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Review

Impact of disease management programs on healthcare expenditures for patients with diabetes, depression, heart failure or chronic obstructive pulmonary disease: A systematic review of the literature

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ABSTRACT

Objective: Evaluating the impact of disease management programs on healthcare expenditures for patients with diabetes, depression, heart failure or COPD.
Methods: Systematic Pubmed search for studies reporting the impact of disease management programs on healthcare expenditures. Included were studies that contained two or more components of Wagner's chronic care model and were published between January 2007 and December 2009.
Results: Thirty-one papers were selected, describing disease management programs for patients with diabetes ($n=14$), depression ($n=4$), heart failure ($n=8$), and COPD ($n=5$). Twenty-one studies reported incremental healthcare costs per patient per year, of which 13 showed cost-savings. Incremental costs ranged between –$16,996 and $3305 per patient per year. Substantial variation was found between studies in terms of study design, number and combination of components of disease management programs, interventions within components, and characteristics of economic evaluations.
Conclusion: Although it is widely believed that disease management programs reduce healthcare expenditures, the present study shows that evidence for this claim is still inconclusive. Nevertheless disease management programs are increasingly implemented in healthcare systems worldwide. To support well-considered decision-making in this field, well-designed economic evaluations should be stimulated.

1. Introduction

Chronic illnesses are the leading cause of disability and death in the western part of the world [1]. Over the coming years, the prevalence of chronic illnesses is predicted to increase as a result of the rapid ageing of the world population and the greater longevity of people with chronic conditions [2,3]. This trend has major economic consequences for health care systems. In the United States for example, the total yearly healthcare costs for heart disease were estimated at $352 billion [3] and the yearly healthcare costs for diabetes were estimated at $116 billion [4].

Disease management programs are increasingly implemented in healthcare systems worldwide in order to enhance quality and continuity of care for the chronically ill, whilst making efficient use of healthcare resources. In broad terms disease management refers to a patient-centred approach of coordinated multiple healthcare interventions that structure chronic care to a specific patient group [5,6]. It is also referred to as e.g. integrated care, managed care, patient-centred care, and case management. Although it is generally believed that disease management programs result into improved patient health

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outcomes and into healthcare cost savings there is a lack of conclusive scientific evidence supporting these suggestions [5–7].

In terms of health outcomes, disease management programs may be particularly effective for patients with diabetes, heart failure, and depression. Disease management programs for patients with COPD, asthma and coronary artery disease have generally shown similar results as usual care [6,8–10]. At the same time disease management programs for COPD and asthma have shown improvements in quality of life [11,12].

In terms of reducing healthcare costs, disease management programs may be particularly effective for patients with heart failure, as a result of e.g. reduced hospitalization rates and emergency room visits [6,13–17]. Evidence is less conclusive for disease management programs for patients with diabetes, coronary artery disease, asthma, COPD, and depression [6,17–21]. Steuten et al. [10], Adams et al. [9], and Sidorov et al. [22] found that disease management programs for these chronic diseases lead to a reduction in healthcare costs due to e.g. fewer hospital admissions or fewer emergency room visits, whereas other studies did not find rigorous evidence for notable reductions in such healthcare costs [8,23–25].

The objective of the present paper was to review the most recent literature on the economic effects of disease management programs. In recent years, disease management programs have received a more prominent role in healthcare. It is expected that this trend generated more economic evaluations of disease management programs and consequently more evidence regarding its economic effects. This paper focuses on disease management programs for diabetes, depression, heart failure, and chronic obstructive pulmonary disease (COPD) since the prevalence of these chronic diseases is high and disease management programs for these chronic diseases are most widespread [3,6,26].

2. Methods

2.1. Disease management

For this study the chronic care model (CCM) of Wagner et al. [27,28] was used to operationalize disease management. The model suggests that disease management ideally comprises six interrelated components. Two components mainly refer to the context where chronic care is provided: 1. *healthcare system* that is open to optimize chronic care and 2. links towards *community resources and policies* (e.g. physical activity programs delivered by a local fitness centre). The remaining four components refer to the actual delivery of care: 3. *self-management support* that helps patients and their families to obtain skills and confidence to manage their chronic condition (e.g. blood glucose monitoring) and assessment of problems and achievements on a regular basis; 4. change in the *delivery system design*; focus on coordinated multidisciplinary collaboration between caregivers (i.e. multidisciplinary team, case management, individual care plans); 5. *decision support*; evidence-based guidelines providing clinical standards for high-quality chronic care, and 6. development of *clinical information systems*; supplying care teams with feedback, reminding them to comply with practice guidelines and providing registries for planning individual and population-based care [27,29]. It was a priori decided to consider a program as disease management if it included two or more components of the chronic care model.

2.2. Search strategy

A Pubmed search was conducted focusing on recent original studies published between 1 January 2007 and 15 December 2009. The following keywords (Medical Subject Headings) were used in the search: *disease (state) management, delivery of health care, integrated health care, comprehensive health care, patient care planning, primary health care, patient care team, critical pathways, case management, continuity of patient care, practice guidelines, guidelines, clinical protocols, patient education, self care, reminder systems, health education, health promotion, community health planning, ambulatory care, feedback, reminder* and variations of the keywords *monitor*; *patient and provider*. These keywords were combined with the following keywords: *health care costs*; *costs and cost analysis*; *cost-benefit analysis*; *health expenditures*; *cost control*; *cost savings* and *diabetes mellitus*; *heart failure*; *depression* or *chronic obstructive pulmonary disease*. Papers not written in English were excluded.

Two reviewers (LL and SdB) independently investigated the relevance of the papers extracted by the search by screening their title and abstract. To be included in the review, studies should have evaluated programs that met our operational definition of disease management and should have reported economic outcomes of care. Any disagreement between the reviewers regarding the relevance of a study was resolved by consensus.

For each of the studies found eligible for our systematic literature review the study characteristics (e.g. study design, characteristics of disease management program, usual care condition, characteristics of economic evaluations) and study outcomes (e.g. healthcare utilization and healthcare expenditures) were tabulated. Cost estimates were adjusted for cross-country purchasing power differences (PPP), using 2007 US$ PPP [30] and for inflation, using GDP prices [30] in order to make meaningful comparisons across studies. Four studies did not report the year of data collection [31–34]. For these studies the year of publication of the papers was used as reference year.

