [37].

What should be noted as well is that patient inclusion criteria in many studies were not very specific as, in some cases, the studies used only one or a few inclusion criteria. Moreover, different studies used different inclusion/exclusion criteria. A particular strength, on the other hand, was that the selected studies typically used adjusted analyses [39, 40, 42, 47]. However, in many studies, some important baseline variables with a documented impact on HF care management were not recorded, possibly confounding outcome results. Typical examples include, in some studies, medical variables like premorbid comorbidities, mental/cognitive status, function and mobility, or demographic variables like age and sex, known predictors of functional outcome [59].

It was not possible to evaluate the potential variations in health-care systems, which may affect the doctor–patient ratio, the nurse–patient ratio, and the observed differences in outcomes between the studies.

Finally, the methods used to develop and implement CPs were not always clearly described. As a consequence of this informative lack, it is not possible to know if (or which) evaluative information was provided to the CP team and patients as a useful basis in improving the CP. These action-oriented issues, based on learner skills and knowledge, ought to constitute the formative evaluation of involved teams and patients [60–62]. On the other hand, key interventions were well defined in most studies, not only in terms of the different phases of the care process (i.e., target setting, time scheduling, variance analysis), but also in terms of their clinical content (i.e., assessment/monitoring, consults, tests/diagnostics, interventions, medications, nutrition, activity, teaching, discharge planning) and their integration in the continuum of care. Because only three studies reported on the presence of a care coordinator in the protocol implementation process, it was not possible to make any consistent conclusion about this issue. This could be a further limitation to the findings, which is also reported in other care pathways literature reviews [16, 63, 64].

Our findings showed a possible effect of care pathways on some of the reported indicators. Therefore, the following measures could be suggested as possible benchmarks for further studies: mortality, functional recovery and mobility indexes (such as ADL level, walking ability and status, weight bearing, modified Barthel Index), medical complication rates, LOS, and cost.

In conclusion, even if some positive results emerged from the present review, the available evidence suffers from a number of limitations and is insufficient for formal recommendations. There is a research need for adequately powered, well-designed, multicenter CP studies for in-hospital and postdischarge management of HF patients.

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