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Economic Evaluations of Multicomponent Disease Management Programs with Markov Models: A Systematic Review

Florian Kirsch[1,2,*]

[1]*Munich School of Management and Munich Center of Health Sciences, Ludwig-Maximilians-University, Munich, Germany;* [2]*Institute for Health Economics and Health Care Management, Helmholtz Zentrum München, Member of the German Center for Diabetes Research (DZD), Neuherberg, Germany*

ABSTRACT

Background: Disease management programs (DMPs) for chronic diseases are being increasingly implemented worldwide. **Objectives:** To present a systematic overview of the economic effects of DMPs with Markov models. The quality of the models is assessed, the method by which the DMP intervention is incorporated into the model is examined, and the differences in the structure and data used in the models are considered. **Methods:** A literature search was conducted; the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement was followed to ensure systematic selection of the articles. Study characteristics e.g. results, the intensity of the DMP and usual care, model design, time horizon, discount rates, utility measures, and cost-of-illness were extracted from the reviewed studies. Model quality was assessed by two researchers with two different appraisals: one proposed by Philips et al. (Good practice guidelines for decision-analytic modelling in health technology assessment: a review and consolidation of quality asessment. Pharmacoeconomics 2006;24:355-71) and the other proposed by Caro et al. (Questionnaire to assess relevance and credibility of modeling studies for informing health care decision making: an ISPOR-AMCP-NPC Good Practice Task Force report. Value Health 2014;17:174-82). **Results:** A total of 16 studies (9 on chronic heart disease, 2 on asthma, and 5 on diabetes) met the inclusion criteria. Five studies reported cost savings and 11 studies reported additional costs. In the quality, the overall score of the models ranged from 39% to 65%, it ranged from 34% to 52%. Eleven models integrated effectiveness derived from a clinical trial or a meta-analysis of complete DMPs and only five models combined intervention effects from different sources into a DMP. The main limitations of the models are bad reporting practice and the variation in the selection of input parameters. **Conclusions:** Eleven of the 14 studies reported cost-effectiveness results of less than $30,000 per quality-adjusted life-year and the remaining two studies less than $30,000 per life-year gained. Nevertheless, if the reporting and selection of data problems are addressed, then Markov models should provide more reliable information for decision makers, because understanding under what circumstances a DMP is cost-effective is an important determinant of efficient resource allocation.

Keywords: chronic disease, cost-effectiveness, DMP, Markov model, review.

Introduction

In the United States, 86% of all health care spending in 2010 was for people with at least one chronic disease [1]. Disease management programs (DMPs) for chronic diseases are being increasingly implemented in health care systems all over the world [2–4]. The primary long-term goal of DMPs is to decrease the cost of illness, in addition to improving disease control and health-related quality of life. DMPs consist of a system of coordinated health care interventions and communications for populations with conditions for which patient self-care is important [5,6]. To evaluate the cost-effectiveness of DMPs, clinical trials that include cost data can be used. Nevertheless, they deal with only the time frame of the trial, whereas health economic models can extrapolate results into the future [7]. In particular, Markov models are useful when a decision problem involves an ongoing risk, when important events may occur more than once, and when the utility of an outcome depends on when it occurs [8]. Therefore, a Markov model may be a reliable tool for decision makers [9] because understanding under what circumstances a DMP is or is not cost-effective is an important determinant of efficient resource allocation [10].

We present a systematic overview of the economic results of DMPs in chronic diseases provided by Markov models. The

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* *Address correspondence to*: Florian Kirsch, Health Economics and Management, Ludwig-Maximilians University, Ludwigstr. 28 RG, Munich 80539, Germany.

E-mail: UUf.kirsch@bwl.lmu.deUU.

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quality of the models is assessed, and how the DMP intervention was incorporated into the model and how it fitted are examined. Finally, differences in the structure and data of the models on outcomes are estimated.

Methods

Data Sources and Searches

We followed the instructions of the standards of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (see Appendix I in Supplemental Materials found at http://dx.doi.org/10.1016/j.jval.2016.07.004) [11]. A systematic literature search was conducted on June 26, 2015 (see Appendix II in Supplemental Materials found at http://dx.doi.org/10.1016/j.jval.2016.07.004). The databases PubMed, Embase, Business Source Complete, and EconLit were screened for articles using the following search terms: *disease management/disease management programme/management program*; *decision analytic/model/Markov*; *chronic disease/COPD/asthma/breast cancer/diabetes/coronary/heart*. After removing duplications, abstracts were screened. For inclusion, the following a priori defined criteria had to be fulfilled: 1) effects and costs were considered, 2) publication year was after 1995, 3) a Markov model was used, 4) articles were in either English or German, and 5) physicians and patients played an active role in the DMP process. Subsequently, all articles that were considered potentially eligible by at least one reviewer were subject to full-text analysis. The reference lists of these studies were searched to find additional relevant literature. Any disagreements on inclusion of studies were solved by consensus.

