MORBISIMMOD - MORBIDITY BASED NEEDS ASSESSMENT USING MICROSIMULATION

M. Gyimesi ^(a), I. Czasny ^(b), G. Fülöp ^(c), S. Mathis-Edenhofer ^(d)

(a) (b) (c) (d) Gesundheit Österreich GmbH, Österreichisches Bundesinstitut für Gesundheitswesen, Vienna, Austria

^(a)michael.gyimesi@goeg.at, ^(b)ines.czasny@goeg.at, ^(c)gerhard.fueloep@goeg.at, ^(d)stefan.mathis-edenhofer@goeg.at

ABSTRACT

Needs-based health care planning is a major objective of modern health care systems and has become a major approach in the 1990s in many countries. Despite need can be seen in different ways and is not always objectively measurable, it is not questioned that health care services should be designed to meet the needs of the community based on the community's morbidity. In order to improve Austrian health care planning we developed a morbidity-based simulation model, the MorbiSimmod, where we combined the protocol of Health Care Needs Assessment with a population- and needs-based policy approach and choose microsimulation as simulation technology. The basic morbidity information is derived from inpatient routine health care data, data from the AT-HIS 2006/2007 plus sociodemographic and socioeconomic data. Together with spatial data we are able to calculate stratified figures of morbidity for in-depth analysis of structural requirements for specific health care services in Austria.

Keywords: microsimulation, needs-based health care planning, health services research, Austrian health care system

1. INTRODUCTION

Health care planning in Austria has a long tradition and is done at the moment primarily by extrapolating routine health care data. In order to improve future projections of the Austrian health care system a so called macro analytical approach of health services research was developed, where the health care need can be related to structural requirements of the Austrian health care system and the need for health becomes a more important part in the planning process (Gyimesi 2012).

Needs based health care planning is a major objective of modern health care systems and has become a major approach in the 1990s, particularly in the United Kingdom, Netherlands, New Zealand, Australia and the United States (Stevens 2004). But besides the beguiling simplicity about the idea that health care services should be designed to meet the needs of the community need can be seen in different ways and the concept of needs as objective states that can be measured is not always feasible or applicable. (Mooney 2006). Therefore various methods for health care planning are in use and each country follows its own way to solve the methodical difficulties as well as the political constraints when implementing health care planning systems.

Despite the common problem of lacking valid data there is also a big discussion in defining the meaning of "need". In general three different aspects should be distinguished:

- Desire
- Need
- Utilization / Demand

Concerning data, surveys on the one hand give an impression of the personal judgment, how much and which kind of health care services are desired within a community. Routine health care data on the other hand, which are produced by the health care system itself, give an overview to the actual utilization of the existing health care services. The real "need" in fact is somewhere situated in between. The definition, when a desire becomes a need, is hard to set and will differ within countries depending on societal values as well as budgetary constraints. When only focusing on the actual utilization, the real need can be underestimated for example in case of missing or too expensive health care providers. On the other hand we also have to bear in mind the so called supply-induced demand, which exceeds the actual need.

Since finding a common definition for the need of health care services is one of the basic requirements to quantify the actual need, this discussion can be a very controversial one and in the end a political decision is needed.

Methods of Health Care Planning

Although the conceptual difficulties concerning health care needs are not negligible, the question how to plan specific services for specific populations groups has still to be answered and different concepts have been developed to tackle the problem. Depending on the available data different methods of estimating the requirement of health care services have been developed. Some of them are listed below (Spycher 2004):

The *Utilization-based Method* focuses on the utilization of the existing health care services. The main advantage of this method is the usually easy availability of data. The big disadvantage is that using this method the existing structure and utilization of the health care system will be continued into the future. Neither medical improvements nor possibly existing under- or over-supply are taken into account.

Another often used method is the *Manpower-Population-Ratio*. Using this method benchmarks concerning the number of services per population are set. These numbers are easy to calculate but do not take into account regional or epidemiological diversities. The main challenge using this method is the selection of reasonable ratios. Mostly measures from other countries or previous periods are taken over, which can lead into controversial discussions concerning the suitability of the chosen ratios.

