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AGGREGATE MODEL FOR ESTIMATING HEALTH CARE SYSTEM RESOURCE REQUIREMENTS (AMER)

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Preface

The aim of the IIASA Modeling Health Care Systems Task is to build a National Health Care System model and apply it in collaboration with national research centers as an aid to Health Service planners. The modeling work is proceeding along the lines proposed in earlier papers. It involves the construction of linked submodels dealing with population, disease prevalence, resource need, resource supply, and resource allocation.

This paper examines how a National Health Care System model can be applied to the planning of health services, and considers step-by-step all submodels involved in modeling resource requirements. This computer model is designed for interactive use by the health manager in testing different alternatives within the health planning process.

Recent related publications of the IIASA Modeling Health Care Systems Task are listed on the back pages of this Memorandum.

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April 1978

Abstract

In the process of national health care system model elaboration, the model for estimating resource requirements plays an important role. Resource needs are determined on the basis of estimates of population trends and morbidity rates, and a set of desired health care standards. For the creation of the morbidity estimation model, data from comprehensive studies carried out in the UK, Japan, and the USSR were used. The desired standards were taken from the practice of central planning now existing in the USSR. Using this model in an interactive regime, it is possible to test alternative planning strategies. Preliminary results of testing and running this model in various countries show that this computer model could be used in different developed countries for estimating resource requirements.

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INTRODUCTION

At the International Institute for Applied Systems Analysis a group of scientists from different countries is working on the development of a national health care system (HCS) model for simulating health care activities, forecasting its development, and testing different policy options. Such a model is designed to help the national level HCS decision maker to consider different versions of planning decisions and to choose the best alternative.

This paper is concerned with the estimation of HCS resource requirements based on a central planning approach. The main purpose of the paper is to introduce an initial version of the Aggregate Model for Estimating HCS Resource Requirements (AMER) developed at IIASA. This model allows planners to explore the implications for resource requirements of trends in a number of relevant factors.

VARIABLES REPRESENTED IN THE AMER MODEL

In order to estimate HCS resource requirements one must have sufficient data to forecast the population's age structure, the morbidity and mortality rates it will be subject to, and the standards that will prevail for the provision and use of health care resources, e.g. average length of stay in hospital and bed turnover interval. In real practice these data can be taken partly from routine statistics and other official material. But the most important data are taken from special health surveys. These sampling surveys, conducted in countries using the central planning approach, have two purposes:

- the comprehensive, epidemiological study of the health of the population (including screening), and

- the estimation of the number and types of health care resources used for each case, disease, group of diseases, and sample of the population.

With this medical information, different means, rates, ratios, and distributions are found which are used for estimating the health care resource requirements of the entire population.

Periodical investigations such as these help decision makers to estimate the trends in population structure, health, and HCS resources consumed, which in turn allows them to forecast resource requirements by extrapolation. Japan, the UK, and the USSR are three countries where such health surveys have been conducted. In comparing the results of these surveys we have drawn three main conclusions. First, although there are differences in the causes of morbidity and mortality indices and structures, the aggregate rates are almost identical; second, trends over time in aggregate morbidity and mortality rates show similar patterns; and third, the ratio between aggregate mortality and morbidity rates (risk ratio) changes only slightly over time.

However, such periodical surveys are prohibitively costly and time consuming. Consequently, mathematical estimations of morbidity derived from mortality rates are extremely useful for the analysis of resource requirements in these countries.

In the case of aggregate modeling, it is necessary to have only aggregate standards, such as: percent of patients hospitalized, average length of stay in hospital, number of consultations per episode (not specified according to disease), bed turnover interval, bed occupancy rate, beds per inpatient doctor equivalent, and workload in the form of consultations per year (not specified according to medical specialty). These standards can be used for modeling HCS resource requirements. Taking into account that these standards are control variables, the decision maker can alter them to fit the real situation of his country.