3. Results

3.1. Study retrieval

Our literature search yielded 231 potentially relevant papers. On the basis of these papers' title and abstract, 42 papers were selected by the reviewers to be retrieved full-text for in-depth screening. This screening process resulted into 31 papers for inclusion in our study. Reasons for exclusion are given in Fig. 1. Papers were sometimes excluded for more than one reason. In the flowchart only the most relevant reason for exclusion is presented.

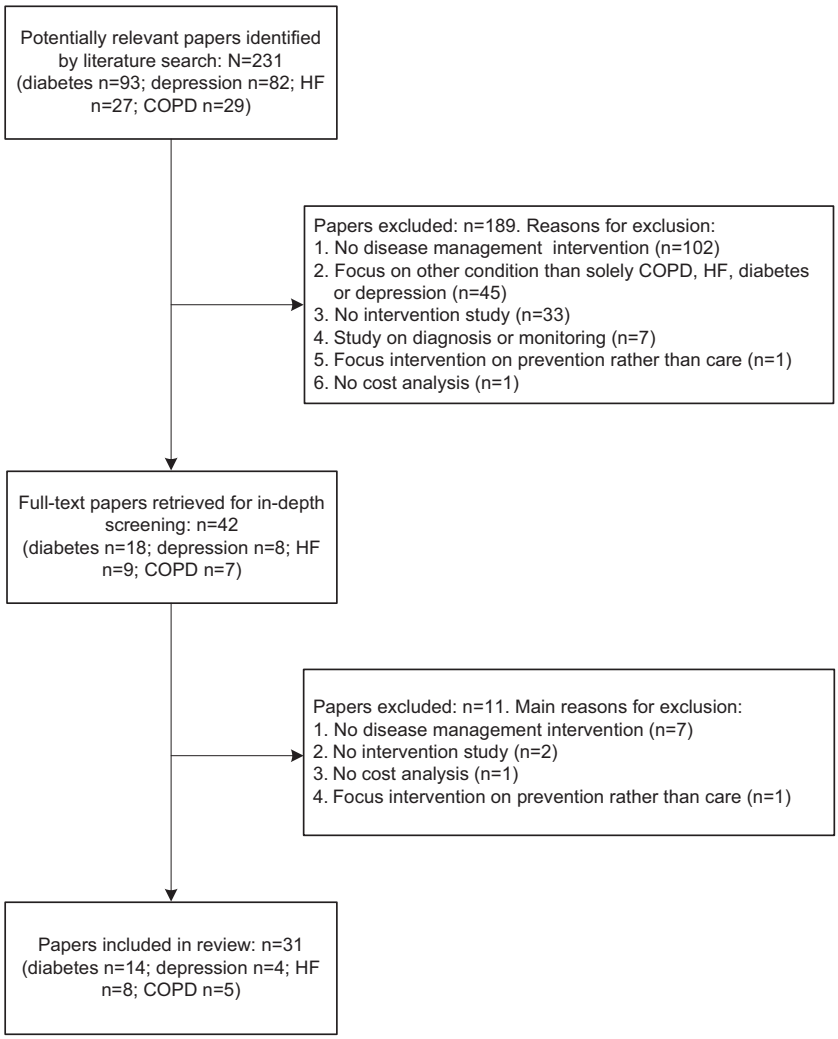

Fig. 1. Flowchart of literature screening process.

3.2. Study characteristics

3.2.1. Study designs

Out of the 31 studies, 14 focused on diabetes, 4 on depression, 8 on heart failure, and 5 on COPD (Table 1). Most studies originated from the USA ($n = 20$) followed by Italy ($n = 3$), United Kingdom ($n = 2$), Australia ($n = 2$), Netherlands ($n = 1$), Taiwan ($n = 1$), Thailand ($n = 1$), and Sweden ($n = 1$). Included were 18 randomized controlled trials, three quasi-experimental studies, three cross-sectional studies, two descriptive studies, two before-after studies, two prospective observational studies and one longitudinal analysis of paid claims. Across all studies sample size varied from 30 to 33,000 subjects.

3.2.2. Usual care conditions

In most studies the effects of disease management were compared with those of care as usual (i.e. no disease management). The studies evaluating disease management programs for diabetes patients were an exception; half of the studies did not include a control group. In the majority of papers that compared results with usual care, a description of care as usual was lacking or poor. Information provided was mostly limited to descriptions such as "conventional hospital-based care", "usual care", "standard care", "standardized usual care" or "usual care by physician". Eight studies reported usual care conditions in (more) detail [32–39] (Table 1).

3.2.3. Characteristics of disease management programs

Table 1 presents the characteristics of the disease management programs included in our review. The table illustrates that, with the exception of the disease management programs described in the studies of Herrin et al. [40], Lairson et al. [39], Littenberg et al. [41], and Welch et al. [42], all disease management programs included the component *self-management support*. All COPD disease management programs comprised two components, mostly a combination of *self-management support* and *delivery system redesign*. Often, programs for patients with

Table 1
Characteristics of studies included in systematic literature review ($n = 31$).

