

# Cost-effectiveness of Case Management: A Systematic Review

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**H**ealth systems around the world are getting more complex. This increasing complexity may affect patients' ability to access the right health services at the right time. This struggle to navigate the system has individual implications for the care seeker's well-being and economic implications when it results in wasting the health system's scarce resources and delaying the provision of the right treatment to the right patient or providing unnecessary care. Case management programs intend to guide individuals with complex medical needs through the health system to improve health service effectiveness and the efficiency of service provision. The concept of case management is not new; it has been practiced in the United States for more than a century, primarily in the disciplines of nursing and social services.<sup>1</sup> Case management programs are generally designed to tackle the challenges of episodic care, which are often fraught with inadequate transitions between care services and health care settings. The programs aim to coordinate fragmented services by providing guidance to individuals, attempting to improve health service effectiveness and reduce cost. Ideally, a case management program facilitates communication and the coordination of care, and its collaborative practice includes patients, caregivers, nurses, social workers, physicians, payers, support staff, other practitioners, and the community.<sup>2</sup>

The oldest and largest case management membership organization in the world, the Case Management Society of America, which facilitates the growth and development of case management, defines case management as "a collaborative process of assessment, planning, facilitation, care coordination, evaluation, and advocacy for options and services to meet an individual's and family's comprehensive health needs through communication and available resources to promote patient safety, quality of care, and cost-effective outcomes."<sup>3</sup> As defined by the UK-based Medical Research Council as well, case management is quite complex.<sup>4</sup> The complexity of case management interventions arises from, among other factors, the number of groups or organizational levels targeted by the intervention, the number and variability of outcomes, the number and difficulty of behaviors required by those delivering or receiving the intervention, and the degree of flexibility or tailoring of the intervention.

## ABSTRACT

**OBJECTIVES:** In this time of aging and increasingly multimorbid populations, effective and efficient case management approaches play a crucial role in supporting patients who are navigating complex health care systems. Until now, no rigorous systematic review has synthesized studies about the cost-effectiveness of case management.

**STUDY DESIGN:** A systematic review was performed.

**METHODS:** The bibliographic databases PubMed and CINAHL Plus were systematically searched using key blocks and synonyms of the terms *case management*, *effectiveness*, and *costs*. The methodological quality of the studies was assessed using the Consensus Health Economic Criteria list.

**RESULTS:** A total of 29 studies were included. In 3 studies, the intervention was less effective and more costly than the control group and can therefore be considered not cost-effective. Two studies found that the intervention was less effective and less costly. A more effective and less costly intervention, and therefore a strong recommendation for case management, was found in 6 studies. In 17 studies, the intervention was more effective while being more costly. Nearly half of the studies met most of the quality criteria, with 16 or more points out of 19.

**CONCLUSIONS:** Existing studies often have adequate quality and, in many cases, show cost-effective or even cost-saving results. Case management appears to be a promising method to support patients facing complex care situations. However, variation among case management approaches is very high, and the topic needs further study to determine the most cost-effective way of providing such care coordination.

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TAKEAWAY POINTS

- ▶ Case management approaches play a crucial role in supporting patients who are navigating complex health care systems.
- ▶ Case management intervention studies often have adequate quality and, in many cases, show cost-effective or even cost-saving results.
- ▶ Variation among case management approaches is very high, and the topic needs further study to determine the most cost-effective way of providing such care coordination.

TABLE 1. Eligibility Criteria

Inclusion	Exclusion
<b>Population</b>	
• Adults (≥ 18 years)	
<b>Intervention</b>	
Case management, including:	• Collaborative care without case manager
• Case finding	
• Assessment	
• Case planning	
• Navigation and coordination	
• Monitoring and review of case plan	
<b>Comparison</b>	
• Usual care	• Same sample (before-after comparison) • Usual care that includes standard case management
<b>Outcomes</b>	
• Cost-effectiveness	• Partial economic evaluation (eg, cost analysis)
• Outcome should be health related	
• Outcome should be related to patients	
<b>Setting</b>	
• Transferability to the German context possible	
<b>Study design</b>	
• Clinical trials	• Models and simulations (eg, Markov model, microsimulations)
• Randomized controlled trials	
• Nonrandomized controlled trials	• Meta-analyses
• Interrupted time series	• Reviews
	• Systematic reviews

Furthermore, there is complexity in the intervention components, among them case finding and assessment, case planning, navigation and coordination, monitoring, and reviewing of the case plan. These components aim to improve continuity of care and to enhance patients' self-management skills and hence are intended to increase efficiency within the health care system.

Especially in regard to the aging multimorbid population, case management may play an important role in the support of patients facing complex care situations. With better coordination, it is posited, the health system's ability to provide high-quality care and maintain resource requirements can improve. One recent analysis of case management's effectiveness is the RubiN project (funded by the

Federal Joint Committee's German Innovations Fund), which is evaluating the implementation of case management for geriatric patients. The goal of RubiN is to develop a form of care throughout Germany that enables older people to remain in their homes for as long as possible. It is hoped that by case managers informing and guiding patients and their (caretaking) relatives, the quality of treatment will rise—by closing gaps in care—and support will be provided to physicians—by conserving scarce personnel resources.

Here, we set out to provide an overview of the evidence regarding cost-effectiveness of case management; until now, no systematic review has been conducted on this topic. Yet systematic reviews that have been done on case management's overall effectiveness are promising: They have found that case management can effectively reduce hospital use and improve satisfaction with care when chronic illnesses are present.<sup>5-7</sup> Furthermore, a systematic review of reviews has found evidence that case management interventions reduce health care utilization in patients with chronic illnesses.<sup>8</sup>

However, the question of whether case management is cost-effective has so far not been adequately addressed. Further, it is unclear whether cost-effective case management interventions have certain characteristics in common. The aim of this systematic review is therefore to investigate the cost-effectiveness of case management.

METHODS

Objectives and Study Design

The objective of this systematic review was to synthesize the evidence for cost-effectiveness of case management. We conducted a systematic review of the literature following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines.<sup>9</sup> Also, this review reported according to the PICOS (Population, Intervention, Comparison, Outcomes, Setting) Framework.<sup>10</sup> A protocol was developed before searching electronic databases.

Eligibility Criteria

Inclusion and exclusion criteria are outlined in Table 1. Briefly, the review included cost-effectiveness studies that compare case management interventions with usual care. Model-based studies were excluded. No limits were applied to language and publication date.

### Electronic Bibliographic Database Searches

The bibliographic databases PubMed and CINAHL Plus were systematically searched using key blocks of the terms *case management*, *effectiveness*, and *costs* and their synonyms. A complete search strategy list is provided in the eAppendix (available at [ajmc.com](http://ajmc.com)).

### Study Selection

Two authors (A.K.K. and J.J.) independently screened titles and abstracts from unduplicated references. The full text was reviewed when a decision was not possible from reading the abstract. Any discrepancies were resolved by discussion.

### Data Collection and Synthesis

Data were collected using an extraction form developed to retrieve relevant information. This included study characteristics (nation, setting, patient group and sample size, comparison group, study design, type of economic evaluation, study duration), case management characteristics (case management model [with description], intensity of intervention, team or single case manager, training received, supervision, 24-hour availability of case manager, caseload per manager/team), and outcome characteristics (outcome measures, costs included, cost perspective, time horizon, cost analysis method, findings, sensitivity analysis/uncertainty assessment). The studies were summarized and synthesized by the first author independently. The extraction table is provided in the eAppendix.

### Quality Assessment

The methodological quality of the cost-effectiveness analyses was assessed by the Consensus Health Economic Criteria (CHEC) list.<sup>11</sup> If a study qualified in a criterion, it scored 1; otherwise, it scored 0. Thus, this tool's range was 0 to 19. In cases in which criteria were not applicable (eg, the question about the appropriate discount rate in a year-long study), the overall achievable score was reduced. Quality appraisal was verified by a second reviewer.

## RESULTS

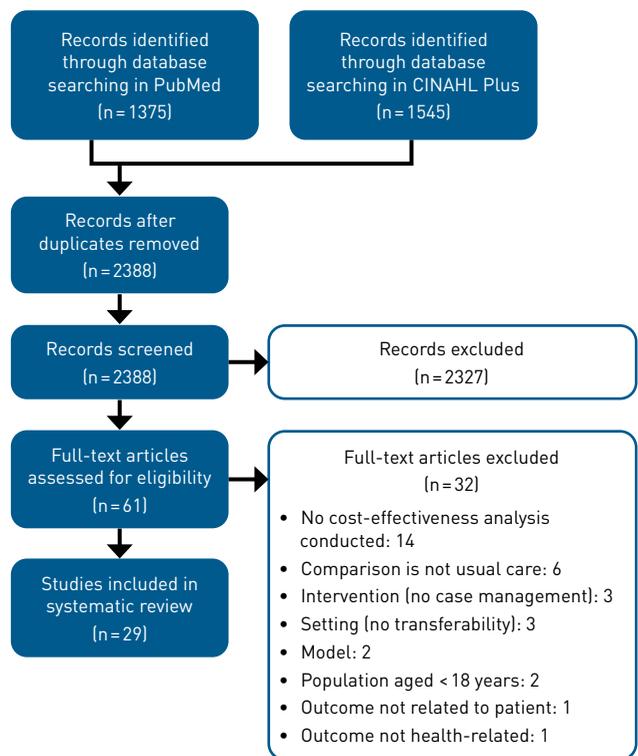
### Study Selection

A total of 2388 unduplicated studies were retrieved from the database searches. After reading titles and abstracts, 61 full texts were analyzed, and inclusion and exclusion criteria were applied. From these, 32 studies were excluded. The remaining 29 studies were included in the qualitative analysis of the review. A flow diagram of this process, according to PRISMA guidelines, is presented in Figure 1.<sup>9</sup>

### Quality Assessment

The results of the CHEC list show that nearly half of the studies (n = 13) met most of the quality criteria (≥ 16 of 19).<sup>12-24</sup> The main limitations were the narrow perspective chosen, as only about a quarter (n = 7) of all studies chose a broad societal perspective,<sup>12,16,17,20,23,25,26</sup> and the chosen short time horizon, which was only 1 year in about half the studies (n = 14).<sup>13,16,19,26-36</sup>

FIGURE 1. PRISMA Flowchart of Screening and Selection Process<sup>9</sup>



PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses. Source: Moher et al (2009).<sup>9</sup>

### Study Characteristics

Studies were from the United States (n = 12)<sup>13-16,18,28,29,34,35,37-39</sup> more than from any other nation, followed by studies from Germany (n = 8),<sup>12,20,21,24,26,30,31,33</sup> the Netherlands (n = 4),<sup>17,19,22,23</sup> the United Kingdom (n = 2),<sup>32,40</sup> Sweden (n = 1),<sup>25</sup> Denmark (n = 1),<sup>36</sup> and Canada (n = 1).<sup>27</sup> Except for one,<sup>33</sup> all studies were trial-based economic evaluations, assessing the cost-effectiveness of case management compared with usual care. Twenty-two of the economic evaluations were based on randomized controlled trials (RCTs)<sup>12-16,18,20-30,32,34,36,39,40</sup>; the rest used non-RCT designs, such as nonrandomized controlled observational studies. Twenty of the studies adopted a health care system perspective in the analysis.<sup>13-15,19,21,24,27-40</sup> A societal perspective was adopted by 7 studies.<sup>12,16,17,20,23,25,26</sup> One study took the employers' perspective.<sup>18</sup> One study adopted a health care perspective, a social care perspective, and a societal perspective.<sup>22</sup>

### Patient Groups

The patient group represented more than any other (see Table 2<sup>12-40</sup>) were those with psychiatric disorders (n = 9), such as depressive disorders, anxiety, and/or posttraumatic stress disorder<sup>12,15,16,18,22,30,31,35,39</sup>; they were followed by older patients (n = 4),<sup>19,25,29,38</sup> patients with dementia (n = 3),<sup>17,24,33</sup> and patients with diabetes (n = 2).<sup>13,37</sup> Further,