Accessibility-oriented-Methods fix a distance or time within the next specific health care service has to be reached by the population living in a certain area.

As none of these concepts is alone and straight forward applicable for Austrian health care planning mostly a combination of these three methods is used. Since all of these methods are limited by the fact that epidemiological diversities between regions and time are not taken into account, our aim is to complement these methods with the results of a *morbidity based needs assessment* and we developed the so called MorbiSimmod.

The MorbiSimmod is a morbidity driven model that derives the necessary epidemiologic information by a microsimulation model. It starts with the Needsrelated policy model, presented by C. Sanderson and R. Gruen in 2006 (Sanderson 2006). This very simple model starts with the number of people in a population or subgroup of the population and analyses a specific health services situation in a stepwise process by reducing these numbers in a way that in the end the number of people who are planned to receive an health service intervention is calculated.

To close the gap between morbidity information of a population group and the structural requirements of health care services we adopt some ideas from the Health Care Needs Assessment Project (HCNA), funded by the Department of Health and latterly the National Institute of Health and Clinical Excellence (NICE) and managed at the University of Birmingham. The project started in the 1990s and produced 38 needs assessments covering many diseases and populations. (Stevens 2004).

HCNA starts with the overlapping but not identical concepts of need, demand and supply, thereby addressing areas of potential health care improvement (Figure 1) and defines a general protocol which is applicable for a wide range of needs assessment scenarios.



Figure 1: Relation of health care need, demand and supply with influencing factors (Stevens 2004)

Both models rely heavily on the calculation of epidemiologic figures. In the MorbiSimmod model we choose to integrate an (agent-based) microsimulation model, based on information of the Austrian health care system like the documentation of diagnoses and procedures in Austrian hospitals, survey data of the last Austrian Health Interview Survey (AT-HIS), spatial data and further sociodemographic data. The epidemiologic figures generated with the microsimulation model are then transformed into structural requirement data, which can be used for different purposes according to the initial question.

The paper is organized as follows: Section two and three will introduce the Needs-related policy model and HCNA in more detail, section four will explain concepts of micro-modeling and why it is useful for calculation of morbidity scenarios. Section five presents the input data for the MorbiSimmod and section six explains the MorbiSimmod in more detail. Finally, we will discuss the strength of the MorbiSimmod model as well as the limitations and further development.

2. NEEDS-RELATED POLICY MODEL

The Needs-related policy model is an epidemiology based needs assessment approach and was defined by Sanderson and Gruen in 2006 as a special case of population-based needs assessment (Sanderson 2006).



Figure 2: Needs-related policy approach (Sanderson 2006)

This model calculates numbers of population groups with decreasing numbers step by step (Figure 2).

- 1. The Model starts with the number of the population or an arbitrary subgroup of the population (e.g. people in a specific federal state, people in a specific age group).
- 2. For this group of people epidemiologic information is gathered to identify the group of people who have a specific disease or group of diseases.
- 3. As not all of the remaining people are eligible for an appropriate intervention, only these with indication for an intervention are taken.
- 4. In the next step, people who are not willing to get the intervention are eliminated. The remaining group includes people who have a relevant disease, have the indication for an intervention and want the intervention.

- 5. Therefore a decision has to be made, how many of these people's requirements are planned to met.
- 6. Based on known structural requirements, numbers for needed structures can be calculated.

The modeling for this population-based approach seems technically straight-forward as it connects easily to microsimulation models (cf. section 4) but it depends heavily on the available data to perform each of the recommended steps. Which data we use and how to use it will be explained in section 5.

Although the Needs-related policy model serves well to formulate the calculation process of morbidity of a given population with a given medical condition, it does not emphasize the distinction of different care models like different possible procedures for the same medical problem or different locations of service provision.

Therefore, we use another epidemiology based needs assessment model with more focus on models of care.

