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Modeling Methods Development for Routine Data based Screening Evaluation: Decision Making for Organized Abdominal Aortic Aneurysm Screening

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Abstract: Screening technologies are under discussion in many health care systems of industrialized countries. Besides cancer screening a growing list of other health problems are getting in focus.This work presents a dynamic simulation based decision support for the evaluation of organized screening interventions concerning patients with abdominal aortic aneurysms (AAA).

The interdisciplinary subject required the collaboration of experts in different fields, which were medical doctors, Health Technology Assessment (HTA) experts and modelers. The here presented modular model structure was constructed in such a flexible way that it allows adaptation on screening research questions for similar diseases. Another focus of the work was integration of risk factors and how this boundaries and restrictions influence the choice of modeling methods to use, fitting the real world structure using a parameterize able implementation. This is especially because of the steadily increasing knowledge about treatment or improved treatment of AAA which could cause the necessity of a periodic evaluation.

By inclusion of several patient specific properties, the model does not only provide comparison of current state which are incidental findings as well as unorganized screening with organized screening of definied age groups, but also the elaboration of alterations of population characteristics, for incidence changing in smoking behavior, and its consequences on AAA cases. The development of the modular model structure was started during the IFEDH cooperation project, and is actually refined in DEXHELPP, where special focus is on the population module.

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Keywords: Screening Program Evaluation, Abdominal Aortic Aneurysm, Agent Based Modeling, Decision Support Modeling, Parameterization Techniques, Routine Data, Billing Data.

1. INTRODUCTION

Abdominal Aortic Aneurysms (AAA) is a disease that describes an overlarge abdominal aorta, which may lead to its rupture. Such a rupture usually ends fatal. Austrian reimbursement data shows that most of aortic aneurysms concern the infrarenal aorta. Incidence is highly increased amongst men (about 5:1 Iribarren (2007)) and it is generally increasing when people are getting on in years. Over 85% of abdominal aortic aneurysms (AAAs), occur within people older than 65 years. Changes in the population structure and an increasing life expectancy arouse the attention of national health institutions and bring the treatment of AAAs into focus.

One major problem of AAAs is the usually asymptomatic course of disease. When the aorta ruptures most of the patients die on their way to hospital (Group (2002)). Therefore the question arises which influence do diagnostic interventions have on AAA care and accruing costs from payer's perspective. For this task a model is developed to

1) simulate development, treatment and screening strategies as intervention for early disease detection (see Fig. 1),
2) analyze incidence of AAA cases and corresponding costs for 65-year old people over the next 20 years,
3) consider key factors for AAA growth and rupture risk defined in literature pointing out their impact of costs and LYG, and,
4) compare currently used practice with organized screening strategies.

Screening for AAAs was also investigated by EUnetHTA (European network for Health Technology Assessment).

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Classification of AAAs and the main screening strategy are inherited from that work. Similar studies, e.g. (Kim (2007)), used Markov models for the health economic analysis of organized AAA screening, whereas we present a flexible Agent Based Model.
The Markov model structure in general has the power to represent the behavior and treatment of organized AAA screening by looking at cohorts with fixed time steps and state changes using a probability matrix following the Markov assumptions, but also has weaknesses, especially:

- reduced flexibility regarding growth behavior and ruptures due to a fixed time step,
- problems in implementation of iterative model extensions which are caused by implementation of additional risk factors or treatment pathways (the Markov matrix has to be recalculated for each extension; in case of splitting the research question, the whole structure doubles),
- boundaries regarding outcome measure changes and interpretation.

The Agent Based Model therefore proved to be better suitable for our purpose of flexibility which is supposed to consider also additional properties of patients.
The general idea is to define single agents with a list of properties and a sort of history. Besides the general information, like age and sex, the property vector includes information about smoking behavior, chronical disease status and the diameter of the abdominal aorta at the starting time.
Additionally a function describing the future growth of the abdominal aorta of each agent realized in the model is individually pre-calculated.
The life expectancy is calculated using data from Statistics Austria, defining an individual life expectancy. This data is then corrected by the over-mortality caused by AAA ruptures. Depending on the AAA diameter and other agent properties the outcome measures are simulated. This is done using the simulation model described in section 2.
Parameterization was mainly addressed in the IFEDH-project (Austrian research project founded by FFG grant number 827347) using systematic literature research, analyzing expert opinions and considering reimbursement data analysis within an interdisciplinary group consisting of modelers, medical doctors and HTA experts. Results of that project were applied for the parameterization of the presented work.

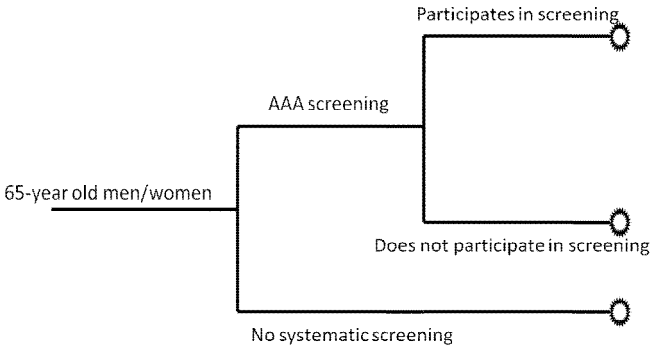

Fig. 1 Basic intervention pathways under discussion: organized screening for 65-year old persons vs. no screening with randomly diagnosis. Pathways with death of persons without AAA relation are not shown in the structure, but occur. The circles at the right side show in every path the endpoint “death”.

2. SIMULATION MODEL

2.1 Model Demand

AAA is a disease that can be developed by all people nevertheless the incidence is depending on several risk factors. Disease progression, represented by a person’s health state, is usually dependent on the diameter of the abdominal aorta. The target of the screening is the timely surgical treatment with a stent. The model serves various purposes. Looking at the disease, detection and health economic questions the model should be able to simulate

1) The target population for abdominal aortic screening programs
2) The development of aortic growth and /or the corresponding health state
3) The influence of identified risk factors on disease progression
4) Effects of treatment (surgery)

With the information generated by a model evaluation, assumed that a model fitting to the defined demand is used, it is possible to estimate the future effects of an organized AAA screening defined by the following output variables: number of avoided deaths and life years gained
If cost data is included in the treatment pathway simulation, also cost effectiveness analysis can be performed and evaluated. The model has to be very transparent to reach high acceptability and to guarantee an open discussion at the political decision level. This would provide the possibility for the model to become an objective decision support tool and to minimize the boundaries and restrictions identified in the Markov models in literature.

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