**TABLE 2.** Study Population and Case Management Components<sup>12-40</sup>

Study	Study population	Assessment	Case planning/ care plans	Navigation/ coordination	Monitoring	Health education	Other
Bosanquet et al (2017) <sup>40</sup>	465 participants ≥ 65 years with major depressive disorder			✓	✓		
Bourbeau et al (2006) <sup>27</sup>	96 previously hospitalized patients ≥ 50 years with COPD				✓	✓	
Dehmer et al (2018) <sup>28</sup>	299 patients ≥ 21 years with elevated blood pressure	✓	✓	✓	✓	✓	
Dorman Marek et al (2018) <sup>29</sup>	301 participants ≥ 60 years with impaired cognitive functioning and needing help to manage oral medications	✓	✓	✓	✓	✓	
Gensichen et al (2013) <sup>12</sup>	562 patients with major depression			✓	✓	✓	
Grochtdreis et al (2018) <sup>30</sup>	325 patients with anxiety, depressive, or somatic symptoms	✓		✓		✓	
Handley et al (2008) <sup>13</sup>	339 English-, Spanish-, and Cantonese-speaking patients with type 2 diabetes				✓	✓	
Hay et al (2012) <sup>14</sup>	387 low-income, predominantly Hispanic patients with diabetes and comorbid depression			✓	✓		Problem-solving therapy
Hay et al (2018) <sup>37</sup>	1406 patients with type 2 diabetes			✓	✓		
Jacke and Salize (2014) <sup>31</sup>	954 patients with incapacity to work for a duration of 28 to 56 days in connection with an affective disorder, discharged from hospital in the 14 days prior to study initiation			✓			
Joesch et al (2012) <sup>15</sup>	1004 patients with panic disorder, generalized anxiety, social anxiety, and/or PTSD with or without major depression				✓	✓	Optimization of medications
Lavelle et al (2018) <sup>16</sup>	629 active-duty service members with PTSD or depression				✓		Increased behavioral health support and stepped psychosocial treatment
Lewis et al (2017) <sup>32</sup>	705 participants ≥ 75 years during the pilot phase and ≥ 65 years during the main trial with subthreshold depression			✓	✓		Behavioral activation
Long and Marshall (2000) <sup>38</sup>	317 functionally impaired clients ≥ 75 years with severe functional disability, excessive hospital use, or ED use		✓	✓	✓		
MacNeil Vroomen et al (2016) <sup>17</sup>	521 informal caregivers and community-dwelling persons with dementia		✓	✓		✓	
Michalowsky et al (2019) <sup>24</sup>	444 participants with dementia, ≥ 70 years, living at home	✓	✓	✓			
Mostardt et al (2012) <sup>33</sup>	48 patients with dementia			✓			
Paez and Allen (2006) <sup>34</sup>	228 adults with hypercholesterolemia, who underwent coronary artery bypass grafting or percutaneous coronary intervention		✓		✓	✓	
Rost et al (2004) <sup>18</sup>	326 primary care patients with depression, with full- or part-time work	✓	✓		✓	✓	
Ruikes et al (2018) <sup>19</sup>	369 frail patients ≥ 70 years	✓	✓	✓	✓		
Saleh et al (2006) <sup>35</sup>	662 participants with more than 1 drug- or alcohol-related offense, a breathalyzer test with a blood alcohol content of 0.2 or higher, or involved in a drug- or alcohol-related accident	✓	✓	✓	✓		
Sandberg et al (2015) <sup>25</sup>	153 frail patients ≥ 65 years	✓	✓	✓	✓	✓	
Seidl et al (2015) <sup>26</sup>	329 patients ≥ 65 years with myocardial infarction	✓			✓	✓	
Seidl et al (2017) <sup>20</sup>	329 patients ≥ 65 years with myocardial infarction	✓			✓	✓	
Simon et al (2009) <sup>39</sup>	600 consecutive primary care patients starting antidepressant treatment			✓	✓		
Sørensen et al (2017) <sup>36</sup>	150 patients with COPD	✓	✓	✓	✓	✓	
Ulrich et al (2019) <sup>21</sup>	505 patients with a long-term indication for oral anticoagulation therapy				✓	✓	
Wansink et al (2016) <sup>22</sup>	49 participants with long-standing psychiatric problems and an accumulation of risk factors for poor parenting	✓	✓	✓	✓	✓	
Wijnen et al (2019) <sup>23</sup>	223 patients with HIV at risk for viral rebound (ie, a recent detectable viral load and suboptimal adherence)				✓	✓	

COPD, chronic obstructive pulmonary disease; ED, emergency department; PTSD, posttraumatic stress disorder.

several studies included patients belonging to more than 1 patient group, such as patients with diabetes and depression,<sup>14</sup> older patients with depression,<sup>32,40</sup> and older patients with myocardial infarction.<sup>20,26</sup> The rest of the studies included patients with HIV,<sup>23</sup> chronic obstructive pulmonary disease,<sup>27,36</sup> elevated blood pressure,<sup>28</sup> hypercholesterolemia,<sup>34</sup> and a long-term indication for oral anticoagulation therapy.<sup>21</sup>

### Case Management Model

In most studies, the case management interventions were described in enough detail to identify the program components. These components are case finding and assessment, case planning, navigation and coordination, monitoring, and reviewing of the case plan (Table 2<sup>12-40</sup>).

The component of monitoring could be found in most descriptions of the case management intervention: Symptom monitoring and regular visits or telephone calls were described in 24 studies. Furthermore, the case management models often included navigation and coordination (n = 19) and health education (n = 17) components, such as informing the patient about the disease, counseling on general health behavior, emphasizing lifestyle changes, and promoting treatment adherence, self-care, and autonomy.

A combination of the components of monitoring and health education was often described,<sup>13,15,21,23,27</sup> as was the combination of monitoring and navigation/coordination.<sup>14,32,37,39,40</sup>

A case management model with all components (assessment, case planning, navigation and coordination, monitoring, and health education) was described in 5 studies.<sup>22,25,28,29,36</sup>

### Case Managers

Case managers were nurses, health care assistants, social workers, physiotherapists, clinical therapists, pharmacists, and mental health workers. About half the studies (n = 14) stated that the case managers received training beforehand. The scope of the training received was heterogeneous, with a duration of several hours, 2 days, or even 2 weeks. Case managers worked alone, although they frequently collaborated closely with the patient's physician. Caseloads ranged between 10 and 76 patients, although 1 study analyzing a telecommunication-supported case management model stated a caseload of up to 120 less-active cases.<sup>35</sup>

### Outcomes and Costs

Highly heterogeneous among the studies were the outcomes. They included patient utility measures (eg, quality of life with EuroQol 5-dimension instrument, Short Form-36 questionnaire, World Health Organization Quality of Life), patient health effect measures (eg, mortality, symptoms, functioning in activities of daily living), other patient-relevant measures or system measures (eg, outpatient contacts, time in patients' home environment, absenteeism), and situational program measures (eg, quality of parenting, abstinence).

Depending on the perspective chosen, intervention costs, direct medical costs (eg, inpatient and outpatient costs, emergency

department costs, medication costs), direct nonmedical costs (costs for social support services [eg, community care such as nurse care and family support]), and indirect costs (eg, informal care costs and productivity losses) were included in the analyses of the studies. A table of perspectives chosen and costs included is provided in the eAppendix.

### Economic Analyses

Findings regarding the economic analyses, the classification within the cost-effectiveness plane, and the results of the quality assessment using the CHEC list are listed in the results grid (Table 3<sup>12-40</sup>).

All except 2 studies<sup>20,25</sup> included an incremental analysis of costs and outcomes; most calculated an incremental cost-effectiveness ratio (n = 24) and conducted a sensitivity analysis (n = 24).

In Figure 2, results are visualized in a cost-effectiveness plane, which is used to visually represent the differences in costs and health outcomes (effects) between treatment alternatives in 2 dimensions by plotting the costs against effects on a graph. Effects and costs are plotted on the x-axis and y-axis, respectively. The cost-effectiveness plane includes 4 quadrants: northwest (NW), southwest (SW), northeast (NE), and southeast (SE).

In 3 studies, the intervention was less effective and more costly than the control group (NW quadrant) and can therefore be considered not cost-effective.<sup>19,30,35</sup> The intervention is dominated by usual care.

Two studies found that the intervention was less effective and less costly (SW quadrant). One of these studies found that both costs (−€17.61) and effects (−0.0163 quality-adjusted life-years [QALYs]) were lower in the intervention group; therefore, the incremental cost-effectiveness ratio (€1080/QALY) represents the savings per additional QALY lost.<sup>26</sup> A study from the Netherlands,<sup>17</sup> which analyzed the cost-effectiveness of case management for patients with diagnosed dementia and their informal caregivers, found that the intervention saves costs and there is an approximately 45% chance that the intervention also has positive effects.

A more effective and less costly intervention (SE quadrant), and therefore evidence for cost-effectiveness, was provided in 6 studies.<sup>12,20,24,27-29</sup>

The majority of studies (n = 18) found that the intervention was more effective while being more costly (NE quadrant). Of these, 7 studies reported incremental cost-effectiveness ratios below a willingness-to-pay threshold of US\$50,000 for the gain of 1 QALY.<sup>14,16,21,23,32,36,40</sup> Only 1 study used QALYs and found that case management is not cost effective at US\$50,000.<sup>13</sup> The remaining studies either used different outcome measures or did not provide a recommendation.

Case management interventions across all studies varied considerably. In cost-effective case management interventions, no patterns of common characteristics, such as case management model, type of case manager, or patient group, could be identified. No correlation of cost-effectiveness with a certain kind of health care system, study design, or time horizon could be observed either. Therefore, it remains unclear what makes some case management interventions cost-effective.

TABLE 3. Results Grid<sup>12-40</sup>

Study	Findings	Cost-effective	CHEC score
Bosanquet et al (2017) <sup>40</sup>	The mean cost per incremental QALY for collaborative care compared with usual care was £26,016. For participants attending 6 or more sessions, collaborative care was £9876/QALY.	NE	15
Bourbeau et al (2006) <sup>27</sup>	The ICER was \$4214 per hospitalization prevented for a caseload of 14 patients per case manager.	Yes, SE	13/18
Dehmer et al (2018) <sup>28</sup>	Total medical costs in the intervention group were lower compared with the usual care group by an average of \$281 per person, but this difference was not statistically significant. Clinic-based office visit, radiology, pharmacy, and hospital costs were also nonsignificantly lower in the intervention group. The intervention cost \$7337 per person achieving hypertension control and \$139 or \$265 per mm Hg reduction in systolic or diastolic blood pressure, respectively. If including the nonsignificant \$281 per person reduction in 12-month medical care costs associated with the intervention, these costs would be moderately lower: \$5809, \$110, and \$210, respectively. Finally, although overall pharmacy costs were equivocal, if the \$82 per person significant increase in hypertension- and lipid-related medication costs were added to the intervention cost, these costs would increase modestly to \$7782, \$148, and \$281, respectively.	Yes, SE but not significant	15
Dorman Marek et al (2018) <sup>29</sup>	NCC + machine group improving 0.1091 QALYs. NCC+ Mediplanner gained 0.0930 QALYs. Cost per QALY gained was \$29,807 in the NCC + machine group; in the NCC + Mediplanner group, it was \$19,484.	Yes, SE	11/18
Gensichen et al (2013) <sup>12</sup>	The point estimate for the cost-utility ratio was €38,429 per QALY gained if only direct costs were considered, and the intervention dominated if total costs were considered. The probability of the intervention being cost-effective was never above 90%.	Yes, SE	17
Grochtdreis et al (2018) <sup>30</sup>	The adjusted differences in QALYs and mean total costs between intervention group and control group were +€0.02 and +€1145, respectively. Neither of the 2 differences was statistically significant. The unadjusted ICUR for an additional QALY showed dominance (ie, less costs and more health effects) of the control group over the intervention group.	No, NW	14/18
Handley et al (2008) <sup>13</sup>	The intervention was associated with a gain of 0.012 QALYs relative to usual care. The annual cost of the ATSM intervention per QALY gained, relative to usual care, was \$65,167 for start-up and ongoing implementation costs combined and \$32,333 for ongoing implementation costs alone.	NE	16/18
Hay et al (2012) <sup>14</sup>	The program cost effectiveness averaged \$4053/QALY per intervention recipient and was more than 90% likely to fall below \$12,000/QALY.	NE	16
Hay et al (2018) <sup>37</sup>	The intervention dominated usual care, showing both statistically significantly lower costs and better patient outcomes. The intervention had a greater than 50% probability of being cost effective relative to the team-supported care model at willingness-to-pay thresholds of more than \$50,000 per QALY.	NE	14
Jacke and Salize (2014) <sup>31</sup>	Intervention yielded benefits for patients at comparable costs. A conservative estimation of the ICER was €44.16. Maximum willingness to pay was €378.82 per year.	NE	13/18
Joesch et al (2012) <sup>15</sup>	The mean incremental net benefit was positive when an anxiety-free day was valued at \$4 or more. For QALYs the mean incremental net benefit was positive at \$5000 or more.	NE	16
Lavelle et al (2018) <sup>16</sup>	The intervention was estimated to cost \$49,346 per QALY gained. There is a 58% probability that the intervention is cost-effective at a \$100,000/QALY threshold.	NE	16/18
Lewis et al (2017) <sup>32</sup>	The incremental cost-effectiveness ratio was £9633 per QALY. Participants allocated to collaborative care displayed significantly higher QALYs than those allocated to the control group (annual difference in adjusted QALYs of 0.044; 95% bias-corrected CI, 0.015-0.072; P=.003).	NE	15/18
Long and Marshall (2000) <sup>38</sup>	Although the average costs for the case-managed group were greater than the costs for the regular-care group, clients in the case-managed group lived an average of 106 days longer. The cost per additional day of life was \$40. The difference in death rates was so small that, by extrapolation, the cost per life saved was more than \$42 million.	NE	14
MacNeil Vroomen et al (2016) <sup>17</sup>	No significant differences were seen in clinical or total cost outcomes among the 3 groups. For all outcomes, the probability that the ICMM was cost-effective in comparison with LM and the control group was larger than 0.97 at a threshold ratio of €0/incremental unit of effect. Cost savings were accompanied by a small nonsignificant negative effect on quality of life for the person with dementia in both case management groups compared with the control group.	SW	19
Michalowsky et al (2019) <sup>24</sup>	DCM increased QALYs (+0.05) and decreased costs (–€569) due to a lower hospitalization rate and a delayed institutionalization (7 months) compared with usual care. The probability of DCM being cost-effective was 88% at willingness-to-pay thresholds of €40,000 per QALY gained and higher in patients living alone compared with those not living alone (96% vs 26%).	Yes, SE	17
Mostardt et al (2012) <sup>33</sup>	Time remaining at home was 16.1 months with a mean of 12.2 months (P=.02) in the control group. Additional costs for the health insurance companies amounted to €41–€53 per additional month in a home environment.	NE	15/18