Finally, this aggregate model for estimating HCS resource requirements will help the decision maker not only to forecast trends in population structure and health indices, but also, by changing these control variables, to estimate resources required. With this model, the decision maker can quickly and efficiently test different planning alternatives and select the one most suitable for his purposes.

Structure

The model structure is presented in Figure 1. It consists of four main blocks: morbidity, population, standards, and output. Input data files are indicated here by double lines.

How does the model work? First, we submit an hypothesis about the future evolution of fertility rates and death rates and with these we forecast the population age structure.

Second, we forecast the morbidity rate by using a quantity which we term *risk*: the ratio of the "all-causes-death rate" to the general (all causes) morbidity rate, for given age/sex group strata of the population. We assume that, for a given stratum, risk remains constant over time; i.e. it is independent of the values of the death rate and the morbidity rate.

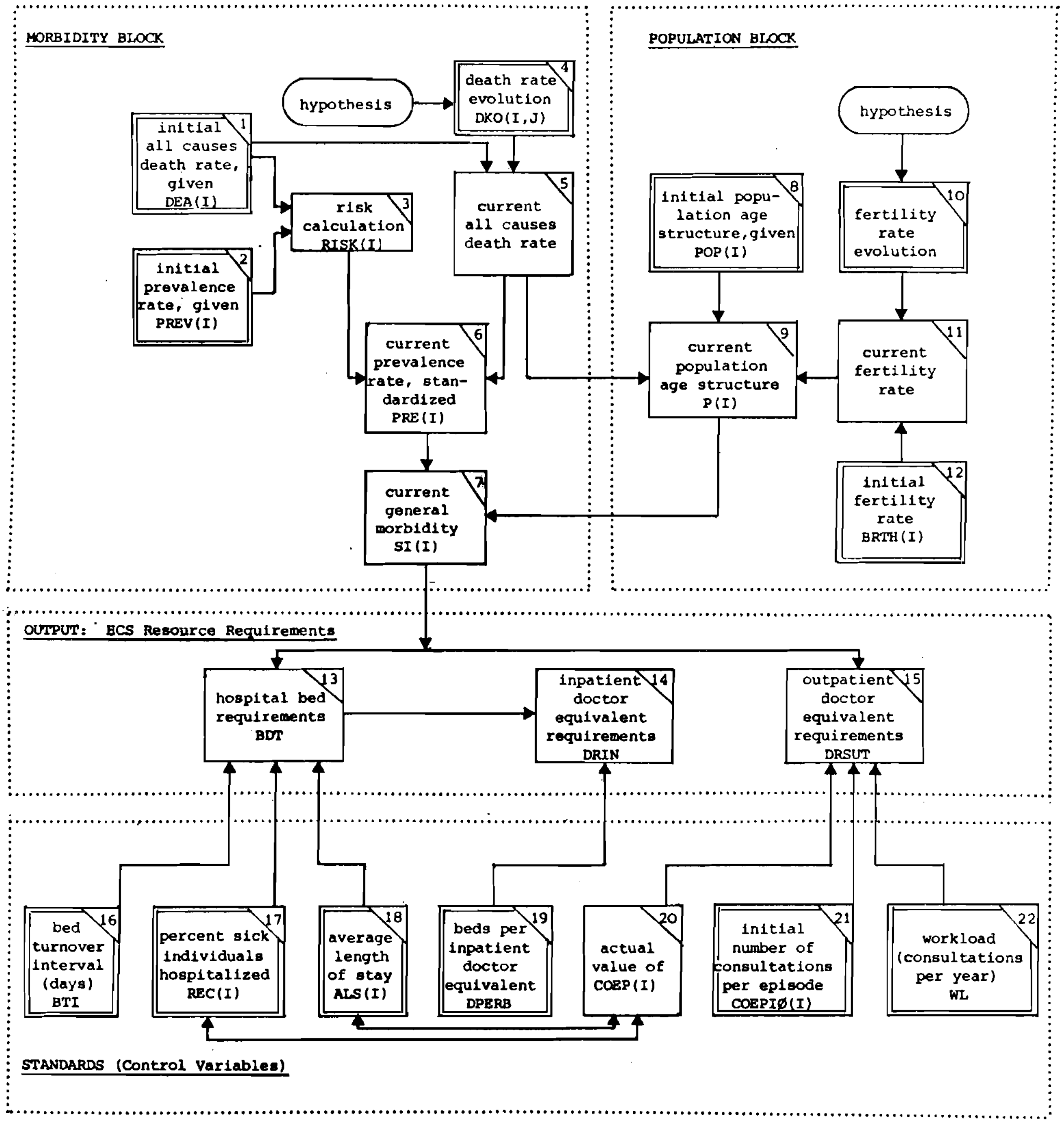

Figure 1. Block diagram: HCS resource requirement estimation model.

Third, we calculate hospital *bed requirements*, taking into account the average length of stay and the percent of hospitalization and bed occupancy. Bed requirements multiplied by the number of beds per inpatient doctor equivalent (standard), yields *inpatient doctor equivalent requirements*. *Outpatient doctor equivalent requirements* are determined using data on estimated morbidity and two standards: workload and number of consultations per episode.

To define the relationships between needs (determined here in terms of general morbidity) and requirements in HCS resources, we use the normative approach [1]. The following types of resources are investigated:

- total number of beds (excluding psychiatric care),

- total number of inpatient doctor equivalents, and

- total number of outpatient doctor equivalents.

Initial Data

In order to run the model we need the following data:

- initial *prevalence rate* [2, PREV(I)]*: number of cases afflicted with any type of disease during one calender year, given for initial year, specified by age per 1000 population;

- initial *all causes death rate* [1, DEA(I)]: number of deaths from all causes during one calender year, given for the initial year, specified by age per 1000 population;

