LUND UNIVERSITY

Economic Evaluation of Management of Dementia Patients - A Systematic Literature Review

Saha, Sanjib; Gerdtham, Ulf-Göran; Toresson, Håkan; Minthon, Lennart; Jarl, Johan

2018

Economic Evaluation of Management of Dementia Patients - A Systematic Literature Review

Sanjib Saha
Ulf-G. Gerdtham
Håkan Toresson
Lennart Minthon
Johan Jarl

December 2018

LUND
UNIVERSITY

Economic Evaluation of Management of Dementia Patients - A Systematic Literature Review

Sanjib Saha[a*], Ulf-G Gerdtham[a,b,c], Håkan Toresson[d], Lennart Minthon[d], Johan Jarl[a]

[a] Health Economics Unit, Department of Clinical Science (Malmö), Lund University, Sweden
[b] Centre for Economic Demography, Lund University, Lund, Sweden
[c] Department of Economics, Lund University, Sweden
[d] Clinical Memory Research Unit, Department of Clinical Science (Malmö), Lund University, Sweden

Abstract

Objective: The objective is to systematically review the literature on economic evaluations of the interventions for the management of dementia and Alzheimer patients in home, hospital or institutional care.

Methods: A systematic search of published economic evaluation studies in English was conducted using specified key words in relevant databased and websites. Data extracted included methods and empirical evidence (costs, effects, incremental cost-effectiveness ratio) and we assessed if the conclusions made in terms of cost-effectiveness were supported by the reported evidence. The included studies were also assessed for reporting quality using the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist.

Results: Twelve studies were identified and there was a considerable heterogeneity in methodological approaches, target populations, study time frames, and perspectives as well as types of interventions. Interventions for the management of dementia patients are in general, not cost-effective. Interventions at the community and home setting for managing both the dementia patients and caregivers on a large scale may have the potential to save societal resources.

Conclusion: More effectiveness studies as well as good quality economic evaluations are required before implementation decisions on management strategies can be made based on cost-effectiveness.

Key words: Dementia, nursing home care, community care, residential care, economic evaluation

JEL Classification: H43; I10; I18

Background

Dementia is a syndrome with progressive deterioration in several cognitive domains that interfere with activities of daily living. Alzheimer's Disease (AD) is the most common dementia disorder and accounts for 60 – 70% of dementia cases [1-3]. Current estimates demonstrate that there are over 40 million people suffering from AD with the number expected to rise to over 100 million by the year 2050 [4].

Dementia affects many levels of society. Firstly, the individual suffers from impairments in cognition and functioning as well as impaired quality of life and shortened life expectancy [5]. Secondly, the relatives suffer from gradually losing a family member and in return receive a high care burden for the affected person. Indeed, the need for informal care increases when dementia progresses with deteriorating cognition and functioning [6]. Thirdly, dementia has a strong economic impact on the society. Care for persons with dementia is very costly and resource-demanding for both the formal and informal sector [7]. The worldwide societal costs for dementia were estimated to be 604 billion US dollars in 2010, of which 252 billion dollars in costs for informal care (for caregivers) [7]. These costs are expected to increase in the future due to population ageing.

There is currently no evidence-based method of preventing or curing dementia. Therefore the immediate priority is to help people to live well with dementia by introducing interventions that have the possibility to ameliorate difficulties and enhance quality of life, so-called tertiary prevention [8].

People with dementia require continuous support from family members, caregivers and the healthcare sectors for normal activities of daily living due to progressive deterioration in cognition, function, and behaviour. At early stages, patients are usually cared for at home where they receive informal care mostly provided by family members or formal care provided by professional community services. When the need for care grows as the disease progresses, many patients are eventually admitted to institutional care. About 60% of people

2

with dementia live at home and the figure is as high as 94% in the low and middle-income countries [9]. In institutional care for older people, it is estimated that over 50% of residents have a recorded diagnosis of dementia [10-12].

Therefore, the demand for both informal and institutional care for dementia patients are high and also increasing. General challenges in the management of dementia include providing medication, addressing neuropsychiatric symptoms and behavioural problems and managing caregivers burden [13]. Developing interventions such as case management involves coordination between different agencies to cover the needs of dementia patients and their caregivers. A range of home support interventions [14, 15] and institutional care/nursing home care/residential care [16, 17] for dementia patients exist, although with little evidence on effectiveness and cost-effectiveness.

Every intervention requires resources highlighting the importance to compare interventions with respect to the outcomes in relation to the cost. Lacking this information constitutes a barrier to policy making. Economic Evaluation is an analytic technique which identifies, measures, values and compares the cost and outcomes of two or more alternative programs or interventions. Economic evaluations can ensure that the limited available resources are allocated as efficiently as possible, helping decision makers to make informed decision on how to get as much as possible out of available resources [18].

Conducting systematic reviews is an appropriate way to identify the common characteristics of existing studies, to evaluate the studies, and to find the areas where more research is required. Therefore, the objective is to study whether the interventions of dementia and Alzheimer patients in home, hospital or institutional care are cost-effective.

Methodology

We performed a systematic literature review to answer the research question in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [19]. Moreover, the guidelines for incorporating economic evidence from the

Campbell and Cochrane Economics Methods Group [20] has been followed including search criteria, data extraction, synthesis and critical analysis.

Search strategy

A systematic search was performed to identify relevant articles published in both health economics and biomedical databases from 01.01.2000 till 31.12.2015. The databases were Medline (Pubmed), Embase and ECONbase, EconLit, Cumulative Index to Nursing and Allied Health (CINAHL), The National Bureau of Economic Research, Latin American and Caribbean Literature on Health Sciences Database (LILACS) and Popline. In addition, we searched specific economic evaluation databases: the Centre for Reviews and Dissemination database maintained by NHS (http://www.crd.york.ac.uk/CRDWeb/) and the Cost-effectiveness analysis registry (http://healtheconomics.tuftsmedicalcenter.org/cear4/Home.aspx). We also searched additional articles from the reference lists of included studies. The search was performed with search/key words and the details of the search strategy, key words, and initial hits are provided in Annex 1 for the reproducibility and transparency of the work.

Inclusion and exclusion criteria

The literature search covers economic evaluations of all types of interventions targeting patients with dementia disorders, their caregivers, and the patient-caregiver dyad. We defined management of dementia where the objective was managing the patients at home and/or in institutional care. This means that economic evaluations of interventions focusing on (1) non-pharmacological interventions and (2) pharmaceuticals are not included, as well as economic evaluations of (3) intervention for screening of dementia patients. These three categories are presented in the other reviews.

Studies were included if they satisfy the criteria: (1) management of people with dementia irrespective of place of care (e.g. at home, hospital, or nursing home); (2) the interventions targeting the patients, their caregivers and/or the patient-caregiver dyad; (3) were economic

evaluations such as Cost Minimization Analysis (CMA), Cost-Effectiveness Analysis (CEA), Cost-Utility analysis (CUA) or Cost-Benefit Analysis; and (4) reported in English in the scholarly literature. Studies were excluded if they were: (1) cost studies such as cost-of-illness analysis; (2) reviews, notes, commentaries, editorials, or working paper related to dementia; and (3) study protocol or study design of interventions.

Selection and data extraction

After each search in the above-mentioned databases the initial hits were exported into EndNote and duplicates were removed. All articles were screened based on the inclusion and exclusion criteria, first based on titles and abstracts and second based on the full text. The selection of the articles was done by one co-author while a second co-author reviewed all studies where assessment according to inclusion or exclusion criteria was challenging.

We extracted data from the selected articles along two main dimensions; the result of the study (empirical evidence) and how the results have been derived (methodology).

In terms of result, we extracted the Incremental Cost Effectiveness Ratio (ICER), net monetary benefit (NMB) or net health benefit (NHB) from the selected articles (if presented), as well as its components (costs and outcomes) and sensitivity measures. We also identified whether the health outcomes were measured as utility index or as other outcomes, e.g. survival years, time spent on institutional care.

Furthermore, we scrutinized whether the intervention was reported as cost-effective by the authors and whether the reported information support the conclusions, based on different scenarios presented in Table 1. We used ICER in table 1 since ICER is more frequently used in the economic evaluation literatures than NMB or NHB [21]. However, the scenarios presented in table 1 can be used for both incremental NMB or incremental NHB. We used the NICE threshold (£30,000 per QALY gain) to term an intervention cost-effective [22, 23]. That is, ICER higher than £30,000 per QALY was considered not cost-effective and in NMB, the value of lambda (λ) was considered £30,000.