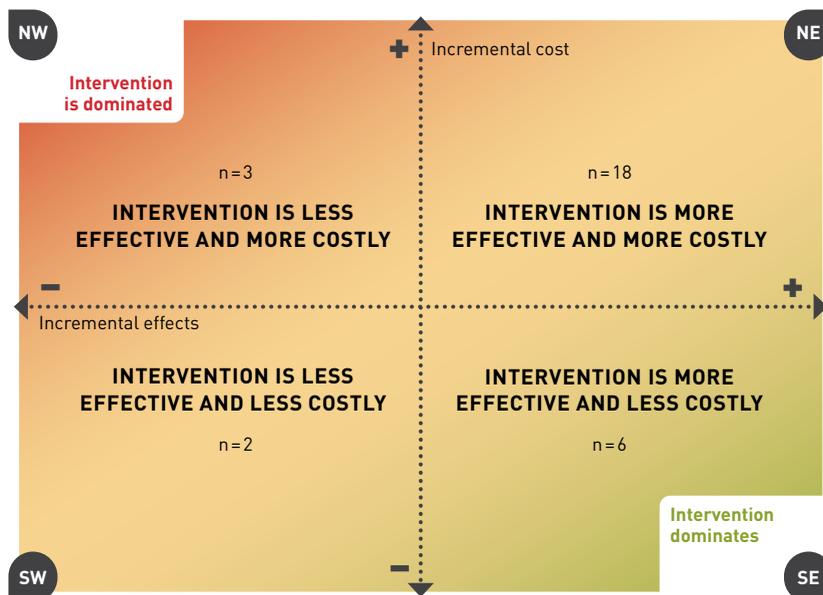
(continued)

**TABLE 3.** Results Grid<sup>12-40</sup>

Study	Findings	Cost-effective	CHEC score
Paez and Allen (2006) <sup>34</sup>	The annual incremental cost-effectiveness of case management was \$26.03 per mg/dL and \$39.05 per percent reduction in LDL-C.	NE	13/18
Rost et al (2004) <sup>18</sup>	In consistently employed subjects, the intervention improved productivity by 8.2% over 2 years at an estimated annual value of \$1982 per depressed full-time equivalent, and it reduced absenteeism by 28.4% or 12.3 days over 2 years at an estimated annual value of \$619 per depressed full-time equivalent.	NE	16
Ruikes et al (2018) <sup>19</sup>	Adjusted mean total costs were €1583 higher in the intervention group than in the control group. No significant differences in functional dependence (adjusted mean difference of 0.37; 95% CI, -0.1 to 0.8) nor QALYs (adjusted mean difference of -0.031; 95% CI, -0.1 to 0.0). INMBs did not show significant differences among groups, but on average tended to favor usual care. INMBs are negative, meaning that the intervention does not provide value for money compared with usual care, although the results are not significant.	No, NW	16/18
Saleh et al (2006) <sup>35</sup>	Based on our results using cumulative costs, the case management conditions were not more cost-effective than the control group (amount spent per substance abuse-free day: control group, \$6.30; social service agency group, \$7.60; treatment agency group, \$10.80; telecommunications group, \$16.60). The results changed, however, when considering the add-on costs (per substance abuse-free day: telecommunications group, \$43.20; treatment agency group, \$36.70; social service agency, \$30.10; control group, \$37.50).	No, NW	13/18
Sandberg et al (2015) <sup>25</sup>	There were no significant differences between the intervention group and the control group for total cost, EQ-5D-based QALY, or EQ-VAS-based QALY for the 1-year study. Incremental cost-effectiveness ratio was not conducted because no significant differences were found for either EQ-5D- or EQ-VAS-based QALY or costs. However, the intervention group had significantly lower levels of informal care and help with instrumental activities of daily living both as costs (€3927 vs €6550; <i>P</i> = .037) and provided hours (200 vs 333 hours per year; <i>P</i> = .037).	N/A	14
Seidl et al (2015) <sup>24</sup>	For cost-utility analysis, both costs (-€17.61) and effects (-0.0163 QALYs) were lower in the intervention group; therefore, the ICER (€1080/QALY) represents the savings per additional QALY lost.	SW	15/18
Seidl et al (2017) <sup>20</sup>	Costs were lower [-€2576; <i>P</i> = .2968] and QALYs were higher [0.0295; <i>P</i> = .7568] in the intervention group but differences were not statistically significant. The probability of cost-effectiveness of the case management at a willingness-to-pay value of €0 per QALY was 84% in the case of QALYs and 81% in the case of VAS-ALs.	Yes, SE	16
Simon et al (2009) <sup>39</sup>	Over 24 months, telephone care management led to a gain of 29 depression-free days (95% CI, -6 to 63) and a \$676 increase in outpatient health care costs (95% CI, \$596 lower to \$1974 higher). The incremental net benefit was negative even if a day free of depression was valued up to \$20. Care management plus psychotherapy led to a gain of 46 depression-free days (95% CI, 12-80) and a \$397 increase in outpatient costs (95% CI, \$882 lower to \$1725 higher). The incremental net benefit was positive if a day free of depression was valued at \$9 or greater.	NE	14
Sørensen et al (2017) <sup>36</sup>	The intervention resulted in a QALY improvement of 0.0146 [95% CI, -0.0216 to 0.0585] and a cost increase of €494 [95% CI, -1778 to 2766] per patient. No statistically significant difference was observed either in costs or effects. The ICER was €33,865 per QALY gained. Scenario analyses confirmed the robustness of the result and revealed slightly lower ICERs of €28,100 to €31,340 per QALY.	NE	14/18
Ulrich et al (2019) <sup>21</sup>	The mean difference in QALYs between the groups was small and not significant [0.03; 95% CI, -0.04 to 0.11]. The mean difference in total costs was statistically significant (€503; 95% CI, €188-€794) because of the costs of case management that applied only to the intervention group. The ICER was €16,767 per QALY. Regardless of the willingness of insurers to pay per QALY, the probability of the intervention being cost-effective never rose above 70%. If the health insurer was willing to pay €15,000 per additional QALY, the probability of cost-effectiveness was 50%.	NE	16
Wansink et al (2016) <sup>22</sup>	Parenting quality improved in the intervention group and declined in the control group. The intervention was shown to be more costly than usual care. ICERs differ from €461 (health care perspective) to €215 (social care perspective) to €175 (societal perspective) per 1-point improvement on the HOME T-score. The results of the sensitivity analyses, based on complete cases and excluding cost outliers, support the finding that the ICER is lower when adopting a broader perspective. The subgroup analysis and the analysis with baseline adjustments resulted in higher ICERs.	NE	18
Wijnen et al (2019) <sup>23</sup>	From a societal perspective, the intervention was slightly more expensive than usual care but also more effective, resulting in an ICER of €549 per reduction in log viral load and €1659 per percentage decrease in treatment failure. In terms of QALYs, AIMS resulted in higher costs but more QALYs compared with usual care, which resulted in an ICER of €27,759 per QALY gained. From a health care perspective, the intervention dominated usual care. Additional sensitivity analyses addressing key limitations of the base case analyses also suggested that the intervention dominates usual care.	NE	18

AIMS, Adherence Improving Self-Management Strategy; ATSM, automated telephone self-management support with nurse care management; CHEC, Consensus Health Economic Criteria; DCM, collaborative dementia care management; EQ-5D, European Quality of Life 5 dimensions; EQ-VAS, European Quality of Life visual analogue scales; HOME, Home Observation for Measurement of the Environment Inventory; ICER, incremental cost-effectiveness ratio; ICMM, intensive case management model; ICUR, incremental cost-utility ratio; INMB, incremental net monetary benefits; LDL-C, low-density lipoprotein cholesterol; LM, linkage model; NCC, nurse care coordination; NE, northeast; NW, northwest; QALY, quality-adjusted life-year; SE, southeast; SW, southwest; VAS-ALs, adjusted life-years from patients' self-rated health states according to the visual analogue scale.

FIGURE 2. Results Within the Cost-effectiveness Plane



NE, northeast; NW, northwest; SE, southeast; SW, southwest.

## DISCUSSION

To our knowledge, this is the first systematic review that systematically synthesized studies to identify the cost-effectiveness of case management interventions. We identified 29 studies, which were published between 2000 and 2019. All studies compared case management to usual care without case management.

The results of the quality assessment of economic evaluations show that the quality of the included studies is good, although most studies chose a payer's perspective and therefore did not include indirect costs such as productivity losses. In addition, in about half of all studies, the chosen time horizon was only 1 year. This is a short observation period, not appropriate to capture all relevant outcomes, because case management effects might be visible only after longer periods of time. In addition, considering that at the beginning of an intervention, costs of case management can be considerably higher because of up-front training costs, a relatively short study period of only 1 year might distort results. Results of the KORINNA studies illustrate this: After 1 year the case management for elderly patients with myocardial infarction was deemed less effective and less costly than usual care,<sup>26</sup> but a follow-up after 3 years<sup>20</sup> showed higher QALYs, significantly better quality of life, and lower costs (although not significantly lower). Hence, longer study durations are strongly recommended.

To provide successful case management, case managers require specialized training. However, only half of the studies stated that the case managers received training. A detailed description of the scope and content of training was scarce. The same applies for data

on caseloads and descriptions of the intensity of case management—in other words, the patient contacts. We therefore recommend that studies provide detailed intervention protocols.

### Limitations

The studies included conducted their interventions in 7 nations in which transferability of the data and conclusions to the German context was possible. Evidence from low- and middle-income countries was not included in this systematic review, and therefore its results may not be broadly applicable.

