Transitions between Care Settings in Dementia: Are They Relevant in Economic Terms?

Sven Lueke, PhD1,2,*, Wolfgang Hoffmann, PhD2,3, Steffen Fleßa, PhD1
1Faculty of Law and Business Administration, Chair of Business Administration and Health Care Management, Greifswald, Germany; 2German Center for Neurodegenerative Diseases (DZNE), Rostock/Greifswald, Greifswald, Germany; 3Institute for Community Medicine, University Medicine Greifswald, Greifswald, Germany

ABSTRACT

Objectives: This study was performed to assess the economic effect of interventions affecting transitions between dementia care settings in Germany. Methods: A Markov-model that models the course of dementia with respect to typical care setting transitions was derived. Model data and parameters were retrieved by literature reviews. A deterministic and probabilistic sensitivity analysis was conducted to account for parameter uncertainty. Results: In the base case, the expected present value of remaining lifetime costs is €25,326 for each cohort member. As a function of effectiveness, pharmaceutical interventions may reduce the costs by 2% to 13% and psychosocial interventions come with savings of 1% to 10%. A structural intervention-promoting group living as a substitute for nursing home care increases costs by 2% to 8%. Sensitivity analyses indicate high variance and variability of results, as well as valuation of informal care being a crucial parameter. Conclusions: There are economic benefits of delayed transitions to institutional settings, especially from the viewpoint of statutory care insurances, but these do unlikely exceed intervention costs. Thus, further intervention effects should be considered. Ultimately, concentrating research on preventive and protective factors of dementia could lead to an efficient intervention from every perspective. Keywords: cost, dementia, group living, modeling, nursing home.

Introduction

Dementia and its underlying diseases (e.g., Alzheimer’s disease), epidemiology, and economic impact are well studied, but there are still some unresolved issues. First, the biomedical causes and effects of degenerative processes are not completely understood. For example, though there are correlations between dementia and mortality, there is currently no identifiable causal connection [1]. Second, the cost of illness of dementia is well known but does barely correlate with the progression of cognitive decline [2,3]. Thus, it is barely possible to predict the economic effects of innovative interventions slowing down progression. Current intervention concepts, nevertheless, focus on slowing down cognitive decline.

Interestingly, a reliable cost predictor is the setting of the care situation, whereby each setting is associated with certain types of cost in varying amounts. In the case of a transition from home to a nursing home, informal care is replaced by formal care, for example. Only few studies have dealt with this issue [4,5]. Furthermore, a transition may have economic effects on different payer perspectives.

The aim of this article was to analyze the economic effects of interventions affecting transitions between care settings, namely, from societal and payer perspectives. The analysis was exemplified on the basis of the care situation in Germany, a health care system with three separate payer entities: statutory health insurance (Gesetzliche Krankenversicherung), statutory care insurance (Soziale Pflegeversicherung), and patients (households).

Methods

The course of dementia depicts a continuous, vectored decline of cognitive ability and other functions. For the purpose of this analysis, a Markov-modeling study was conducted. The model consists of six states: a state of healthy population (sHealthy), a state of dead population (sDead), and four states for people with dementia in different care settings. These care settings are living at home with formal care (sHomeMinus), living at home with formal and, in addition, informal care (sHomePlus), living in a group living facility (sGroupLiving), and living in a nursing home (sNursingHome). Several transitions between the states are possible, as depicted in Figure 1.

Starting from sHealthy, each population member is at risk to develop dementia that is also diagnosed or to die (going to sDead) per cycle. The state sHealthy comprises the initial population, that is, the population without dementia, but at risk of developing dementia. Therefore, no costs specific to dementia were associated
with this state. Likewise, the state sDead, representing the dead population of the model cohort, is not associated with any costs.