3. HCNA

HCNA became established in the years from 1980 and 1990 in the United Kingdom (Stevens 2004). The aim of HCNA is to provide information to plan, negotiate and change services for the better and to improve health in other ways. Because HCNA bases much on conclusions from epidemiological data (but also on 'effectiveness and cost effectiveness' and on 'existing services') the method is described by its authors as an 'epidemiological approach to needs assessment'. Unlike other approaches that capitalise on existing services and make incremental changes to them, HCNA has a strong non-local, but population based focus on epidemiological data.

For applying the method on a certain health problem the authors of the methodical handbook on HCNA have defined a 'universal protocol' (Stevens 2004) for the 'epidemiological approach' of needs assessment. This protocol is summarized in the following text.

3.1. Statement of the problem

At the beginning the authors of an individual HCNA make a precise statement of the problem also including an appropriate description of the context and perspectives of related controversies.

3.2. Sub-categories

The health problem is sub-divided into categories that best support the requirements for service planning.

3.3. Prevalence and incidence

Epidemiological data may derive from the epidemiological literature, from official statistics and from national health surveys. Data must be adjusted to regional frequencies. estimate Beside these epidemiological information two other types of information is needed in order to define the need for health care by means of 'the population's ability to benefit from health care': existing services and (cost-) effectiveness.

3.4. Services available and their costs

The situation of currently provided services can serve as starting point for considering change of services. For this section it is relevant how many specialists are available per unit of population (structure) and how many people are treated per unit of population (process).

3.5. Effectiveness and cost-effectiveness of services

Data on effectiveness and cost effectiveness may be derived from the Cochrane Collaboration initiative and other initiatives of the Evidence Based Medicine movement. The evidence for an intervention can be graded regarding the size of effect and the quality of evidence.

3.6. Quantified models of care and recommendations

The authors try to find a formula that calculates the need from incidence and prevalence figures. From disparities of this calculated need and the current service provision recommendations emerge. Due to several lacks of information (inadequate data, lack of relevant thresholds, definitions and because of complex pathways) various flexible approaches must be developed in dependence of the actual problem.

3.7. Outcome measures, audit methods and targets

To support long term agreements on services and other health care activities the authors of HCNA must identify measures and targets that might be used. Agreements may include specific services and health and quality objectives.

3.8. Information and research requirements

The assessment may bring out new research questions respectively a lack of information or data. Such challenges and questions can be forwarded to national research programs or a national health priority setting program.

4. MICROSIMULATION

As stated in recent publications the use of dynamic models is a small but emerging field in health services research. It can provide an important complement to static and statistical analysis of health care problems and as shown by Einzinger the addition of routine health care data can be particularly valuable (Einzinger et al., 2012). Furthermore Austria has a history in using dynamic modeling and simulation as decision support instrument in health care (Miksch 2010, Breitenecker 2010a, Zauner 2010, Miksch 2011).

While simulation models with a top-down approach are usually easier to generate, they lack the possibility of modeling complex dependencies of the system (Zuchelli 2010). Therefore we decided to use a bottom- up microsimulation model, a very flexible modeling technique being able to account for population heterogeneity, multiple outcomes, the capacity to capture long-run effects and fitting to our health care needs assessment approaches. It gained raising popularity in recent years as a tool for ex-ante evaluation of health policies, and particularly in the field of public health interventions, where evaluations are often challenging and costly. (Zuchelli 2010, Brown 2011, Lymer 2011a, Lymer 2011b, Spielauer 2007, IQWIG 2009, Brouwers 2011, Décarie 2012).

The Austrian health care data the model is build on are mainly collected for reimbursement purposes and despite the Austrian health care payment system is highly fragmented the data from inpatient sector and outpatient sector can be linked statistically to suit microsimulation modeling (Katschnig 2012). More details on the data aspect can be found in section 5.

To analyse the structural requirements of specific Austrian health care situations we developed a fictitious analogue to the Austrian population with statistical representatives or agents. These agents do have diagnosis information from intramural care as well as extramural care. By adding spatial data the agents can be differentiated by municipal districts.

At the moment we do not think of our model as an agent-based one, because agents are not aware of other agents and environmental parameters, e.g. the dynamic evolution of the model population is generated just corresponding to the demographic forecast of Statistics Austria up to 2030 and no feedback mechanism concerning raising or falling morbidity is implemented. Although there is no clear separation between agent-based modeling and micro-modeling, we refer to MorbiSimmod as a micro-simulation model because of its data-driven approach.