## CONCLUSIONS

This systematic review found that because of a large variation in case management programs, the evidence for cost-effectiveness is not yet fully conclusive for case management in general. More definitive studies with a defined protocol of case management are needed to determine cost-effectiveness. However, the existing studies often have adequate quality and, in most cases, produce recommendable

conclusions. The confluence of highly developed health systems, fragmented health care services, and aging populations with multimorbidity is a situation that calls out for individualized coordination and support. Case management appears to be a promising method to support patients facing complex care situations. We therefore advise policy makers to establish case management programs as core components of effective, patient-oriented health care systems, and to support rigorous evaluation of each program. ■

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## Supplemental data

### *Search Strategy*

#### 1. PubMed

((("economic evaluation"[Title/Abstract] OR "cost-benefit analysis"[MeSH Terms]) OR "cost effectiveness"[Title/Abstract] OR cost utility[Title/Abstract] OR (cost\*[Title/Abstract] AND effect\*[Title/Abstract]) OR (cost\*[Title/Abstract] AND benefit\*[Title/Abstract]) OR (cost\*[Title/Abstract] AND efficien\*[Title/Abstract])) AND (("care management"[Title] OR "case management"[MeSH Terms]) OR "case management"[Title] OR "care coordination"[Title]))

1. economic evaluation.ab,ti.
2. "costs-benefit analysis"/
3. cost effectiveness.ab,ti.
4. cost utility.ab,ti
5. Cost\*.ab,ti AND effect\*.ab,ti
6. Cost\*.ab,ti AND benefit\*.ab,ti
7. Cost\*.ab,ti AND efficien\*.ab,ti
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. care management.ti.
10. "case management"/
11. case management.ti.
12. care coordination.ti.
13. 9 or 10 or 11 or 12
14. 8 and 13

#### 2. CINAHL Plus

((AB economic evaluation OR MW cost benefit analysis) OR AB cost effectiveness OR AB cost utility OR (AB cost\* AND AB effect\*) OR (AB cost\* AND AB benefit\*) OR (AB cost\* AND AB efficien\*)) AND ((TI care management OR MW case management) OR TI case management OR TI care coordination)

## eAppendix Table 1 Perspectives and costs

Study	Perspective	Intervention costs	Medical care costs	Other costs
Bosanquet, K., et al. (2017)[40]	Payer	✓		
Bourbeau, J., et al. (2006) [27]	Payer	✓	✓ Emergency department visits costs, hospitalization costs	
Dehmer, S.P., et al. (2018)[28]	Payer		✓	
Dorman Marek, K. (2018)[29]	Payer	✓		
Gensichen, J., et al. (2013)[12]	Society		✓ Psychiatric in-patient care, out-patient care provided by psychologists, psychiatrists and family doctors/GPs and antidepressant drug use	✓ Lost work days
Grochtdreis, T., et al. (2018)[30]	Payer		✓ Inpatient care and rehabilitation, outpatient physician and non-physician services, formal nursing care, use of medication	
Handley, M.A., et al. (2008)[13]	Payer	✓		
Hay, J.W., et al. (2012) [14]	Payer	✓	✓	
Hay, J.W., et al. (2018)[37]	Payer	✓	✓	
Jacke, C.O. and H.J. Salize (2014)[31]	Payer	✓		
Joesch, J.M., et al. (2012)[15]	Payer		Outpatient visits, ER visits, and psychiatric medication use	
Lavelle, T.A., et al. (2018)[16]	Society	✓	✓ Medications, inpatient stays, emergency department visits, outpatient tests and procedures, outpatient visits, and telephone contacts	✓ Productivity losses
Lewis, H., et al. (2017)[32]	Payer	✓	✓	
Long, M.J. and B.S. Marshall (2000)[38]	Payer	✓	✓ Hospital costs, outpatient costs, ED visit costs	
MacNeil Vroomen, J., et al. (2016)[17]	Society	✓	✓ General practitioner visits and medication use	✓ Time spent on care by informal carers, days absent from paid work or unable to do daily activities such as housekeeping or voluntary work because of caregiver responsibilities
Michalowsky, B., et al. (2019)[24]	Payer	✓	✓ Outpatient and inpatient treatment, medications, medical aids, ambulatory care, day care, nursing home care	✓ Informal care time
Mostardt, S., et al. (2012)[33]	Payer	✓	✓ Outpatient costs, inpatient costs, medication costs, nursing case costs, costs for nursing aids	
Pacz, K.A. and J.K. Allen (2006)[34]	Payer	✓		
Rost, K., J.L. Smith, and M. Dickinson (2004)[18]	Employer			✓ Productivity (work-days and daily earnings), absenteeism days
Ruikes, F.G.H., et al. (2018)[19]	Payer	✓	✓ GP care, hospital care, institutionalization (i.e. nursing home admission, care home admission), home care, and physiotherapy, domestic care and day care, medication costs	
Saleh, S.S., et al. (2006) [35]	Payer	✓		
Sandberg, M., et al. (2015)[25]	Society		✓ Healthcare costs for inpatient and outpatient care;	✓ Community care costs, or costs provided by the municipality; Costs associated with the participant and family included the patient fee and estimated costs for informal help provided by family and friends; costs for the intervention
Seidl, H., et al. (2015)[26]	Society	✓	✓ Visits physicians and physiotherapists, ambulatory clinic in the hospital, inpatient care/hospital, inpatient rehabilitation, outpatient rehabilitation, drugs	✓ Outpatient nursing service, paid household help, informal care
Seidl, H., et al. (2017)[20]	Society	✓	✓ Visits physicians and physiotherapists, ambulatory clinic in the hospital, inpatient care/hospital, inpatient rehabilitation, outpatient rehabilitation, drugs	✓ Outpatient nursing service, paid household help, informal care
Simon, G.E., E.J. Ludman, and C.M. Rutter (2009)[39]	Payer	✓	✓	
Sorensen, S.S., et al. (2017)[36]	Payer	✓	✓ Costs related to COPD: general practitioner contacts, in and outpatient hospital treatment, costs for prescription medication	✓ Home nurse care, practical in-home assistance, household cleaning, training, stay at nursing home
Ulrich, L.R., et al. (2019)[21]	Payer	✓	✓	
Wansink, H.J., et al. (2016)[22]	a) the healthcare perspective b) the social care perspective c) the societal perspective	✓	✓	✓ a) Healthcare perspective: costs for health and child/family support services b) Social care perspective: plus costs for childcare c) Societal perspective: all measured use of services, including ICBs within the educational sector, the criminal justice system and services for debt restructuring
Wijnen, B.F.M., et al. (2019)[23]	Society	✓	✓	✓ Informal care costs, productivity losses

## eAppendix Table 2 Extraction table

Study	Country	Setting	Patient group or disease; sample size	Study Design/Economic analysis method	Comparison group	Intervention duration/Study duration
Bosanquet, K., et al., Collaborative care for Screen-Positive Elders with major depression (CASPER plus): a multicentred randomised controlled trial of clinical effectiveness and cost-effectiveness. <i>Health Technol Assess</i> , 2017. 21(67): p. 1-252.	United Kingdom	69 general practices	465 participants aged 65+ with major depressive disorder	Cost-effectiveness analysis in the context of a pragmatic, multicentred, two-arm, parallel, individually randomised controlled trial with embedded qualitative study	Usual care	18 months study duration
Bourbeau, J., et al., Economic benefits of self-management education in COPD. <i>CHEST</i> , 2006. 130(6): p. 1704-1711.	Canada	Respiratory referral centers	96 previously hospitalized COPD patients aged 50+	Cost-effectiveness analysis in the context of a multicenter randomized clinical trial	Usual care	12 months study duration
Dehmer, S.P., et al., Economic Evaluation of the Home Blood Pressure Telemonitoring and Pharmacist Case Management to Control Hypertension (Hyperlink) Trial. <i>J Am Coll Clin Pharm</i> , 2018. 1(1): p. 21-30.	United States of America	Multispecialty practice	299 patients aged 21+ years with elevated blood pressure	Cluster randomized controlled trial; cost-effectiveness analysis	Usual care	12 months 36 months
Dorman Marek, K., Cost Utility Analysis of a Home-Based Nurse Care Coordination Program. <i>Nursing Economic</i> , 2018. 36(2): p. 83-96.	United States of America	home, recently discharged from one of three area home healthcare agencies	301 participants aged 60+; with a need of help to manage oral medications and an impaired cognitive functioning	Cost-utility analysis in the context of a three-arm randomized-controlled trial	Usual care & pharmacy screen	12 months 12 months
Gensichen, J., et al., Cost-effectiveness of depression case management in small practices. <i>Br J Psychiatry</i> , 2013. 202: p. 441-6.	Germany	74 small primary care practices	562 patients with major depression	Cost-effectiveness analysis in the context of a pragmatic randomised controlled trial	Usual care	12 months 24 months
Grochtdreis, T., et al., Cost-utility of collaborative nurse-led self-management support for primary care patients with anxiety, depressive or somatic symptoms: A cluster-randomized controlled trial (the SMADS trial). <i>International Journal of Nursing Studies</i> , 2018. 80: p. 67-75	Germany	20 primary care practices	325 patients with anxiety, depressive or somatic symptoms	Cost-effectiveness analysis in the context of a cluster-randomized controlled trial	Usual care	12 months study duration
Handley, M.A., M. Shumway, and D. Schillinger, Cost-effectiveness of automated telephone self-management support with nurse care management among patients with diabetes. <i>Ann Fam Med</i> , 2008. 6(6): p. 512-8.	United States of America	4 San Francisco safety net clinics	339 English-, Spanish-, and Cantonese-speaking patients with type 2 diabetes	Cost-utility analyses in the context of a randomized trial	Usual care	9 months 12 months
Hay, J.W., et al., Cost-effectiveness analysis of collaborative care management of major depression among low-income, predominantly Hispanics with diabetes. <i>Value Health</i> , 2012. 15(2): p. 249-54.	United States of America	Los Angeles County public community clinics	387 low income, predominantly Hispanic diabetes patients with comorbid depression	Cost effectiveness analysis in the context of a randomized controlled trial	Enhanced usual care (standard clinic care plus pamphlets and resource list)	12 months 24 months

Study	Case Management Model (with description)	Intensity of intervention (patient contacts)/ Caseload/Team or single case manager/24 hour availability	Qualification CM and Training received/ Supervision
Bosanquet, K., et al., 2017.	Low-intensity intervention of collaborative care, including behavioural activation, by a case manager: telephone support, medication management, symptom monitoring and active surveillance, facilitated by a computerised case management	On average six sessions over 8–9 weeks, the first was delivered face to face, subsequent sessions via the telephone 10.4 patients who completed at least one session single case manager	Primary care mental health worker/Improving Access to Psychological Therapies worker. 2 days of training. Topics: collaborative care approach, medication management, behaviour theory and -activation adapted for older adult); Case managers: weekly supervision. Weekly discussion of case managers and their supervisor. Patient: weekly discussion of case managers and their supervisor
Bourbeau, J., et al., 2006.	Patient education program with weekly skill-oriented phone calls and follow-up telephone calls after the end of all teaching sessions. Provision of a stationary bicycle for the first 2 months of follow-up.	Weekly teaching first 6-7 weeks, then monthly telephone calls 14 per case manager single case manager 24 hour availability	Experienced nurse or respiratory therapist plus 2 weeks of specific training
Dehmer, S.P., et al., 2018.	Pharmacists case management: 1. Assessment and case planning: establishing care and instructing patients on using the home blood pressure telemonitoring system. 2. Monitoring: regular phone call for blood pressure control. 3. Emphasizing of lifestyle changes and medication adherence. 4. Communication with patients' primary care teams	First 6 months: every 2 weeks a phone visit until blood pressure control was sustained for 6 weeks, then monthly phone visits. Second six months: phone visits every two months Single case manager	Pharmacists trained in medication management therapy (MTM)
Dorman Marek, K., 2018.	Nurse Care Coordination: 1. Comprehensive assessment 2. Establishment of care plan to monitor for signs and symptoms associated with medical diagnoses, medications, and support self-management behaviors. 3. Communicating with provider 4. Visits by nurse case coordinator (NCC) to fill either their Medi planner or MD2 machine 5. When participants were hospitalized, NCC visited the participant during and after hospitalization and participated in discharge planning. 5. Two intervention groups: (a) nurse care coordination (NCC) plus a Medi planner (b) nurse care coordination plus MD2 Medication Dispensing machine	Nurse care coordinator visited the participant at least every 2 weeks, additional visits as needed. Additional visits were made as needed, relating to change in medications, or as the condition required Team of APNs and registered nurses	N/A
Gensichen, J., et al., 2013	Case management intervention in accordance with the chronic care model: 1. Case managers monitored symptoms of depression using a structured questionnaire 2. Support of medication adherence 3. Encouragement to undertake pleasant activities 4. Report of results to the GP in a structured manner, stratifying the urgency of contact in terms of symptom severity"	Once a month for 1 year by telephone Single case manager	Healthcare assistants trained as depression case managers during a 2-day workshop
Grochtdreis, T., et al., 2018	Collaborative nurse-led self-management support: 1. Initial assessment 2. Individual appointments: counselling to promote self-management to the patients - problem-solving techniques, relaxation exercises or strengthening self-confidence activities were used during the counselling process 3. Supporting patient in finding psychotherapeutic treatment, community based psychosocial services and self-help groups, informing patient, modify the patient's behavior 4. Coordination and case conferences	Single case manager	Nurse, N/A for training received Nurses were regularly supervised by the study physician and psychotherapist
Handley, M.A., M. Shumway, and D. Schillinger, 2008	Automated telephone self-management support with nurse care management in three languages: 1. Surveillance 2. Patient education, 3. one-on-one telephone counseling, and was implemented in 3 languages	Weekly phone calls	Nurses, training received
Hay, J.W., et al., 2012	Multifaceted Diabetes and Depression Program (MDDP): 1. Problem-Solving Therapy provided by graduate social work diabetes depression clinical specialists and/or antidepressant medications prescribed by the treating primary care provider 2. Telephone follow-up symptom monitoring, treatment maintenance and relapse prevention 3. Care and service system navigation.	Telephone follow-up: monthly Telephone DDCCS supervision: weekly	N/A