The population with newly diagnosed dementia will go to sHomePlus and sHomeMinus, respectively. This means that a proportion of people with newly diagnosed dementia lives in a care setting in which formal care is provided and, in addition, support from informal caregivers (family and friends) is available (sHomePlus). For this reason, this state comprises formal care costs (e.g., professional home care) and informal care costs (e.g., caregiver time for care and support). The other proportion of people with newly diagnosed dementia lives in a care setting in which informal support is not available (sHomeMinus). As a consequence, only formal care costs are relevant.

With each modeling cycle, there are different transitions between care settings possible, which were identified on the basis of empirical evidence [6,7]. Possible transitions occur from sHomePlus and sHomeMinus to sGroupLiving, sNursingHome, and sDead. The state sGroupLiving represents a small institution-based facility that provides dementia-specific formal care and accommodation in a familiar group (8–12 people). The state sNursingHome represents an institution-based facility as well, but here on a larger scale. Thus, both institution-based care settings have specific formal care costs and also differing cost of living in contrast to home-based care settings (sHomePlus and sHomeMinus). A transition from sHomePlus to sGroupLiving or sNursingHome illustrates the collapse of informal care at home. Common reasons for this collapse are caregivers’ illness or burden due to severe deterioration in patients’ cognitive and functional abilities. Consequently, a home-based care is not feasible anymore. Likewise, transitions occur from sHomeMinus but, because of the absence of informal support and restricted independence, at an earlier point of time. There are several transitions from sGroupLiving. A worsening health state may necessitate a comprehensive care in a nursing home (transition to sNursingHome). Also, returning home from sGroupLiving (because of dissatisfaction, for example) is possible, because cognitive and functional decline may not have reached an advanced state yet. Because of its degenerative course, people with dementia are likely to stay in sNursingHome. Nevertheless, there are also transitions from sNursingHome to sGroupLiving because some residents favor a more familiar care setting.

The model structure refers to the disease progression of dementia by taking a multidimensional instead of a single-dimensional decline (e.g., Mini-Mental State Examination scale) into consideration. This multidimensional decline is marked by declines in cognition, function (e.g., activities of daily living), and behavior (e.g., agitation and wandering), expressing an overall grade of dependency. In turn, the grade of dependency determines the need for institutional care (nursing home) and the expected level of caregiver burden and is a causal predictor for care costs [2,3].

The model states are associated with several parameters, namely, transition rates to other states and specific costs. The model parameters were retrieved by searching scientific databases (PubMed, PsycINFO, Springerlink, Thieme) for reviews or field studies, respectively. Furthermore, relevant national scientific reports were included, for example, on group living and care situation of elderly and people with dementia in Germany. Table 1 outlines the transition rates of the model, which were standardized on 1 year.

The age-specific mortality rates are based on mortality tables of the Federal Bureau of Statistics (Statistisches Bundesamt) [8]. The product of the age-specific incidence rates and a constant diagnostic detection rate (81.5%) equals tpDiag 1 and tpDiag 2, that is, the transition probabilities from sHealthy to sHomePlus and sHomeMinus for each cycle [9,10]. Table 2 displays the cost parameters of the model, which refer to the Markov states sHomePlus, sHomeMinus, sGroupLiving, and sNursingHome.

The cost of living in sHomePlus and sHomeMinus was assumed to be identical because most of the informal caregiving is provided by people who often do not live in the same home (e.g., daughter-in-law) [6]. Also, the cost of formal care was assumed to be the same in sHomePlus and sHomeMinus. The assumption is that the need for professional care does not depend on the existence of informal support because informal care is rather seen as an add-on

