Interventions used in disease management programmes for patients with chronic illness—which ones work? Meta-analysis of published reports

Scott R Weingarten, James M Henning, Enkhe Badamgarav, Kevin Knight, Vic Hasselblad, Anacleto Gano Jr, Joshua J Ofman

ELPS

This is an abridged version; the full version is on bmj.com

Abstract

Objective To systematically evaluate the published evidence regarding the characteristics and effectiveness of disease management programmes.
Design Meta-analysis.
Data sources Computerised databases for English language articles during 1987-2001.
Study selection 102 articles evaluating 118 disease management programmes.
Main outcome measures Pooled effect sizes calculated with a random effects model.
Results Patient education was the most commonly used intervention (92/118 programmes), followed by education of healthcare providers (47/118) and provider feedback (32/118). Most programmes (70/118) used more than one intervention. Provider education, feedback, and reminders were associated with significant improvements in provider adherence to guidelines (effect sizes (95% confidence intervals) 0.44 (0.19 to 0.68), 0.61 (0.28 to 0.93), and 0.52 (0.35 to 0.69) respectively) and with significant improvements in patient disease control (effect sizes 0.35 (0.19 to 0.51), 0.17 (0.10 to 0.25), and 0.22 (0.1 to 0.37) respectively). Patient education, reminders, and financial incentives were all associated with improvements in patient disease control (effect sizes 0.24 (0.07 to 0.40), 0.27 (0.17 to 0.36), and 0.40 (0.26 to 0.54) respectively).
Conclusions All studied interventions were associated with improvements in provider adherence to practice guidelines and disease control. The type and number of interventions varied greatly, and future studies should directly compare different types of intervention to find the most effective.

Introduction

Chronic diseases account for billions of dollars in annual medical expenditures. In the United States asthma, depression, and diabetes are estimated to account for $5.1bn (£3.4bn, €5.2bn), $12.4bn, and $44bn respectively, in annual direct medical costs.[1–3] Loss of work time and decreased worker productivity contribute to indirect costs. Unsurprisingly, therefore, there has been much interest in systematically improving the quality and reducing the cost of caring for patients with chronic illness.

Disease management programmes have proliferated recently as a means of improving the quality and efficiency of care for patients with chronic illness. However, such programmes can be costly to develop, implement, and evaluate. A limited number of published trials have documented the effectiveness of disease management in specific situations, but uncertainty remains about its overall value. Understanding which interventions are most effective could guide the development of disease management programmes.

This study reviews the types of interventions used in published trials of disease management programmes and provides quantitative and qualitative evaluation of the evidence regarding the effectiveness of different types of intervention.

Methods

Literature review

We performed a systematic review of the medical literature to identify studies evaluating the effectiveness of disease management programmes in improving care or reducing costs for patients with common chronic conditions. We conducted a search of the Medline, HealthStar, and Cochrane databases for English language articles published between January 1987 and June 2001 (see bmj.com).

Our working definition of disease management was "an intervention designed to manage or prevent a chronic condition using a systematic approach to care and potentially employing multiple treatment modalities." We excluded programmes aimed exclusively at evaluations of single treatment methods (such as psychotherapy or specific drugs) and drug compliance programmes. We rejected articles if they did not use acceptable experimental or quasi-experimental study designs,[4] or if they did not report sufficient information to allow for estimation of at least one relevant measure of programme effect and its variance.

Classification of interventions

Intervention components were classified as follows:

- Provider education—Materials or instruction given to healthcare providers regarding appropriate care for patients with the condition targeted by the programme

Zynx Health, 9100 Wilshire Boulevard 665E, Beverly Hills, CA 90212, USA
Scott R Weingarten *president*
Enkhe Badamgarav *clinical project leader*
Kevin Knight *research manager*
Anacleto Gano Jr *research associate*
Joshua J Ofman *senior vice president research*

TAP Pharmaceutical Products, Lake Forest, IL, USA
James M Henning *associate director*

Duke Clinical Research Institute, Duke University, Durham, NC, USA
Vic Hasselblad *associate research professor*

Correspondence to: S Weingarten sweingarten@cerner.com

BMJ 2002;325:925–8

- Provider feedback—Information given to healthcare providers regarding the specific care or results of care received or experienced by their patients
- Provider reminders—Prompts given to providers to perform specific patient care tasks
- Patient education—Materials and instructions issued to patients providing information on their condition and how it could be managed
- Patient reminders—Prompts given to patients to perform specific tasks related to care for their condition
- Patient financial incentives—Payments (direct monetary payments, discounts, or services) made to patients for achieving specific treatment-related goals.