In the absence of any significance test, we used the information on the Cost-Effectiveness Acceptability Curve (CEAC) to judge the cost-effectiveness of the intervention, if presented. CEAC was developed as an alternative to produce CIs around the ICER which shows the probability that the intervention is cost-effective in comparison with the comparator for a range of Willingness-To-Pay (WTP) thresholds. We consider an intervention cost-effective or weakly cost-effective if the probability of the intervention being cost-effective was 90% or 80% at the NICE threshold.

We also considered other methods of presenting uncertainties such as cost-effectiveness plane, intervals for ICER, intervals for net benefits and expected value of perfect information [24], if these were presented in any of the selected studies.

Studies were appraised for quality of reporting using the CHEERS statement [25]. This checklist was produced with the aim of harmonizing the presentation of information, raising the quality standard of economic evaluations. The CHEERS guideline has 24 items in six categories (title and abstract, introduction, methods, results, discussion and other). The items were scored as 'Yes' (reported in full), 'No' (not reported), and 'Not Applicable'. In order to assign a score of reporting, we assigned a score of 1 if the requirement of reporting was completely fulfilled for that item and 0 otherwise. Therefore, the maximum score was 24.

Results

We included twelve studies in this review. A flowchart of the study selection procedure is presented in Figure 1, and the detailed characteristics of the studies are presented in Table 2. The interventions can be categorised into three groups: at home/community management, interventions at the institutional care settings and interventions at the hospital or general practitioner setting. The included studies were predominantly performed in western European countries and the USA from healthcare or societal perspectives. The economic evaluations are CUA, CEA and CMA. In the CUA effectiveness is measured as Quality Adjusted Life

Years (QALYs) whereas in CEA, the measure of effectiveness varies considerably; e.g. Life Years Gained (LYG), days of institutionalization prevented, and survival. In CMA, only the cost differences between the interventions were compared. The effectiveness data are derived from single randomized control trials or literature reviews of several trials from participants' country if available and otherwise from other nations. Results are presented as ICER vs. the comparator. The discount rate varies from 3% to 6%, and the majority uses the same discount rate for both cost and effect.

Home/ Community Care

Challis et al. [26] evaluated an intervention where people with dementia were provided tailor-made intensive case management in a community setting compared to usual care in the UK. The case management is provided by a multidisciplinary team including psychiatrists, psychologists, nurses, occupational therapists, social workers and administrative staff. The control group received traditional doctor-led model of services. The two-year intervention reduced the number of patients admitted to nursing home care compared to the control group. For the intervention group, significant improvements were observed in many aspects such as more social contacts, a decrease in stress of careers, reduction of overall need and improvement in aspects of daily living. There were no significant differences in cost between the two groups. Duru et al. performed a CMA of coordinated dementia care management together with the caregivers at home, primary health care centre and subsequently nursing home in the USA [27]. The intervention consisted of structured home assessment, identification of problems, initiating care plan actions, and sending a summary to the primary care physician and other designated providers by a care manager. After 18 months the intervention did not differ in costs compared to usual care. However, the intervention was shown to significantly improve multiple measures of dementia care quality, as well as patient and caregiver outcomes. Kuo et al. [28] compared home care to institutional care to find an optimal model for dementia management in Taiwan. The researchers collected costs related

to healthcare and informal care for the patients and caregiver living at home and in institutional care. They estimated the effectiveness as QALY measured by EQ-5D incorporating the Chinese tariff. Although the researchers did not calculate the ICER, patients residing in the home had higher QALY (statistically significant) and lower costs than the patients residing in the institutional care. However, physical dependency level of the patients had a significant impact on the cost. High physical dependency patients had significantly higher cost at home than institutional care due to high informal care cost. The opposite was found for the low physical dependency patients. Therefore, the researchers suggested the optimal care plan could be to stay at home for low physical dependency patients and for high physical dependency patients institutional care is a better choice.

We found two studies where the management of caregivers' programs was evaluated. Since both of the programs started from home/community care, we included these two in these categories. Long et al. [29] estimated the cost saving of a caregiver intervention program in Minnesota using a Markov model. The intervention is called the New York University Caregiver Intervention (NYUI). The NYUI was initially an RCT which provided enhanced support services to spouse and adult caregivers of the dementia patients. The intervention consisted of individual and family counselling, weekly support group and ad hoc telephone counselling for an indefinite period. A Markov model was used to estimate the saving which consisted of three Markov health states: living in the community, being institutionalized and dead. The model simulated all eligible dementia patients for a period from 2010 to 2025. It was estimated that over the 15 years NYUI could save $996 million in direct costs in Minnesota. The North Dakota Assistance Program for the dementia caregivers, on the other hand, saved $40 million over 42 months period in North Dakota [30]. The saving came from reduced use of medical services as well as delayed long-term care placement. The main goal of the program was delay premature nursing home placement, reduce the acute health services by dementia patients and to increase the empowerment of the caregivers. The

services included individual counselling sessions for the caregivers, family counselling, weekly support group as well as telephone counselling.

Interventions at the institutional care settings

We found two studies economically evaluating person-centred care (PCC) for dementia patient in the institutional setting [31, 32]. Kitwood and Berdin [33] first came up with this idea of PCC for dementia patient management which involves tailoring a person's care to their interests, abilities, history and personality. This helps the patients to take part in the things they enjoy and can be an effective way of preventing and managing behavioural and psychological symptoms of dementia. One systematic literature review of PCC suggests that PCC reduces agitation, neuropsychiatric symptoms, and depression and improve the quality of life of the patients [34]. Dementia-care mapping (DCM) is a multicomponent PCC developed by the Bradford Dementia Group at the University of Bradford in the UK [35]. DCM is a cyclic intervention consisting of three components: systematic observation, feedback to the staff, and action plans. The action plans are developed by the nursing home staff and are based on the observation of the actual needs of the patients. This method introduces timely tailor-made interventions at the individual level both for the patient and their caregivers. Furthermore, the continuous training and feedback enable healthcare professionals at the nursing home to develop further PCC skills in daily practice. The DCM has shown mixed results as some found it effective in improving the quality of life [36, 37] while others found no significant effect on agitation or quality of life [38, 39].

Chenoweth et al. [31] performed a CEA where dementia patients at the institutional care were randomized to PCC and DCM compared to usual care. The intervention was provided for 4 months and then followed for additional 4 months. The researchers reported an ICER of AUS$ 8.01 for PCC and AUS$ 48.95 for DCM per unit of Cohen-Mansfield agitation inventory (CMAI) reduction compared to usual care 4 months post-intervention. Comparing to the PCC and DCM, PCC was found to be dominating, i.e. lower cost and higher effect.

Another study performed in the Netherlands by van de Van et al. [32] also compared DCM with usual care. At first, the nursing home staffs were trained in DCM by professionals from DCM Netherlands. The 18-month intervention showed that there were no statistically significant differences in terms of cost and effect (number of falls) between DCM and usual care.

We found two studies which economically evaluated interventions conducted at the institutional care [40, 41]. Zwijsen et al. [40] performed a CEA and CUA for the GRIP intervention, an intervention to manage the challenging behaviour without providing psychoactive medication. GRIP consists of an education package and a work package with the following four steps: detection, analysis, treatment and evaluation. The effectiveness was measured by CMAI, QALY, and QUALIDEM (a scale to measure the quality of life of the dementia patients). The intervention had significantly higher costs and significantly lower QALY than usual care. However, the intervention had some positive effects in some subscales of QUALIDEM. Hakkaart-van Roijen et al. [41] performed both CEA and CUA of a RCT incorporating integrative psychotherapeutic nursing home programme compared to usual care. The intervention consisted of short-stay reactivation and rehabilitation programme in a nursing home, including psychotropic drug treatment, performed by multidisciplinary team. The team consisted of a nursing team, a psychogeriatrician, a clinical psychologist, a social worker, a music therapist, a psychomotor therapist, a creative therapist, a physiotherapist, an occupational therapist, a speech therapist, a dietician and a welfare worker. The intervention also included family therapy for the caregivers. The effectiveness was measured by the Neuropsychiatric Inventory (NPI) score, Caregivers burden (CB), caregivers' competence (CCL) and QALY. After 40 months, it was observed that the ICER was €276,289 per QALY gained although the QALY gain and cost differences were not significant for the intervention group. Others measure such as NPI, CB and CLL had an ICER of €323, €129 and €540 per unit change, respectively where all the effects had a

significant change.