Study	Outcome measures	Costs included	Cost perspective	Time horizon & discount rate	Findings
Bosanquet, K., et al., 2017.	1. Primary outcome: Patient-reported depression severity (PHQ-9) 2. Secondary outcomes: depression severity and symptomatology (PHQ-9), binary depression severity (PHQ-9), quality of life (SF-12 and EQ-5D-3L), psychological anxiety (GAD-7), mental health medication, physical health problems (PHQ-15), psychological resilience (CD-RISC2), mortality"	Intervention costs	Health and personal social services	18 months Costs and QALYs were discounted at 3% for observations beyond 12 months"	Mean cost per incremental QALY for collaborative care compared with usual care: £26,016. Participants attending six or more sessions, collaborative care appears to represent better value for money (£9876/QALY).  Probability that the incremental cost-effectiveness of collaborative care was less than £20,000 per QALY: 39% and the probability that it fell below the willingness-to-pay threshold of £30,000 per QALY was 55%. When participants who engaged with six or more sessions were included in the analysis, the cost per QALY estimate fell to £9876 per QALY.
Bourbeau, J., et al., 2006.	Costs for each group, and program cost estimated per hospitalization prevented"	1. Intervention 2. emergency department visit 3. hospitalization costs	Health-care payer	12 months	The observed incremental cost-effectiveness ratio was \$4,214 per hospitalization prevented for a caseload of 14 patients per case manager, as compared to usual care.  With assumed caseloads of 30, 50, and 70 patients per case manager, the estimated incremental cost-effectiveness ratios were \$2,053, \$1,326, and \$1,016 per hospitalization prevented, respectively.
Dehmer, S.P., et al., 2018.	Blood pressure control (mm Hg systolic and diastolic blood pressure reduction)	1. Direct program costs of administering the intervention 2. Incremental effect of the intervention on total medical care costs relative to usual care	Health care sector	12 months	On average, the intervention cost \$7337 per person achieving hypertension control and \$139 or \$265 per mm Hg reduction in systolic or diastolic blood pressure, respectively. If including the non-significant \$281.40 per person reduction in 12-month medical care costs associated with the intervention, these costs would be moderately lower: \$5809, \$110, and \$210, respectively. Finally, although overall pharmacy costs were equivocal, if the \$81.80 per person significant increase in hypertension- and lipid-related medication costs were added to the intervention cost, these costs would increase modestly to \$7782, \$148, and \$281, respectively.  Two sensitivity analyses were conducted: one with the inclusion of non-statistically significant incremental total medical costs and a second with the inclusion of statistically significant incremental sub-component costs (in this case, hypertension- and lipid-related pharmacy costs).
Dorman Marek, K., 2018.	QALYs gained derived from changes in participants' answers to the SF-36 survey	Intervention costs	Health-care payer	12 months, therefore no discounting	Compared to the control group, both intervention groups demonstrated gains in QALYs, with NCC + machine group improving at 0.1091 while the NCC+ Medi planner gained 0.0930. Cost per QALY gained was higher in the NCC + machine group at \$29,807 while the NCC + Medi planner group was \$19,484.
Gensichen, J., et al., 2013	Primary outcome: ICER calculated as the ratio of differences in mean costs and mean number of QALYs. Secondary outcome: mean depression-free days (DFDs) between the intervention and control group at 24-month follow-up"	1. Healthcare utilisation (including psychiatric in-patient care, out-patient care provided by psychologists, psychiatrists and family doctors/GPs as well as antidepressant drug use) 2. Lost work days in the 12 months preceding the interview	Societal perspective	2 years, no discounting done	IG vs. CG: no significant difference in QALYs; significantly more DFDs (mean: 373 v. 311, P<0.01); no significant difference in mean direct healthcare costs (4495 Euro v. 3506 Euro, P = 0.16); considerably lower mean indirect costs (5228 Euro v. 7539 Euro, P = 0.06), resulting in lower total costs (9723 Euro v. 11 045 Euro, P = 0.41). Point estimate for the cost-utility ratio was 38 429 Euro per QALY gained if only direct costs were considered, and 'dominance' of the intervention if total costs were considered. Regardless of decision makers' WTP per QALY, probability of the intervention being cost-effective was never ≥ 90%.
Grochtdreis, T., et al., 2018	QALYs based on the EQ-5D-3L-index QALYs were calculated based on EQ-VAS scores"	Service utilization (inpatient care and rehabilitation, outpatient physician and non-physician services, formal nursing care, use of medication)	Health care payer	12 months, therefore no discounting	The adjusted differences in QALYs and mean total costs between intervention group and control group were +0.02 and +1145 Euro, respectively. Neither of the two differences was statistically significant. Probability for cost-effectiveness of the intervention was 49% for a willingness-to-pay of 50,000 Euro per additional QALY. The probability for cost-effectiveness did not exceed 65%, independent of the WTP
Handley, M.A., M. Shumway, and D. Schillinger, 2008	QALYs from SF-12	1. Direct implementation costs 2. direct nurse telephone care management with patients	Health system	12 months, therefore no discounting	The ATSM intervention was associated with a gain of 0.012 QALYs relative to usual care. The annual cost of the ATSM intervention per QALY gained, relative to usual care, was \$65,167 for start-up and ongoing implementation costs combined, and \$32,333 for ongoing implementation costs alone.
Hay, J.W., et al., 2012	Depression-free days (DFD) were calculated from the Patient Health Questionnaire-9 (PHQ-9). Health-related quality of life (QOL) was assessed using the MOS Short-Form Health Survey (SF-12). These utility scores were used to estimate QALYs	1. Medical care costs and utilization 2. Intervention costs"	Payer	18 months, no discounting done	The program cost effectiveness averaged \$4,053/QALY per MDDP recipient and was more than 90% likely to fall below \$12,000/QALY.

Study	Country	Setting	Patient group or disease; sample size	Study Design/Economic analysis method	Comparison group	Intervention duration/Study duration
Hay, J.W., et al., Cost-Effectiveness of a Technology-Facilitated Depression Care Management Adoption Model in Safety-Net Primary Care Patients with Type 2 Diabetes. <i>Value Health</i> , 2018. 21(5): p. 561-568.	United States of America	8 public ambulatory care clinics	1,406 patients with type 2 diabetes	Cost-effectiveness analysis in the context of a non-randomized trial	1. Usual care (UC) 2. Supported care (SC) model <sup>11</sup>	18 months study duration
Jacke, C.O. and H.J. Salize, [Cost effectiveness of a health insurance based case management programme for patients with affective disorders]. <i>Neuropsychiatr</i> , 2014. 28(3): p. 130-41.	Germany	2 different regions/states	954 patients with incapacity to work with a duration of 28 to 56 days in connection with an affective disorder, discharged from hospital in the 14 days prior to study initiation	Cost-effectiveness analysis in the context of a prospective controlled intervention study	Usual care	12 months study duration
Joesch, J.M., et al., Incremental benefits and cost of coordinated anxiety learning and management for anxiety treatment in primary care. <i>Psychological Medicine</i> , 2012. 42(9): p. 1937-1948.	United States of America	17 primary care clinics in 4 US cities	1,004 patients with panic, generalized anxiety, social anxiety, and/or posttraumatic stress disorder with or without major depression	Incremental net benefit analysis in the context of a randomized, controlled effectiveness trial	Usual care	3 to 12 months 18 months
Lavelle, T.A., et al., Cost-effectiveness of collaborative care for depression and PTSD in military personnel. <i>Am J Manag Care</i> , 2018. 24(2): p. 91-98.	United States of America	18 Army primary care clinics at 6 military installations	629 active-duty service members with PTSD or depression	Cost-effectiveness analysis in the context of a randomized controlled trial	Optimized usual care (OUC): care management and increased behavioral health support	18 months 12 months
Lewis, H., et al., Collaborative care and active surveillance for Screen-Positive Elders with subthreshold depression (CASPER): a multicentred randomised controlled trial of clinical effectiveness and cost-effectiveness. <i>Health Technol Assess</i> , 2017. 21(8): p. 1-196.	United Kingdom	Thirty-two general practitioner (GP) practices in the north of England	705 elderly participants aged $\geq 75$ years during the pilot phase and $\geq 65$ years during the main trial with subthreshold depression	Cost-effectiveness analysis in the context of a pragmatic, multicentred, two-arm, parallel, individually randomised controlled trial	Usual care	7-8 weeks 24 months
Long, M.J. and B.S. Marshall, What price an additional day of life? A cost-effectiveness study of case management. <i>American Journal of Managed Care</i> , 2000. 6(12): p. 881-886.	United States of America	managed care organization (MCO)	317 elderly, functionally impaired clients ( $\geq 75$ years with severe functional disability, excessive hospital use, or emergency department (ED) use)	Cost-effectiveness analysis in the context of a larger study	Usual care	24 months 24 months
MacNeil Vroomen, J., et al., The Cost-Effectiveness of Two Forms of Case Management Compared to a Control Group for Persons with Dementia and Their Informal Caregivers from a Societal Perspective. <i>PLoS One</i> , 2016. 11(9): p. e0160908.	Netherlands	participating organizations provided lists of their clients who already receiving care and met the inclusion criteria. In the control group, recruitment took place via outpatient geriatric or neurologic (memory) clinics, Alzheimer centers and general medical practices.	521 informal caregivers and community-dwelling persons with dementia	Cost-effectiveness analysis in the context of a non-randomized control prospective observational study	Usual care	24 months study duration
Michalowsky, B., et al., Cost-effectiveness of a collaborative dementia care management-Results of a cluster-randomized controlled trial. <i>Alzheimers Dement</i> , 2019. 15(10): p. 1296-1308.	Germany	recruitment through GPs in Germany, delivered in participants' homes	444 participants, 70+ years, living at home, with dementia	Cost-effectiveness analysis in the context of a cluster-randomized, controlled trial	Usual care	6 months 36 months

