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Impact of home-based palliative care on health care costs and hospital use: A systematic review

Valentina Gonzalez-Jaramillo, M.D., M.SC.[1,2], Valérie Fuhrer, M.D.[3], Nathalia Gonzalez-Jaramillo, M.D., M.SC.[1,2], Doris Kopp-Heim, B.B.S.[4], Steffen Eychmüller, M.D.[3] and Maud Maessen, PH.D.[1,3]

[1]Institute of Social and Preventive Medicine (ISPM), University of Bern, Mittelstrasse 43, 3012 Bern, Switzerland; [2]Graduate School for Health Sciences, University of Bern, Bern, Switzerland; [3]University Center for Palliative Care, Inselspital University Hospital Bern, University of Bern, Bern, Switzerland and [4]Public Health & Primary Care Library, University Library of Bern, University of Bern, Bern, Switzerland

Review Article

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Author for correspondence:
Valentina González-Jaramillo, Institute of Social and Preventive Medicine (ISPM), University of Bern, Mittelstrasse 43, 3012 Bern, Switzerland. E-mail: valentina.gonzalez@ispm.unibe.ch

Abstract

Objective. To assess the effectiveness of home-based palliative care (HBPC) on reducing hospital visits and whether HBPC lowered health care cost.

Method. We searched six bibliographic databases (Embase (Ovid); Cochrane Central Register of Controlled Trials; Medline (Ovid); PubMed; Web of Science Core Collection; and, CINAHL) until February 2019 and performed a narrative synthesis of our findings.

Results. Of the 1,426 identified references, 21 articles based on 19 unique studies met our inclusion criteria, which involved 92,000 participants. In both oncological and non-oncological patients, HBPC consistently reduced the number of hospital visits and their length, as well as hospitalization costs and overall health care costs. Even though home-treated patients consumed more outpatient resources, a higher saving in the hospital costs counterbalanced this. The reduction in overall health care costs was most noticeable for study periods closer to death, with greater reductions in the last 2 months, last month, and last two weeks of life.

Significance of results. Stakeholders should recognize HBPC as an intervention that decreases patient care costs at end of life and therefore health care providers should assess the preferences of patients nearing the end-of-life to identify those who will benefit most from HBPC.

Introduction

As the population of the world ages (He et al., 2016), demand for health and social care is increasing, raising costs, and placing ever greater burdens on national health care systems (Guzman-Castillo et al., 2017).

In this context, a careful evaluation of healthcare resources is crucial to deliver the most appropriate treatments to patients with severe chronic illnesses. Besides treatments focused on curing, patients with prevalent non-curative chronic conditions have a great need of care-oriented treatments, including palliative care (PC). Such a treatment is an approach that seeks to improve the quality of life of patients and their families by the prevention and alleviation of suffering through early identification, evaluation, and treatment of pain and other physical, psychosocial, and spiritual problems ("World Health Organization. WHO definition of palliative care," 2019). Inpatient PC effectively improves patients' quality of life and satisfaction with their care (Gade et al., 2008) and a recent meta-analysis showed that PC lowers hospital costs for patients (May et al., 2018). However, inpatient PC is not for everyone; patients with a terminal illness benefit even more when PC and other types of care are delivered to them at home. Home care reduces hospital visits and hospital deaths, which is associated with a better quality of life for patients at the end of life (Zhang et al., 2012).

Effectiveness and cost-effectiveness of home-based general care have already been shown (Maru et al., 2015; Winkler et al., 2018). A 2013 Cochrane systematic review determined the effectiveness of home-based palliative care (HBPC) in reducing symptom burden for patients and also pointed out that there was not enough literature to assess cost-effectiveness. It also found that most of the literature focused on oncological patients (Gomes et al., 2013). Several more recent studies have assessed the economic impact of HBPC. To date, a comprehensive and systematic appraisal of the existing literature on this impact is missing. Therefore, we conducted a systematic review to (1) assess the effectiveness of HBPC on reducing hospital visits and (2) assess whether HBPC lowered health care costs.

Methods

Literature search

We conducted a systematic review that follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline and registered the protocol in PROSPERO (Moher et al., 2009).

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With the aid of an experienced medical information specialist (DK), we searched six electronic databases for peer-reviewed scientific literature related to cost of HBPC, with the goal of identifying studies published between 2013 and 11 February 2019 (date of last search). The search was done in Embase (Ovid); Cochrane Central Register of Controlled Trials; Medline (Ovid); PubMed; Web of Science Core Collection; and, CINAHL. We combined terms related to the exposure (PC, end-of-life care, ambulatory care, domiciliary care) and our outcomes (health expenditures, health care costs, hospitalization rate). We did not apply a language restriction. The full search strategies are available in the appendix (Supplementary material 1). To identify additional sources, we added a Google Scholar search and inspected the references of studies that qualified for full-text review (backward searching).

Study selection and inclusion criteria

Two independent reviewers (VG and VF) screened all titles and abstracts and then reviewed potentially relevant articles based on full text. They resolved differences through discussion before coming to consensus. If no consensus was reached, a third independent reviewer solved discrepancies between the two reviewers.

We included prospective and retrospective observational studies (case–control or cohort) cross-sectional studies, and interventional studies (randomized and non-randomized) that studied an adult palliative population (≥18 years old), at the end of life, with severe illness or with a disease end-stage and compared hospital visits or health care costs of those who received PC at home to those who received usual care. Usual care might include PC in the hospital, but not at home. We defined HBPC as PC that includes home visits.

Data extraction

We used a predesigned data collection form to extract relevant information from the selected studies including study design, sample size, characteristics of the study population, intervention, and type of controls. We also extracted the outcomes each study assessed, and the correspondent measure of associations (e.g., hospitalization rate, mean length of stay, overall cost, inpatient cost, prevalence of death at home).

Assessing the risk of bias

Three reviewers (VG, VF, and NG) independently rated study quality based on the Joanna Briggs Institute Critical Appraisal Tools Checklists for use in systematic reviews. The checklist has 11 items for cohort studies, nine items for quasi-experimental studies, and 13 items for RCTs.

Data synthesis

We conducted a narrative synthesis of the findings of the included studies. For each study, we determined if cost or utilization differed between groups, and whether the difference favored the intervention or the control. Initially, we sought to pool their results using a random effects meta-analysis model. Because studies varied in duration and type of exposure, the time points of outcome assessment, and were conducted in different health systems, we could not pool these results. However, we could make a summary estimate of cost savings by calculating the percentage of costs reduced by the HBPC intervention for those studies that reported the difference between overall costs for patients with and without HBPC. Because several studies reported total costs at different time periods (e.g., from 6, 3, or 1 month until death), we performed two calculations: one included data from the period furthest from death and the other included data from the period closest to death. For studies that stratified cost by groups (e.g., disease), we calculated the average cost in savings across the groups.