Classification of process measures or outcomes

Our analyses focused on measures of provider adherence to guidelines as key processes of care and on measures of disease control as key outcomes of care.

Extraction of data

Using a standardised abstraction form, we collected data describing interventions, components used, study design, population characteristics, sample size, intervention strategies, and measures of programme effects on processes and outcomes of care from unmasked articles that met our inclusion criteria (see bmj.com).

When appropriate, we used changes over baseline values rather than follow up values in our analyses.

Meta-analysis

We calculated effect sizes—defined as a difference between the means of the treatment and control arms divided by the pooled estimate of the standard deviation (continuous variables) or the log odds ratio multiplied by a constant variance term (binary outcomes)—for each study outcome to allow pooling of similar outcomes. We constructed effect sizes so that positive numbers denoted treatment benefit. We used the more conservative random effects, to pool the estimated effects.

Results

Literature review

Our initial search strategy identified 16 917 references published between January 1987 and June 2001. In total 102 studies met our criteria for inclusion (see bmj.com). Multiple reports of the same intervention reduced the count of studies by 17.

The 102 accepted studies evaluated 118 discrete intervention programmes and reported 352 estimates of programme effect. Of the 118 programmes, 92 used patient education, 47 used provider education, 32 used provider feedback, 28 used patient reminders, 19 used provider reminders, and only six used financial incentives for patients.

Patient education was an integral part of most programmes studied (9/9 for congestive heart failure, 3/3 for chronic pain, 6/7 for back pain, 6/7 for chronic obstructive pulmonary disease, and 21/26 for diabetes). However, provider education was widely used for only a few conditions—depression (17/25), diabetes (9/26), hypertension (5/8), and hyperlipidaemia (4/7). The six programmes that used financial incentives for patients were for asthma, depression, hyperlipidaemia, and hypertension. Patient reminders were often used in programmes for patients with congestive heart failure (4/9), coronary artery disease (3/6), and diabetes (9/26).

The number of different interventions included in each disease management programme varied, with 48 programmes using a single intervention, 41 using two, 22 using three, and seven using four interventions (see bmj.com).

Impact of programmes with provider interventions

Disease control

We identified 32 programmes addressing six conditions that included provider education and evaluated disease control (table 1). Twelve of these (38%) produced significant improvements in disease control. Disease management for depression and diabetes had the highest percentage of programmes that produced significant benefits (40% (6/15) and 25% (2/8), respectively). Overall, programmes that included provider education showed a modest but significant improvement in disease control.

Twenty three programmes addressing asthma, depression, diabetes, renal disease, hyperlipidaemia, and hypertension included provider feedback and evaluated disease control (table 1). Of these, nine (39%) showed significant improvements in disease control (eight of which were depression programmes). Overall, programmes with provider feedback produced a small but significant improvement in disease control.

Table 1 Effects of disease management programmes with interventions directed at healthcare providers on disease control