Study	Case Management Model (with description)	Intensity of intervention (patient contacts)/ Caseload/Team or single case manager/24 hour availability	Qualification CM and Training received/Supervision
Hay, J.W., et al., 2018	Information and communication technologies (ICT) facilitated depression care management program: 1. Low-intensity periodic calls assessing depression symptoms and treatment adherence 2. If patients exhibited depressive symptoms, self-harm intentions, or concerns about medication, automated task or alerts would engage providers to provide appropriate care management.	Once per month, once per quarter for patients without prior history or diagnosis	Disease management team staff members: nurse practitioners, nurses, and social workers, acquainted with guidelines and protocols to support diabetes care management for high-risk or high-use patients.
Jacke, C.O. and H.J. Salize, 2014	Coordination (general medical treatment and the specialist medical or psychotherapeutic treatment)	N/A	Yes, training provided
Joesch, J.M., et al., 2012	1. Realtime, web-based clinical outcome monitoring and a computer-assisted program to optimize CBT delivery by non-expert care managers 2. Promotion of treatment adherence 3. Optimization of medications	Months 3-12: Preferred treatment for 10-1212 weeks. Symptomatic participants and participants who thought to benefit from additional treatment could then receive more of the same or the alternative modality for up to 3 more steps of treatment at 3-month intervals over a year. After treatment completion: continued care and monthly follow-up telephone calls	N/A
Lavelle, T.A., et al., 2018	care management, increased behavioral health support, stepped psychosocial treatment and routine centralized team monitoring	9.9 times over the 12-month study period vs 1.5 times for OUC patients; team: weekly caseload review calls between nurse coordinators and staff psychiatrists as well as regular case management calls between the nurse coordinator and the patient and other contacts as needed.	Nurse care managers received additional training in behavioral activation, problem solving, and motivational interviewing to provide additional support to patients
Lewis, H., et al., 2017	Low-intensity intervention of collaborative care: 1. Behavioural activation 2. Regular phone calls 3. Provision of participant-specific feedback to GPs: Advising GPs on patient's care 4. Case managers were also charged with a duty of care to engage outside agencies (e.g. social services or in response to safeguarding issues) in situations where they became aware of abuse"	6 sessions on average, 8-10 telephone calls with occasional face-to-face contacts over a period of 12 weeks, contacts last 45 minutes for session one and 20-30 minutes for each subsequent contact: first session held face to face average case load of 19.1 randomised patients per case manager single case manager	Case managers were psychological wellbeing practitioners. 3 training events of 2 days. Trainers supervised case managers during implementation. Weekly supervision.
Long, M.J. and B.S. Marshall, 2000	Patient advocacy model: 1. Development of care plan 2. periodic home visits by case managers, revision of care plan as necessary 3. Coordination and navigation: scheduling of medical appointments 4. Accompanying and assisting patients on these appointments	Weekly visits for some clients, for some one visit every 6 months Team: case manager, client's personal physician, and the physician advisor.	Healthcare professionals with geriatric case-management experience. Case managers make periodic home visits and report back to the care team
MacNeil Vroomen, J., et al., 2016	Intensive case management model (ICMM): one care organization 1. Guiding and supporting people with dementia 2. Care plan Linkage model (LM): different care organizations 1. collaboration between multiple care providers 2. educational, emotional and practical support	Single case manager, but multidisciplinary meetings are held regularly	Expert advice can be sought through multidisciplinary meetings held regularly with experts from the various collaborating organizations.
Michalowsky, B., et al., 2019	Collaborative dementia care management (DCM): 1. Standardized assessment 2. Development and implementation of an individual intervention plan 3. Coordination with GP and various health care and social service professionals	Single case manager	Specialized nurses

Study	Outcome measures	Costs included	Cost perspective	Time horizon & discount rate	Findings (related to cost-effectiveness)
Hay, J.W., et al., 2018	Depression-free days were calculated from the PHQ-9. Health-related quality of life was assessed using the SF-12-. These utility scores were used to estimate QALYs	1. Medical care costs and utilization 2. Intervention costs"	Payer	18 months, no discounting done	Medical costs were statistically significantly lower for the intervention (-\$2,328; P=.001) relative to usual care but not significantly lower than SC (team supported care). The intervention had a > 50% probability of being cost effective relative to team supported care at WTP thresholds over \$50,000 per QALY.  <b>The intervention dominated usual care, showing both statistically significantly lower costs and better patient outcomes. The intervention had a greater than 50% probability of being cost effective relative to the SC model (team-supported care) at willingness to pay thresholds over \$50,000 per QALY.</b>
Jacke, C.O. and H.J. Salize, 2014	Average outpatient contacts per patient to psychiatric specialists or psychotherapists	Intervention costs	Payer (health insurance)	12 months, therefore no discounting	A conservative estimation of the ICER was 44,16 €. Maximum WTP was 378,82 € per year.  Sensitivity analyses showed that this amount of maximum WTP can be reduced to 34,34 € per year or 2,86 € per month due to cost depression effects.
Joesch, J.M., et al., 2012	Anxiety-free days, quality-adjusted life years (QALYs), and expenditures for outpatient visits, emergency room visits, inpatient stays, and psychiatric medications	1. Outpatient visits 2. ER visits 3. Psychiatric medication use	Payer	18 months	The mean incremental net benefit of CALM versus usual care was positive when an anxiety-free day was valued $\geq$ \$4. For QALYs based on the SF-12 and the EQ-5D the mean incremental net benefit was positive at $\geq$ \$5,000.  A QALY has to be worth between \$2,500 and \$5,000 to reach a positive INB. To reach positive 95% CIs, a QALY has to be worth $\geq$ \$90,000 for the EQ-5D and $\geq$ \$35,000 for the SF-6D
Lavelle, T.A., et al., 2018	1. Depression and PTSD were derived from PDS and the HSCL-2 2) Health-related quality of life were derived from SF-12 3) QALYs were derived from SF-6D. 4) Depression-free days were derived from the scored HSCL-20 5) PTSD-free days (PFDs) were derived from the PDS	1. Intervention costs 2. Other (nonintervention) healthcare resources utilized 3. Productivity costs "	Societal perspective	12 months, therefore no discounting	CACT patients gained 0.02 QALYs (95% CI, -0.001 to 0.03) relative to OUC patients. 12 months costs, including productivity, were \$987 (95% CI, -\$3056 to \$5030) higher for CACT versus OUC. CACT was estimated to cost \$49,346 per QALY gained compared with OUC over 12 months. There is a 58% probability that CACT is cost-effective at a \$100,000/QALY threshold.  Excluding productivity costs increased the cost of CACT relative to OUC, resulting in a ratio of \$112,081/QALY. Similarly, halving the number of patients followed by centralized management increased the ratio to \$110,089/QALY. Other sensitivity analyses resulted in more favorable ICERs for CACT relative to OUC.
Lewis, H., et al., 2017	1. Patient-reported depression severity (PHQ-9) 2. Secondary outcomes: depression severity and symptomatology (PHQ-9), binary depression severity (PHQ-9), quality of life (SF-12 and EQ-5D), psychological anxiety (GAD-7), mental health medication, mortality	1. Personnel costs 2. Training costs 3. Use of health-care resources"	Health and personal social services	12 months, therefore no discounting	Base-case cost-effectiveness analysis found that the ICER was €9633 per QALY. On average, participants allocated to collaborative care displayed significantly higher QALYs than those allocated to the control group (annual difference in adjusted QALYs of 0.044, 95% bias-corrected CI 0.015 to 0.072; p = 0.003).  Parametric bootstrapping of the difference in costs and QALYs to characterise uncertainty in the ICER: 10,000 replications. 99.76% of them fall within the north-east quadrant, which implies that collaborative care will add both costs and health benefits. Uncertainty in the ICER implies that the probability that collaborative care is cost-effective will vary as a decision-maker's WTP increases. The probability that the ICER for collaborative care is $<$ €20,000 per QALY is 0.9239 and $<$ €30,000 per QALY is 0.9735.
Long, M.J. and B.S. Marshall, 2000	1. Primary outcomes: average death rate and number of days of coverage 2. Secondary outcomes: Health status variables included ADL and IADL dependency, the level of dependency, self-assessed health status, and quasi-objective health status (QOHS)	Program costs (CM salaries and fringe benefits) and service costs (Hospital costs, outpatient costs, ED visit costs)	Health care	24 months, no discounting done	Average costs for the IG were greater than the costs for the CG, clients in the IG lived an average of 106 days longer. The cost per additional day of life was \$40. The difference in death rates was so small that, by extrapolation, the cost per life saved was $>$ \$42 million
MacNeil Vroomen, J., et al., 2016	Neuropsychiatric symptoms (NPI), psychological health of the informal caregiver (GHQ-12), and QALY of the person with dementia and informal caregiver	1. Resource utilization and associated costs. 2. Direct healthcare costs 3. Direct non-healthcare costs 4. Indirect non-healthcare costs	Societal perspective	24 months, costs and effects in the 2. year were discounted at 4% and 1.5% respectively	The probability that the ICMM was cost-effective in comparison with LM and the CG was $>$ 0.97 at a threshold ratio of 0 E/incremental unit of effect.
Michalowsky, B., et al., 2019	Cognitive impairment according to the MMSE, comorbidity according to the Charlson Comorbidity Index, depression according to the Geriatric Depression Scale, and deficits in daily living activities according to the Bayer Activities of Daily Living Scale. HRQoL was assessed as self-rating using SF-12, Health-care resource utilization	1. Health-care resource utilization 2. formal care 3. Informal care time	Public payer perspective (excluding informal care and caregivers QALYs)	24 months, costs and QALYs were discounted at 5% per year	DCM increased QALYs (+0.05) and decreased costs (-569 Euro) due to a lower hospitalization and a delayed institutionalization (7 months) compared with usual care.  The probability of DCM being cost-effective was 88% at WTP thresholds of 40,000€ per QALY gained and higher in patients living alone compared to those not living alone (96% vs. 26%).

Study	Country	Setting	Patient group or disease; sample size	Study Design/Economic analysis method	Comparison group	Intervention duration/Study duration
Mostardt, S., et al., [Efficacy and cost effectiveness of case management in patients with dementia]. <i>Z Gerontol Geriatr</i> , 2012. 45(7): p. 642-6.	Germany	Specialist counselling centers	48 patients with dementia	Cost-effectiveness analysis	Usual care	12 months study duration
Paez, K.A. and J.K. Allen, Cost-effectiveness of nurse practitioner management of hypercholesterolemia following coronary revascularization. <i>Journal of the American Academy of Nurse Practitioners</i> , 2006. 18(9): p. 436-444.	United States of America	Tertiary medical center	228 adults with hypercholesterolemia, who underwent coronary artery bypass grafting or percutaneous coronary intervention (PCI)	Cost-effectiveness analysis in the context of a randomized controlled trial	Usual care enhanced with feedback on lipids to primary provider and/or cardiologist.	12 months 12 months
Rost, K., J.L. Smith, and M. Dickinson, The effect of improving primary care depression management on employee absenteeism and productivity. A randomized trial. <i>Medical Care</i> , 2004. 42(12): p. 1202-1210.	United States of America	Twelve community primary care practices	326 depressed primary care patients with full- or part-time work	Post-hoc analysis of randomized controlled trial data, intent-to-treat analyses using time-trend (growth curve) models with an unstructured variance-covariance matrix	Usual care	24 months 24 months
Ruikes, F.G.H., et al., Cost-effectiveness of a multicomponent primary care program targeting frail elderly people. <i>BMC Fam Pract</i> , 2018. 19(1): p. 62.	Netherlands	12 general practices	369 frail elderly aged $\geq 70$ years	Cost-benefit analysis performed alongside a cluster-controlled effectiveness study	Usual care	12 months 12 months
Saleh, S.S., et al., Cost-effectiveness of case management in substance abuse treatment. <i>Research on Social Work Practice</i> , 2006. 16(1): p. 38-47.	United States of America	Community-based, nonprofit, substance abuse treatment agency	662 participants with more than one drug- or alcohol-related offense, a breathalyzer test with a blood alcohol content of 0.2 or higher, or involved in a drug- or alcohol-related accident	Cost-effectiveness analysis in the context of a clinical trial	Usual care	36 months 12 months
Sandberg, M., et al., Cost-utility analysis of case management for frail older people: effects of a randomised controlled trial. <i>Health Econ Rev</i> , 2015. 5(1): p. 51.	Sweden	Municipality with three primary care centres and a private specialist healthcare clinic with medical services including gynaecology, general orthopaedics, day surgery and physiotherapy.	153 frail elderly aged 65+ years	Two-armed randomised controlled trial (RCT) (Cost-benefit analysis (not performed) and cost utility analysis (not performed))	Usual care	12 months 48 months
Seidl, H., et al., Cost-effectiveness of nurse-based case management versus usual care for elderly patients with myocardial infarction: results from the KORINNA study. <i>European Journal of Health Economics</i> , 2015. 16(6): p. 671-681.	Germany	Patients with an acute first or recurrent myocardial infarction treated in the Central Hospital of Augsburg	329 elderly aged 65+ years with myocardial infarction	Cost-effectiveness analysis in the context of a randomized controlled trial	Usual care	12 months 12 months