Results

We identified 1,426 unique references (Figure 1). Based on the title and abstract, we selected the full text of 30 articles for detailed evaluation; 21 of these articles, based on 19 studies, met our eligibility criteria and were included in this review. Figure 1 explains the reasons why the remaining nine articles were excluded.

General characteristics of the included studies

Table 1 details the characteristics of the 19 included studies, which together included data on 92,871 people. Most of the studies (n = 12) assessed health care cost and use, six assessed only health care use, and one assessed only health care cost. Ten studies assessed the place of death. The majority of the studies (n = 9) included participants from the U.S., two from Italy, and the rest included participants from Belgium, Denmark, England, Israel, Singapore, Spain, Sweden, and Taiwan. Twelve were retrospective cohort studies, five were quasi-experimental studies (before–after studies), and two were randomized controlled trials (RCTs).

Most of the studies included both oncological and non-oncological patients (n = 10) (Chitnis et al., 2013; Lukas et al., 2013; Murphy et al., 2013; Kerr et al., 2014; Hopp et al., 2015; Brian Cassel et al., 2016; Lustbader et al., 2017; Pouliot et al., 2017; Sudat et al., 2018; Maetens et al., 2019); six studies (reported in seven publications) included only oncological patients (Alonso-Babarro et al., 2013; Bentur et al., 2014; Riolfi et al., 2014; Blackhall et al., 2016; Chiang and Kao, 2016; de Miguel et al., 2018; Skov Benthien et al., 2018), two studies (reported in three publications) included only patients with heart failure (Wong et al., 2013; Brannstrom and Boman, 2014; Sahlen et al., 2016), and one study included non-oncological patients (Ferroni et al., 2016). Non-oncological conditions included in the studies were dementia, senility, respiratory disease, liver disease, kidney disease, coronary artery disease, neurodegenerative disease, and diabetes.

Supplementary Tables 1–3 show the risk of bias assessment for each study. Although RCTs are rare within PC research, we found three. These studies were the studies at lower risk of bias. The risk within those studies mainly consisted out of non-concealment of the HBPC intervention. The five quasi-experimental studies also had low risks of bias scores. The biggest problem with quasi-experimental studies was the lack of an independent control group as those studies were before-after studies. The 13 retrospective cohort studies were at higher risk of bias due to unclear or non-existing handling of confounding (Chiang and Kao, 2016; Lustbader et al., 2017; de Miguel et al., 2018).

HBPC intervention

Out of the 19 studies, 18 clearly described the intervention. The remaining one used claim data to search for care codes and those patients with home hospice codes were included in the

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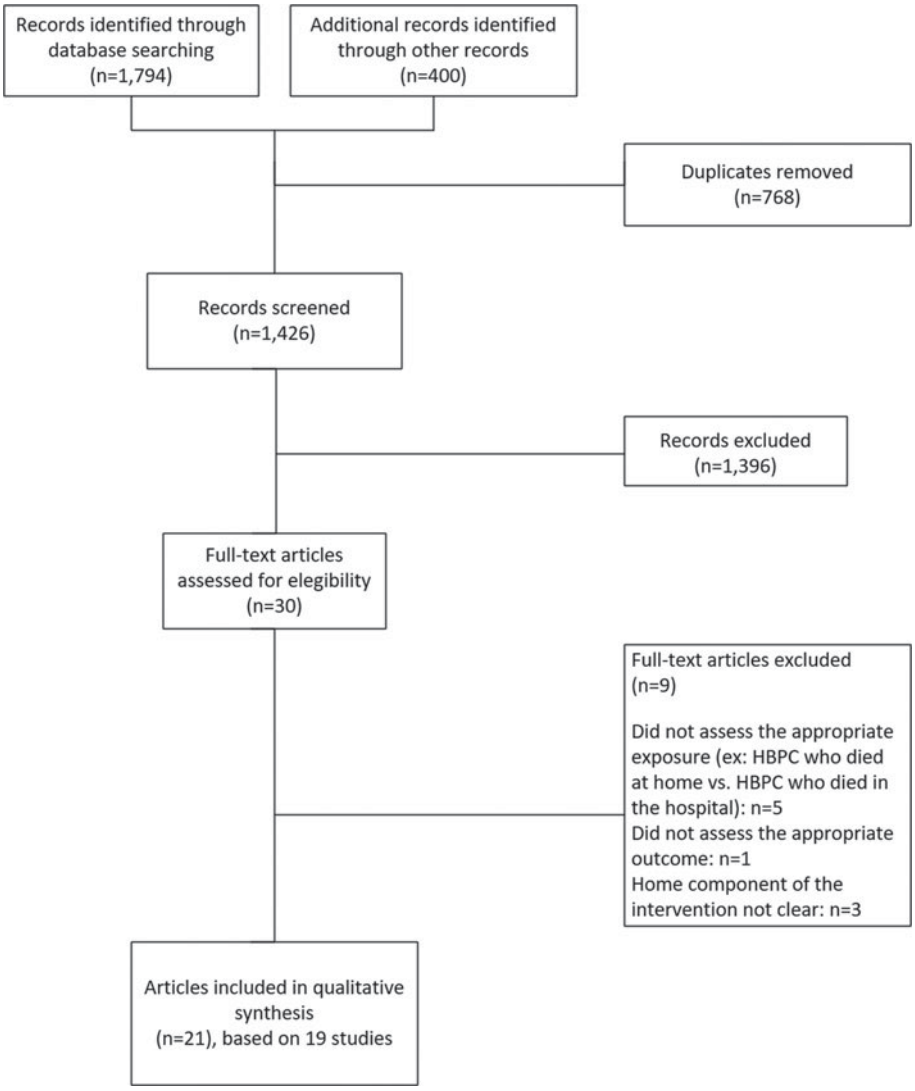

Fig. 1. Flowchart of the studies included in the systematic review.

intervention group (Chiang and Kao, 2016). The majority of the studies ($n = 11$) consisted of a multidisciplinary team that involved nurses, PC specialists, social workers, psychologists, physiotherapists, chaplains, or other spiritual care providers. In five studies, the care in the intervention group was only provided by physicians and nurses, in one by PC specialist and heart failure specialist and in one by nurses and assistants (Table 1). At least six of the studies stated the availability of the assistance was 24 h per day, seven days of the week, whether face-to-face or by telemedicine.