- initial *population age structure* [8, POP(I)]: population specified by age per 1000 population, given for the initial year;

- initial *fertility rate* [12, BRTH(I)]: number of live births during one calender year, given for the initial year and specified by age per 1000 population;

- *death rate* [4] and *fertility rate* [11]: the evolution of these rates represents the formalization of the hypothesis about future changes in the corresponding value.

The data listed above are necessary for estimating general morbidity. To calculate the output of the model--HCS resource

*The notation in brackets refers to the number of the appropriate block in Figure 1 and the corresponding variable used in the computer program.

requirements--the following standards of HCS activities are used:

- average length of stay in hospital per inpatient, in days [18, ALS(I)];
- percent sick individuals hospitalized from a given age stratum [17, REC(I)];
- number of consultations per episode for sick individuals from a given age stratum [20, COEP(I)];
- outpatient doctor's workload: number of consultations per one outpatient doctor equivalent per calender year [22, WL];
- inpatient doctor's workload: number of beds per inpatient doctor equivalent [19, DPERB];
- BTI: bed turnover interval, in days.

Morbidity and Mortality

As mentioned above, data about morbidity and its trends can, with a certain amount of difficulty, be taken from real comprehensive studies, conducted periodically in some developed countries. But since there are only slight variances among aggregate morbidity rates, aggregate mortality rates, and ratios between them (risk ratio) over time, it was decided to estimate aggregate morbidity data using mortality data and the risk ratio. Mortality data can be obtained from official vital statistics and demographic forecasting models.

Standards

Although there exist several standards concerning specific diseases, specialties, departments, and establishments, in the case of the AMER model it is necessary to have aggregate standards. We used several generally accepted ones, such as average length of stay in hospital, percent sick individuals hospitalized, bed occupancy rate, and bed turnover interval. These standards, published in official annual statistics on health, reflect the situation of the previous period. Therefore, before they can be used for estimating resource requirements they must be revised.