Study	Case Management Model (with description)	Intensity of intervention (patient contacts) Caseload/Team or single case manager/24 hour availability	Qualification CM and Training received/Supervision
Mostardt, S., et al., 2012	<ol style="list-style-type: none"> <li>1. Coordination between care sectors, such as organizing outpatient care for patients after a hospital stay</li> <li>2. Advice, planning and organization of home care</li> <li>3. Information, planning and advise on existing low-threshold services</li> <li>4. Assisting in obtaining services</li> </ol>	On average, a case manager spent 10 hours per case	Employees of the counseling center: social workers, social pedagogues, and social scientists with professional experience in dealing with people suffering from dementia
Paez, K.A. and J.K. Allen, 2006	<p>Lipid management</p> <ol style="list-style-type: none"> <li>1. Prescription and monitoring of lipid-lowering drug therapy</li> <li>2. Care plan for lipid management</li> <li>3. Counseling for lifestyle modifications</li> <li>4. Followup telephone calls</li> </ol>	<p>Case manager spent an average of 5.0 h total per patient in 1 year.</p> <p>First 6 month: an average of 3.3 h was needed to manage each patient.</p> <p>Last 6 month: an average of 1.7 h per patient.</p> <p>Each patient received an average of six telephone</p> <p>Single case manager, but primary care physician and/or cardiologist participated in a partnership</p>	Nurse
Rost, K., J.L. Smith, and M. Dickinson, 2004	<ol style="list-style-type: none"> <li>1. Contact to patients in person or by phone</li> <li>2. Assessment of depressive symptoms</li> <li>3. Education on disease and treatment</li> <li>4. Care Plan</li> </ol>	<p>Case managers contacted patients who reported 3 or more of 9 depressive symptoms every month, and patients who reported 2 or fewer depressive symptoms every 3 months. average of 11.9 telephone or in-person sessions of 10–15 minutes duration over 2 years;</p> <p>Care manager with GP</p>	Physicians and care managers received brief training (Training emphasized the need for physicians and care managers to encourage patients to initiate guideline-concordant pharmacotherapy or psychotherapy during the acute phase of treatment)
Ruikes, F.G.H., et al., 2018	<p>CareWell program, consisting of multidisciplinary team meetings, proactive care planning, case management, and medication reviews:</p> <ol style="list-style-type: none"> <li>1. Assessment by trained nurses during home visit</li> <li>2. Individual proactive care plans</li> <li>3. Coordination</li> <li>4. Medication reviews</li> </ol>	Single case manager, in collaboration with GP	Either a nurse or social worker
Saleh, S.S., et al., 2006	<p>Iowa Case Management model, organized around 6 functions: (a) orientation and contracting, (b) assessment and monitoring, (c) solution planning, (d) referral, (e) orientation to transitional case management, and (f) client-directed case management.</p> <ol style="list-style-type: none"> <li>1. assessment and monitoring</li> <li>2. solution planning</li> <li>3. Referrals</li> <li>4. client-directed case management</li> </ol>	<p>Condition A: case managers participated in clinical meetings at MECCA and had much easier access to the clients</p> <p>Condition B: case managers participated in the administrative organization of the social service agency and had more difficulty accessing clients</p> <p>Condition C: This case manager met with patients in person at the primary treatment facility one to three times to complete some basic tasks and then provided most case management through a telecommunications system.</p> <p>Conditions A and B: active case loads ranging from 16 to 20 clients, less active case loads (those beyond the first 90 days after treatment) that ranged from 48 to 60; telecommunication case manager had a double case load (32 to 40 active, 96 to 120 less active)</p> <p>Single case manager</p>	Social workers
Sandberg, M., et al., 2015	<ol style="list-style-type: none"> <li>1. traditional case management tasks (assessment, care plans, care coordination, home visits, telephone calls, and advocacy)</li> <li>2. general information (about the healthcare system, social activities, nutrition, exercise)</li> <li>3. specific information (related to the respondent's specific health status, individual needs and medication)</li> </ol>	<p>home visits at least once a month from each of two CMs. the nurse case managers made on average 11.1 home visits and 1.9 telephone calls during the 12-month intervention. The corresponding numbers for the physiotherapist case managers were 10.4 visits and 0.8 telephone calls.</p> <p>Single case manager</p>	Nurses or physiotherapists
Seidl, H., et al., 2015	<ol style="list-style-type: none"> <li>1. initial session shortly before hospital discharge in which patients received an information booklet and at which a first home visit or an appointment for a telephone call was arranged.</li> <li>2. After hospital discharge, at least one home visit and quarterly telephone calls were carried out</li> <li>3. Counselling on the intake of medication, nutrition, physical activity, weight control and general health behaviour</li> <li>4. Monitoring (e.g. blood pressure, pulse rate, blood glucose)</li> </ol>	<p>At least one home visit and quarterly telephone calls</p> <p>Single case manager</p>	Trained nurses

Study	Outcome measures	Costs included	Cost perspective	Time horizon & discount rate	Findings (related to cost-effectiveness)
Mostardt, S., et al., 2012	Time in patients' home environment in months. The difference in costs incurred in the IG and the KG was compared to the difference in months spent in the home environment of both groups	1. Outpatient costs 2. Inpatient costs 3. Medication costs 4. Nursing case costs 5. costs for nursing aids 6. Case costs according to SGB V	Payer (health insurance and nursing funds)	12 months, therefore no discounting	Additional costs for the health insurance companies amounted to 41-53 € per additional month in a home environment.  Assuming higher average case management costs, the ICER is 53 € per additional month in a home environment.
Paez, K.A. and J.K. Allen, 2006	change in LDL-C and per percent reduction in LDL-C	Cost for 1. the NP's time 2. Lipid-lowering drugs 3. Lab monitoring.	Managed care organization	12 months, therefore no discounting	The annual incremental cost-effectiveness of NP case management was \$26.03 per mg/dL and \$39.05 per percent reduction in LDL-C.
Rost, K., J.L. Smith, and M. Dickinson, 2004	1. Productivity as effectiveness at work over the past 2 weeks 2. Absenteeism (total number of work hours lost due to illness or doctor visits over the past 4 weeks) 3. Full-Time Equivalent Daily Earnings (estimated by dividing the sum of annual baseline wages plus self-employment income by 240 days. FTE daily earnings were estimated by multiplying minimum wage by 8 hours/day.) 4. Treatment 5. Depression Severity 6. Emotional Role Functioning	1. productivity (average work-days and daily earnings) 2. absenteeism	Employer	24 months, earnings inflated to Year 2000 dollars	Employed patients in the enhanced care condition reported 6.1% greater productivity and 22.8% less absenteeism over 2 years, intervention effects were more observable in consistently employed subjects where the intervention improved productivity by 8.2% over 2 years at an estimated annual value of \$1982 per depressed full-time equivalent and reduced absenteeism by 28.4% or 12.3 days over 2 years at an estimated annual value of \$619 per depressed full-time equivalent.  Sensitivity analyses indicated that intervention effects on productivity and absenteeism were comparable across occupational categories and paid sick leave benefits.
Ruikes, F.G.H., et al., 2018	Dependence in functioning in (instrumental) activities of daily living (measured with the Katz-15 change score and health-related quality of life (measured with the EQ-5D-3 L	1. Intervention costs regarding time spent on team meetings, care planning, case management, and medication reviews 2. Healthcare utilization variables, i.e. GP care, hospital care, institutionalization (i.e. nursing home admission, care home admission), home care, and physiotherapy, domestic care and day care, medication costs	Healthcare perspective	12 months, therefore no discounting	Incremental Net Monetary Benefits didn't show significant differences between groups, but on average tended to favour usual care. INMBs are negative, meaning that the intervention does not provide value for money compared to usual care, although the results are not significant.  Sensitivity analysis, excluding medication costs, underlined these results.
Saleh, S.S., et al., 2006	1. addiction severity index 2. number of days of abstinence during the past month	1. Costs of treatment 2. CM staff salary and benefits 3. Travel costs, 4. Cost of the telecommunication system	Program administration	12 months, therefore no discounting	CM conditions weren't more cost-effective than CG. (CG \$6.30, social service agency group: \$7.60, treatment agency group: \$10.80, telecom. group \$16.60 spent per substance abuse-free day). Changed results, when considering the add-on costs (telecom. group treatment group: \$43.20, agency group: \$36.70, social service agency: \$30.10, CG: \$37.50 per substance abuse-free day.)  To examine the robustness of the results, the cost-effectiveness ratios for the four IGs were compared using the 95% CI boundaries of the number of substance abuse-free days. The results show some overlap in the cost-effectiveness ratios especially for cumulative cost estimation, which highlights the lack of major differences between the study groups when the inputs are changed.
Sandberg, M., et al., 2015	health-related quality-of-life instruments EQ-5D and EQ-VAS	1. Healthcare costs for inpatient and outpatient care 2. Community care costs, or costs provided by the municipality 3. Costs associated with participant and family 4. Estimated costs for informal help 5. Intervention costs	Society	No discounting done	No significant differences between the IG and CG for total cost, EQ-5D-based QALY or EQ-VAS-based QALY for the 1-year study. No significant differences were found for ICER, EQ-5D- or EQ-VAS-based QALY, or costs. The intervention group had significantly lower levels of informal care and help with instrumental activities of daily living both as costs (€3,927 vs. €6,550, p = 0.037) and provided hours (200 vs. 333 hours per year, p = 0.037).
Seidl, H., et al., 2015	QALYs, based on EQ-5D-3. Secondary measurements were EQ-5D-3L utility values and patients' self-rated health states	1. Intervention costs 2. Costs of inpatient care 3. Costs of all other healthcare components	Societal perspective	12 months, therefore no discounting	For cost-utility analysis, both costs (-17.61 Euro) and effects (-0.0163 QALYs) were lower in the iG; therefore, the ICER (1,080 Euro/QALY) represents the savings per additional QALY lost.  The probability of acceptable cost-effectiveness was 71 % for a maximum WTP of 20,000 €, increasing to 85 % for a maximum WTP of 45,000 € per VAS-AL. Multiple imputation approach led to slightly different but also non-significant results. Mean QALY difference -0.0139 (CI -0.0680; 0.0354), and the cost difference was estimated at 20.97 € (CI -2,187; 2,533).

