Simulation Modelling Based on Health Care Routine Data

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Health care decision makers need tools for planning, testing and assessment of new technologies or interventions.

Routine care data is (relatively) easily available.

Simulation models should make use of these data to be as accurate as possible.

Three examples show how we did it in projects for Austria’s social insurance.
Example 1: Reimbursement Systems
Reimbursement of physicians can consist of:

- payment for single services (e.g., injections)
- capitation (lump sums)
  - per visit
  - per episode of disease
  - per reimbursement period

Objective: Compare what would be the result of different hypothetical reimbursement systems.
Our view of the problem

- Patients develop Medical Problems and visit Medical providers.
- Medical services influence Reimbursement which is paid by Payers.
- Different reimbursement systems (A and B) influence Reimbursement.
Agent-Based Implementation in AnyLogic

Patients, Reimbursement, Health Market

Global parameters

Functions for initialization

Medical providers in different specialties

Medical problems (diseases)
Reimbursement System is Exchangeable and Gets Information from Visit Objects

Provider sends visit object:
- Provider ID
- Patient ID
- Date
- Services
- Diagnoses
Parameterization Read from Excel File

- 20 worksheets, separated by parameter type
- Parameters stratified by age group, medical problem, specialty etc.

Scaling and Memory Issues

- 8.3 million inhabitants in Austria
- Scaling factor normally 1:10 (1 patient agent $\triangleq$ 10 persons): 830 000 agents
- Higher scaling factor problematic, because of too few medical providers in some specialties
- Memory requirements > 3 GB (scaling 1:10) $\rightarrow$ 64 bit version of AnyLogic necessary
Outlook: Locations of Medical Providers (Hospitals) as GIS Map
Example 2: Group Practices
Initial Situation (Base Scenario)

- Group practice internist
- Group practice pulmonologist
- Other internists
- Other pulmonologists
Question: „What happens if physicians form a group practice?“
System Dynamics Model with Modular Structure

Cases \rightarrow Consultations \rightarrow Individual services

Work Load \rightarrow Salary

Reimbursement
Nearly Every Variable Is an Array Variable Because of Four Groups of Physicians

Cases other pulmonologists
Cases group practice internist
Cases group practice pulmonologist
Cases other internists

4 groups (2x2 dimensions in array variables)
Implementation in AnyLogic: Main
Input and Output of the Model

**Input**
- Strategic Assumptions
- System Assumptions:
  - More Referrals
  - More New Cases
- Fixed Parameterization:
  - Data Analyses
  - OOEGKK
  - Internist/Pulmonologist

**Model**
- Results from 12. quarter of year after founding of group practice

**Output**
- Total Fees
- Consultations
- Cases
- Special Services
- Case Value
- Evitable Double Services

Results from 12. quarter of year after founding of group practice
Example 3: Abdominal Aortic Aneurysm (AAA) Screening
Initial Situation

- About 6% of Austrian men with 65 years have an abdominal aortic aneurysm (AAA)
- AAA development and rupture risk is dependent of several risk factors (e.g. smoking)
- Ultrasonography is used for early detection
Research Questions

- Which people benefit most from organized AAA screening?
  → People with different properties according to the situation in Austria

\[ \text{diameter}' = f(\text{diameter, sex, age, smoking, ...}) \]

- What are the optimal screening strategies?
- Is organized screening for 65+ old people cost-effective? → Comparison
Agent Based Model in Anylogic

Population initialization
- populationDistribution
  - mortality
  - setMortality
  - ageGroup
  - timestep
  - nettoMortality
- initParameter
  - setPrevalence
  - smoker
  - sexdistribution

AAA development
- prevalence
  - prevalenceSmall
  - prevalenceMedium
  - prevalenceLarge
- SmalAAA
- MediumAAA
- LargeAAA
- smallToMedium
- mediumToLarge
- smokingIncreasedIncidence
- smokingIncreasedGrowth

Screening specific
- participation
- randomDetected
- randomDetection
- USSensitivity
- USSpecificity

Ruptures
- increasedRuptureWomen
- screeningInterval
- probRuptureSmall
- probRuptureMedium
- probRuptureLarge
- reachHospitalAlive
- probOpenSurgery
- probEVAR
- probNoSurgery
- mEVARElective
- mOpenElective
- mOpenEmergency
- mEVAREmergency

Treatment
- eVARElective
- cOpenElective
- cOpenEmergency
- cEVAREmergency
- cOther

Costs
- cScreeningInvitation
- cSonography
- screeningIntervalSmall
- screeningIntervalMedium
- I2/ToEuro
- organisedScreening
- L4Multiplier

Protocol
- ergFile
- resultsLog
- writeResults
- detailedProtocoll
- writeProtocol
- AAApatients
Sensitivity Analysis

AAA Related Deaths

Parameter
- Participation
- Incidental Detection
- AAADistribution
- Mortality
- Smoking
- Surgery Costs
- Growth
- Treatment Costs
- Sonography Costs

Deviation from Base Case

var
- Sonography Costs
- Treatment Costs
- Growth
- Surgery Costs
- Smoking
- Mortality
- AAADistribution
- Incidental Detection
- Participation
Results
Conclusion

- Routine care data are a valuable source of information for health care models.
- Important decisions are:
  - Where to use routine care data?
  - How much aggregation is acceptable?
- Further research: Extraction of causal relationships, patient pathways