5. DATA

5.1. Routine health care data

The health care system in Austria mainly consists of two sectors: the inpatient care in hospitals and the outpatient care, which is provided by physicians (general practitioners and specialists) and medical institutes as well as by ambulances in hospitals.

Since these sectors are financed in different ways the quality, the reliability and the completeness of the existing billing data are quite different. Concerning the **inpatient care** comprehensive routine data are available for all hospitals (DLD). Since the payment of hospital care in Austria is case-based, taking into account the diagnosis (ICD coded) and the main undertaken procedures, detailed hospital admission statistics also including basic personal information for each patient (e.g. sex, age and place of residence) are provided by each hospital. Since these data are already collected for several years and comprehensive plausibility checks are obligatory, data quality and completeness of the inpatient data are quite satisfying.

Nevertheless, the usefulness of these routine data for estimating morbidity is seen controversial. For instance, an important methodological limitation is that these data are originally collected for the purpose of payment. Since a corresponding effect on the selection of diagnoses cannot be ruled out, the reliability of these routine data for epidemiologic purposes is limited. Another possible limitation is the missing unique personal identifiers in the data available for our studies. Instead the data records are only linked to single hospital admissions. Therefore the actual number of patients with a specific diagnosis can only be estimated by identifying readmissions using the given personal indicators.

Concerning **the outpatient care** the situation is quite different: until now no systematic recording of the diagnosis is obligatory. Therefore at the moment we do not have reliable routine data providing evidence on the "outpatient morbidity".

For using the inpatient data in the MorbiSimmod the DLD-data concerning the years 2006 and 2007 were analysed and aggregated. The resulting dataset DLD-A contains anonymous information for each patient, who was discharged from an Austrian hospital (including sanatoria and rehabilitation centers) in the year 2006 or 2007. The data set includes information about sex, age, nationality, place of residence and the information whether a diagnosis within a specific ICD-10 chapter was reported.

It has to be taken into account that these routine hospital data can only be used for calculating the "inpatient morbidity". Whether or not this can be seen as a good estimation for the general morbidity depends on the specific diagnosis. Whereas these hospital data will be very suitable for prevalence estimation of diseases such as heart attack or cataract the prevalence of diseases, which do not necessarily require hospital care, will be underestimated.

5.2. AT-HIS

To complement the prevailing results, the Austrian Health Interview Survey (AT-HIS) 2006/2007 was chosen as a second data source. The results of this survey are representative for the Austrian population in the age of 15 years and older (Klimont 2007).

The main advantage of this data source is the direct connection to the population's morbidity without referring to routine data, and therefore to the existing health care services and their utilization. Nevertheless it has to be taken into account that self reporting health problems can also induce underestimation (e.g. psychological problems) as well as overestimation (e.g. migraine headache) of morbidity. That the information of AT-HIS is available just for some pre-defined major chronic diseases has to be seen as another severe limitation.

5.3. Sociodemographic and socioeconomic stratification

Besides age and sex other determinants of health like sociodemographic and socioeconomic factors are known to have an influence on the individual health status. E.g. recent analyses showed that the risk of chronic diseases depends on the educational level as well as on the available income. Also unemployment is a relevant risk factor, which influences morbidity. (e.g. Klimont 2008)

Since the DLD-dataset only includes basic patientspecific information such as sex and age other datasets are used to impute relevant sociodemographic and socioeconomic indicators.

In the end the characteristics of the statistical representatives of the Austrian population include

- Place of residence,
- Sex,
- Age,
- Educational level,
- Employment status and
- Income level.

5.4. Addition of further data

A main advantage of the micro-modeling approach is the extensibility of the basic data used for the simulation model. As there are other research groups in Austria, who use partially different data (e.g. the GAP-DRG database) for similar purposes (Weisser 2010, Endel 2010, Breitenecker 2010b), the MorbiSimmod is build in a way that data from additional databases can be added easily in the future.