Interventions at the hospital or general practitioner setting

In the UK, Tanajewski et al. [42] performed an RCT of a special unit in a hospital for people with cognitive impairment comparing to standard care. The special unit had specialist mental health staff, staff trained with PCC, planned therapeutic and diversionary activities, a suitable environment and proactive family carers. The 3-month intervention showed that the special unit had lower cost and patients gained QALY although neither of these was significantly different from the usual care group. However, they reported that at a willingness-to-pay of £20,000 per QALY, the intervention had 95% chance to be cost-effective.

Two other studies evaluated interventions in the GP context [43, 44]. Meeuwsen et al. performed a CUA of managing people with dementia in a memory clinic (MC) or GP care in the Netherlands [43]. The MC intervention consisted of tailor-made intervention informing patients about the prescribed drugs and dosages, together with non-drug interventions such as day structure, referral to a nurse specialist, day care or home care. The 12-months intervention showed that the cost was lower for the MC group (not statistically significant) and the MC group had lost QALY (not statistically significant) comparing to GP care. The ICER was € 41,442 per QALY lost. In the other study, Menn et al. [44], performed both CEA and CUA of a three-group RCT for dementia care in GP setting in Germany. All GPs got training on dementia diagnosis, treatment and management. In the first group, the drugs and nonmedical treatment options were not part of the training which serves as a control group. In the second group and third group, doctors received training on the German health care system, non–medication-based treatment, information and counselling of caregivers, medical treatment options, therapy of non-cognitive disorders, and specific problems. The only difference between the second group and the third group was that in the second group, caregivers counselling was started at the beginning of the intervention whereas in the third group the counselling started after the first year. The primary outcome was the postponement

of nursing home replacement. In the secondary outcome, five disease-specific instruments were used including QALY measured by EQ-5D. The patients were followed-up at the second and fourth year after the intervention. The cost was calculated from the societal perspective including the caregiver's costs. After 2 and 4 years neither the costs nor any of the health effects statistically differed between the groups.

Discussion

The identified studies differ in many aspects such as type interventions, length of study period, target groups, perspective, included costs and outcomes, and instruments to measure the outcomes. This makes general comparison across all studies difficult to achieve as there are also differences in the setting of the different studies, e.g. different healthcare systems, community or nursing home care, clinical practices, population values, availability and accessibility of drugs, technologies and institutional care. However, we will discuss the main differences between studies in relation to the results.

Cost-effectiveness is at its heart a normative concept as it refers to if an intervention is worth its costs, i.e. the decision-maker willingness-to-pay for the outcome under study. This will differ between settings but also between individuals, and it is therefore essential that the authors of economic evaluations are clear about the valuation of the outcomes when determining an intervention's cost-effectiveness. Preferably a societal valuation should be used when reporting cost-effectiveness although this value is generally unknown. An exception is the value of a QALY where NICE in the UK uses a cost-effectiveness threshold range of £20,000 to £30,000 per QALY gained [22, 23]. There are no official guidelines for the USA and Australia although 50,000 US$/QALY is frequently employed as a threshold in the USA [45] and 50,000 AUS$/Disability Adjusted Life Year (DALY) in Australia [46]. We used NICE threshold to term an intervention cost-effective in this study.

In Table 3, we presented the cost-effectiveness of the included articles as reported by the authors as well as our own assessment based on the reported information. It is foremost important to establish that there is a difference in costs and/or outcomes between the intervention and the comparator before calculating the ICER, for example, by reporting confidence intervals (CIs). If CIs were not available, we take a conservative approach and assess the cost-effectiveness as "unknown due to lack of information" as it cannot be established if the intervention is different from the comparator. Our assessments are in line with the reported conclusions in five studies as the interventions were neither significantly better nor significantly cheaper than the comparators [27, 40, 41, 43, 44]. However, many studies do not report the 95% CIs (or corresponding test) for either costs or outcomes (Table 3)[26, 29, 30]. We acknowledge that, in economic evaluations, costs and effects are very disperse and it may be difficult to find significant differences between two comparators. However, 95% CIs (or corresponding tests) of the differences in costs and effects should always be included.

Some studies handle the uncertainties around costs and effects by presenting Cost-Effectiveness Acceptability Curve (CEAC) (Table 3) [42, 43] which is a good practice that should be included in all economic evaluation studies. CEAC was developed as an alternative to producing CIs around the ICER. However, there is no agreement on when to claim an intervention cost-effective based on the findings from the CEAC. For ease of comparison, we termed an intervention "cost-effective" (weakly cost-effective) if the intervention had 90% (80%) probability to be cost-effective at the NICE threshold as it is clearly preferable to the alternative.

There is a monetary valuation (threshold) of QALY which researchers as well as policy makers can rely upon when comparing different interventions in terms of cost-effectiveness, despite the disagreement about the precise value. However, there is no agreed upon valuation for other effectiveness measurement such as CMAI score, NPI score, and number of falls

prevented (Table 2). In these cases, it is the authors' responsibility to establish the societal valuation of the used outcome, for example by comparing to the value that the society has been willing to pay in the past. A few exceptions exist however; if the intervention is both better (worse) and less (more) costly than the comparator (scenarios 2 and 4 in the Table 1), it is (not) preferred irrespective of the valuation of the outcome measure. However, none of the included studies makes a convincing case for the valuation. In only one study, the authors acknowledged that the ICER value for these types of outcomes does not have any societal value and are thus not helpful for policy decision making [41]. Zwijsen et al. stated that the ICER for 1% point sickness absence reduction was €6,738, although it was not established if the societal valuation for 1% point sickness absence reduction is above or below this figure. It is therefore not possible, with any certainty, to make any conclusions regarding the cost-effectiveness of the intervention and labelling these interventions as "cost-effective" is inappropriate. We consider the cost-effectiveness of these intervention "unknown due to no agreed cost-effective threshold value" (Table 3).

Considering all these conditions, we found that interventions for the management of dementia patients are, in general, not cost-effective (Table 3). Out of 12 interventions, 6 were not cost-effective and 3 lacked sufficient information to determine cost-effectiveness. Interventions at the community and home setting for managing both dementia patients and caregivers on a large scale may have the potential to save societal resources. However, it is worth stating that neither the cost-effectiveness threshold nor the inference drawn from the CEAC should be used as the only decision-making tool for implementations of these interventions. Instead, a country and context-specific process for decision making should be considered, reflecting legislation and involving patients group, caregivers and civil society organizations [47, 48].

Cost minimization analysis (CMA), Cost-Effectiveness Analysis (CEA) and Cost-Utility Analysis (CUA)

We found a few Cost minimization analyses (CMA) [27, 29, 30, 32] (Table 2). In CMA, researchers compared only the cost between two interventions with the assumption that there were not significant differences in the effects between the interventions. We found that only van de Ven et al. [32] explicitly discussed that since there were no significant differences in the effect between the two interventions, they performed a CMA. However, other researchers did not explicitly mention that they are performing CMA, but it can be extracted from the results that the analyses are CMA. It is worth to mention that the CMA estimated the benefits of the interventions in terms of reduction of healthcare resources utilization such as reduced hospitalizations and days prevented in the admission to the institutional care, but these beneficial outcomes were converted into costs. This approach is rather a CEA with the NMB method for presenting the findings than a CMA.

We labelled a study CEA if the outcome was not a utility-based index and CUA study if it was (Table 2). Researchers argue that the CEA which uses a natural unit as measurement is more relevant to clinicians [49] while CUA is more relevant to decision-makers [50] as this enable comparison between different interventions. All CUA have used QALY, which is a health-related utility index, measured by the generic instrument EQ-5D (Table 3). Using a generic measure as an outcome for any intervention is generally recommended [50] although there is a debate on using EQ-5D to measure the effectiveness in dementia populations. One group is arguing that EQ-5D may not be an appropriate tool to detect changes in mental well-being of the patients with dementia [51, 52] while others are in favour of using EQ-5D [53, 54]. EQ-5D is not designed to detect changes in mental well-being beyond one question on anxiety/depression. Moreover, there is very little diversity in scores on items like 'self-care' and 'usual activities', and improvements in these dimensions are unlikely, which makes the instrument insensitive to population-specific changes.