Main outcomes

Hospital use

Hospital admission. Fourteen studies assessed hospital admission rates; two of these evaluated admissions to an intensive care unit (ICU) (Brian Cassel et al., 2016; Maetens et al., 2019). Most studies ($n = 9$) compared groups of patients who had and did not have access to HBPC (Table 1). These studies found that the group of patients with HBPC had a smaller percentage of patients being hospitalized or admitted at least once to the ICU compared to the group without HBPC. Additionally, the group with HBPC showed a lower average number of hospitalizations per patient or per intervention group and lower risk of hospital admission. Only one study, a secondary analysis of an RCT, noted more hospital admissions in the intervention group, but the difference was not significant. This study's results were derived from an intention-to-treat analysis in which two thirds of the patients in the control group also received the intervention (Skov Benthien et al., 2018).

These results aligned with the results of the five quasi-experimental studies in which the control was the patient before HBPC intervention. These five studies found hospital admissions dropped after the HBPC service was introduced regardless when the mark before/after was chosen. Four of them compared the hospital admissions in a symmetric way, for example, 18 months before intervention vs. 18 months after intervention (Lukas et al., 2013), or 6 months before vs. 6 months after the intervention (Hopp et al., 2015). They found the reduction in hospital admission to be significant (Lukas et al., 2013; Wong et al., 2013; Hopp et al., 2015; Pouliot et al., 2017). The remaining study, which was the only one not assessing the outcome in a symmetric way, did not reach the established significance level (Murphy et al., 2013).

Hospitalization length. The length of hospital stay was assessed by nine studies. All of them found that significantly shorter

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Table 1. General characteristics of the studies included

Author, publication year	Population	Sample size	Study design	Confounder control	Exposed group	Exposition/Intervention	Comparison group
Alonso-Babarro et al., 2013[a]	Oncological	*n* = 549	Retrospective cohort	Age, sex, marital status, SES, cancer type	Patients living in an area with access to HBPC who received HBPC	The HBPC team was composed of two physicians, two nurses, an assistant nurse, and an administrative clerk. The team conducted a regular follow-up of patients referred by acute care hospitals, medical oncologists, or family physicians when these patients were perceived as having a progressive incurable disease and high symptom distress.	Patients without HBPC
Chitnis et al., 2013	Oncological and non-oncological	*n* = 59,076	Retrospective cohort	Matched analysis	Patients who received home-based end-of-life nursing care delivered by the Marie Curie Nursing Service	The intervention, provided by registered nurses and healthcare assistants, gives hands-on care and emotional support for people in their own homes, day and night at the end of life. It aims to provide care that makes it possible for people to spend their last days of life at home rather than in hospital.	Controls individually matched on variables including age, socioeconomic deprivation, prior hospital use, number of chronic conditions, and prior diagnostic history.
Lukas et al., 2013	Oncological and non-oncological	*n* = 369	Quasi-experimental	Adjusted (no specifications)	Patients with advanced complex illness referred for home-based palliative consultation	Patient care was provided by three nurse practitioners who were supported by a collaborating physician (20% effort). Follow-up visits varied by need for symptom management and advanced care planning. Psychospiritual needs that exceeded the nurses' scope of practice were addressed by referral to a psychiatric homecare nurse, network chaplain, or behavioral health physician.	Controls were the same patients before the intervention.
Murphy et al., 2013	Oncological and non-oncological	*n* = 146	Quasi-experimental		Patients receiving care from the Primary Palliative and Supportive Care Clinic	The clinic provides 24-h access to a PC specialist. The mission is to provide both primary care and PC to patients with life-limiting illness and no primary provider. Patients also have weekday access to a PC nurses who address and coordinate needs.	Controls were the same patients before the intervention.
Wong et al., 2013	Heart failure	*n* = 44	Quasi-experimental	Follow-up duration	End-stage heart failure patients recruited into the PC program	The HBPC program consisted of a multidisciplinary team of a doctor, a nurse, and/or a counselor. Telephonic consults were made available 24/7 to facilitate updates of clinical conditions and delivery of advice/educations.	Controls were the same patients before the intervention.
Bentur et al., 2014	Oncological	*n* = 193	Retrospective cohort	Adjusted (no specifications)	Deceased patients that lived in an area with community care, who received community care and were referred to home hospice	The home hospice unit is a 24-h service provided by a multidisciplinary PC team that includes physicians, nurses, and social workers who visit the patient's home once a week or more, as needed.	Deceased patients that lived in an area with community care, who received regular community care
Brannstrom and Boman, 2014[b]	Heart failure	*n* = 72	RCT	Randomization	Patients randomly assigned to the PREFER intervention	PREFER is a multidisciplinary approach involving collaboration between specialists in palliative and heart failure care. The patients also get person-centered care at home. The home care unit provides services Monday–Friday during the day. The home visits and the phone calls use ranges from several times per day to every other week.	Patients randomly assigned to the control arm: usual care provided mainly by GPs or doctors and/or the nurse-led heart failure clinic at the Medicine-Geriatrics department.

(*Continued*)

Table 1. (*Continued.*)

Author, publication year	Population	Sample size	Study design	Confounder control	Exposed group	Exposition/Intervention	Comparison group
Kerr et al., 2014	Oncological and non-oncological	*n* = 686	Retrospective cohort	Matched analysis	Expired patients that were under the Home Connections program	The program includes a PC-trained registered nurse, social worker, volunteers, and PC physician. Service includes 24/7 on-call PC nurse support. Nurses and social workers visit participants a minimum of once per month and a biweekly interdisciplinary group meeting is held to discuss each patient case with the PC physician.	Controls were patients matched with propensity score using age, gender, insurance product, median household income, neighborhood percentage minority, prospective risk score, and diagnoses historically associated with PC.
Riolfi et al., 2014	Oncological	*n* = 402	Retrospective cohort	Age, sex, and type of cancer	Patients living in an area with Palliative Home care Team who received this care.	The team consists of 2 PC physicians and 30 non-specialist nurses, who cooperate with GPs. GPs have to guarantee their on-call availability. The services are assured from Monday to Friday (8.00 a.m. to 20.00 p.m.). During the night and weekends, PC physicians are available by phone.	Patients living in an area with Palliative Home Care Team who did not receive this care.
Hopp et al., 2015	Oncological and non-oncological		Quasi-experimental		Older population (mean age 69 ± 15) with both oncological and non-oncological diagnosis in the @HOMe Support program	The @HOMe program is an interdisciplinary home-based program for patients and caregivers facing advanced illness. Services of the program were delivered by health care clinicians (physicians, nurses, social workers, and aides).	Controls were the same patients before the intervention.
	Primarily advance-stage cancer		Quasi-experimental		Younger population (mean age 53 ± 9.4) with advanced cancer in the @HOMe Support program	The @HOMe program is an interdisciplinary home-based program for patients and caregivers facing advanced illness. Services of the program were delivered by health care clinicians (physicians, nurses, social workers, and aides).	Controls were the same patients before the intervention.
Blackhall et al., 2016	Oncological	*n* = 376	Retrospective cohort	Demographics and malignancy characteristics	Patients in the CARE track program	The program provides outpatient PC including home hospice. The staff includes registered nurses, physicians, and nurse practitioners. The same physicians and nurse practitioners staff all of the settings. PC providers often serve as the hospice attending once a patient is referred to that service.	Patients who died without any contact with PC or had contact with PC only while hospitalized (inpatient PC)
Brian Cassel et al., 2016	Oncological and non-oncological	*n* = 1,443	Retrospective cohort	Matched analysis	Patients with home-and clinic-based PC	The team includes doctors, nurses, spiritual care providers, and social workers. They provide in-home medical consultation, ongoing evidence-based prognostication of further survival, caregiver support, advance health planning, pain management, education, and psychosocial and spiritual support.	A comparison patient was chosen based on propensity score matching based on age, race, sex, and hospital and nonhospital charges in the first 6 months of the 2-year period. For comparison participants, an index date was created that was the same number of days before death as the matching intervention participant.