6. THE MORBISIMMOD MODEL

The MorbiSimmod consists of two main models. On the one hand it propagates a predefined structured process to analyse the structural requirements for health care based on health care needs. On the other hand a microsimulation model was developed that enables us to investigate exactly these questions with a data-driven bottom-up approach for the Austrian health care system.

6.1. The MorbiSimmod Process model

In order to produce policy-relevant answers to health services research and health care planning questions not only microsimulation but some pre- and post-processing steps are part of the MorbiSimmod. In the preparation phase we integrate these tasks to specify the problem or question and to update the MorbiSimmod model according to the problem. In the post-processing phase we transfer the results of the microsimulation model calculation into corresponding models for health care system planning. Process steps are defined in figure 3.



Figure 3: Process steps of MorbiSimmod

6.1.1. Definition of the problem

Based on the original health policy or public health question we operationalise the question by

- defining the the morbidity spectrum and the focused granularity (single diagnosis, diagnosis group, risk factor, etc...),
- defining the geographical target population,
- defining the target population regarding to specific characteristics (age stratum, social class,...),
- defining the focused time period respectively the time horizon for prognostic calculations,
- the identification of relevant planning benchmarks, guidance values, indicators levels or strategic controlling parameters that relate to the morbidity figures of the specific health problem.

6.1.2. Literature search and modeling the relevant strategic planning parameters

We search for basic information regarding the above defined health service problem in the literature. The search includes reports on epidemiological figures, new medical developments and additional information on relevant benchmarks, guiding values, strategic parameters or indicators. After the search we analyse the relations of relevant benchmarks, parameters and indicators for other influencing factors to be able to define certain analytical scenarios. Finally, we prepare specific models for benchmarks, parameters and indicators based on available morbidity input data of the microsimulation model. For each model underlying basic assumptions and definition of scenarios have to be set.

6.1.3. Model update

The basic microsimulation model is updated with the latest available data on morbidity. Additionally missing data in the context of the problem defined in the first step might be imputed by assumptions based on data from populations that are similar to the target population or by a demographic extrapolation of the target population by extrapolating medical trends.

6.1.4. Running the microsimulation model and calculating morbidity figures according to the initially formulated problem

This step delivers figures on the morbidity in the defined context (time horizon, target population and spacial granularity).

6.1.5. Generation of recommended values

Step five connects the results of the generated morbidity scenarios to the secondary models for the selected planning benchmarks, guidance values, indicator levels or strategic controlling parameters. These results have to be calculated on the base of the assumptions and scenarios defined in step 2.

6.2. The MorbiSimmod simulation model

The MorbiSimmod simulation model overlaps with the process model in steps 3 to 5 (figure 3), when the appropriate indicators for the defined health care question are chosen, the simulation is run and specified output figures are calculated.

7. CONCLUSIONS

Needs based health care planning is a major objective of modern health care systems despite the fact that the concept of needs as objective measurable states that can be measured is not always feasible or applicable. Up to now in Austria health care planning is based on a mixture of the utilization-based, manpower-populationratio and accessibility-oriented planning method.

Our aim with the development of the MorbiSimmod is to complement these methods with a morbidity based needs assessment method. The

MorbiSimmod derives the necessary epidemiologic information by a microsimulation model. It incorporates ideas from the Needs-related policy model developed by Sanderson and Gruen as well as the Health Care Needs Assessment project developed at the University of Birmingham.

The MorbiSimmod model consists of two main models. On the one hand it propagates a predefined structured process to analyse structural requirements for health care based on health care needs. On the other hand a microsimulation model was developed, that enables us to investigate exactly these questions with a data-driven bottom-up approach for the Austrian health care system. Comprehensive data from inpatient care, survey data from the Austrian Health Interview Survey (AT-HIS) 2006/2007, spatial data on a municipal level as well as sociodemographic and socioeconomic data are used to compute result figures for defined scenarios. At the moment the dynamics of the model are triggered just by demographic extrapolation.

Future developments include the implementation of more complex relations of agents with the environment and inter-agent relations. Furthermore, it is planned to integrate additional data sources.

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