Author (year)	Country	Study design (n)[a]	CCM comp.[b]	Usual care condition	Disease management program
Diabetes ($n = 14$)					
Adler-Milstein et al. [54]	USA	Descriptive study	SMS, DSD, CIS, DS	No control group	Information technology-enabled diabetes management approaches
Clancy et al. [31]	USA	RCT ($n = 186$)	SMS, DSD	Quarterly physician visits	Group visits with education and one-on-one consultations with physicians and nurses
Fera et al. [55]	USA	Quasi-experimental study (pre-test/post-test) ($n = 573$)	SMS, DSD, DS	No control group	Patient care services provided by community-based pharmacists within a collaborative care management model
Handley et al. [53]	USA	RCT ($n = 226$)	SMS, DSD, CIS	Not specified	Automated telephone self-management support with nurse care management
Herrin et al. [40][c]	USA	RCT ($n = 2007$)	DSD, CIS, DS	No control group	Performance feedback and nurse case management. Three intervention types: 1. claims-based practice profiling (claims group); 2. Claims-based profiling plus diabetes quality improvement project practice profiling (claims plus medical record group): 3. diabetes resource nurse intervention (DRN group)
Huang et al. [56]	USA	Cross-sectional follow-up study ($n = 80$, each year)	SMS, DSD, CIS, DS	No control group	Collaborative quality improvement program including patient self-management support, flow sheets in medical charts to remind physicians of care processes and software to track patients over time
Lairson et al. [39]	USA	Quasi-experimental ($n = 870$)	DSD, CIS, DS	Usual care disease management including education, individual visits, monthly reports to physician, yearly diabetes eye exam letter and letters to high-risk patients	Intensified disease management system including computer analysis of patient encounters and diagnostic testing, patient reminder letters, case management, workflow support system
Littenberg et al. [41]	USA	Longitudinal analysis of paid claims with concurrent and historical controls ($n = 1023$)	CIS, DS	No diabetes information system	Diabetes information system which is laboratory based registry and decision support system
Lowey et al. [50]	UK	Descriptive study ($n = 53$)	SMS, DSD, DS	No control group	Pharmacist-led treatment of cardiac risk incorporating preparation of individualized patient information and education and an algorithm for adjustment of medication
McRae et al. [51]	Australia	Prospective observational study (data drawn from range of sources)	SMS, DSD, CIS, DS	No control group	Integrated care program facilitating case management by provision of information and education to GPs
Rerkasem et al. [47]	Thailand	Comparative cross-sectional ($n = 96$)	SMS, DSD, DS	Not specified	Multidisciplinary foot protocol including specific decision tree pathways, treatment options and follow-up schedules for specialists and devices

Table 1 (*Continued*)

Author (year)	Country	Study design (*n*)[a]	CCM comp.[b]	Usual care condition	Disease management program
Smith et al. [52]	USA	RCT (*n* = 639)	SMS, DSD, CIS, DS	No provision of virtual consultation but periodic generic information via email	Electronic decision support system providing speciality advice and evidence based messages to physicians regarding medication management or cardiovascular risk
Welch et al. [42]	USA	Before–after-study with control (*n* = 56 practices)	CIS, DS	No electronic health records	Electronic health records in community physician practices incorporating health information and data storage, management of test results, electronic ordering, clinical decision support, administrative processes
Wilhide et al. [48]	USA	Prospective observational study (*n* = 1289)	SMS, DSD	No control group	Customized education intervention with nurse educator follow-up
Depression (n = 4)					
Bosmans et al. [36]	The Netherlands	RCT (*n* = 151)	SMS, DSD	Usual care comprising oral and written information on medication	Pharmacy-based coaching program including take home videos and written instructions
Simon et al. [57]	USA	RCT (*n* = 600)	SMS, DSD, DS	Any treatment normally available	Telephone care management and telephone psychotherapy incorporating outreach calls for monitoring and support, feedback to treating physicians and care coordination plus sessions of structured cognitive behavioral therapy program
Unutzer et al. [37]	USA	RCT (*n* = 551)	SMS, DSD, DS	Any treatment routinely provided for depression, plus encouragement to follow-up with primary care provider	Collaborative care program provided by a nurse or psychologist care manager working in participant's primary care clinic to support patient's regular primary care physician
Wells et al. [46]	USA	RCT (*n* = 746)	SMS, DSD, DS	Not specified	Quality improvement interventions providing education to manage depression and resources to facilitate access to medication management or psychotherapy
Heart failure (n = 8)					
Del Sindaco et al. [32]	Italy	RCT (*n* = 173)	SMS, DSD	All treatments and services ordered by primary care physician and/or cardiologist	Combined hospital and home based care (cardiologists and nurse coordinators, and GPs resp.)
Esposito et al. [49]	USA	RCT (*n* = 32,930)	SMS, DSD, CIS, DS	Not specified	Program that provides primarily telephonic patient education and monitoring services
Gambetta et al. [33]	USA	Quasi-experimental (*n* = 282)	SMS, CIS, DS	Heart failure clinic treatment plan	Heart failure clinic treatment plan plus telemanagement
Hebert et al. [45]	USA	RCT (*n* = 406)	SMS, DSD	Not specified	Nurse-led program with regular telephone follow-up
Miller et al. [38]	USA	RCT (*n* = 751)	SMS, DSD, DS	Standard discharge planning and care	Nurse-led intervention focused on transition from hospital-to-home and supportive care for self-management after hospital discharge

Table 1 (*Continued*)

Author (year)	Country	Study design (*n*)[a]	CCM comp.[b]	Usual care condition	Disease management program
Murray et al. [58]	USA	RCT (*n* = 314)	SMS, DSD, DS	Prescription services from pharmacists who did not receive specialized training and did not have access to patient-centred study materials	Multi-level pharmacist delivered intervention by using protocol and providing patient-centred verbal instructions and written materials about medications
Patel et al. [59]	Sweden	RCT (*n* = 31)	SMS, DSD, DS	Treatment in accordance with hospital guidelines	Home care by specialist nurses based on written physician directed care plan
Smith et al. [60]	USA	RCT (*n* = 1069)	SMS, DSD, CIS	Not specified	Disease manager (registered nurse) performing patient education and medication management with primary care provider. Some patients additionally received in-home devices for enhanced self-monitoring
COPD (n = 5)					
Aimonino Ricauda et al. [43]	Italy	RCT (*n* = 104)	SMS, DSD	Admission to general medical ward providing routine hospital care	Geriatric home hospitalization service by multidisciplinary team
Lu et al. [35]	Taiwan	Quasi-experimental (*n* = 50)	SMS, DSD	Routine care following routine nursing procedures and protocols	Case management program executed by registered nurse
Spiliopoulos et al. [62]	Australia	Cross-sectional study (*n* = 363)	SMS, DSD	No control group	Respiratory coordinated care program managed by respiratory physician and GPs
Sridhar et al. [61]	UK	RCT (*n* = 122)	SMS, DSD	Usual care by primary care physician or secondary care and/or respiratory nursing service as appropriate	Nurse led intermediate care package
Vitacca et al. [34]	Italy	RCT (*n* = 101)	SMS, CIS	Traditional care comprising follow-up outpatient visits and mechanical and/or long term oxygen therapy according to usual procedures	Tele-assistance by nurse with call centre availability 24 hours a day

[a] Number of subjects at study entry.
[b] Components of chronic care model: SMS, self-management support; DSD, delivery system (re)design; CIS, clinical information systems; DS, decision support.
[c] Study was a three arm RCT without control group. Patients were randomized to 1 of 3 conditions.

diabetes, depression or heart failure additionally included the components *clinical information systems* and/or *decision support*. Disease management programs for depression and heart failure patients mostly consisted of three components, whereas programs for diabetes patients more frequently consisted of four components. The components *healthcare organization* or *community resources and policies* were not observed. However, the authors may not have explicitly mentioned these components in some cases.