Chiang and Kao, 2016	Oncological	*n* = 568	Retrospective cohort		Patients under home hospice care.	Home hospice care.	Patients under inpatient hospice care.
Ferroni et al., 2016	Non-oncological	*n* = 2,087	Retrospective cohort	Diagnosis, age, sex, marital status, Charlson score	Patients under HBPC for Chronic Diseases	HBPCe for Chronic Diseases plan of care: GPs, nurses, out-of-hours physicians, and PC physicians. The GPs are generally readily available on call 12 h/5 days with on-call physicians providing coverage for the rest of time. For more complex patients, PC nurses and PC specialist readily available on call 24 h/7 days and 12 h/days, respectively.	Patients that were never seen by HBPC for Chronic Diseases
Sahlen et al., 2016[b]	Heart failure	*n* = 72	RCT	Randomization	Patients randomly assigned to the PREFER intervention	PREFER is a multidisciplinary approach involving collaboration between specialists in palliative and heart failure care. The patients also get person-centered care at home. The home care unit provides services Monday–Friday during the day. The home visits and the phone calls use ranges from several times per day to every other week.	Patients randomly assigned to the control arm: usual care provided mainly by GPs or doctors and/or the nurse-led heart failure clinic at the Medicine-Geriatrics department.
Lustbader et al, 2017	Oncological and non-oncological	*n* = 651	Retrospective cohort		Decedents enrolled in the HBPC program	The HBPC team comprised six registered nurses, two social workers, two doctors, one data analyst, three administrative staff, and volunteers. Most patients get at least one house call and two telephone calls per month (additional as needed). Telepalliative care is available for a virtual visit for patients and their caregivers using their own smart phone or computer. The nurses may also receive physician support via telemedicine while in the patient's home. Patients have access to coverage 24/7 by telephone or telemedicine to one of the program physicians.	Patients who died under usual care
Pouliot et al., 2017	Oncological and non-oncological	*n* = 123	Quasi-experimental		Patients seen by Care Choices, an in-home PC program provided by the Visiting Nurse Services of Northeastern New York and Ellis Medicine's community hospital serving New York's Capital District.	The program offers interdisciplinary in-home care by a team (medical director, nurse, social worker, chaplain, and home health aides) exclusively dedicated to palliative home care to meet the patient's physical, emotional, and spiritual needs. Additionally, home visits offer education, advance directive planning, and psychosocial and spiritual support.	Controls were the same patients before the intervention.
de Miguel et al., 2018[a]	Oncological	*n* = 226	Retrospective cohort		Patients living in an area with access to HBPC who received HBPC	The HBPC team was composed of two physicians, two nurses, an assistant nurse, and an administrative clerk. The team conducted regular follow-up of patients referred by acute care hospitals, medical oncologists, or family physicians when these patients were perceived as having a progressive incurable disease and high symptom distress.	Patients without HBPC

(*Continued*)

Table 1. *(Continued.)*

Author, publication year	Population	Sample size	Study design	Confounder control	Exposed group	Exposition/Intervention	Comparison group
Skov Benthien et al., 2018	Oncological	$n = 322$	RCT (Secondary analysis)	Randomization	Patients randomly assigned to specialized PC at home	Specialized PC at home: Basic PC at home by district nurses, psychological sessions, home conference with specialist PC team, district nurses, and (if possible) GP.	Patients randomly assigned to usual care that includes referral to specialized PC at home on demand.
Sudat et al., 2018	Oncological and non-oncological	$n =$ 7,938	Retrospective cohort	Matched analysis	Patients enrolled in the home-based support program called Advanced Illness Management	The program is part of the PC service and includes physician- and call-center-based telephonic support, hospital-based care liaisons, and nursing and social work home visits.	At least four controls were matched with each intervention patient using "genetic matching", a matching that takes into account age, sex, race, co-morbidity, nurse utilization, and death date.
Maetens et al., 2019	Oncological and non-oncological	$n =$ 17,674	Retrospective cohort	Matched analysis	People who used at least one type of palliative home care support in the last 2 years of life.	The intervention included 1.The use of a multidisciplinary palliative home care team, which includes at least one GP, two nurses and an administrative assistant; 2. Palliative home care nursing or physiotherapy, or 3. Allowance for palliative home patients.	People who did not use palliative home care support in the last two years of life.

SES: socioeconomic status; HBPC: home-based palliative care; PC: palliative care; RCT: randomized controlled trial; GP: general practitioner.
[a]Population of the study published in 2018 is a sub-sample of the one published in 2013.
[b]Data derived from the same RCT (same population).

hospital stays were significantly shorter among patients with HBPC than among controls. One study of more than 7,900 oncological and non-oncological patients compared the length of hospital stay over the last 3 months of life in patients receiving HBPC compared to their matched controls. They found a significant reduction in length of hospital stay in the patient group receiving HBPC. They found that the number of days in the hospital during the last 3, 2, and 1 months of life was significantly reduced; the difference was greater than 30% (Sudat et al., 2018). Another study of more than 2,000 non-oncological participants assessed the risk of prolonged hospitalization at the end of life, defined as a stay that exceeds the 75th percentile of the stay that occurred during the last month of life. The authors found that there was a dose–response relationship: risk decreased with an increase in the number of HBPC visits per week (Ferroni et al., 2016) (Table 2).