In some countries there exist lists of "ideal standards", which are calculated during comprehensive health surveys and expert medical team estimations of each sample unit (case, disease, etc.). It is clear that the quantitative level of these standards reflects the real situation of each country, but differs greatly from country to country. For example, 20% of all sick individuals are hospitalized in the USSR, as compared to 11% in the UK.

Taking into consideration the interrelation of all subsystems within the health care system, during the modeling process it is necessary to incorporate the substitution effect. For example, what happens to the average length of stay in hospital if the hospitalization rate is decreased? What effect does this have on the outpatient service? All of these substitution coefficients do not exist in routine statistics and can be taken only from special studies.

It is clear that these substitution rates differ not only between countries, but also between regions of the same country. They reflect the interrelationships between different subsystems of the same hierarchical level (horizontal substitution rates). Besides these horizontal substitution rates there also exist vertical substitution rates which reflect the vertical interrelationships between different hierarchical levels. For example what would happen to the average length of stay in the district hospital if the central hospital began to admit the most serious patients from the whole region?

In the AMER model, we used only horizontal substitution rates taken from special surveys.

THE METHOD

The formal description of the model is presented in this section. By definition, risks are calculated as follows:*

$$\text{RISK(I)} = \frac{\text{DEA(I)}}{\text{PREV(I)}} \quad . \tag{1}$$

The all causes death rate vector, DE(I)_J, for time interval J, is determined by:

$$\text{DE(I)}_J = \text{DEA(I)} \cdot \text{DKO(I,J)}^{**} \quad , \tag{2}$$

where {DKO(I,J)} is a matrix with all positive values. Elements of this matrix are determined in accordance with the hypothesis.

The standardized prevalence rate, PRE(I), for a given age stratum can now be calculated as:

---

*Definitions of the model's variables are given in Appendix 1.

**For reasons of simplification, the subscript J is omitted below from the values dependent on it.

$$PRE(I) = \frac{DE(I)}{RISK(I)} \cdot 10^{-3} \quad . \tag{3}$$

For a given age stratum the absolute value for general morbidity is:

$$SI(I) = PRE(I) \cdot p(I) \quad , \tag{4}$$

and the respective total value is:

$$SISUM = \sum_{I=1}^{18} SI(I) \quad . \tag{5}$$

For total hospital bed requirements we have:

$$BDSTO = \sum_{I=1}^{18} \frac{SI(I) \cdot REC(I) \cdot ALS(I)}{100 \cdot DPYR} \quad , \tag{6}$$

where

$$DPYR = \frac{365 \cdot ALS(I)}{ALS(I) + BTI} \tag{7}$$

is the number of days per year a bed is occupied, and ALS(I), BTI, and REC(I) are the variables defined above.

The number of inpatient doctor equivalents now is:

$$DRIN = \frac{BSDTO}{DPERB} \quad , \tag{8}$$

where DPERB is the workload defined above. To calculate outpatient doctor equivalent requirements (DRSUT), the substitution effect should be taken into account: the lower the percent of hospitalization (REC(I)) and the shorter the average length of stay (ALS(I)), the greater the number of consultations per episode (COEP(I)). A linear approximation of this dependency can be made:

$$\mathrm{COEP(I)} = \mathrm{COEP\emptyset(I)} - \mathrm{BETA} \cdot (\mathrm{REC(I)} - \mathrm{REC\emptyset(I)}) - \mathrm{GAMMA} \cdot (\mathrm{ALS(I)} - \mathrm{ALS\emptyset(I)}) \quad , \tag{9}$$

where COEPØ(I), RECØ(I), and ALSØ(I) constitute the initial values and COEP(I), REC(I), and ALS(I) the trial values of the corresponding control variables. BETA and GAMMA are the constant rates of substitution for percent hospitalization and bed-days by outpatient consultation, respectively. Now

$$\mathrm{DRSUT} = \sum_{I=1}^{18} \frac{\mathrm{SI(I)} \cdot \mathrm{COEP(I)}}{\mathrm{WL}}^{*} \quad . \tag{10}$$

In this section population age structure, p(I), is implied as a given vector for every magnitude of time index J. In the model, vector p(I) is actually calculated for every $J = \overline{0,N}$ in a separate submodel, which is described in [2].