Using both a generic instrument (i.e. EQ-5D) and a disease specific instrument (i.e. QUALIDEM) may be beneficial for both policy makers and clinicians which was observed in

many studies [31, 40, 41]. We also recommend this practice despite the fact that results vary depending on the choice of health outcomes [43]. However, we did not find that the choice of a certain instrument affected the cost-effectiveness conclusions.

In research involving dementia and their caregivers, it may also be useful to consider a social context, rather than a health context, which may be more appropriate in a nursing home setting. A growing body of research is suggesting to incorporate the overall quality of life instead of just health-related-quality-of-life as factors outside of health status, for example dignity, independence, and having control over their daily lives, are important contributors to residents' quality of life [55, 56]. Instruments such as the Adult Social Care Outcomes Toolkit (ASCOT) has been suggested which capture dimensions of social well-being or the ICEpop CAPability measure for Older people (ICECAP-O) which measures capability [57]. Ultimately, it is important that the chosen instrument is sensitive enough to capture changes in the studied population.

In terms of decision making based on different health or social outcomes, one approach may be to present an array of outcome measures for each alternative, allowing the decision-makers to make their own trade-offs between measures of effectiveness [58]. An economic evaluation commonly known as cost consequence analysis [59].

Caregivers

Dementia is expected to affect people close to the patient directly and indirectly through the burden of informal care. Most studies included in this review have included some form of caregivers' outcome in the analyses. In the World Alzheimer Report, the cost of informal care contributed 42% of total cost worldwide [7] for Alzheimer care. It is difficult to estimate the cost of informal care for a number of reasons. First, it is debatable what types of activities need to be considered as caregiving. For example, the World Alzheimer Report considers both times related to helping patients with Activities of Daily Living (ADL) and support with Instrumental Activities of Daily Living (IADL) as caregiving. Meeuwsen et al [43] used the

same cost for both ADL and IADL (wage of a cleaning person) whereas Menn et al. [44] used different costs for ADL (wage for a nurse) and IADL (wage for a housekeeper). Second, it is difficult over a long period of time to monitor each activity of caregivers which may lead to recall and interpolation bias. Third, there is much controversy regarding the valuation of time for informal care [60]. Meeuwsen et al. [43] used friction cost approach for valuing the time of caregiver whereas Kuo et al. [28] used the exact salary of the caregivers who need to take care of the patient at his/her working hour. For other time, they used cost for a home help aid. Inclusion of caregiver's cost generally have a strong impact on the cost-effectiveness outcome as suggested in a recent review of informal care cost in economic evaluations studies [61] and should be included in all economic evaluations targeting dementia disorders.

In terms of capturing the health effect of interventions on caregivers, we found only one study [43] where the sum of patient's QALY and caregiver's QALY was used in the denominator while calculating the ICER and the intervention dominates usual care. Although researchers have shown that QALY can capture the "spillover" effects on caregivers [62, 63], studies need to include the effect of interventions on caregivers while calculating ICER otherwise the estimation could be biased.

A wide body of research is also suggesting that caregivers' competence, satisfaction and carer preferences need to be included while considering the benefit of an intervention for people with dementia, especially those who are at the end stage of their life [64]. However, we found only one study where caregiver burden and competence have been included as an outcome [41]. Besides the question of a valid instrument to capture caregiver's satisfaction, caregivers' preferences need to be included in the framework of economic evaluations. As describe above, a cost consequence analysis can be helpful to provide all the benefits for the patients as well as caregivers [65].

RCTs and Economic Evaluation

Out of 12 studies, 8 studies performed economic evaluations alongside of an RCT. RCTs play a key role in providing estimates of the efficacy of health interventions [66] and are a source of data on resource use, health values, and relative treatment effect [67]. Randomization reduces selection bias, and so RCTs offer high internal validity ("Does this intervention work under the conditions set forth in the study?"), but are less well suited to provide information on external validity ("Will it work in other settings and contexts?") [68]. Assessing internal validity is important, as without it one cannot be sure whether the intervention works at all, but resource allocation decisions need to be informed based on studies with high external validity. That is, decision should be made based on information relevant for the actual context. The high reliance on RTC in the field is thus a cause for concern. Studies with Decision Analytic Models (DAM) could be an alternative where the effectiveness of any specific intervention (e.g. DCM) can be obtained from meta-analysis. Another prominent aspect of economic evaluations alongside RCTs is that randomization is performed by considering the clinical characteristics and socioeconomic characteristics of the participants [27, 31, 44], and not from an economic evaluation perspective. In economic evaluations, generally more sample is required than the clinical studies to detect the cost and effect differences. If the randomization is not even with respect to clinical characteristics between two groups, which can happen by chance like in [44], additional methods are required to control for the differences when performing economic evaluations otherwise the cost-effectiveness estimation may be biased.

Economic evaluations conducted alongside RCTs follows the (shorter) duration of trial which is considered a drawback [67]. Generally, short duration runs the risk of not providing a good indication of longer-term effects of the intervention and its associated longer-term costs. The duration of the studies included in this review ranges from three months to 24 months. However, lifelong duration may be more preferable in case of management studies as there exists high rate of mortality of the severe stage of dementia population which was seen in

some of the studies [31, 42, 44]. One particular example, Tanajewski et al. [42] found that the mortality rate was 25% over the intervention duration of only 90 days.

Good guidelines now exist on conducting economic evaluations alongside RCTs [69-71], including some suggestions on methodological improvements [72]. One such improvement is the power and sample size selection to capture the differences in costs and health effects while considering economic evaluations alongside RCTs [73, 74].

Another important aspect is that the effectiveness of management studies largely depends on the skill and motivation of the staff and thus affected by selection bias. The successful implementation of DCM, for example, requires well-functioning networks, highly trained staff, a dementia friendly environment and flexible organisational structure [75]. The advocates of DCM have an emphasis on the implementation of DCM in nursing home care with adequate training for the nursing home staff to have a health effect first and then the economic evaluations can be performed. This can have an impact of the effectiveness as well as cost-effectiveness of the interventions. It is thus possible that the trials that are found not to be cost-effective might have non-motivated staff.

Many drawbacks of economic evaluations based on RCTs can be overcome by using DAM, but it is used in only one study [29]. Interesting to note that DAM is much more common in economic evaluations of pharmaceutical treatments related to dementia [76, 77]. The rare use of DAM in the management is probably due to lack of high-quality, well-funded trials in contrast to pharmaceuticals treatment. Building a DAM requires a large investment in terms of time and expertise, something that has not been done in non-pharmacological research in dementia.

Reporting quality assessment

We scored the articles based on the CHEERS statement and observed that the quality of reporting was insufficient for several articles. It can be argued that CHEERS statement is very recent and many of the articles were published before the CHEERS statement. However,

other guidelines were available earlier (e.g. [78-81]) and following any of these guidelines would have improved the presentations.

We found three studies which were not economic evaluations but with enough information to calculate an ICER [26, 28, 31]. These studies performed poor in terms of CHEERS score. Several items were only partially or not reported at all in most articles which impede proper comparison between the studies. Some examples are lack of proper description of costing methods such as unit costs, and sources of costs items (i.e. was the cost collected at the time of the intervention or collected retrospectively, from registers or from other settings, etc.). We also found that most studies did not have heterogeneity analyses. We hope that the availability of the CHEERS statement will lead to improvements in reporting. However, it should be kept in mind that these guidelines are to ensure the quality of the reporting and not the quality of the study, although a positive correlation is expected.

Role of funding source

A majority of the studies were funded by governmental or non-governmental organizations (Table 2). This is different compared to economic evaluations of drugs for dementia and AD patients which generally are funded by pharmaceutical industries [76, 77]. No differences in cost-effectiveness could be discerned based on funding source.

Strength and Limitation

The current literature review poses particular strengths. It includes studies that focused not only on patients but also caregivers. In line with recommendations, we searched key electronic bibliographic databases and other sources. Manual searching of reference lists of the reviewed articles was carried out to identify relevant studies. Identified studies were independently assessed for inclusion against a set of predetermined criteria. No restrictions were applied on types of economic evaluations or country of origin.

There may have been some potential limitations to our study. First, the quality of reporting of the articles based on CHEERS scoring is based on the interpretation of the reviewers and

disagreement may arise. We have not assessed the methodological quality of the articles and we did not perform a systematic quantitative assessment to identify key drivers of the cost-effectiveness.