Emergency department admission. Seven studies assessed emergency department (ED) admission; five found that patients with HBPC used significantly less ED, measured as the percentage of patients admitted at least once to ED or as risk of an ED admission. One large study of over 59,000 oncological patients found that only 12% of the patients with HBPC had at least one ED admission vs. 35% of the matched controls (Chitnis et al., 2013). Another large study of more than 17,000 oncological and non-oncological patients found that the risk of ED admission during the last two weeks of life was twice as high for those without HBPC than those with HBPC (Maetens et al., 2019). The remaining two studies found no difference or an insignificantly lower difference in ED use (Murphy et al., 2013; Bentur et al., 2014) (Table 2).

Health care cost

Average overall cost. There were 11 studies assessing this outcome. Of them, the majority of the studies ($n = 10$) compared a group of patients who had access to HBPC to patients without access. The remaining study used the same patients as controls (before the introduction of HBPC) and as the intervention group (Hopp et al., 2015) (Table 1). The studies assessed the outcome over different periods, ranging from the last month to the last year of life (Table 3). Seven studies included both oncological and non-oncological patients (Chitnis et al., 2013; Kerr et al., 2014; Hopp et al., 2015; Brian Cassel et al., 2016; Lustbader et al., 2017; Sudat et al., 2018; Maetens et al., 2019), three only oncological patients (Bentur et al., 2014; Blackhall et al., 2016; Chiang and Kao, 2016), and one only patients with heart failure (Sahlen et al., 2016).

Of the 11 studies that assessed overall cost in health, six studies specified that they had taken into account the costs of the intervention itself while the other five did not specify whether they had included these costs or not. When taking into account all the articles that evaluated overall cost in health, regardless of whether or not they included the costs of the intervention itself, the average total health care cost per patient was lower for those with access to HBPC than for controls.

Studies that assessed the outcome at different points in time found that the cost reduction was most noticeable closer to death, with the greatest reductions in the last 2 months, 1 month, and two weeks of life (Kerr et al., 2014; Blackhall et al., 2016; Lustbader et al., 2017). Including all 11 studies assessing average overall cost, the intervention saved 36.3% (IQR: 28.8–51.8%) when taking into account the costs reported at the period closest to death. Similar results were obtained when taking into

Table 2. Results of the studies assessing health care utilization

Author, publication year	Population	Sample size	Study design	Outcome period	Outcome	Result
Alonso-Babarro et al., 2013[a]	Oncological	$n = 549$	Retrospective cohort	Last 2 months of life	Hospital admission	The patients from the area with HBPC used inpatient services less frequently than those in the area without HBPC (66% vs. 76%, $p = 0.012$).
					Emergency department admission	The patients from the area with HBPC used emergency services less frequently than those in the area without HBPC (68% vs. 79%, $p = 0.004$).
Chitnis et al., 2013	Oncological and non-oncological	$n =$ 59,076	Retrospective cohort	From start with the program to death	Emergency department admission	Only 12% of the patients with HBPC had an emergency hospital admission compared with 35% of controls ($p < 0.001$).
Lukas et al., 2013	Oncological and non-oncological	$n = 369$	Quasi-experimental	18 months before vs. 18 mothers after intervention	Hospital admission	The average number of hospitalizations was 2.23 before intervention, compared to 1.25 post-intervention ($p < 0.001$).
					Hospitalization length	The average lengths of stay were 11.2 pre-intervention and 4.5 days after the intervention ($p < 0.001$).
Murphy et al., 2013	Oncological and non-oncological	$n = 146$	Quasi-experimental	12 months before enrollment vs. date of data extraction	Hospital admission	The average number of hospital admissions decreased post-enrollment (pre: mean = 1.28 ± 1.99; post: mean = 1.02 ± 1.44). This represents a 20.2% reduction in hospital admissions ($p = 0.057$).
					Emergency department admission	The mean number of ED visits per week decreased significantly after enrollment, from mean = 2.46 ± 4.74 to 1.76 ± 3.13. This represents a 28.6% reduction in ED utilization.
Wong et al., 2013	Heart failure	$n = 44$	Quasi-experimental	1 year before vs. 1 year after intervention or death	Hospital admission	After adjustment for follow-up duration, mean all-cause hospitalisations were 3.6 and 1.2 episodes per patient ($p < 0.001$) before and after enrollment, respectively; mean HF hospitalisations were 2 and 0.5 episodes per patient ($p < 0.001$) before and after enrollment, respectively.
Bentur et al., 2014	Oncological	$n = 193$	Retrospective cohort	Last 6 months of life	Hospital admission	About 89% of those under home hospice had been hospitalized at least once during the last 6 months of their life, compared to 83% in the control group.
					Emergency department admission	53% of those receiving HBPC care had visited ED at least once during the last 6 months of their life, compared to 52% in the control group.
Brannstrom and Boman, 2014	Heart failure	$n = 72$	RCT	Last 6 months of life	Hospital admission	The mean number of hospitalizations was significantly lower in the group with HBPC than in the control group (0.42 ± 0.60 vs. 1.47 ± 1.81, $p = 0.009$), as well as the total number of hospitalizations (15 in the HBPC group and 53 in the control).
					Hospitalization length	The mean number of days was significantly lower in the HBPC group (2.9 ± 8.3 vs. 8.5 ± 12.4, $p = 0.011$) compared with the control group. The total number of days spent in hospital was 103 (range 1–45 days) in the HBPC group and 305 (range 2–46 days) in the control group.
					Hospitalization length	Mean hospital days declined from 7.65 in the 6 months pre entry to 5.77 in the period following entry into the program ($p = 0.027$).