	Programmes with provider education		Programmes with provider feedback		Programmes with provider reminders	
Condition	No of effective programmes*	Pooled effect size (95% CI)	No of effective programmes*	Pooled effect size (95% CI)	No of effective programmes*	Pooled effect size (95% CI)
Asthma			0/1	0.03 (–0.1 to 0.19)	0/1	0.03 (–0.1 to 0.19)
Back pain						
Coronary artery disease	0/1	0.39 (–0.03 to 0.81)				
Chronic pain						
Congestive heart failure						
Chronic obstructive pulmonary disease						
Depression	6/15	0.32 (0.11 to 0.52)	8/15	0.22 (0.13 to 0.31)	2/5	0.29 (–0.01 to 0.61)
Diabetes	2/8	0.21 (0.1 to 0.34)	0/3	0.19 (0.02 to 0.37)	2/4	0.28 (0.12 to 0.44)
End stage renal disease			0/1	–0.25 (–0.4 to –0.06)	0/1	–0.25 (–0.4 to –0.06)
Hyperlipidaemia	1/2	0.24 (0.04 to 0.43)	1/2	0.25 (0.06 to 0.43)	1/2	0.24 (0.04 to 0.43)
Hypertension	2/5	0.67 (–0.15 to 1.5)	0/1	0.08 (–0.01 to 0.17)	1/1	0.52 (0.1 to 0.93)
Rheumatoid arthritis and osteoarthritis	1/1	0.78 (0.06 to 1.5)				
All conditions (n=73)	12/32	0.35 (0.19 to 0.51)	9/23	0.17 (0.1 to 0.25)	6/14	0.22 (0.1 to 0.37)

*No of assessments showing significant treatment benefit (α=0.05)/total No of assessments.

Table 2 Effects of disease management programmes with interventions directed at patients on disease control

Condition	Programmes with patient education		Programmes with patient reminders		Programmes with patient financial incentives	
	No of effective programmes*	Pooled effect size (95% CI)	No of effective programmes*	Pooled effect size (95% CI)	No of effective programmes*	Pooled effect size (95% CI)
Asthma	2/3	1.1 (0.04 to 2.1)	0/1	0.03 (–0.1 to 0.19)		
Back pain						
Coronary artery disease	1/3	0.40 (0.18 to 0.62)	0/2	0.31 (–0.01 to 0.63)		
Chronic pain	1/2	0.87 (0.27 to 1.47)				
Congestive heart failure						
Chronic obstructive pulmonary disease	0/2	0.01 (–0.38 to 0.39)	0/1	0.29 (–0.3 to 0.86)		
Depression	10/18	0.27 (0.18 to 0.36)	2/3	0.34 (0.14 to 0.55)	1/1	0.26 (0.1 to 0.43)
Diabetes	6/17	0.22 (0.15 to 0.30)	4/7	0.31 (0.18 to 0.44)		
End stage renal disease	0/1	–0.25 (–0.4 to –0.06)				
Hyperlipidaemia	1/4	0.20 (0.07 to 0.33)	0/1	0.09 (–0.27 to 0.44)	0/1	0.22 (–0.04 to 0.48)
Hypertension	2/2	1.6 (0.30 to 2.9)			2/2	0.48 (0.44 to 0.53)
Rheumatoid arthritis and osteoarthritis	1/3	0.19 (–0.11 to 0.50)	0/1	0.21 (–0.31 to 0.73)		
All conditions	24/55	0.24 (0.07 to 0.40)	6/16	0.27 (0.17 to 0.36)	3/4	0.40 (0.26 to 0.54)

*No of assessments showing significant treatment benefit (α=0.05)/total No of assessments.

Fourteen programmes incorporating provider reminders evaluated disease control (table 1). Of these, six (43%) significantly improved disease control. Programmes with provider reminders were effective for patients with diabetes and hyperlipidaemia. Overall, the programmes made a small but significant improvement in disease control.

Provider adherence to guidelines

Twenty four programmes that included provider education assessed measures of provider adherence to guidelines, of which 12 (50%) significantly improved these measures (see bmj.com). Disease management for depression had the highest percentage of programmes with significant benefit (9/14). Overall, programmes with provider education components significantly improved provider adherence to guidelines (effect size 0.44 (0.19 to 0.68)).

Sixteen programmes with provider feedback evaluated provider adherence to guidelines (see bmj.com). Nine of these (56%) significantly improved provider adherence, with programmes for depression being most successful (8/12). Overall, these programmes were effective in improving provider adherence (effect size 0.62 (0.28 to 0.93)).

Ten programmes with provider reminders examined provider adherence (see bmj.com). Six (60%) significantly improved adherence, with programmes for depression being most successful (5/8). Overall, these programmes were also effective in improving provider adherence (effect size 0.52 (0.35 to 0.69)).