---

**Table 1 – Transition rates.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>tpDeath</td>
<td>Transition rate from all states to sDeath</td>
<td>Age-specific</td>
<td>Statistisches Bundesamt [8]</td>
</tr>
<tr>
<td>tpDiag1</td>
<td>Transition rate from sHealthy to sHomePlus</td>
<td>Age-specific</td>
<td>Bickel [9], Boustani et al. [10]</td>
</tr>
<tr>
<td>tpDiag2</td>
<td>Transition rate from sHealthy to sHomeMinus</td>
<td>Age-specific</td>
<td>Bickel [9], Boustani et al. [10]</td>
</tr>
<tr>
<td>tpHomePlus</td>
<td>Transition rate from sGroupLiving to sHomePlus</td>
<td>0.083</td>
<td>Wolf-Ostermann [7]</td>
</tr>
<tr>
<td>tpHomeMinus</td>
<td>Transition rate from sGroupLiving to sHomeMinus</td>
<td>0.083</td>
<td>Wolf-Ostermann [7]</td>
</tr>
<tr>
<td>tpGroupLiving1</td>
<td>Transition rate from sHomePlus to sGroupLiving</td>
<td>0.01</td>
<td>Assumption: 1% per year</td>
</tr>
<tr>
<td>tpGroupLiving2</td>
<td>Transition rate from sHomeMinus to sGroupLiving</td>
<td>0.01</td>
<td>Assumption: 1% per year</td>
</tr>
<tr>
<td>tpGroupLiving3</td>
<td>Transition rate from sNursingHome to sGroupLiving</td>
<td>0.045</td>
<td>Wolf-Ostermann [7]</td>
</tr>
<tr>
<td>tpNursingHome1</td>
<td>Transition rate from sHomePlus to sNursingHome</td>
<td>0.181</td>
<td>Lupp et al. [11]</td>
</tr>
<tr>
<td>tpNursingHome2</td>
<td>Transition rate from sHomeMinus to sNursingHome</td>
<td>0.267</td>
<td>Eby et al. [12]</td>
</tr>
<tr>
<td>tpNursingHome3</td>
<td>Transition rate from sGroupLiving to sNursingHome</td>
<td>0.093</td>
<td>Wolf-Ostermann [7]</td>
</tr>
</tbody>
</table>

sDead, a state of dead population; sHealthy, a state of healthy population; sHomeMinus, living at home with formal care; sHomePlus, living at home with formal and informal care; sGroupLiving, living in a group living facility; sNursingHome, living in a nursing home.
service to formal care, thus sustaining home care for an extended period of time. Therefore, a lack of informal support assumingly results in a premature transition to an institutional setting.

The informal care costs were calculated by applying the replacement cost approach [21]. For that, each hour of informal care (on average 12.34 h/wk [14]) was valued with €22.47 (average cost per hour of a professional care service [15]). In case of relevance, an expected percentage of costs was calculated for each payer by the use of legal maximum payment-offsets for payer institutions (SPV) [22]. The cost of living (cHomeLiving, cGroupLivingLiving, cNursingHomeLiving) was balanced to cLiving; that is, this cost type reflects additional or saved expenses on living due to nursing home admissions.

A cohort simulation was performed, whereby one modeling cycle represents 1 year. The initial population consisted of 100,000 healthy people aged 65 years. Thirty-five years were modeled, leaving the survivors at an age of 100 years. All costs were discounted at 5% per annum.

The effect of three hypothetic interventions was analyzed, namely, a pharmaceutical intervention, a psychosocial intervention, and a structural intervention. The pharmaceutical intervention slows down cognitive decline in the course of dementia and affects all people with dementia in the model (model states: sHomePlus, sHomeMinus, sGroupLiving, and sNursingHome). The intervention affects the transition rates from sHomePlus and sHomePlus to sGroupLiving (tpGroupLiving 1 and 2) and sNursingHome (tpNursingHome 1 and 2) because the slowdown of disease progression results in a delayed institution-based care. As a reference point for the cost of this hypothetic intervention, a pharmaceutical intervention, a psychosocial intervention, and a structural intervention (pharmaceutical, psychosocial, structural, and primary preventive) have a constant effect on the targeted population with each modeling cycle.