(*Continued*)

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Table 2. (*Continued.*)

Author, publication year	Population	Sample size	Study design	Outcome period	Outcome	Result
Riolfi et al., 2014	Oncological	$n = 402$	Retrospective cohort	Last 2 months of life	Hospital admission	HBPC patients had fewer hospital stays compared with patients without HBPC (0.4 ± 0.7 vs. 1.3 ± 1.0 admissions), respectively, $p < 0.001$.
					Hospitalization length	HBPC patients had shorter hospital stays (4.4 vs. 19.6 days, $p < 0.001$) than patients without HBPC.
Hopp et al., 2015	Oncological and non-oncological		Quasi-experimental	6 months before vs. 6 months after intervention	Hospital admission	The percentage of participants who experienced at least 1 hospitalization decreased from 83% in the 6 months pre entry to 54% in the period following entry ($p = 0.001$).
Blackhall et al., 2016	Oncological	$n = 376$	Retrospective cohort	Last 3 months of life	Hospital admission	Of the patients with access to HBPC, 37.6% were hospitalized in the last month of life, compared to 80.6% of patients who received PC only in the hospital. The difference remains significant after adjustment.
Brian Cassel et al., 2016	Oncological and non-oncological	$n =$ 1,443	Retrospective cohort	From start with the program to death	Hospital admission	For each disease, the percentage of participants hospitalized during the evaluation period, as well as in the last month of life, was lower for HBPC than for controls (all $p \leq 0.001$). The percentage using the intensive care unit in the final month of life was also lower for HBPC than controls ($p < 0.001$).
					Hospitalization length	For each disease, the number of hospital days was lower for HBPC than for controls (all $p \leq 0.001$).
Chiang and Kao, 2016	Oncological	$n = 568$	Retrospective cohort	Last month of life	Hospitalization length	The median days of hospital stay in the last month of life were fewer in the home hospice group than in the control (10.5 vs. 22.0, $p < 0.001$).
					Home deaths	Compared with patients in the inpatient group, the home group had a significantly larger proportion of death at home (55.5% vs. 22.1%, $p < 0.001$).
Ferroni et al., 2016	Non-oncological	$n =$ 2,087	Retrospective cohort	Last month of life	Hospitalization length	The relative risk of prolonged EOL hospital stay decreased significantly, with a dose–response relationship, according to the number of homecare visits/week performed during the last 90–31 days before death.
Lustbader et al, 2017	Oncological and non-oncological	$n = 651$	Retrospective cohort	Last year of life	Hospital admission	Hospital admissions were reduced by 34% in the final month of life for patients enrolled in HBPC ($p = 0.022$).
					Emergency department admission	ED visits were reduced by 20% in the final month of life for patients enrolled in HBPC ($p < 0.001$).
Pouliot et al., 2017	Oncological and non-oncological	$n = 123$	Quasi-experimental	Entire duration in the program. If a patient had been enrolled in the program for 2 months, hospitalization records 2 months before enrollment were used for comparison.	Hospital admission	There was a significant decline in the average number of inpatient admissions after enrollment in the home care program (mean 1.21 ± 1.01, before vs. mean 0.38 ± 0.70, after) $p < 0.001$.
					Emergency department admission	There was a significant decline in the average number of ED visits after enrollment in the home care program (mean 1.79 ± 1.46, before vs. mean 1.00 ± 1.08, after) $p < 0.001$.

(*Continued*)

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Table 2. (*Continued.*)

Author, publication year	Population	Sample size	Study design	Outcome period	Outcome	Result
de Miguel et al., 2018[a]	Oncological	$n = 226$	Retrospective cohort	Last 2 months of life	Hospital admission	The percentage of patients who had at least one hospital admissions was significantly lower in the group with access to HBPC (41%) compared to those without it (71%). The number of hospital admissions per patient was also lower in the group with HBPC.
					Hospitalization length	The average number of inpatient days was 7.5 vs. 16.5, depending on whether they had HBPC or not, respectively, $p < 0.001$.
					Emergency department admission	The percentage of patients who had at least one ED visit was lower in the group with HBPC (57% vs. 70%). The number of ED visits was also lower in the group with access to HBPC, borderline in statistical significance.
Skov Benthien et al., 2018	Oncological	$n = 322$	RCT (Secondary analysis)	6 months	Hospital admission	Mean number of admissions per patient was 2.02 (Control) vs. 2.14 (Intervention) ($p = 0.6304$).
Maetens et al., 2019	Oncological and non-oncological	$n =$ 17,674	Retrospective cohort	Last two weeks of life	Hospital admission	Those using HBPC had, compared with those who did not, lower risk of hospital admission (27.4% vs. 60.8%; RR = 0.45, 95% CI 0.43 to 0.46), and lower risk of ICU admission (18.3% vs. 40.4%; RR = 0.45, 95% CI 0.43 to 0.48).
					Emergency department admission	Patients with HBPC had a lower risk of ED admission (15.2% vs. 28.1%; RR = 0.54, 95% CI 0.51 to 0.57).

HBPC: home-based palliative care; ED: emergency department; RCT: randomized controlled trial; COPD: chronic obstructive pulmonary disease; HF: heart failure.
[a]Population of the study published in 2018 is a sub-sample of the one published in 2013.

account for the analysis the cost reported at the period most distant to death, with a saving in the overall health cost of 35.7% (IQR: 26.2–36.8%) in favor of the HBPC group.

The largest study, a retrospective cohort that included more than 29,500 oncological and non-oncological patients who had been under HBPC and had died matched them 1:1 to patients without HBPC who died during the same period, had similar demographic and clinical characteristics, and similar prior hospital use; average overall cost per person for those under HBPC was significantly lower than the cost for the controls (Chitnis et al., 2013).

Those six studies that took into account the cost of the intervention program (Kerr et al., 2014; Brian Cassel et al., 2016; Sahlen et al., 2016; Lustbader et al., 2017; Sudat et al., 2018; Maetens et al., 2019) also found a reduction in average total health care. Of them, three large studies summing up more than 27,000 found costs to be lower among patients with HBPC in the last 3, 2, and 1 months of life (Brian Cassel et al., 2016; Sudat et al., 2018; Maetens et al., 2019). One of these studies presented results by patient diagnosis and found that cost reductions were significant across all conditions they included (cancer, COPD, heart failure, and dementia) (Brian Cassel et al., 2016). Another study taking into account the cost of the intervention program analyzed the average overall cost in different periods (Kerr et al., 2014). This study showed that patients with HBPC had significantly lower average overall costs compared to patients without HBPC during the last 3 months, last month, and last two weeks of life. When they analyzed these same costs during the last 6 months and last 2 years of life, the costs were equal between both groups. Another study found HBPC lowered cost over the last year of life and significantly lowered cost over the last 6 months, last 3 months, and last month of life (Lustbader et al., 2017). Outpatient cost and staff cost were generally equal or higher for patients with HBPC than for patients without HBPC (Kerr et al., 2014; Sahlen et al., 2016; Maetens et al., 2019), so the drop in overall health care costs was a result of significantly lower inpatient cost among patients with HBPC.

Hospitalization cost. Seven studies assessed costs generated by hospitalizations, and all found that inpatient costs were lower in patients who received palliative home care. One RCT conducted among patients with heart failure with 6 months follow-up found that inpatient cost in the group with access to HBPC was at least three times less than the cost in the control arm (Sahlen et al., 2016). Two large retrospective cohorts with a combined total of over 25,000 participants used matched analysis to adjust for confounders and found significantly lower hospitalization cost among patients with HBPC during the last 3 months, 2 months, 1 month, and two weeks of patients' life (Sudat et al., 2018; Maetens et al., 2019) (Table 2).