Impact of programmes with patient interventions on disease control

Fifty five programmes included patient education and evaluated disease control (table 2). Of these, 24 (44%) significantly improved disease control. The highest percentage of programmes producing significant improvements were among those for depression (10/18), asthma (2/3), and hypertension (2/2). Overall, patient education produced a small but significant improvement in disease control.

Sixteen programmes including patient reminders evaluated disease control (table 2). Six (38%) significantly improved disease control. The highest percentage of programmes producing significant improvements were among those for depression (2/3) and diabetes (4/7). Overall, programmes with patient reminders produced a small but significant improvement in disease control.

Four programmes incorporating patient financial incentives evaluated disease control (table 2). Three, including one depression programme and two hypertension programmes, significantly improved disease control. Overall, these programmes seemed effective in improving disease control.

Discussion

Our study showed that many different interventions—including provider education, provider feedback, provider reminders, patient education, patient reminders, and patient financial incentives—were associated with improvements in provider adherence to guidelines and patient disease control. However, since existing studies do not directly compare different interventions, less is known about which interventions produce the greatest relative improvements in care.

Strengths and limitations of study

To the best of our knowledge, our study is the first comprehensive attempt to evaluate the effectiveness of different disease management programmes for patients with chronic illness. Our study brought together disparate information of disease management, to allow for qualitative and quantitative interpretation. We evaluated 16 917 different article titles and identified 102 different disease management studies. We evaluated multiple potential implementation strategies for many different diseases and conditions, and we evaluated both the process of care (provider adherence to guidelines) and the outcome of care (disease control). Disease control measures were carefully selected and related to the key clinical goals of the treatment of each disease. In addition, our study provided both qualitative and quantitative information to assess the effectiveness of different interventions; most other studies have evaluated only qualitative findings.[5–11] Therefore, in addition to integrated information on the effect sizes of interventions on patient disease control and adherence to guidelines,[12] we have provided detailed descriptions of each study

(see authors' website www.zynx.com\research\disease_management.htm).

Our study has several limitations, most importantly the quality, quantity, and heterogeneity of the original studies. The studies included great variation in interventions used, patient populations, provider populations, and measured processes and outcomes of care. Many provided insufficient detail in the methods section for us to understand the quality of the interventions and the intensity or duration of each intervention. For example, a study might report that provider education was used, but provide insufficient information for readers to understand how the educational process was performed and how to replicate the process.

The clinical significance of effect sizes may be unclear and need to be interpreted with caution and related to the measured clinical effects reported in the trials.[12] Few studies directly compared the effectiveness of different interventions, and without direct comparisons of interventions in trials it is difficult to evaluate each intervention's relative effectiveness.

Conclusions

The available published literature shows that most disease management programmes directed at providers and patients are associated with improvements in care. However, little is known about the relative effectiveness and costs associated with different implementation strategies, and few studies have directly compared intervention strategies. Further research is needed to determine the effectiveness and costs of different implementation strategies that could be used in disease management programmes. These studies should adhere to methodological standards and be described in peer reviewed literature in sufficient detail to enable others to understand and reproduce the results in different patient populations, and to understand the relative effectiveness of different disease management interventions for improving the care of patients with chronic diseases.

The burden of disease

Global burden of disease and injury attributable to selected risk factors, 1990

Risk factor	Deaths (thousands)	As % of total deaths	YLLs (thousands)	As % of total YLLs	YLDs (thousands)	As % of total YLDs	DALYs (thousands)	As % of total DALYs
Malnutrition	5881	11.7	199 486	22.0	20 089	4.2	219 575	15.9
Poor water supply, sanitation, and personal and domestic hygiene	2668	5.3	85 520	9.4	7 872	1.7	93 392	6.8
Unsafe sex	1095	2.2	27 602	3.0	21 100	4.5	48 702	3.5
Tobacco	3038	6.0	26 217	2.9	9 965	2.1	36 182	2.6
Alcohol	774	1.5	19 287	2.1	28 400	6.0	47 687	3.5
Occupation	1129	2.2	22 493	2.5	15 394	3.3	37 887	2.7
Hypertension	2918	5.8	17 665	1.9	1 411	0.3	19 076	1.4
Physical inactivity	1991	3.9	11 353	1.3	2 300	0.5	13 653	1.0
Illicit drugs	100	0.2	2 634	0.3	5 834	1.2	8 467	0.6
Air pollution	568	1.1	5 625	0.6	1 630	0.3	7 254	0.5