Future research

Future research should focus on more high-quality studies (e.g. pragmatic trial) with a life long duration for measuring both costs and outcomes (health). Since the caregiver burden is substantial, a societal perspective is recommended. In terms of outcome measurements, researcher need to capture the overall quality of life of the patient and caregivers instead of just health related quality of life. Although it is a common practice to perform an economic evaluation beside an RCT, researchers should keep in mind that larger samples are required for economic evaluations studies. Last but not least, implementation of promising interventions is required to evaluate the cost-effectiveness in a "real-life" setting.

Conclusion

We found that interventions targeting management of dementia patients are not, in general, cost-effective. More research is required to estimate effectiveness as well as cost-effectiveness of management interventions for dementia patients and their caregivers.

References

1.   Gabuzda, D., J. Busciglio, and B.A. Yankner, *Inhibition of beta-amyloid production by activation of protein kinase C.* J Neurochem, 1993. **61**(6): p. 2326-9.
2.   Jorm, A.F., A.E. Korten, and A.S. Henderson, *The prevalence of dementia: a quantitative integration of the literature.* Acta Psychiatr Scand, 1987. **76**(5): p. 465-79.
3.   Lobo, A., et al., *Prevalence of dementia and major subtypes in Europe: A collaborative study of population-based cohorts. Neurologic Diseases in the Elderly Research Group.* Neurology, 2000. **54**(11 Suppl 5): p. S4-9.
4.   Alzheimer's, A., *2013 Alzheimer's disease facts and figures.* Alzheimer's & Dementia, 2013. **9**(2): p. 208-245.
5.   Rizzuto, D., et al., *Dementia after age 75: survival in different severity stages and years of life lost.* Current Alzheimer Research, 2012. **9**(7): p. 795-800.
6.   Nordberg, G., et al., *The amount of informal and formal care among non-demented and demented elderly persons—results from a Swedish population-based study.* International journal of geriatric psychiatry, 2005. **20**(9): p. 862-871.
7.   Wimo, A., et al., *The worldwide economic impact of dementia 2010.* Alzheimer's & Dementia, 2013. **9**(1): p. 1-11. e3.

8.   Cooper, B., *Thinking preventively about dementia: a review.* Int J Geriatr Psychiatry, 2002. **17**(10): p. 895-906.

9.   Prince, M.J., *World Alzheimer Report 2015: the global impact of dementia: an analysis of prevalence, incidence, cost and trends.* 2015.

10.   Caffrey, C., et al., *Characteristics of residents living in residential care communities, by community bed size: United States, 2012.* NCHS Data Brief, 2014(171): p. 1-8.

11.   Stewart, R., et al., *Current prevalence of dementia, depression and behavioural problems in the older adult care home sector: the South East London Care Home Survey.* Age Ageing, 2014. **43**(4): p. 562-7.

12.   Hoffmann, F., et al., *Prevalence of dementia in nursing home and community-dwelling older adults in Germany.* Aging Clin Exp Res, 2014. **26**(5): p. 555-9.

13.   Parmar, J., et al., *Diagnosis and management of dementia in primary care: exploratory study.* Can Fam Physician, 2014. **60**(5): p. 457-65.

14.   Reilly, S., et al., *Case management approaches to home support for people with dementia.* Cochrane Database Syst Rev, 2015. **1**: p. Cd008345.

15.   Health, N.I.f. and C. Excellence, *Dementia: Supporting people with dementia and their carers in health and social care.* 2006: National Institute for Health and Clinical Excellence.

16.   Hyde, J., R. Perez, and B. Forester, *Dementia and assisted living.* Gerontologist, 2007. **47 Spec No 3**: p. 51-67.

17.   Calkins, M.P., *Evidence-based long term care design.* NeuroRehabilitation, 2009. **25**(3): p. 145-54.

18.   Michael F. Drummond, et al., *Methods for the Economic Evaluation of Health Care Programmes.* 3rd ed. 2005: Oxford University Press.

19.   Moher, D., et al., *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA StatementThe PRISMA Statement.* Annals of Internal Medicine, 2009. **151**(4): p. 264-269.

20.   Higgins, J.P. and S. Green, *Cochrane handbook for systematic reviews of interventions.* Vol. 5. 2008: Wiley Online Library.

21.   Trippoli, S., *Incremental cost-effectiveness ratio and net monetary benefit: Current use in pharmacoeconomics and future perspectives.* Eur J Intern Med, 2017. **43**: p. e36.

22.   McCabe, C., K. Claxton, and A.J. Culyer, *The NICE Cost-Effectiveness Threshold: What it is and What that Means.* PharmacoEconomics, 2008. **26**(9): p. 733-744.

23.   NICE, *NICE guide to the methods of health technology appraisal.* 2004, NICE.

24.   Groot Koerkamp, B., et al., *Limitations of acceptability curves for presenting uncertainty in cost-effectiveness analysis.* Med Decis Making, 2007. **27**(2): p. 101-11.

25.   Husereau, D., et al., *Consolidated health economic evaluation reporting standards (CHEERS) statement.* BMC medicine, 2013. **11**(1): p. 1.

26.   Challis, D., et al., *Care management, dementia care and specialist mental health services: an evaluation.* International journal of geriatric psychiatry, 2002. **17**(4): p. 315-325.

27.   Duru, O.K., et al., *Cost evaluation of a coordinated care management intervention for dementia.* Am J Manag Care, 2009. **15**(8): p. 521-8.

28.   Kuo, Y.C., et al., *Dementia care costs and the patient's quality of life (QoL) in Taiwan: home versus institutional care services.* Arch Gerontol Geriatr, 2010. **51**(2): p. 159-63.

29.   Hall Long, K., et al., *Estimating The Potential Cost Savings From The New York University Caregiver Intervention In Minnesota.* Health Affairs, 2014. **33**(4): p. 596-604 9p.

30.   Klug, M.G., G. Wagstrom Halaas, and M.-L. Peterson, *North Dakota Assistance Program For Dementia Caregivers Lowered Utilization, Produced Savings, And Increased Empowerment.* Health Affairs, 2014. **33**(4): p. 605-612 8p.

31.   Chenoweth, L., et al., *Caring for Aged Dementia Care Resident Study (CADRES) of person-centred care, dementia-care mapping, and usual care in dementia: A cluster-randomised trial.* The Lancet Neurology, 2009. **8**(4): p. 317-325.

32.   van de Ven, G., et al., *The Economics of Dementia-Care Mapping in Nursing Homes: A Cluster-Randomised Controlled Trial.* PLOS ONE, 2014. **9**(1): p. e86662.

33.   Kitwood, T. and K. Bredin, *Towards a theory of dementia care: personhood and well-being.* Ageing Soc, 1992. **12**: p. 269-87.

34.   Kim, S.K. and M. Park, *Effectiveness of person-centered care on people with dementia: a systematic review and meta-analysis.* Clinical Interventions in Aging, 2017. **12**: p. 381-397.

35.   Ballard, C. and D. Aarsland, *Person-centred care and care mapping in dementia.* The Lancet Neurology. **8**(4): p. 302-303.

36.   Yasuda, M. and H. Sakakibara, *Care staff training based on person-centered care and dementia care mapping, and its effects on the quality of life of nursing home residents with dementia.* Aging Ment Health, 2016: p. 1-6.

37.   Chenoweth, L., et al., *Caring for Aged Dementia Care Resident Study (CADRES) of person-centred care, dementia-care mapping, and usual care in dementia: a cluster-randomised trial.* Lancet Neurol, 2009. **8**(4): p. 317-25.

38.   van de Ven, G., et al., *Effects of dementia-care mapping on residents and staff of care homes: a pragmatic cluster-randomised controlled trial.* PLoS One, 2013. **8**(7): p. e67325.

39.   Dichter, M.N., et al., *Dementia care mapping: effects on residents' quality of life and challenging behavior in German nursing homes. A quasi-experimental trial.* Int Psychogeriatr, 2015. **27**(11): p. 1875-92.

40.   Zwijsen, S.A., et al., *The cost-effectiveness of grip on challenging behaviour: an economic evaluation of a care programme for managing challenging behaviour.* Int J Geriatr Psychiatry, 2015.