Other costs. Two studies assessed outpatient cost. Of them, one included the home care cost in the outpatient cost and found higher values for those with access to HBPC (Maetens et al., 2019). The other one reported no difference in cost at 6 months before death and lower cost in the lasts 3 months, 2 months, and two weeks of life among patient with access to HBPC. This last study additionally reported costs derived from visits to the ED and found no difference in none of the time periods (Kerr et al., 2014) (Table 2).

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Table 3. Results of the studies assessing health care cost

Author, publication year	Population	Sample size	Study design	Outcome period	Outcome	Result
Chitnis et al., 2013	Oncological and non-oncological	*n* = 59,076	Retrospective cohort	From start with the program to death	Average overall cost in health	The costs of care were lower for intervention patients than matched controls (average overall costs £610 per person vs. £1,750, $p < 0.001$).
Lukas et al., 2013	Oncological and non-oncological	*n* = 369	Quasi-experimental	18 months before vs. 18 mothers after intervention	Hospitalization cost	The average hospitalization costs were $23,386 and $16,467 before and after the intervention, respectively.
Bentur et al., 2014	Oncological	*n* = 193	Retrospective cohort	Last 6 months of life	Average overall cost in health	The average cost of care for the last 6 months of life, for patients with home hospice care, was US$13,648 compared to US $18,503 for patients without home hospice care.
Kerr et al., 2014	Oncological and non-oncological	*n* = 686	Retrospective cohort	2 years, 1 year, 6 months, 3 months, 1 month, and two weeks before death	Average overall cost in health	There were statistically significant differences from the last 3 months to the last two weeks of life, in which HBPC patients incurred lower costs, even with program fees included. There were statistically significant differences from the last 3 months to the last two weeks of life, in which HBPC patients incurred lower costs, even with program fees included. At 3 months prior to death the average total cost per member per month was $6,804 for those with HBPC, compared to $10,712 for those not enrolled. At 1 month prior death $7,170 vs. $13,440 for controls and in the last two weeks $6,674 compared to $13,846 for controls.
					Hospitalization cost	HBPC participants had significantly lower inpatient costs than controls at all time points, with the greatest differences at the last one month and two weeks of life.
					Outpatient cost	No difference was observed at 6 months. At 3 months, 1 month, and two weeks, outpatient costs were significantly lower for HBPC members.
					Emergency department cost	There were no significant differences in ED costs or utilization between HBPC members and controls at any time point analyzed.
Hopp et al., 2015	Oncological and non-oncological		Quasi-experimental	6 months before vs. 6 months after intervention	Average overall cost in health	Total monthly costs declined US$3,416, from an average of US$9,294 per month at baseline to US $5,878 at 6 months ($p < 0.001$).
	Primarily advance-stage cancer		Quasi-experimental	6 months before vs. 6 months after intervention	Average overall cost in health	1. Participants where all monthly costs post entry < US$70,000: Although non-significant, the average total costs decreased from US$18,787 to US$13,781.
					Average overall cost in health	2. Participants where at least 1 monthly cost > US $70,000: Although significant reductions in outpatient costs, there was a dramatic increase in inpatient costs, leading to an overall increase in average total costs pre- and post entry from US $20,845 to US$51,435 ($p = 0.004$).
					Hospitalization cost	For each disease, hospital costs per month were lower for HBPC participants (all $p \leq 0.002$).
Chiang and Kao, 2016	Oncological	*n* = 568	Retrospective cohort	Last month of life	Average overall cost in health	The mean health care costs in the last month of life were significantly less for patients in the home hospice group than for those in the inpatient hospice group (US $1,385 versus US $2,155, $p < 0.001$).
Sahlen et al., 2016	Heart failure	*n* = 72	RCT	6 months	Average overall cost in health	Average costs per participant were €4,078 and €5,727 for patients with and without HBPC, respectively. Including program cost, during 6 months, the intervention saved €61,000.

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Table 3. (*Continued.*)

Author, publication year	Population	Sample size	Study design	Outcome period	Outcome	Result
					Hospitalization cost	During the 6 months, the total cost of hospital care was 58,793 in the home care group compared to 176,357 in the control.
Lustbader et al, 2017	Oncological and non-oncological	*n* = 651	Retrospective cohort	Last year of life	Average overall cost in health	Including home health services, the average cost per patient was significantly lower in the HBPC group than in the control during the last 6 months ($32,869 vs. $44,291, respectively), last 3 months ($20,420 vs. $32,420, respectively), and last month of life ($6,423 vs. $10,712, respectively). There was no difference in the last year.
Sudat et al., 2018	Oncological and non-oncological	*n* = 7,938	Retrospective cohort	Last 3 months, 2 months, and 1 month of life	Average overall cost in health	Incorporating the estimated cost of home-based program, in the final month of life, those enrolled in the HBPC program generated on average US$4,824 (23%) less in overall health cost (CI = US$3,379, US $6,268). In the last three and last 2 months of life, there was no significant difference.
					Hospitalization cost	Inpatient cost was significantly lower in the home-based program during the last 3 months, 2 months, and 1 month of life.
de Miguel et al., 2018	Oncological	*n* = 226	Retrospective cohort	Last 2 months of life	Hospital cost (hospitalization + ED)	The average cost per patient was significantly lower in the HBPC (€3,363) group than in the group without access to HBPC (€7,324).
Maetens et al., 2019	Oncological and non-oncological	*n* = 17,674	Retrospective cohort	Last two weeks of life	Average overall cost in health	After matching, mean total costs of care were lower for those using HBPC (€3,081 [95% CI €3,025 to €3,136] vs. €4,698 [95% CI €4,610 to €4,787]). Including home care cost, outpatient cost was higher in the HBPC group compared to the controls but this was counterbalanced by lower inpatient cost in the HBPC group (difference in cost: −€1,617 [$p < 0.001$]).
					Hospitalization cost	Mean total inpatient costs were lower for people using HBPC (€1,766; 95% CI €1,706 to €1,826) compared with those who did not use HBPC (€4,222; 95% CI €4,133 to €4,311) ($p < 0.001$)
					Outpatient cost	Mean total outpatient costs were higher for people using HBPC (€1,314; 95% CI €1,291 to €1,337) compared with those without HBPC (€476; 95% CI €461 to €492) ($p < 0.001$).