Table 2 provides more detailed information about the disease management programs included in our review using illustrative examples. The table demonstrates the diversity in the operationalization of these components. Moreover, it illustrates that a component of a specific disease management program can include multiple interventions. For example, the program evaluated by Aimonino Ricauda et al. [43] included the following *delivery system redesign* interventions: development of an individualized care plan, collaboration within a multidisciplinary team, and home visits by a nurse.

3.2.4. Characteristics of economic evaluations

Table 3 presents the characteristics of the economic evaluations. Both partial (*n* = 23) and full economic eval-

Table 2
Illustrative examples of interventions within components of chronic care model.

Disease	Self-management support	Delivery system (re)design	Clinical information system	Decision support
Diabetes	• Monthly group meetings of patients where health education (e.g. nutrition, exercise, foot care) is given by e.g. physicians and nurses [31]	• Diabetes educator in primary care practice [52]	• Reminder letters to patients overdue for recommended testing or routine physician follow-up [39]	• Regular adjustment to anti-hypertensive medication by pharmacist using evidence-based algorithm [50]
	• Customized education (e.g. disease, medication management, diet and nutrition, exercise) with nurse educator follow-up [48]	• Case-management services for patients identified as being persistently noncompliant or with significant obstacles to care [39]	• Computerized workflow support system for documentation of patient communications, clinical decision support and coordination of services [39]	• Specific decision tree pathways developed to guide foot examination [47]
	• Instruction to recognize foot lesions and to contact hospital [47]	• Pharmacist-led treatment of cardiac risk [50]	• Centralized database of diabetic patients with GP information on care provision and clinical indicators used to send recall reminders to GPs, provide regular audit reports to GPs on adherence to guidelines [41,51] • Teleconsultation and videoconferencing for patient–caregiver communication (e.g. monitoring and feedback) [20]	
Depression	• Take home video with education on use of antidepressants [36]	• Coaching contacts with pharmacist to stimulate medication adherence [36]	• NA	• Algorithm-based recommendations regarding need for e.g. medication adjustment or specialty clinic provided by care manager to primary care physician [37,57]
	• Self-management workbook [57]	• Regular follow-up (e.g. telephone calls) by care managers/nurse specialists to monitor and improve antidepressant adherence [37,46,57]		• Pocket reminder cards for practice teams to enable patient assessment, education and activation of treatment [46]
Heart failure	• Standardized detailed educational program received at discharge with information on low-salt diet, self-monitoring of blood pressure and symptoms, daily weight, smoking cessation, etc. [32,49]	• Nurse led program with home visit and regular telephonic follow-up to stress treatment adherence [45]	• Telemanagement system stimulating patients to daily call in and answer a short health questionnaire. Information was stored and automatically analyzed by decision support tools [33,60]	• Pharmacists studied guidelines, key concepts in pharmaceutical care [58]
	• Teaching patients better self-management skills by instructing and encouraging them to monitor their health [49]	• Home visits by specialist nurse from HF clinic who provided hospital care, followed by short consultation nurse and physician after each visit [59]		• Alerts were set in telemanagement system for abnormalities requiring immediate intervention by nurse [33]
	• Icons used for medication containers matching with icons on written instruction about medication [58]	• Cardiologists were care managers and documented treatment plan [32]		

Table 2 (*Continued*)

Disease	Self-management support	Delivery system (re)design	Clinical information system	Decision support
		• Development of individualized care plan on basis of health and functioning assessment [49]		
COPD	• General education about disease and treatment, individualized physical training program, recognizing early triggers of exacerbation, importance of smoking cessation [61,62]	• Multidisciplinary care team plus home visits by nurse providing hospital care at home [43]	• Pulse oximeter with modem system which is able to transmit information on arterial oxygen saturation through telephone line to a receiving station where tele-assistance nurse is available for tele-consultation [34]	• NA
		• Case manager in charge of patient clinical care plan [35] • Personalized COPD care plan [43,61]		

N.A., none of the disease management programs for patients with depression or for patients with COPD evaluated in the studies included in our systematic literature review included the components *clinical information system* or *decision report*, respectively. No examples of interventions within these components could therefore be given.

uations ($n = 8$) [44] were reported. Three types of partial economic evaluations were observed: cost description (i.e. analysis of costs of a single treatment; $n = 2$); cost-outcome description (i.e. analysis of costs and outcomes of a single treatment; $n = 3$); cost-analysis (i.e. analysis of costs of two or more treatment alternatives; $n = 18$). In a full economic evaluation the costs and effects of two or more treatment alternatives are compared. Three types of full economic evaluations were observed: cost-benefit analysis (i.e. analysis of effects in monetary terms; $n = 1$); cost-effectiveness analysis (i.e. analysis of effects in a natural health unit common to both alternatives; $n = 1$); and cost-utility analysis (i.e. analysis of effects in terms of utility, typically expressed in quality-adjusted life years (QALY); $n = 6$).

There was substantial variation in the cost dimensions that were reported by the authors. Direct healthcare costs, such as costs of hospitalization, emergency room (ER) visits, medication and healthcare staff were always included in the economic evaluations. Three studies also included direct non-healthcare costs such as travel costs to the healthcare facility [34,45,46]. Three studies additionally incorporated indirect non-healthcare costs such as productivity loss, lost wages, and income lost by family caregivers [36,47,48]. In one study, in addition to direct healthcare and non-healthcare costs, indirect healthcare costs (healthcare costs occurring during life years gained) were included [48].