41.   Hakkaart-van Roijen, L., et al., *Economic evaluation alongside a single RCT of an integrative psychotherapeutic nursing home programme.* Bmc Health Services Research, 2013. **13**.

42.   Tanajewski, L., et al., *Economic Evaluation of a General Hospital Unit for Older People with Delirium and Dementia (TEAM Randomised Controlled Trial).* PLoS One, 2015. **10**(12): p. e0140662.

43.   Meeuwsen, E., et al., *Cost-effectiveness of one year dementia follow-up care by memory clinics or general practitioners: Economic evaluation of a randomised controlled trial.* PLoS ONE, 2013. **8**(11).

44.   Menn, P., et al., *Dementia care in the general practice setting: A cluster randomized trial on the effectiveness and cost impact of three management strategies.* Value in Health, 2012. **15**(6): p. 851-859.

45.   Weinstein, M.C.P., - *How Much Are Americans Willing to Pay for a Quality-Adjusted Life Year? Editorial.* - Medical Care April 2008;46(4):343-345, 2008(- 0025-7079).

46.   Moodie, M., et al., *Cost-effectiveness of a family-based GP-mediated intervention targeting overweight and moderately obese children.* Economics & Human Biology, 2008. **6**(3): p. 363-376.

47.   Bertram, M.Y., et al., *Cost–effectiveness thresholds: pros and cons.*

48.   Woods, B., et al., *Country-Level Cost-Effectiveness Thresholds: Initial Estimates and the Need for Further Research.* Value Health, 2016. **19**(8): p. 929-935.

49.   Gold, M., et al., *Cost-Effectiveness in Health and Medicine.* 1996, New York: Oxford University Press.

50.   Jakubiak-Lasocka, J. and M. Jakubczyk, *Cost-effectiveness versus cost-utility analyses: what are the motives behind using each and how do their results differ?—A Polish example.* Value in Health Regional Issues, 2014. **4**: p. 66-74.

51.   Hounsome, N., M. Orrell, and R.T. Edwards, *EQ-5D as a quality of life measure in people with dementia and their carers: evidence and key issues.* Value Health, 2011. **14**(2): p. 390-9.

52.   Ettema, T.P., et al., *A review of quality of life instruments used in dementia.* Quality of Life Research, 2005. **14**(3): p. 675-686.

53.   Aguirre, E., et al., *How does the EQ-5D perform when measuring quality of life in dementia against two other dementia-specific outcome measures?* Qual Life Res, 2016. **25**(1): p. 45-9.

54.   Li, L., et al., *Utility-Based Instruments for People with Dementia: A Systematic Review and Meta-Regression Analysis.* Value in Health, 2017.

55.   Milte, C.M., et al., *How important is health status in defining quality of life for older people? An exploratory study of the views of older South Australians.* Appl Health Econ Health Policy, 2014. **12**(1): p. 73-84.

56.   Ratcliffe, J., et al., *Does one size fit all? Assessing the preferences of older and younger people for attributes of quality of life.* Qual Life Res, 2017. **26**(2): p. 299-309.

57.   Bulamu, N.B., B. Kaambwa, and J. Ratcliffe, *A systematic review of instruments for measuring outcomes in economic evaluation within aged care.* Health Qual Life Outcomes, 2015. **13**: p. 179.

58.   Easton, T., et al., *Where's the evidence? a systematic review of economic analyses of residential aged care infrastructure.* BMC Health Services Research, 2017. **17**: p. 226.

59.   Mauskopf, J.A., et al., *The Role of Cost—Consequence Analysis in Healthcare Decision—Making.* PharmacoEconomics, 1998. **13**(3): p. 277-288.

60.   Koopmanschap, M.A., et al., *An overview of methods and applications to value informal care in economic evaluations of healthcare.* Pharmacoeconomics, 2008. **26**(4): p. 269-280.

61.   Krol, M., J. Papenburg, and J. van Exel, *Does including informal care in economic evaluations matter? A systematic review of inclusion and impact of informal care in cost-effectiveness studies.* Pharmacoeconomics, 2015. **33**(2): p. 123-35.

62.   Al-Janabi, H., T.N. Flynn, and J. Coast, *QALYs and carers.* Pharmacoeconomics, 2011. **29**(12): p. 1015-23.

63.   Al-Janabi, H., T.N. Flynn, and J. Coast, *Estimation of a preference-based carer experience scale.* Med Decis Making, 2011. **31**(3): p. 458-68.

64.   Al-Janabi, H., N. McCaffrey, and J. Ratcliffe, *Carer preferences in economic evaluation and healthcare decision making.* Patient, 2013. **6**(4): p. 235-9.

65.   McCaffrey, N., et al., *Better informing decision making with multiple outcomes cost-effectiveness analysis under uncertainty in cost-disutility space.* PLoS One, 2015. **10**(3): p. e0115544.

66.   Drummond MF, et al., *Methods for the Economic Evaluation of Health Care Programmes.* Vol. 3rd. 2005, Oxford: Oxford University Press.

67.   Sculpher, M.J., et al., *Whither trial-based economic evaluation for health care decision making?* Health Economics, 2006. **15**(7): p. 677-687.

68.   Mercer, S.L., et al., *Study Designs for Effectiveness and Translation Research: Identifying Trade-offs.* American Journal of Preventive Medicine, 2007. **33**(2): p. 139-154.e2.

69.   Petrou, S. and A. Gray, *Economic evaluation alongside randomised controlled trials: design, conduct, analysis, and reporting.* Bmj, 2011. **342**.

70.   Ramsey, S., et al., *Good Research Practices for Cost-Effectiveness Analysis Alongside Clinical Trials: The ISPOR RCT-CEA Task Force Report.* Value in health, 2005. **8**(5): p. 521-533.

71.   Husereau, D., et al., *Consolidated health economic evaluation reporting standards (CHEERS) statement.* BMC medicine, 2013. **11**(1): p. 80.

72.	Thorn, J.C., S.M. Noble, and W. Hollingworth, *Methodological developments in randomized controlled trial-based economic evaluations.* Expert Review of Pharmacoeconomics & Outcomes Research, 2014. **14**(6): p. 843-856.

73.	Glick, H.A., *Sample Size and Power for Cost-Effectiveness Analysis (Part 2) The Effect of Maximum Willingness to Pay.* Pharmacoeconomics, 2011. **29**(4): p. 287-296.

74.	Glick, H.A., *Sample Size and Power for Cost-Effectiveness Analysis (Part 1).* Pharmacoeconomics, 2011. **29**(3): p. 189-198.

75.	Quasdorf, T., et al., *Implementing Dementia Care Mapping to develop person-centred care: results of a process evaluation within the Leben-QD II trial.* J Clin Nurs, 2017. **26**(5-6): p. 751-765.

76.	Oremus, M., *Systematic review of economic evaluations of Alzheimer's disease medications.* Expert review of pharmacoeconomics & outcomes research, 2008. **8**(3): p. 273-289.

77.	Pouryamout, L., et al., *Economic Evaluation of Treatment Options in Patients with Alzheimer's Disease.* Drugs, 2012. **72**(6): p. 789-802.

78.	Ramsey, S., et al., *Good research practices for cost-effectiveness analysis alongside clinical trials: the ISPOR RCT-CEA Task Force report.* Value Health, 2005. **8**(5): p. 521-33.

79.	Siegel, J.E., et al., *Recommendations for reporting cost-effectiveness analyses. Panel on Cost-Effectiveness in Health and Medicine.* Jama, 1996. **276**(16): p. 1339-41.

80.	Drummond, M.F. and T.O. Jefferson, *Guidelines for authors and peer reviewers of economic submissions to the BMJ. The BMJ Economic Evaluation Working Party.* BMJ, 1996. **313**(7052): p. 275-83.

81.	McGhan, W.F., et al., *The ISPOR Good Practices for Quality Improvement of Cost-Effectiveness Research Task Force Report.* Value Health, 2009. **12**(8): p. 1086-99.