Study	Country	Setting	Patient group or disease; sample size	Study Design/Economic analysis method	Comparison group	Intervention duration/Study duration
Seidl, H., et al., The 3-Year Cost-Effectiveness of a Nurse-Based Case Management versus Usual Care for Elderly Patients with Myocardial Infarction: Results from the KORINNA Follow-Up Study. <i>Value Health</i> , 2017. 20(3): p. 441-450.	Germany	Patients with an acute first or recurrent myocardial infarction treated in the Central Hospital of Augsburg	329 elderly aged 65+ years with myocardial infarction	Cost-effectiveness analysis in the context of a randomised controlled trial	Usual care	36 months 36 months
Simon, G.E., E.J. Ludman, and C.M. Rutter, Incremental benefit and cost of telephone care management and telephone psychotherapy for depression in primary care. <i>Arch Gen Psychiatry</i> , 2009. 66(10): p. 1081-9.	United States of America	Seven primary care clinics of a prepaid health care plan in Washington	600 consecutive primary care patients starting antidepressant treatment	Cost-effectiveness analysis in the context of a randomised controlled trial	Usual care	24 months 24 months
Sørensen, S.S., et al., Economic Evaluation of Community-Based Case Management of Patients Suffering From Chronic Obstructive Pulmonary Disease. <i>Appl Health Econ Health Policy</i> , 2017. 15(3): p. 413-424.	Denmark	Third largest municipality in Denmark	150 patients with COPD	Cost-utility analysis in the context of a randomised controlled trial	Usual care	12 months 12 months
Ulrich, L.R., et al., Cost-effectiveness analysis of case management for optimized antithrombotic treatment in German general practices compared to usual care - results from the PICANT trial. <i>Health Econ Rev</i> , 2019. 9(1): p. 4.	Germany	N/A	505 patients with a long-term indication for oral anticoagulation therapy	Cost-effectiveness analysis in the context of a cluster-randomized controlled trial	Usual care	24 months 24 months
Wansink, H.J., et al., Cost-effectiveness of preventive case management for parents with a mental illness: a randomized controlled trial from three economic perspectives. <i>BMC Health Serv Res</i> , 2016. 16: p. 228.	Netherlands	Community mental health institute	49 participants with longstanding psychiatric problems and an accumulation of risk factors for poor parenting	Cost-effectiveness analysis in the context of a randomised controlled trial	Control group received information about COPMI interventions and had the opportunity to make use of COPMI consultations and COPMI support groups in addition to psychiatric treatment (CAU)	The PBCM program ended when parenting and the children's development were sufficient according to the PBCM coordinator and the continuity of the necessary services over a longer period was secured. 18 months
Wijnen, B.F.M., et al., Cost-effectiveness and Cost-utility of the Adherence Improving Self-management Strategy in Human Immunodeficiency Virus Care: A Trial-based Economic Evaluation. <i>Clinical Infectious Diseases</i> , 2019. 68(4): p. 658-667.	Netherlands	7 Dutch HIV-clinics	223 patients at risk for viral rebound (i.e., a recent detectable viral load and suboptimal adherence)	Cost-effectiveness and cost utility analysis in the context of a multi-center randomized controlled trial	Usual care: 1-on-1 nurse-support. They delivered tailored information and medication intake instructions, feedback on clinical outcomes, encouraged adherence, developed individually-tailored medication plans with reminders, offered dose organizers and reminder devices/SMS services, explored social support, and discussed adherence problems and solutions	15 months 15 months

Study	Case Management Model (with description)	Intensity of intervention (patient contacts)/ Caseload/Team or single case manager/24 hours availability	Qualification CM and Training received/Supervision
Seidl, H., et al., 2017	<ol style="list-style-type: none"> <li>1. initial session shortly before hospital discharge in which patients received an information booklet and at which a first home visit or an appointment for a telephone call was arranged.</li> <li>2. After hospital discharge, at least one home visit and quarterly telephone calls were carried out</li> <li>3. Counselling on the intake of medication, nutrition, physical activity, weight control and general health behaviour</li> <li>4. Monitoring (e.g. blood pressure, pulse rate, blood glucose)</li> </ol>	<p>One home visit and quarterly telephone calls in the first year, and semi-annual calls in the following 2 years</p> <p>Single case manager</p>	Trained nurses
Simon, G.E., E.J. Ludman, and C.M. Rutter, 2009	<p>Telephone care management intervention</p> <ol style="list-style-type: none"> <li>1. monitoring and support</li> <li>2. feedback to treating physicians</li> <li>3. care coordination</li> </ol>	<p>Up to 5 outreach calls, telephone contacts lasted a mean of 13 minutes. Participants assigned to the care management plus psychotherapy group received up to 12 calls, including both care management and a structured cognitive behavioral psychotherapy program delivered by telephone.</p> <p>Single case manager</p>	<ol style="list-style-type: none"> <li>1. Bachelors-trained clinicians with prior experience in telephone assessment. Care managers received approximately 4 hours of training</li> <li>2. Therapists: masters-level clinicians, ≥1 year of experience in outpatient psychotherapy for depression, 12 h of didactic instruction and role play, trainee's observation of ≥ 6 sessions, and conduct of 6 sessions with audiotape observation" approximately 30 minutes of supervision each week, therapists received 60 minutes of supervision each week from a psychologist and a psychiatrist.</li> </ol>
Sørensen, S.S., et al., 2017	<ol style="list-style-type: none"> <li>1. Assessment of health risk and care planning</li> <li>2. Monitoring of individual health status</li> <li>3. Promotion of self-care and autonomy</li> <li>4. Provision of COPD knowledge and support</li> <li>5. Facilitation of relevant health and social services and coordination of care</li> </ol>	<p>follow-up phone calls every month, in-person meeting every 3 months, follow-up as needed with an in-person meeting at least every 3 months. On average 6.46 case-manager contacts during the follow-up period, of which the majority were face-to-face meetings.</p> <p>all 76 COPD patients per case manager</p> <p>Single case manager</p>	One COPD nurse with more than 20 years of experience, who completed a health promotion coaching course focusing on motivational dialogue.
Ulrich, L.R., et al., 2019	<ol style="list-style-type: none"> <li>1. monitoring</li> <li>2. inform and encourage patients about their disease and treatment condition</li> </ol>	Team (HCAs and GPs)	HCAs and GPs were trained in CM
Wansink, H.J., et al., 2016	<p>The PBCM intervention consisted of five steps:</p> <ol style="list-style-type: none"> <li>1. the enrolment procedures, in which families were referred by the parent's therapist</li> <li>2. systematic assessment</li> <li>3. the design of an integrated preventive plan for tailored preventive care</li> <li>4. linking and coordinating services</li> <li>5. monitoring</li> </ol>	Single case manager	Meetings with colleague-coordinators
Wijnen, B.F.M., et al., 2019	<p>Nurse-led, 1-on-1 self-management intervention incorporating feedback from electronic medication monitors, delivered during routine clinical visits:</p> <ol style="list-style-type: none"> <li>1. educational, motivational, action planning, and self-management techniques</li> <li>2. measurement of medication intake with an electronic medication monitor. These data are discussed with patients to identify causes of and tailored solutions for suboptimal adherence.</li> </ol>	<p>Patients were expected to receive the intervention at least three times: at baseline, and around month 5 and 10</p> <p>Single case manager</p>	Nurses were trained in AIMS for approximately 18 hours

Study	Outcome measures	Costs included	Cost perspective	Time horizon & discount rate	Findings (related to cost-effectiveness)
Seidl, H., et al., 2017	QALYs, based on the EQ-5D-3L health utilities. Secondary measurements were EQ-5D-3L utility values and patients' self-rated health states	1. Intervention costs 2. Costs of inpatient care 3. Costs of all other healthcare components	Societal perspective	3 years, discount rate of 3%	Costs were lower (-2576 €; P= 0.2968) and QALYs were higher (+0.0295; P = 0.7568) in the IG and differences remained stable after applying a discount rate of 3%, no ICER was calculated.  The probability of cost-effectiveness of the intervention at a WTP of 0 € per QALY was 84% in the case of QALYs and 81% in the case of VAS-ALs.
Simon, G.E., E.J. Ludman, and C.M. Rutter, 2009	Number of depression-free days over 24 months using the SCL-90 depression scale	1. Health services costs were measured using health care plan accounting records 2. Costs for intervention services."	Health care plan	24 months, no discounting done	Care management led to a gain of 29 depression-free days (95% confidence interval, -6 to +63) and a \$676 increase in outpatient health care costs (95% CI, \$596 lower to \$1974 higher).The incremental net benefit was negative even if a day free of depression was valued up to \$20. Care management plus psychotherapy led to a gain of 46 depression-free days (95% CI, +12 to +80) and a \$397 increase in outpatient costs (95% CI, \$882 lower to \$1725 higher). The incremental net benefit was positive if a day free of depression was valued at \$9 or greater.
Sørensen, S.S., et al., 2017	EQ-5D-3L was applied to obtain a measure of healthrelated quality of life	Costs to healthcare providers: 1. Direct disease related costs in the primary healthcare sector) 2. the secondary healthcare sector 3. cost for community care 4. costs for prescription medication, and intervention costs	Healthcare sector	12 months, no discounting	The intervention resulted in a QALY improvement of 0.0146 (95% CI -0.0216; 0.0585), and a cost increase of £494 (95% CI -1778; 2766) per patient. No statistically significant difference was observed either in costs or effects. The ICER was £33,865 per QALY gained. Scenario analyses confirmed the robustness of the result and revealed slightly lower ICERs of £28,100-£31,340 per QALY.  CM was cost-effective in only 43% of the simulations at a cost-effectiveness threshold of £20,000, whereas CM was cost effective in 49% of the simulations at a threshold of £30,000,
Ulrich, L.R., et al., 2019	QALYs using the generic EQ-5D-3 L. QALYs were calculated by converting the EQ-5D-3 L health states into utility scores.	1. All disease-related direct health care costs from the payer's perspective 2. CM costs for the intervention group.	Statutory health funds	No discounting done	The ICER was 16,767 € per QALY. Regardless of the WTP of insurers per QALY, the probability of the intervention being costeffective never rose above 70%. If the health insurers WTP was 15,000 Euro per additional QALY, the probability of cost-effectiveness was 50%.  5% of participants that generated the highest costs were excluded: no statistically significant differences between the groups in terms of either direct health care costs, or QALYs. Similar results, when the 10% of participants that were responsible for the highest cost were excluded. In terms of total costs, the results were only statistically significant because of the additional CM costs relating to the IG The sensitivity analyses had only minimal effects on the incremental cost-effectiveness ratio.
Wansink, H.J., et al., 2016	Quality of parenting, measured using the HOME inventory	1. the healthcare perspective 2. the social care perspective 3. the societal perspective 4. intervention costs."	1. the healthcare perspective 2. the social care perspective 3. the societal perspective	18 months, no discounting done	Parenting quality improved in the PBCM group and declined in the CAU group, and PBCM was shown to be more costly than CAU. ICERs differ from 461 € (healthcare perspective) to 215 €(social care perspective) to 175 € (societal perspective) per one point improvement on the HOME T-score.  The ICER is highest in the analysis conducted from narrowest perspective (healthcare, 461€), lower in the analysis conducted from broader perspective (social, 215 €), and lowest in the analysis conducted from broadest perspective (societal, 175 €). Sensitivity analyses based on excluding cost outliers, excluding incomplete cases and the subgroup analysis, confirmed that broader perspective leads to lower ICER. Conclusion: the choice of perspective has had an impact on the outcome of the analysis. Difference between ICERs is larger between the healthcare perspective and the social care perspective (246 €) than it is between the social care perspective and the societal perspective (40 €).Whether PBCM is considered cost-effective over CAU depends on the WTP max per point gain on the HOME T-score (Fig. 2d,e,f ). The probabilities of PBCM being cost-effective start at 20 % (healthcare perspective), 37 % (social care perspective) and 39 % (societal perspective) at a WTP max of 0 Euro and increase with an increasing WTP max. For thresholds lower than 2,500 €, the chances of PBCM being favorable over the CG are higher when a broader perspective is adopted. For thresholds higher than 2,500 €, there is a near 100 % probability of PBCM being cost-effective regardless of the perspective chosen
Wijnen, B.F.M., et al., 2019	1. viral load 2.treatment failure (two consecutive detectable viral loads) 3. QALYs (Utilities were measured using the SF-12v2	1. direct costs (e.g, intervention costs and other health care costs) 2. indirect costs (e.g, informal care costs, productivity losses)	societal perspective	15 months	Societal perspective, AIMS was slightly more expensive than treatment as usual but also more effective, resulting in an ICER of 549 € per reduction in log viral load and 1,659 € per percentage decrease in treatment failure. In terms of QALYs, AIMS resulted in higher costs but more QALYs compared to treatment as usual, which resulted in an ICER of 27,759 € per QALY gained. From a healthcare perspective, AIMS dominated treatment as usual. Additional sensitivity analyses addressing key limitations of the base case analyses also suggested that AIMS dominates treatment as usual.  The first sensitivity analysis using only baseline and follow-up data, resulted in a dominant ICER (i.e. AIMS was more effective and is cheaper than treatment as usual). The CEAC showed an 74% to 72% probability that AIMS is cost-effective regardless of the ceiling ratios. The second sensitivity analysis using individual mean imputation showed similar results. The third sensitivity analysis including the reduced risk of HIV transmission, showed lower costs and higher effects (i.e. AIMS dominated treatment as usual) for all outcomes. Likewise, the analyses from a healthcare perspective produced dominant ICERs.