The level of specification within each of the cost categories widely differed between studies. For example, Bosmans et al. [36], Hebert et al. [45], Rerkasem et al. [47], Vitacca et al. [34], and Wilhide et al. [48] extensively specified the costs of each of the cost categories in their analyses, whereas e.g. Esposito et al. [49], Herrin et al. [40], Littenberg et al. [41], and Lu et al. [35] only indicated that all direct healthcare costs were taken into account without further specification. Other studies only included part of the direct healthcare costs like Miller et al. [38] and Herrin et al. [40] who for example, only included costs from the payer perspective and did not take into account costs that were not covered by Medicare/insurance companies. Length of follow-up of the majority of studies with a longitudinal design varied between 6 and 24 months. Prospective studies such as Lowey et al. [50] and McRae et al. [51] had longer time spans. Eight studies reported the results of a sensitivity analysis.

Of the studies that compared healthcare costs of disease management programs with those of care as usual ($n = 23$), we report the incremental healthcare costs of the disease management programs. These studies were mostly RCTs and quasi-experimental studies. Incremental costs can be defined as the difference in healthcare costs for patients enrolled in a disease management program and those for patients receiving care as usual. Incremental healthcare costs are of primary interest as they provide information on the potential added value of disease management compared to care as usual. Incremental costs can be either negative or positive. Negative incremental costs imply that healthcare costs for patients enrolled in a disease management program are lower than those for patients receiving care as usual. Positive incremental costs imply that healthcare costs for patients enrolled in a disease management program are higher than those for patients receiving care as usual.

In the next section we first summarize the incremental direct healthcare costs across all disease groups. In the following subsections we report incremental direct healthcare costs by disease group and give possible explanations for observed cost reductions or cost increases, as provided by the authors. In addition we present the results of the studies that did not compare disease management programs with care as usual, and for which no incremental healthcare costs could be calculated. We therefore report other outcomes such as total direct healthcare costs, lifetime costs, or avoided healthcare costs. In addition we report indirect healthcare costs and cost-effectiveness ratios in case these were given.

Table 3
Characteristics and outcomes of economic evaluations.

Author (year)	Economic evaluation method[a]	Costs included[b]	Time-span of study (months)	Incremental analysis	Healthcare utilization[c]	Healthcare expenditures[d] (per patient/year)
Diabetes (n = 14)						
Adler-Milstein et al. [54]	CD	1	–	No	• NA	• Acquisition costs: $93 to $686 (small practices), $2 to $121 (large practices) • Annual costs: $60 to $441 (small practices), $8 to $334 (large practices)
Clancy et al. [31]	CA	1	12	Yes	• Significant reduction of number of specialty care visits in intervention group	• Incremental costs: mean charges −$2483 ($5730 vs. $8212), significant
Fera et al. [55]	CA	1	12	No	• NA	• Costs: $698
Handley et al. [53]	CUA	1	12	Yes	• NA	• Incremental costs: $828 ($417 start-up costs and $411 ongoing costs), only costs for disease management program taken into account
Herrin et al. [40][e]	CA	1	12	No	• Physician visits higher in diabetes resource nurse group than in claims-based profiling plus DQIP-based practice profiling group (claims/MR group) and claims-based practice profiling	• Costs: payments (by Medicare) $1848 and charges (by healthcare provider) $5512 in claims group; payments $1970 and charges $5769 in claims/MR group; payments $1948 and charges $5390 in DRN group, not significant
Huang et al. [56]	COD	1	48 (plus life-time simulation)	No	• NA	• Costs: life-time costs $644 ($12,784 over lifetime)
Lairson et al. [39]	CA	1	12	Yes	• No significant difference in number of hospital admissions between intervention and control group	• Incremental costs: $192 ($1986 vs. $1794), not significant.
Littenberg et al. [41]	CA	1	60	Yes	• NA	• Incremental costs: −$2533, significant
Lowey et al. [50]	COD	1	6 (and 120 months simulation)	No	• NA	• Costs: $218
McRae et al. [51]	COD	1	60 (and 480 months simulation)	No	• NA	• Costs: $151 (over 40 years $2246)
Rerkasem et al. [47]	CA	1, 2, 3	NA	Yes	• Mean number of outpatient visits significantly higher in intervention than in control group • Mean number of inpatient days did not differ significantly between intervention and control group	• Incremental costs: total healthcare costs −$260, significant. Indirect non-healthcare costs −$54.

Table 3 (*Continued*)

Author (year)	Economic evaluation method[a]	Costs included[b]	Time-span of study (months)	Incremental analysis	Healthcare utilization[c]	Healthcare expenditures[d] (per patient/year)
Smith et al. [52]	CA	1	21 on average (no discounting)	Yes	• Significantly less hospitalizations for elective management of musculoskeletal pain and orthopaedic surgery in intervention than in control group • No significant differences between intervention and control group in frequency of office visits, formal referrals to endocrine consultation, number of patient visits and telephone calls with diabetes educator	• Incremental costs: mean total healthcare costs −$2449 ($6622 vs. $9071), significant
Welch et al. [42]	CA	1	12	Yes	• NA	• Incremental cost: more rapid cost increase (3.5% vs. 2.9%)
Wilhide et al. [48]	CA	1, 3, 4	12	No	• Reduction in % of patients having a hospitalization (21–5%)	• Costs avoided: $5200 (only costs of avoided complications taken into account)
Depression (n = 4)						
Bosmans et al. [36]	CEA	1, 2, 3	6	Yes	• No significant differences between groups in use of healthcare resources.	• Incremental costs: mean direct $37 ($1796 vs. $1760), mean indirect $742 ($6311 vs. $5569), not significant
Simon et al. [57]	CBA	1	24	Yes	• NA	• Incremental costs/patient: $459 telephone care management ($5008 vs. $5467) and −$38 telephone care management plus psychotherapy ($5008 vs. $4970)
Unutzer et al. [37]	CA	1	48	Yes	• NA	• Incremental costs: mean total healthcare costs −$863 ($7551 vs. $8414), not significant
Wells et al. [46]	CUA	1, 2	24	Yes	• NA	• Incremental costs: $46 in sub threshold depression patients ($4290 vs. $4245) and $1132 among patients with 12-month depressive disorder ($6220 vs. $5087), not significant. Average incremental healthcare costs over 2 patient groups: $589
Heart failure (n = 8)						
Del Sindaco et al. [32]	CA	1	24	Yes	• Total number of heart failure and all-cause hospital (re)admission and length of hospital stay significantly lower and shorter, respectively in intervention than in control group	• Incremental costs: −$578 ($98 vs. $676)