Table 1: Decision rules for economic evaluations (new intervention vs. comparator)

Scenarios	Cost	Outcome	Interpretation
1	↑	↑	Cost-effective if the willingness-to-pay exceeds the ICER
2	↓	↑	Cost-effective (new intervention dominates the comparator)
3	≈	↑	Cost-effective (new intervention dominates the comparator)
4	↑	↓	Not cost-effective (comparator dominates the new intervention)
5	↓	↓	Cost-effective if the ICER exceed the willingness-to-accept threshold
6	≈	↓	Not cost-effective (comparator dominates the new intervention)
7	↑	≈	Not cost-effective (comparator dominates the new intervention)
8	↓	≈	Cost-effective (new intervention dominates the comparator i.e. cost-saving)
9	≈	≈	Not cost-effective (new intervention and comparator are equal)

Abbreviation: ↑: statistically significantly higher; ↓: statistically significantly lower; ≈: no statistical significant differences

Table 2: Detailed characteristics of the identified studies

First author, year, country	Analysis; Study design	Intervention	Comparator	Target population; Sample size	Perspective; Time horizon	Costs items	Currency, Price year	Outcomes measures	ICER	Sensitivity analysis	CHEERS checklist	Funding source
Home/ community care												
Challis, 2002, UK [26]	CEA; Quasi experimental	Intensive case management in community-based care	Usual care	Diagnosed with dementia with perceived risk of institutionalization, 43 matched pairs	NM; 24 months	Long-term care, day care, home care, hospital care, respite care, professional visits, social services, personal expenditures, housing, care givers	GBP; NM	Social contacts, stress for caregivers, overall need reduction, aspects of daily living, level of risk etc.	ICER not mentioned. Intensive case management had some benefits to the patients such as aspects of daily living, overall need.	No sensitivity	16	Govt. and non Govt.
Duru, 2009, USA [27]	CMA; Cluster RCT	Care management at home	Usual care	Dementia patients aged ≥65 and their caregivers, Intervention =170, UC=126	Payer and societal perspective; 18 months	Inpatient, outpatient, healthcare at home and informal care	USD; NM	Healthcare Resources utilization	Cost do not differ significantly, -$555 (p=0.28)	DSA	21	Govt.
Kuo, 2010, Taiwan [28]	CUA; Cross sectional	Institutional care	Home care	Dementia patients and their caregivers; intervention=51 pairs, HC=89 pairs	NM	Medications, food and equipment, care services, transportation, caregiver's productivity loss	NTD; NM	QALY	ICER not mentioned. Home care had higher QALY and low cost	No sensitivity	15	NM
Long, 2014, USA [29]	CMA	Enhanced support for caregivers	Usual care	Spouse and adult children of dementia patients; modelling study	Healthcare; 15 years	Medical care, assisted living costs and nursing home	USD; 2011	Healthcare Resources utilization	Cost saving is $996 million in 15 years ($100 million to $2.64 billion)	Scenario analyses	20	Govt. and non Govt.
Klug, 2014, USA [30]	CMA	Support for caregivers	Usual care	Dementia patients and their caregivers. 951 patients and 1,750 caregivers	Healthcare; 42 months	Medical care and costs for nursing home	USD; 2011	Delayed replacement to nursing home, caregivers' empowerment	Cost saving 39.8 million in two years	No	19	Govt. and non Govt.
Interventions at the institutional care settings												
Chenoweth, 2009,	CEA; RCT	Person-centred care (PCC),	Usual care	Dementia patients in residential	4 months intervention and 4	Intervention and drug	AUS, 2008	Cohen-Mansfield agitation inventory (CMAI)	AUS$ 8.01 for PCC and AUS$ 48.95 for DCM	DSA	20	Govt.

Australia [31]		dementia-care mapping (DCM)		care; PCC=109, DCM=98, UC=82	months follow-up; NM				per CMAI point averted after intervention and AUS$ 6.43 and AUS$ 46.89 at follow up, respectively.			
van de Ven, 2014, NED [32]	CMA; Cluster RCT	Dementia-care mapping (DCM)	Usual care	Dementia patients residing in nursing home and their caregivers; DCM=154, UC=164	Health care; 18 months	Intervention, outpatient, inpatient and nursing home health care professional	USD; 2010-12	Healthcare Resources utilization	Cost neutral	No sensitivity	19	Govt.
Zwijsen, 2015, NED [40]	CEA, CUA; Cluster RCT	Managing challenging behaviour without providing psychoactive medication in a dementia care unit	Usual care	Dementia patients residing in dementia special care unit, intervention=325, UC=327	Societal, 20 months (mean duration)	Medication and intervention	Euro; NM	CMAI, QALY, QUALIDEM, sickness absence, number of medications	Dominated by Usual care. Cost was €82 higher and QALY loss was 0.02	Bootstrap	21	Govt.
Hakkaart-van Roijen, 2013, NED [41]	CEA, CUA; RCT	Psychotherapeutic nursing home program	Multidisciplinary nursing home care	People with dementia and cognitive disorders; Intervention=81 and comparator group=87	NM; 3 months intervention 6 months follow-up	Home care, daily care, hospital care, nursing home, assisted living residence	Euro, 2004	Neuropsychiatric Inventory (NPI) score, Caregivers burden (CB), caregiver's competence (CCL), QALY	ICER for NPI=€ 323; CB=€129; CCL=€540 and QALY=€276289	No sensitivity	19	Govt.
Interventions at the hospital or general practitioner setting												
Tanajewski, 2015, UK [42]	CUA; RCT	A specialist unit for people with delirium and dementia	Usual care	Cognitive impairment, aged ≥65, intervention=109, UC=100	Societal; 3 months	Inpatient, day-case, outpatient, primary care, critical care, ambulance services, mental health trust, social care, intervention	GBP, 2011/2012	QALY	Intervention dominates UC. Cost reduction was £149 and QALY gain was 0.001	PSA	21	Govt.
Meeuwsen, 2013, NED [43]	CUA; RCT	Memory clinic	GP care	People with mild to moderate dementia; MC=83, GP care=77	Societal; 12 months	Intervention, outpatient, medication, inpatient, home care, day care, nursing	Euro, 2009	QALY	€41,442 per QALY loss	No sensitivity	19	Govt.

| Study	Analysis	Intervention	Comparator	Population	Perspective; Time horizon	Cost items	Currency	Outcomes	Results	Sensitivity analysis		
						home, physiotherapy, occupational therapy, productivity loss, informal care						
Menn, 2012, Germany [44]	CEA; RCT	Dementia care at GP setting	GP not trained in dementia care	Mild to moderate dementia patients aged ≥ 65 and their caregivers, 390 pairs	Societal; 2 years and 4 years	Inpatient and outpatient care, prescribed drugs, rehabilitation, medical aids, and nonphysical services, informal care givers and intervention	Euro, 2008	Time to institutionalization, BSFC, MMSE, ADL, IADL, QALY	Neither cost nor effect differ significantly	DSA	20	NM

Table 3: Reported and evaluated cost-effectiveness of the identified management interventions

First author, year, country	Effectiveness measures	Reported	Evaluation	Remarks
Home/community care				
Challis, 2002, UK [26]	Healthcare Resources utilization	Did not report cost-effectiveness	Significance tests for parts of costs and effects were provided but the total cost and effects were not summed up	Unknown due to lack of information
Duru, 2009, USA [27]	Healthcare Resources utilization	Not cost-effective	Significance test did not show any difference in cost between the intervention and usual care group	Not cost-effective
Kuo, 2010, Taiwan [28]	QALY by EQ-5D	Did not report cost-effectiveness	No significant differences in QALYs were observed. Significant differences in cost were observe. For low dependency population home care had significantly lower cost and for high dependency population institutional care had significantly lower cost	Cost-effective depending on the dependency level of the dementia patients
Long, 2014, USA [29]	Healthcare Resources utilization	Cost saving	No significance test was available	Unknown due to lack of information
Klug, 2014, USA [30]	Healthcare Resources utilization	Cost saving	No significance test was available	Unknown due to lack of information
Interventions at the institutional care settings				
Chenoweth, 2009, Australia [31]	CMI, number of falls	Did not report cost-effectiveness	Significance differences in CMAI and number of falls were presented. No significance test was presented for cost	Cost-effective
van de Ven, 2014, The Netherlands [32]	Healthcare Resources utilization	Cost-neutral	No significant differences in total cost were observed	Not cost-effective
Zwijsen, 2015, The Netherlands [40]	CMAI, QALY by EQ-5D, QUALIDEM	Not cost-effective	Cost was significantly higher and QALY was significantly lower for the intervention group	Not cost-effective
Hakkaart-van Roijen, 2013, The Netherlands [41]	QALY by EQ-5D, NPI, CB, CCL	Not cost-effective	No significant differences in costs and QALYs were observed. Significant differences in NPI, CB and CCL were observed.	Not cost-effective (QALY). Cost-effective (NPI, CB, CCL).
Interventions at the hospital or general practitioner setting				
Tanajewski, 2015, UK [42]	QALY by EQ-5D	Dominant	No significant differences in costs and QALYs were observed. CEAC showed 78% probability to be cost-effective at £30,000 WTP for complete cases. 90% probability to be cost-effective at £30,000 WTP for full cases (imputation) analysis	Weakly cost-effective
Meeuwsen, 2013, The Netherlands [43]	QALY by EQ-5D	Not cost-effective	No significant differences in costs and QALYs were observed. CEAC showed 55% probability to be cost-effective at £30,000 WTP	Not cost-effective
Menn, 2012, Germany [44]	QALY by EQ-5D	Not cost-effect	No significant differences in costs and QALYs were observed.	Not cost-effective