To estimate the robustness of results, a deterministic sensitivity analysis was performed to examine results' dependence on single parameters. Also, a probabilistic sensitivity analysis that analyzes parameter uncertainty from a multivariate viewpoint was performed. Because there are only few data on variance and variability of parameters for the probabilistic analysis, theoretical parameter distributions such as triangular and gamma distributions were chosen. The assumptions and estimations made are displayed in Table 3.

A triangle distribution was applied in case only very limited data were available for the distribution of costs and transition probabilities. A gamma distribution was applied for some of the data with evidence on the shape of the distribution.

Because modeling means to reduce complexity, several assumptions have to be made. First, the model structure ignores alternative risks of institutionalization and does not allow transitions to depend on earlier transitions as is characteristic for Markov models. Second, dementia is assumed to have no specific impact on mortality. And third, the different care settings are not supposed to influence quality of life, medical costs, or mortality.

Results

The simulation of the base case shows the model results in the default, that is, without any intervention. After half of the model runtime, roughly half of the initial population is still healthy, while 10% have dementia and approximately 40% are dead. The remaining lifetime risk for dementia is 33%. The expected present value of remaining lifetime costs is €25,326 per cohort member.
A closer look at these costs of care reveals that especially institutional care sums up to more than half of the costs (cGroupLivingCare, €2,508; cNursingHomeCare, €11,526). The cost for informal care (cInfCare) is likewise a relevant cost type summing up to €7,266, whereas the cost of formal care at home (cFormCare) is €3,055. A comparably minor cost type is cDiagnostics with €32. Considering the cost of living, €939 extra expenses are necessary due to nursing home admissions.

In case of decreasing the age-specific incidence rate of dementia (primary prevention) in certain effectiveness intervals without intervention costs, the expected present value of remaining-lifetime costs of dementia care is €19,809 (25% effectiveness), €13,806 (50%), €7,237 (75%), and €0 (100%), respectively.

In the first intervention scenario, the progression of dementia is slowed down by means of a pharmaceutical intervention leading to a decrease in the institutionalization rates of institutional care facilities (group living, nursing home). Table 4 compares the results with the base case depending on effectiveness.

The intervention gradually reduces expenses for institutional care costs, while formal and informal care costs are increased on a remaining-lifetime scope. Both the statutory care insurance and patients benefit from saved costs because of delayed or averted institutionalizations. However, the largest share accounts for the statutory care insurance with approximately 85% of savings. Taking the costs of the current drug treatments into account (expected costs, €1778 per person), an effectiveness of approximately 75% is needed for a break-even. This means that the transition probability to institution-based care has to be decreased by 75% to reach savings equal to the intervention costs. In case only people with dementia at home receive respective medications, an effectiveness of 50% is needed.

In a second intervention scenario, a psychosocial intervention enhancing caregiver’s coping strategies is introduced. The enhancement leads on to the ability to care for a spouse with dementia or a relative for an extended period of time. Accordingly, this intervention affects the population in sHomePlus only. In this scenario, the expected total costs are reduced by €349 (25% effectiveness), €920 (50% effectiveness), €1483 (75% effectiveness), and €2276 (100% effectiveness). In correspondence with a pharmaceutical intervention, costs are also saved because of delayed or averted institutionalizations. Because of its restricted effect range, the savings are slightly lower. Solely the statutory care insurance benefits from the intervention, whereas the patients’ budget is neither debited nor credited.

The third intervention scenario is an increasing share of institutionalizations in favor of group living instead of nursing home care; that is, the structure of institutionalized care for people with dementia is changed. In this scenario, the total costs are increased by €389 (25% effectiveness), €822 (50% effectiveness), €1305 (75% effectiveness) and €1845 (100% effectiveness). The results show that promoting group living leads on to a higher expected present value of remaining-lifetime costs in dementia care. The reason is that care costs in group living facilities exceed nursing home care costs by far. The cost of nursing home care is reduced by €1797 to €8416, whereas the cost of group living is increased by €2101 to €9876. Yet, there are savings related to the cost of living (e.g., €539 at 50% effectiveness). Despite this fact, the statutory care insurance benefits from this intervention, starting from €517 to €2418. Patients, however, are debited from €906 up to €4,263.