Table 3 (*Continued*)

Author (year)	Economic evaluation method[a]	Costs included[b]	Time-span of study (months)	Incremental analysis	Healthcare utilization[c]	Healthcare expenditures[d] (per patient/year)
Esposito et al. [49]	CA	1	18	Yes	• No significant differences between groups in proportion of patients with hospital admission, average annual number of admissions and ER visits • Proportion of patients with ER visit significantly lower in intervention than in control group	• Incremental costs: mean Medicare expenditures −$121, significant
Gambetta et al. [33]	CA	1	7	Yes	• Significantly lower % of patients hospitalized in both groups compared with baseline • Control group had significantly higher risk for hospitalization than intervention group	• Incremental costs: mean expenditures −$4970, difference not tested for significance
Hebert et al. [45]	CUA	1, 2	12	Yes	• Significantly less hospitalizations in intervention than in control group	• Incremental costs: mean direct medical costs $913, mean direct non medical costs −$30 ($3018 vs. $3048), not significant
Miller et al. [38]	CUA	1	18 (plus life time simulation)	Yes	• NA	• Incremental costs: over lifetime $5461
Murray et al. [58]	CA	1	12	Yes	• Patients in intervention group 19% fewer exacerbations than in control group resulting into less emergency department visits and hospitalizations	• Incremental costs: mean direct medical costs −$3333, not significant
Patel et al. [59]	CUA	1	12	Yes	• No significant differences between groups in utilization of unplanned health care related to heart failure	• Incremental costs: −$286 ($310 vs. $596) including costs for HF clinic visits, significant
Smith et al. [60]	CUA	1	18	Yes	• NA	• Incremental costs: $3305
COPD (n = 5)						
Aimonino Ricauda et al. [43]	CA	1	6	Yes	• Significantly lower incidence of hospital readmissions and significantly more days between discharge and readmission in intervention than in control group	• Incremental costs: mean total costs −$528, significant
Lu et al. [35]	CA	1	NA	Yes	• No significant difference between intervention and control group in average length of hospital stay	• Incremental costs: −$151 ($782 vs. $933), not significant

Table 3 (*Continued*)

Author (year)	Economic evaluation method[a]	Costs included[b]	Time-span of study (months)	Incremental analysis	Healthcare utilization[c]	Healthcare expenditures[d] (per patient/year)
Spiliopoulos et al. [62]	CD	1	–	No	• Length of hospital stay and average number of hospital admissions per patient per year decreased	• Costs: total costs of providing disease management program $1244
Sridhar et al. [61]	CA	1	24	Yes	• Significantly less unscheduled GP contacts in intervention than control group • No significant differences in total number of hospital admissions, % of patients having admission to hospital during study, number of admissions/patient and days alive and out of hospital between intervention and control group	• Incremental costs: mean costs for unscheduled healthcare plus intervention costs $9 ($121 vs. $130)
Vitacca et al. [34]	CA	1, 2	12	Yes	• Significantly fewer hospital admissions in intervention than in control group, and higher probability of avoiding hospitalization, urgent GP call and emergency room admission	• Incremental costs: mean healthcare services costs −$16,996 ($11,310 vs. $28,306)

[a] Partial economic evaluations: CD, cost description = only costs of disease management program are examined, no comparison between alternatives is made; COD, cost-outcome description = both costs and effects of disease management program are examined, no comparison between alternatives is made; CA, cost analysis = costs of two or more alternatives are compared but costs and consequences of each alternative are not examined simultaneously. Full economic evaluations: CEA, cost-effectiveness analysis = costs of two or more alternatives are related to a single, common effect which may differ in magnitude between the alternatives; CBA, cost-benefit analysis = both costs and consequences of two or more alternatives are compared; CUA, cost-utility analysis = analysis that allows for quality of life adjustments to a given set of treatment outcomes whilst simultaneously providing a generic outcome measure for comparison of costs and outcomes in different programs.

[b] 1 = direct healthcare costs (e.g. hospitalization, ER visits, GP visits, medication, ICT costs), 2 = direct non-healthcare costs (e.g. cost of travel to healthcare facility by patient), 3 = indirect non-healthcare costs (e.g. productivity loss, lost wages, income lost by family members), 4 = indirect healthcare costs (e.g. healthcare costs occurring during life years gained).

[c] Differences or changes were considered significant at $p \leq 0.05$.

[d] Depending on the type of economic evaluation costs are presented as costs per patient or practice, or as incremental costs per patient per year. Negative incremental costs: healthcare costs for patients enrolled in a disease management program are lower than those for patients receiving care as usual. Positive incremental costs: healthcare costs for patients enrolled in a disease management program are higher than those for patients receiving care as usual. Differences or changes were considered significant at $p \leq 0.05$.

[e] Study was a three arm RCT without a control group. Patients were randomized to 1 of 3 conditions.

NA: not available (not documented or not measured in the study).

3.3. Study outcomes

3.3.1. All disease groups

Fig. 2 displays the incremental healthcare costs (in 2007 US$ PPP and GDP prices) for studies that reported costs per patient per year ($n = 21$). Across all disease groups incremental costs per patient per year ranged from −$16,996 to $3305. Results of the two other studies that reported incremental healthcare costs [38,42] were not included in the figure. Welch et al. [42] reported the results on the GP practice level rather than on patient level. Miller et al. [38] only reported incremental lifetime costs which were estimated at $5461 per patient.