HBPC: home-based palliative care; ED: emergency department; RCT: randomized controlled trial; COPD: chronic obstructive pulmonary disease; HF: heart failure.

Additional outcomes

Place of death

Among the 10 studies reporting this outcome, 6 reported percentage of deaths at home. Among these studies, the percentage of patients who died at home was at least twice as high among those who had access to HBPC compared to those who did not, with a ratio ranging from 2.2 to 6.8 (Chitnis et al., 2013; Bentur et al., 2014; Riolfi et al., 2014; Chiang and Kao, 2016; de Miguel et al., 2018; Maetens et al., 2019). Three studies reported the percentage of patients who died outside the hospital, including home and health care facilities such as hospices (Blackhall et al., 2016; Brian Cassel et al., 2016; Sudat et al., 2018). Their results were consistent, with a higher amount of patients dying outside hospitals in the HBPC group. Finally, the remaining study reported the risk of hospital in each group and found that the relative risk of hospital death decreased with a dose–response relationship, according to the number of homecare visits per week performed in the last months of life (Ferroni et al., 2016).

Discussion

Main findings

We found HBPC was consistently effective in reducing the number and length of hospital visits, regardless of a patient's oncological status. The number of ED visits was lower or equal to the number in the control group. HBPC consistently reduced health care costs by reducing costly hospital stays, even though home-treated patients consumed more outpatient resources.

Since the studies designed their interventions differently and were implemented in widely different health systems, they were too heterogeneous to allow us to conduct a meta-analysis so we could not generate a pooled estimate cost saving. Despite their heterogeneity, their results consistently demonstrate that HBPC reduced costs.

This review found cost reductions were highest in studies that assessed the outcome closer to death possibly because the number of hospitalizations increases as patients near death and with it the number of hospital deaths (Alonso-Babarro et al., 2013; Bentur

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et al., 2014; Blackhall et al., 2016; Chiang and Kao, 2016; Chitnis et al., 2013; de Miguel et al., 2018; Maetens et al., 2019; Riolfi et al., 2014). The average number of hospitalizations increases when the patients near death, because chronic diseases progress, symptoms worsen, and standard (home) care is overburdened. Additionally, when a patient is hospitalized in a period close to death, the chances of dying in the hospital increase which can be showed to be much more expensive than dying in another setting. Using data from Medicaid, data analysts reported that dying in hospital is seven times more expensive than dying at home (Solutions, 2016).

Applicability of evidence

All the studies we included were carried out in high-income countries where the cost of hospitalization is higher than it is in middle- and low-income countries ("World Health Organization. Public Spending on Health: A Closer Look at Global Trend," 2018), so our results may not be generalizable to those countries. To improve the applicability of our evidence, we provided the results of the savings in the average overall health costs as percentages, instead of the net decrease in costs. However, the results from our systematic review should be taken with caution before generalization.

Limitations

The studies we included did not aggregate the total cost of health care. They did not include out-of-pocket expenses or other informal costs of care like the drop in household income when family members reduce their working hours to help care for a patient at home. These costs are difficult to measure but informal care has shown to account for a high proportion of costs during the last year of life, highlighting the important role of informal caregivers in PC (Brick et al., 2017). There is a risk that HPBC reduced overall health care costs less than they appeared to, since they may have shifted costs from the system to patients and their caregivers, and thus rendered those costs invisible.

As others also report (Brereton et al., 2017), we were limited by the fact that study authors did not clearly describe their interventions, which meant we could draw only general conclusions. For example, most authors did not clearly define the precise content of HBPC or describe patient diagnosis and any associated need for intensive and specialist care in hospitals, although these influence the hospital admission rate. We could only focus on cost and easily measurable effect outcomes like hospital utilization but did not have enough comparable information to include important effectiveness outcomes like quality of death and the burden imposed on family caregivers.

Studies were generally of good quality but because few clearly reported the exposure there is a risk of non-differential misclassification, which could have led us to underestimate the effect. Additionally, given that most studies were observational, despite having used different strategies to control for confounders, there may still be residual confounding introducing bias into the results.

Despite the heterogeneity of interventions and study design (Table 1), results were consistent across studies, especially for health care cost outcome, but there was some inconsistency in findings about the use of health care. Skov et al.'s study, a secondary analysis of an RCT that assessed hospital admissions as outcome, found no difference between those randomized to specialized PC at home and those in the control arm (usual care including referral to specialized PC at home on demand); 66% of patients assigned to the control group received specialized PC at home (Skov Benthien et al., 2018). Bentur et al.'s study was also problematic, since patients in the reference group also received home-based care as part of usual community care (Bentur et al., 2014).

Implications

The ethical argument for HBPC is strong for patients with a marked prognosis decline who want to remain at home. Our study bolsters that ethical argument with evidence that HBPC reduces health care system costs.

When analyzing the cost-effectiveness of a new intervention, results are divided into four quadrants. If a new intervention is less effective and more expensive (upper left quadrant), it ought to be discarded. If it is more effective but also more expensive (upper right quadrant) or less effective and cheaper (lower left quadrant), it warrants discussion. If it is cheaper and more effective (lower right quadrant), it is dominant and should be implemented. Therefore, from an economic perspective, our finding that HBPC decreases hospital visits while decreases costs suggests that, when properly analyzed in a cost-effectiveness analysis, the home-based approach may be a dominant technology when compared to the traditional care (Petrou and Gray, 2011). However, the studies identified did not report classic cost-effectiveness metrics such as the incremental cost-effectiveness ratio. Therefore, we could not perform the cost-effectiveness analysis.

HBPC should be available to all patients in a recognizable end-of-life phase, e.g., with a marked progressive decline, who desire to remain at home and die there. Further research would be necessary to determine which specific type of patient benefits the most from HBPC and has the highest impact on reducing health care cost. Our findings apply at the population level, but patients must be managed individually, taking into account the complexity of their underlying pathology to determine if patients with complex conditions (e.g., polymorbid patients) will benefit most from HBPC or in-hospital management. We thus recommend linking HBPC programs to a hospital PC program in case referral is necessary. In addition, reducing hospital utilization at the end of life should be a goal for health care planners only if access to quality home care at the end of life is guaranteed. The main objective should not be where to die, but how.

Conclusion

Our systematic review provides clear and homogenous evidence that HBPC reduces overall end-of-life health care costs by reducing the number of hospitalizations in the last months of life, and thus the number of in-hospital deaths. Therefore, stakeholders should recognize HBPC as an intervention that decreases patient care costs at end of life and health care providers should assess the preferences of patients nearing the end-of-life to identify those who will benefit most from HBPC.

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