As a matter of course, all results depend on parameter validity. Figure 2 shows the responsiveness of the base-case results to several parameters.

The discount rate (base case, 5%) and valuation of informal care time affects the relative validity. The discount rate is relevant in terms of absolute effects only, whereas using varying valuation methods for informal care time affects the relative advantageousness of interventions.

The probabilistic sensitivity analysis provides information on the results’ variance, within the limits of assumptions made. The expected present value of remaining-lifetime costs is €24,641 with a standard deviation of €13,889. The confidence interval (95%) lies between the boundaries €14,320 and €36,396.

Discussion

The analyses show that there are certain economic effects when transition rates in dementia care are affected. This fact is pivotal for public health issues. The planning and implementation of innovative care strategies requires interventions to be effective.
Table 4 – Interventional effects.

<table>
<thead>
<tr>
<th>Cost type</th>
<th>Base case</th>
<th>Effectiveness a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Pharmaceutical</td>
<td>25%</td>
<td>32</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>32</td>
<td>3,055</td>
</tr>
<tr>
<td>Structural</td>
<td>25%</td>
<td>7,266</td>
</tr>
<tr>
<td>cDiagnostics</td>
<td>72%</td>
<td>11,526</td>
</tr>
<tr>
<td>cFormCare</td>
<td>2,508</td>
<td>939</td>
</tr>
<tr>
<td>cInfCare</td>
<td>2,508</td>
<td>939</td>
</tr>
<tr>
<td>cGroupLivingCare</td>
<td>11,526</td>
<td>939</td>
</tr>
<tr>
<td>cNursingHomeCare</td>
<td>25%</td>
<td>2,508</td>
</tr>
<tr>
<td>Living</td>
<td>939</td>
<td>806</td>
</tr>
<tr>
<td>Total</td>
<td>25,326</td>
<td>24,843</td>
</tr>
</tbody>
</table>

Note. All costs in euro (€).

a Effectiveness means gradual decrease in institutionalization risks (pharmaceutical and psychosocial intervention) and gradual substitution of nursing home care in favor of group living.

and efficient as well. Affecting transition rates in dementia care is an important lever to avoid wasting health care resources.

However, interventions need a presumably high effectiveness to yield a suitable cost-efficiency. There are some pharmaceutical drugs available that claim to slow down cognitive decline in dementia, for example, acetyl cholinesterase inhibitors and N-Methyl-D-aspartate-antagonists. Current medications have not yielded proven major effects on slowing down cognitive decline but have shown some limited impact on the course of dementia [24]. Taking current medication prices into account, at least 50% to 75% effectiveness is needed for a balanced result between intervention costs and economic effects. Although a pharmaceutical intervention would be particularly beneficial for the statutory care insurance, the effectiveness needed presents a major obstacle for cost-efficiency.

Because psychosocial interventions solely focus on caregivers of informal care, effectiveness has to be even larger than in the pharmaceutical intervention or intervention costs have to be very low to reach cost-efficiency. Fostering group living is presumably not associated with specific intervention costs, but at the moment this is an even more expensive option compared with nursing homes. Interestingly enough, German care policy tends toward promoting group living as an alternative to nursing homes.

Because Germany has various payer institutions in the health care system, each transition affected also has effects on payer budgets. The interventions described focus mainly on crediting statutory care insurance, while patients’ expenses will just slightly decrease or even increase. Can this result be applied to other health care systems? A comparison in quantitative terms is difficult for various reasons, for example, differing financing systems, health services, and cost structures. So, the model’s transition probabilities and costs assumingly vary among different health care systems. However, the results’ qualitative statement is assumingly valid for other health care systems: interventions intending to avoid institutionalizations lead on to a shift from formal care cost to informal care cost. From an economic point of view, cash costs (formal care) are replaced by noncash costs (informal care).