Reproduced with permission from Murray CJL, Lopez AD. *The global burden of disease*. Cambridge, MA: Harvard University Press, 1996

In 1990 the main avoidable hazards to health worldwide were malnutrition, poor water supply and sanitation, unsafe sex, and tobacco and alcohol use. This table shows how these and other important risk factors contributed to overall deaths, premature deaths in years of life lost (YLLs), years of life lived with a disability (YLDs), and—as a combined measure or premature death and disability—disability adjusted life years (DALYs). The global burden caused by tobacco and alcohol will almost certainly increase rapidly as their use spreads throughout less developed countries.

What is already known on this topic

Disease management programmes have gained popularity in recent years as a means of improving the quality and efficiency of care of patients with chronic diseases

A limited number of trials have documented the effectiveness of disease management in specific situations, but uncertainty remains about its overall value and which interventions are most effective

What this study adds

Programmes using education, feedback, or reminders for healthcare providers produced significant improvements in provider adherence to care guidelines

Programmes using the provider strategies or education, reminders, or financial incentives for patients improved disease control

Further study is needed to assess the relative effectiveness of the different strategies

Contributors: see bmj.com

Funding: This work was partially supported by a research grant from TAP Pharmaceutical Products.

Competing interests: SRW has been reimbursed for speaking at conferences on the topic of disease management and was a member of the NCQA Disease Management Advisory Committee. At the time of the study Zynx Health was owned by Cedars-Sinai Health System and affiliated with the UCLA School of Medicine; it is now a subsidiary of Cerner Corporation. At no time has it derived revenue from selling or providing services for disease management programmes.

1 Smith DH, Malone DC, Lawson KA, Okamoto LJ, Battista C, Saunders WB. A national estimate of the economic costs of asthma. *Am J Respir Crit Care Med* 1997;156:787-93.
2 Greenberg PE, Stiglin LE, Finkelstein SN, Berndt ER. The economic burden of depression in 1990. *J Clin Psychiatry* 1993;54:405-18.
3 American Diabetes Association. Economic consequences of diabetes mellitus in the U.S. in 1997. *Diabetes Care* 1998;21:296-309.
4 Cochrane Effective Practice and Organisation of Care Group (EPOC) information page. Cochrane Database of Systematic Reviews website. http://gateway.ovid.com/rel410/server1/ovidweb.cgi (accessed 19 Jul 2000).
5 Ellrodt G, Cook DJ, Lee J, Cho M, Hunt D, Weingarten S. Evidence-based disease management. *JAMA* 1997;278:1687-92.
6 Oxman AD, Thomson MA, Davis DA, Haynes RB. No magic bullets: a systematic review of 102 trials of interventions to improve professional practice. *CMAJ* 1995;153:1423-31.
7 Davis DA, Thomson MA, Oxman AD, Haynes RB. Evidence for the effectiveness of CME. A review of 50 randomized controlled trials. *JAMA* 1992;268:1111-7.
8 Grol R. Beliefs and evidence in changing clinical practice. *BMJ* 1997;315:418-21.
9 Davis DA, Taylor-Vaisey A. Translating guidelines into practice. A systematic review of theoretic concepts, practical experience and research evidence in the adoption of clinical practice guidelines. *CMAJ* 1997;157:408-16.
10 Grimshaw JM, Russell IT. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. *Lancet* 1993;342:1317-22.
11 Committee to Advise the Public Health Service on Clinical Practice Guidelines, Institute of Medicine. *Clinical practice guidelines: directions for a new program*. Washington DC: National Academy Press, 1990.
12 Kazis LE, Anderson JJ, Meenan RF. Effect size for interpreting changes in health status. *Med Care* 1989;27:S178-89.

(Accepted 6 September 2002)