Abbreviations: QALY, Quality Adjusted Life Years; QUALIDEM, Quality of life Dementia; ICER, Incremental Cost-Effectiveness Ratio; CEAC, Cost-Effectiveness Acceptability Curve; NPI, Neuropsychiatric Inventory; CB, caregiver's burden; CCL, Caregivers' competence

Figure 1: A flow chart for selection of articles
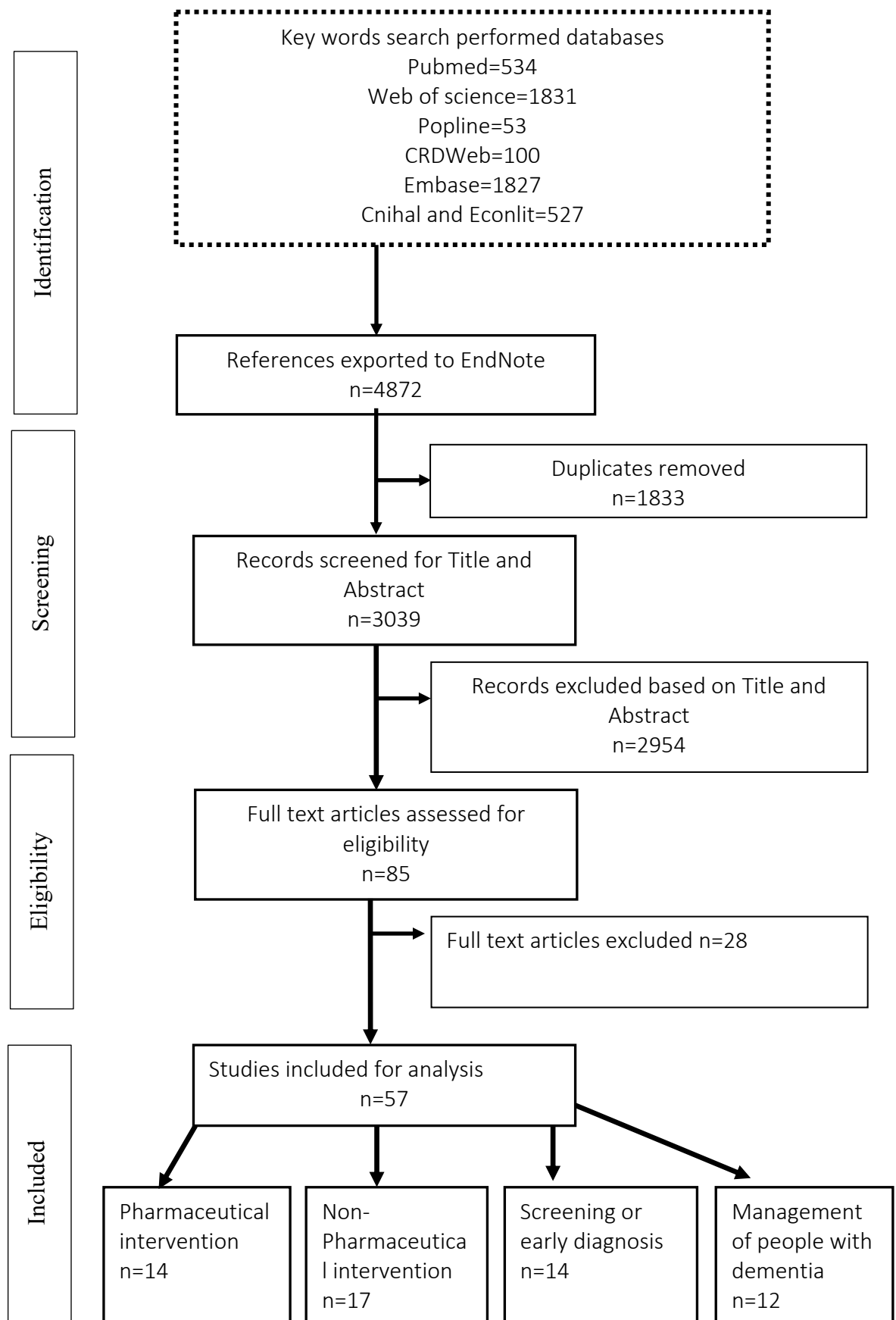
Annex 1: Detailed search history in databases with keywords

Pubmed

("economic evaluation"[All Fields] OR "cost-benefit analysis"[MeSH Terms] OR "cost-effectiveness"[All Fields] OR "cost-benefit analysis"[MeSH Terms] OR "cost-benefit analysis"[MeSH Terms] OR "cost benefit"[All Fields] OR "cost utility"[All Fields] OR "cost-utility"[All Fields]) AND ((("dementia"[MeSH Terms] OR "dementia"[All Fields]) OR "dementia"[MeSH Terms]) OR "mild cognitive impairment"[All Fields]) AND (("2000/01/01"[PDAT] : "2015/12/31"[PDAT]) AND English[lang])

= 534

CRDWeb

((dementia)) and ((Economic evaluation:ZDT and Bibliographic:ZPS) OR (Economic evaluation:ZDT and Abstract:ZPS)) IN NHSEED FROM 2000 TO 2016

=100

EMBASE

1. 'dementia'/exp OR dementia

2. 'cost effectiveness' OR 'cost utility' OR 'cost benefit analysis' OR 'economic evaluation'
3. 'mild cognitive impairment':ab
4. #1 OR #3
5. 'cost consequence analysis'
6. #2 OR #5
7. #4 AND #6
8. #7 AND (2000:py OR 2001:py OR 2002:py OR 2003:py OR 2004:py OR 2005:py OR 2006:py OR 2007:py OR 2008:py OR 2009:py OR 2010:py OR 2011:py OR 2012:py OR 2013:py OR 2014:py OR 2015:py)

=1827

Web of science

1. TOPIC: Dementia
2. TOPIC: Mild cognitive impairment
3. TOPIC: Alzheimer
4. TOPIC: Vascular dementia
5. TOPIC: Parkinson's disease
6. 1 OR 2 OR 3 OR 4 OR 5
7. TOPIC: (cost effectiveness) OR TOPIC: (cost-effectiveness analysis) OR TOPIC: (cost-effectiveness) OR TOPIC: (cost utility analysis) OR TOPIC: (cost-utility analysis) OR TOPIC: (cost benefit) OR TOPIC: (cost-benefit) OR TOPIC: (economic evaluation)
8. 6 AND 7 (Refined by: Publication Years (2000 to 2015))
9. 8 (Refined by: Language (English)

= 1831

1. Dementia
2. AB dementia
3. AB dementia OR mild cognitive impairment
4. Cost effectiveness
5. Cost benefit analysis
6. Cost utility analysis
7. Cost-utility analysis in healthcare
8. Economic evaluation
9. Cost consequences analysis in health economics
10. 4 OR 5 OR 6 OR7 OR 8 OR 9
11. 10 AND 3
12. 11 (limiters- 20000101-20151231)

= 527

Popline
1. ((((Title:dementia) OR (Title:alzheimer)))) AND ((Language:English) AND (Publication Year:[2000 TO 2015]) AND (Peer Reviewed:1) AND (Journal Article:1))

2. ((((Title:cost effectiveness analysis) OR (Title:cost utility analysis) OR (Title:economic evaluation) OR (Title:cost benefit analysis)))) AND ((Language:English) AND (Publication Year:[2000 TO 2015]) AND (Peer Reviewed:1) AND (Journal Article:1))

3. 1 OR 2

= 53