Comparisons to other economic models of dementia are hardly possible. On the one hand, informal care costs are often not considered (see Jones et al. [5]), so avoiding nursing home admissions would lead to an even higher cost-effectiveness. On the other hand, most studies still focus on using cognitive states as a predictor for care cost, for example, Neumann et al. [4]. Interestingly, values of transition probabilities widely vary between models, and even across the published literature. A systematic review from Lupp et al. [11], which served as a basis for the present analysis, identifies annual transition probabilities ranging between 4.5% and 44% from home-based to institutional care. In contrast, Spackman et al. [25] exemplified by means of a multinomial logistic model that the respective transition probabilities may be even lower (1.2%–6.6% per year), whereby only Alzheimer’s disease was included [25]. Although the costs of dementia are well known, there are still knowledge gaps regarding transition probabilities.

Limitations

There are some methodological limitations in the study that correspond to the basic assumptions of the model. First, alternative risks of institutionalization were not considered, though there might be other reasons of nursing home admissions. This means that the model slightly overestimates the effect of transitional interventions because a certain proportion is institutionalized because of other reasons. Furthermore, in a Markov model, transitions do not depend on earlier transitions. In reality, a
transition between settings may influence the probability of future transitions. For example, an undiagnosed dementia case would have a higher chance of being detected in the future because diseases’ progression would become more obvious.

Second, dementia was defined as having no specific mortality rate. There is knowledge about how people with dementia die [26] and when they die [1], but there is a lack of causal connection between dementia and death. A specific dementia mortality rate would affect the modeling results in so far that less time is spent in care settings. As a consequence, all costs would absolutely decrease in the model runtime.

Third, quality of life, mortality, and medical costs were assumed to be equal in all care settings and so these costs can be neglected. The question whether dementia is associated with restrictions in quality of life is arguable. Currently, there are no unquestioned instruments measuring quality of life in dementia and, even so, are ill suited for economic evaluation purposes [27]. One explanation is that there is no subjective decrease in quality of life in dementia at all. From a medical point of view, this concludes from the inability of patients with advanced dementia to perceive their cognitive deterioration [28]. Another possible explanation would be that current instruments are not sensitive enough to measure quality of life in dementia. Nevertheless, there are definitely studies needed to prove the effects of care settings on quality of life, mortality, and medical costs.

Sensitivity analyses showed expectedly high variances and standard deviations with discount rate and valuation of informal care as crucial parameters. The valuation of informal care was performed by applying the replacement cost approach. Anyhow, there are still methodological challenges in assessing and valuing informal care [21,29].

### Conclusions

Interventions affecting transitions between care settings are definitely related to economic effects. Within the limitations of the modeling and simulation procedure, the results show that there are some benefits in modifying transition rates. Nevertheless, interventions presumably need a high effectiveness to exceed the particular intervention costs. Apart from this, the benefits of all interventions go most likely to the statutory care insurance. Interestingly, group living is a favored and fostered care setting in Germany, though the present analysis shows benefits mainly from an statutory care insurance’s perspective. From a public health perspective, these insights help in planning effective and efficient interventions. This may lead on to a more factual discussion on cost-efficiency in innovative dementia care strategies.

Further on, additional research in the field of care setting transitions is needed, especially on transition rates, causes of institutionalization, as well as costs. Also, there is a strong focus on research on easing the burden of existing dementia cases, but only few concentrate on preventive and protective factors for future generations—a likewise effective and efficient strategy in the long term.

Source of financial support: The authors have no other financial relationships to disclose.

### Supplemental Materials

Supplemental materials accompanying this article can be found in the online version as a hyperlink at http://dx.doi.org/10.1016/j.jval.2014.06.008 or, if a hard copy of article, at www.valueinhealthjournal.com/issues (select volume, issue, and article).

### References