3.3.2. Diabetes

Seven studies evaluating diabetes disease management programs reported incremental direct healthcare costs [31,39,41,42,47,52,53]. The study of Welch et al. [42] reported incremental direct healthcare costs at the GP practice level and showed more rapid cost increases in practices that implemented a disease management program than in practices providing care as usual. The

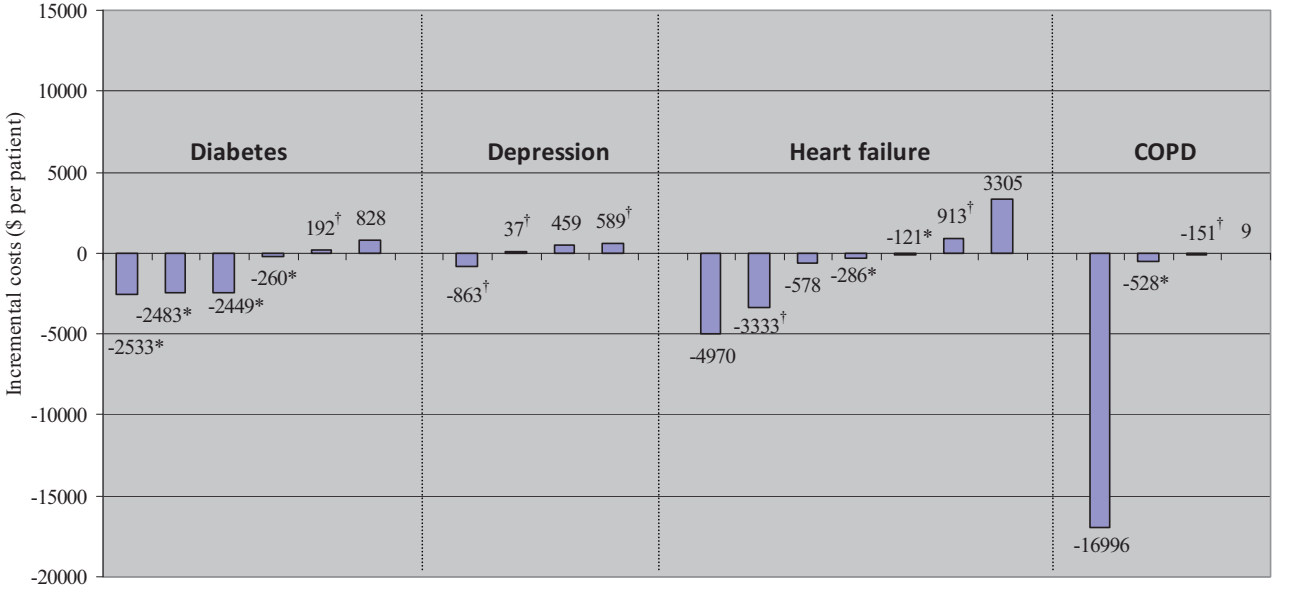

Fig. 2. Incremental healthcare costs ($) per patient per year for patients enrolled in disease management programs versus patients receiving usual care. *: Significant at $p \leq 0.05$; †: not significant; others unknown. (Cost in 2007 GDP prices and adjusted for purchasing power differences (US$ PPP). For the study of Wells et al. we calculated the average incremental costs of two patient groups: sub threshold depression patients and patients with 12-month depressive disorder (depression: 589 US$ PPP) [46].)

other studies reported incremental direct healthcare costs at the patient level which ranged from −$2533 to $828 per patient per year [31,39,41,47,52,53]. Significant cost savings were reported in four of these studies [31,41,47,52] which in two studies could be related to reductions in e.g. specialty care visits and hospitalizations [31,52]. Studies of Handley et al. [53] and Lairson et al. [39] showed higher incremental direct healthcare costs due to the implementation of the disease management program and no effect on healthcare utilization [39].

Six studies on diabetes disease management programs did not report incremental costs, yet only the direct healthcare costs of the disease management program [40,50,51,54–56]. The study of Adler-Milstein et al. [54] reported costs of the disease management program at the GP practice level, which were estimated at $93–686 for small practices and at $2–121 for large practices [54]. The other studies reported costs of the disease management program at the patient level which ranged from $151 to $698 per patient per year [40,50,51,55,56]. Herrin et al. [40] reported health care payments between $1848 and $1970 per patient per year for three disease management programs. Huang et al. [56] and McRae et al. [51] also reported lifetime costs following a disease management program which were estimated at $12,784 per patient [56] and $2246 per patient [51].

One study reported avoided healthcare costs following a disease management program, which were estimated at approximately $5200 per patient [48]. Two studies reported indirect non-healthcare costs which were estimated at −$54 [47] and $844 [48]. Three studies performed a broader economic evaluation. Handley et al. [53] estimated the incremental cost-effectiveness of a diabetes disease management program between $34,248 and $69,027 per QALY. Huang et al. [56] and McRae et al. [51] estimated lifetime costs per QALY of a diabetes disease management program format respectively $36,526/QALY and $7436/QALY.

3.3.3. Depression

All studies evaluating disease management programs for depression reported incremental direct healthcare costs which ranged from −$863 to $589 per year. Only in the study of Unutzer et al. [37] notable cost savings were found for inpatient and outpatient care which were, however, not significant. In the other studies the added costs of the disease management program were not or only partially offset by decreased use of healthcare services. Consequently, higher or similar healthcare expenditures were found for patients enrolled in a disease management program compared with those receiving usual care [36,46,57]. The study of Bosmans et al. [36] reported in addition to incremental direct healthcare costs, incremental indirect non-healthcare costs which were estimated at $742 per patient per year. The study of Wells et al. [46] performed a broader economic evaluation and found an incremental cost-effectiveness ratio between $2518 and $66,686 per QALY, for patients with depression.

3.3.4. Heart failure

All studies evaluating disease management programs for heart failure patients reported incremental direct healthcare costs, ranging from −$4,970 to $3305 per patient per year [32,33,45,49,58–60]. The study of Miller et al. [38] reported lifetime costs which were estimated at $5461 per patient.

Cost savings due to the disease management program were reported in five studies [32,33,49,58,59]. In four studies these reductions were realized through significant reductions in hospital (re)admissions and ER visits [32,33,49,58]. In one study significant cost savings were due to lower direct healthcare costs of the disease management program [59]. In two studies the costly implementation of the disease management program in combination with only limited effects on healthcare utilization caused higher direct healthcare costs [45,60]. Although the study of Hebert et al. [45] showed that the costs of the disease management program were offset by significantly less hospital costs, the higher costs for outpatient procedures, medications, and home healthcare prevented the disease management program from being cost-saving. The study of Hebert et al. [45] also included incremental direct non-healthcare costs which were estimated at −$30 per patient per year.

Three studies performed a broader economic evaluation and reported incremental costs per QALY gained. Cost-effectiveness of disease management for patients with heart failure ranged from $17,747 to $156,655 per QALY in the studies reporting cost per QALY per year [45,60] and $49,147 per QALY in the study reporting lifetime costs [38].

