Effectiveness and efficiency for ambulatory care assisted by mobile technological devices

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Abstract

In our paper, we evaluate the impact of a mobile assistive technology (MAT) that may increase the self-sufficiency and autarky of end users and informal caregivers in aspects of costs of care and quality of life. The focused mobile assistive system aims at reducing the patient's probability to need inpatient care. We use a Markov model that encompasses stage depended costs for dementia. Stages represent care arrangements that may be directly influenced by the mobile device and its corresponding service structure. A random virtual sample of about 300.000 people aged 65 and more was included. A continuous incidence of 3.2 % is assumed. We compute the cumulative cost-effectiveness after eight years which is a proxy for the maximum period of living with dementia and predict a surplus of 1,892 additional life years gained in outpatient setting using the mobile technology advice. Moreover, there is a cumulative cost advantage of about € 69 million. The economic impact of an assistive technology presumes a high level of acceptance but the research has to go on to elaborate different countervailing effects.

1 Introduction

Considering the challenge of age-related diseases with chronic characteristics like dementia, there is an increased need of organized care for informal caregivers. Thus, the role and number of professional care services and long-term care institutions will be even more relevant. Particularly, geriatric diseases like dementia are an increasing challenge for families because in most industrialized countries family members have cared for the elderly without any professional assistance [1].

Relating to literature two strands can be mentioned. A first line of literature stresses the potential interaction between formal and informal caregiving which relates to the scope and effectiveness of organisational assistance for outpatient caregiving [2]. Papers like *Van Houten and Norton* (2004) highlight the role of reimbursement schemes for doing informal care as well as the role an organised cost payers should have. The second line of papers discusses forms of technological and global economic aspects ambient assisted living has for home-based nursing as well as sheltered homes without respect to explicit economic evaluation of long-term care effects [3].

Hence, for promoting business models in ambient assisted living it becomes more relevant to stress aspects of product and process innovation by introducing assistive technologies. In our paper, we evaluate the impact of a mobile assistive technology (MAT) that may increase the self-sufficiency and autarky of end users and informal caregivers in aspects of costs of care and quality of life. For sharpening the perspective of our economic model we use the consequences of assistive care that are involved in new ways of organising outpatient care for people suffering from dementia.

2 Methods

2.1 Research agenda

Before discussing the economic model we describe the idea of an assistive system which helps people suffering from dementia to foster needs for autonomy and autarky. Dementia itself is a broad term describing a decline in intellectual functioning that result in cognitive impairments as well as in higher risks for falls or elopement. As dementia is in timeline of increasing dependency the role of the interplay of different forms of care is relevant [4]. Hence, an assistive care system that combines needs for safety and communication as well as tracking and observation could help caregivers as well as cared-people to remain independent for longer period of time. An assistive technology in the sense described above tries to compensate disabilities or enhances strategies for empowering cared-persons living in their own environment.

For evaluating the impact of the assistive health care system we stress methods of economic evaluation. We want to proof the hypotheses that an introduction of a MAT would enable formal and informal caregivers to organise care and cure for people suffering from dementia more effectively. Especially, the MAT in our model is a mean that allows caregivers to delegate some care giving activities to the mobile system for instance tracking, activity monitoring as well as fall detection. Hence, using the assistive system would have an impact upon the caregiver's marginal productivity for care and cure.

2.2 Theoretical background

To compute the economic cost-effectiveness we refer to a cost-effectiveness-model that employs a head-to-head design without addressing a patient-related outcome. The theory of economic evaluation encompasses two main strategies: measurement and assessment [5]. The first one tries to find out an appropriate way to highlight the economic cost center that reflects an average patient's career very well. The second one aims at the decision process a third party has to go through. The economic evaluation should help the third party to rationalize its decision. In order to gain an economic evaluation tool we compare costs and outcome. As the relating research project "Barrier free Health Assistance" does only aim at a laboratory prototype we use assumptions to elaborate the effectiveness of the assistive care system. Hence, the outcome depicts the probability to need inpatient care which does not reflect any patients' utilities at all. In consequence we refer to cost-effectiveness-analysis without considering any patients' related outcomes. Moreover, we employ modeling techniques to overcome the missing empirical data which are a result by the research project. In other words, we predict the costs of the MAT for a long-term period in comparison to a virtual cohort not using the MAT. As we cannot refer to detailed empiric effectiveness we employ a Markov model [5].

In a good strategy for economic evaluation all relevant parameters should be included to prepare an appropriate instrument for value for money. Since rarely all information come from the same source it is appropriate to use modeling techniques to get a theoretically based framework for further research. A Markov model can be used given expected costs and outcomes are an adequate approximation of the unknown value for money.