Data Extraction

Data extraction was performed by one investigator. The fulfillment of the requirements of the Disease Management Association of America on full-service DMPs was considered. As far as we know, there is no standard or validated method to grade the intensity of a DMP or of usual care. Therefore, we took a pragmatic approach. An intervention that met all six requirements was assessed as a high-intensity treatment, one that met five was medium intensity, and one that met fewer than five was low intensity. The degree of care in the control group was divided into low-, medium-, and high-intensity care. High intensity was achieved if a management plan and patient education were provided, medium intensity if one of these was provided, and low intensity if neither was provided.

Differences in costing year were addressed by using the gross domestic product index of the Organisation for Economic Co-operation and Development [12]. First, the costs were inflated to the price year 2011 in the original country and then converted into US $ to US purchasing power parities.

Quality Assessment

Model quality was assessed with two appraisals: one proposed by Philips et al. [13] in 2006 and the other proposed by Caro et al. [14] in 2014. One amendment was made to the framework of the appraisal of Philips et al. [13]: quality items concerning costs from the 2004 appraisal [15] were added. Because this review is not written from the perspective of a specific decision maker, the first part of the Caro et al. [14] appraisal, which addressed the extent to which the results of the model apply to the setting of interest to the decision maker, was not considered further. All items in the quality appraisals evaluated as not available were rated as not fulfilled for the descriptive analysis of the quality appraisals. The quality assessment was performed by two researchers, and any disagreements on the rating of items were solved by consensus.

Results

Literature Search

The literature search (Fig. 1) yielded a total of 3180 citations. After removing 799 duplications, 2381 abstracts were screened and the full-text articles of 66 citations plus 39 citations from reference lists were reviewed. A total of 16 studies met the inclusion criteria: 9 studies focused on chronic heart disease, 2 on asthma, and 5 on diabetes.

Additional study characteristics can be found in Tables 1 to 3, and the costs and utility values incorporated into the model are provided in Tables I and II in Supplemental Materials found at http://dx.doi.org/10.1016/j.jval.2016.07.004.

Economic Results

For DMPs in chronic heart disease, the results ranged from cost savings of $657 and an increase of 0.0051 quality-adjusted life-years (QALYs) [16,17] to additional costs of $4,607 per life-year gained (LYG) [18] and $146,544 per QALY [19]. Three studies [16–18] reported cost savings and six studies [19–24] reported additional costs.

The two studies for asthma reported cost savings of $798 and a gain of 0.62 QALYs [22], or additional costs of $3635 per QALY [25].

The remaining five studies for diabetes reported results from cost savings, which were not specified further in one study [26], to additional costs, of up to $21,701 per LYG [27] and $85,087 per QALY [24].

Quality Assessment

In the Philips et al. [13] quality appraisal, the overall score results for chronic heart disease ranged from 39% [18] to 65% [23], for asthma from 53% [25] to 58% [22], and for diabetes from 45% [27] to 53% [28] (see Table III in Supplemental Materials found at http://dx.doi.org/10.1016/j.jval.2016.07.004, and also Fig. 2).

For the Caro et al. [14] quality appraisal, the overall scores for chronic heart disease ranged from 34% [18] to 52% [20,21,23,29], for asthma from 31% [25] to 38% [22], and for diabetes from 34% [28] to 51% [30] (see Table IV in Supplemental Materials found at http://dx.doi.org/10.1016/j.jval.2016.07.004, and also Fig. 3).

The performance of the models for the subdimensions and each item for the Philips et al. [13] and Caro et al. [14] quality appraisals can be found in Tables III and IV in Supplemental Materials and in Figures 2 and 3. Chronic heart disease models performed the best, with average overall scores of 55% and 48% in the Philips et al. [13] and Caro et al. [14] quality appraisals, respectively, compared with 56% and 36% for asthma and 50% and 43% for diabetes. In the Philips et al. [13] quality appraisal, the chronic heart disease models performed the best in the dimension structure, with an average overall score of 65% versus 61% for asthma and 62% for diabetes.

There was only a slightly positive trend in the quality of results over time, and the average overall score from models published from 2010 onward [16,17,19,26,31,32] was 57% versus 51% from models published before 2010 [18,20–25,27,28,30] in the Philips et al. [13] quality appraisal and was 47% versus 43% in the Caro et al. [14] quality appraisal. To see whether the models were ranked in the same order in both quality appraisals, the Spearman rank correlation coefficient was calculated as 0.262 with a t value of 1.016. This low value shows that the correlation between the two quality appraisals is weak, although the positive value