3.3.5. COPD

Four studies evaluated COPD disease management programs and reported incremental direct healthcare costs ranging from −$16,996 to $9 per patient per year. Cost savings were reported in three studies [34,35,43] which in two studies could be related to significant less use of hospital care reflected in less (re)admissions, urgent GP call and/or ER visits in the intervention group than in the usual care group [34,43]. The study of Sridhar et al. [61] showed similar costs for the disease management group and usual care group. In their study significantly less GP contacts were observed in the intervention group, whereas no differences were found in hospital (re-)admissions. The study of Spiliopoulos et al. [62] only reported direct healthcare costs for patients enrolled in the disease management program, which were estimated at $1244 per patient per year [62].

4. Discussion

This systematic literature review presents results of recent evaluations on the economic effects of disease management programs for diabetes, depression, heart failure, and COPD. In more than half of the included studies evaluating incremental healthcare costs, disease management was associated with lower healthcare expenditures. In line with previous reviews [6,13,15–17,24,63,64], also our literature review shows that results may be most positive for disease management programs for patients with heart

failure and least positive for patients with depression. Our review additionally presents a number of studies reporting cost savings for disease management programs for patients with diabetes or COPD.

It should, however, be noted that in several studies results were not statistically significant or were not tested for significance. There further was substantial variation in cost-estimates, which may be (partly) due to differences between the disease management programs and the economic evaluations in terms of methods and definitions. As a result, we should be careful with drawing firm conclusions. Still, the results of this study are considered useful. Reflections on characteristics of previous studies evaluating the economic effects of disease management programs may be input for further research in this area.

Our review focused on disease management programs for four chronic diseases. By reviewing the literature for the effects of disease management programs on healthcare expenditures for four different diseases, we aimed to gain insight into the effects of disease management in general. To draw overall conclusions, differences in the course of these diseases and the related differences in healthcare utilization over time of these patient groups should be taken into account [6,17]. For instance, disease management programs for patients with COPD or heart failure may be more likely to affect healthcare expenditures (e.g. by reducing hospitalizations or ER visits) in the short term than disease management programs for patients with diabetes or depression. The reason is that patients with heart failure or COPD are more likely to use expensive healthcare services (e.g. hospitalization, ER visits) in the short term, because of exacerbations [65–68], than patients with diabetes or depression. For diabetes patients, utilization of healthcare services is more likely to increase in the longer term, since it largely depends on the development of complications [69–71]. Our literature review yielded few studies having a follow-up period beyond one year. This may explain why notable cost savings due to disease management were less frequently found for diabetes and depression.

We examined a variety of disease management programs that differed in the number, type and operationalization of components. Disease management programs that reduced healthcare expenditures did not seem to differ in terms of the number and type of components and the operationalization of components from programs not showing such positive outcomes. Disease management programs consisting of two components [31,32,34,43] as well as disease management programs consisting of three or four components resulted into reduced healthcare expenditures [33,49,52,58]. It is therefore hard to establish what components and interventions a disease management program should include and under which conditions such programs can be (most) cost saving. Since all studies evaluated multifaceted disease management programs it is even more complex to determine how various components can affect healthcare expenditures. Additionally, it should be noted that it is unknown whether the disease management programs were correctly implemented and if the programs were fully adopted by the patients and the caregivers that were involved. The diversity in the effects may therefore also be related to differences in the level of implementation of disease management programs across settings.

Our literature review provided some indications under which circumstances disease management programs may be most effective. Disease management programs containing three or more components may be most effective in reducing healthcare utilization of COPD patients [25]. Positive effects on healthcare utilization and/or healthcare expenditures may further particularly be seen in patients with less severe symptoms [45] or over a longer period [37,41,49].

A persistent limitation of (economic) evaluations of disease management programs, which was also encountered in the present review, is the heterogeneity of studies. This issue is generally acknowledged by disease management researchers [11,12,16]. The heterogeneity may have influenced the variation in outcomes. Substantial variation was found across studies in the number and type of components and the operationalization of these components. Despite recommendations of earlier studies [6,25], methodologically sound studies and high-quality economic evaluations remain scarce. Variation in the type of direct healthcare costs and the type of cost categories included in the cost analyses was large. Furthermore, information on the reliability of estimates was often lacking and most studies only reported point estimates. We decided not to exclude studies on the basis of methodological characteristics, otherwise only few studies could have been included. At the same time this illustrates the need for more well-designed studies.

The large variation in the usual care conditions further complicates the issue. This variation may be due to differences in healthcare systems between countries and between settings within countries. Consequently, it is likely that the contrast between the usual care conditions and disease management programs varied over the included studies as well. A limited contrast may have resulted into a lack of difference in the effects of usual care and disease management whereas larger contrasts may have resulted into more visible differences. It was, however, often difficult to establish the level of contrast between the usual care conditions and disease management program since usual care was mostly poorly described.

In order to more validly conclude whether disease management programs live up to their promise, it is important to improve the comparability and interpretability of future studies. It is therefore recommended to better describe disease management programs, their level of implementation, and usual care conditions. It is further recommended to improve reporting on the costs that are included in the economic evaluations, to evaluate similar study outcomes, and to use more rigorous study designs (e.g. experimental setup, larger sample sizes, longer time-spans). Studies comparing the economic effects of disease management programs with those of care as usual (e.g. RCTs or quasi-experimental studies) are particularly recommended since these studies provide insight into the incremental healthcare costs. This outcome is of primary interest in this context, since it provides information on the potential added value of disease management as compared to care as usual. Additionally,

future studies should provide more information on the reliability and validity of their estimates. Finally, future studies may consider using a societal perspective rather than the healthcare perspective which has mostly been used. Disease management programs may have economic effects outside the healthcare sector that may be relevant from the perspective of policy makers. Future studies, taking the aforementioned recommendations into account, will enable more valid conclusions regarding the ability of disease management programs to reduce healthcare expenditures.

5. Conclusion

Although it is widely believed that disease management programs reduce healthcare expenditures, the present study shows that evidence for this claim is still inconclusive. Nevertheless disease management programs are increasingly implemented in healthcare systems worldwide. To support well-considered decision-making in this field, well-designed economic evaluations should be stimulated.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.healthpol.2011.03.006.

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