2.3 Baselines of the model

We refer to a standard patient career for people suffering from dementia. In our first stage these persons are included after getting the diagnosis but firstly not getting any kind of organized care. Organized care in the paper means a kind of team production where informal and formal care acts simultaneously [6]. We assume this kind of team production is the best approximation for depicting the team production effects of formal and informal care for people suffering with dementia.

This idea resembles the care categories used by Rothgang et al. (2011) and therefore we can outline five different stages [7]:

- Stage 1:
Diagnosed Dementia but no care
- Stage 2:
Outpatient Care with higher level for informal care
- Stage 3:
Outpatient Care with higher level for formal care
- Stage 4:

Inpatient Care, patients do not reverse to outpatient care

- Stage 5:
Death

The structure of model is depicted in figure 1.

Figure 1: Markov-Model

Referring to a Markov-Model we set stages 4 and 5 as absorbing stages. They reflect the basic hypotheses that the MAT should enable people to stay longer in different forms of outpatient care.

2.4 Data set

For the first computation we refer to published data regarding the cost weights and transmission probabilities for the stages involved. The last one follows the research done by Kiencke et al. (2011) [8].

Because of the desktop research we cannot differentiate the two outpatient stages and therefore both stages are combined. For the cost weights we also refer to Kiencke et al. as well as to Häcker et al. (2007) [9].

- Costs Stage 1: 2,635 € p.a.
- Pooled Costs Stages 2 and 3: 31,729 €
- Costs Stage 4: 41,310 €
- Costs Stage 5: 0 €

The increasing costs per stage are the result of a higher level of formal caregiving as well as the higher impact of care and cure technologies that are involved. The transmission probability has to be adjusted from a probability per quarter to a one-year transmission probability [8]. Kiencke et al. use a probability for mid-year term and therefore we have convert this probability back to an one-year-probability.

The introduction of the MAT changes the probability to get inpatient care. Because of different “economies of scale” we assume the effect will be higher the more caregivers are familiar with the assistive system. Hence, MAT relieves the burden of care for both forms of caregiving and by a better organization of health care environment. The relief will be

- 20 percent given patient receives no care at all
- 30 percent for patients located in an outpatient care arrangement.

2.5 Selection of Patients

For the prediction scenario we include all patients living in the European Metropolitan Area Nuremberg into our Markov-Model. Assuming 343,184 persons are older than 65 years and living in this region in the period 2009 we calculate a constant incidence rate of about 3.2 % p. a.. Relating to our modeling scenario we elaborate the cumulative cost-effectiveness of the persons involved for a period of eight years which is a proxy for the maximum period of living with dementia. As we employ a cohort-model we can only look at the cost of an average patient. Differences in morbidity or individual adjustment in health care are excluded.

3 Results

Due to our cohort model-approach, we calculate costs for each cycle, adding the costs for each state weighted by the proportion in the state, and finally adding costs cycles. For the first computation of our model we can predict a surplus of 1,892 additional life years in outpatient setting using the mobile technology advice over eight years. Moreover, there is a cumulative cost advantage of about € 69 million for the cohort using the MAT-technology because the cumulative costs are € 781 million in comparison to about € 851 million for the comparator.

We find two different skewed curves for costs and cumulative incidence. In addition to this, the progression of dementia often resembles a convex function. Hence, we cannot infer an average costs value [10]. That is why an incremental cost effectiveness ratio is a better mean to assess the technology’s effectiveness. We can interpret the incremental ratio as an approximation to the marginal costs and marginal gains that result from the intervention. As we can show in figure 2 the overall-cost-effectiveness holds given our assumption because treatment dominates the costs. But we have controlled for diminishing returns up to now which could be expected for broader geographic dissemination of our MAT- intervention.

Figure 2: Cost-effectiveness-plane [11]

4 Conclusions

The economic impact of an assistive technology can be discussed within a health-oriented structure for the use-case dementia. We focus on care arrangements that help to face different costs of formal and informal care to highlight the impact of a MAT in an outpatient setting. Given the declared assumptions the use of MAT can make the patient’s career being more effective by prolonging the outpatient period. However, there exist some countervailing effects. The benefit of lower costs of inpatient care following from the shorter inpatient care period must outweigh the costs of informal care that would probably be higher in consequence of a longer outpatient period. Especially long-term effects caused by the burden of care for the informal caregiver concerning the mental and physical health as well as the employability need to be considered in further research. Moreover, there is a need to work out the distribution function of the effectiveness and the costs more precisely in the future. Perspectively, aspects of endusers’ willingness-to-pay and the implementation in the benefit basket shall be focused in subsequent research.

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5 References

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