USING THE MODEL

The AMER model has been installed at IIASA on the PDP-11/45 computer. The computer program, written in FORTRAN IV, is called BOM.F. The following files are used as inputs:

ASTUK - population age structure file. It consists of N + 1 blocks, with 18 real numbers each. The first block represents the initial population age structure, and the others represent the forecasted population age structure.

CHADE - (N + 1) × 18 number matrix representing the assumed evolution of the death rate vector over time.

DEUK - 18 real number vector representing the initial death rate.

PRUK - 18 real number vector representing the initial prevalence rate.

CTL - actually a scenario, in which trial values of standards and other parameters which the user plays with are presented. The contents and format of the file are made understandable by Figure 2.

*Due to a lack of data in the recent version of the model it was decided to set ALS(I) = ALSI, REC(I) = RECI, and COEP(I) = COEPI, i.e. they are independent of the patient's age.

MN - consists of the following input values: m, n, kpri, beta, and gamma.

A sample printout is shown in Appendix 4. The structure of the output file is self-explanatory.

= file CTL =

	base year	future years / trial fugures				ideal
		year 5	year 10	year 15	year 20	
averg lngth stay	23.8	23.	22.	20.5	19.0	19.0
prcntge hsptlsd	10.53	10.4	10.1	9.8	9.5	9.5
bds/inp doc eqvt	21.81	21.81	21.81	21.81	21.81	17.0
bed trnvr intrv	4.94	4.7	4.5	4.3	4.1	4.0
cnslts/otpt doc/yr	7033.0	7033.0	7033.0	7033.0	7033.0	6000.0
bed's cost/yr	3145.0	3300.0	3400.0	3500.0	3600.0	
cost/otpt doc/yr	29400.0	30000.0	31000.0	32000.0	33000.0	
cnslts/epsd	3.5					

Figure 2. Contents and format of the CTL file.

How does one operate the AMER model? The following sequence of user-oriented instructions should be followed:

1. Prepare a population age structure* file using the Willekens-Rogers model, or a similar one [3] giving forecasts of a population age structure. Store these data in a file AST. (As an example, see file ASTUK in Appendix 3.)

2. Prepare a death rate evolution coefficient file that follows from the adopted hypothesis. Call this file CHADE. (As an example, see file CHADE in Appendix 3.)

3. Prepare the initial death rate data and store them in a file DE having the format of the file DEUK in Appendix 3.

4. Prepare the initial prevalence rate data and store them in a file PRE having the format of the file PRUK in Appendix 3.

*The population is grouped into five-year age group strata, in thousands.

5. Auxiliary variables m, n, kpri, beta, and gamma are to be collected in file MN.

6. Put trial values of the parameters indicated in Figure 2 into a file CONT of the same format as file CTL.

7. Run the program BOM.F using the command:
bio2 1=otpr 2=cont 5=ast 7=de 8=pre 9=chad 12=fini 14=mn

8. Results of calculations are displayed on the screen of the terminal in the format shown in Figure 3.

```
#INPUT-OUTPUT SUMMARY#
                        year 0    year 5    year 10   year 15   year 20   ideal
-------------------------------------------------------------------------------
averg lngth stay  :   23.80 :   23.00 :   22.00 :   20.50 :   19.00 :   19.00 :

prcntge hsptlsd   :   10.53 :   10.40 :   10.10 :    9.80 :    9.50 :    9.50 :

bds/inp doc eqvt  :   21.81 :   21.81 :   21.81 :   21.81 :   21.81 :   17.00 :

bed trnvr intrv   :    4.94 :    4.70 :    4.50 :    4.30 :    4.10 :    4.00 :

cnslts/otp doc/yr :   7033, :   7033. :   7033. :   7033. :   7033. :   6000. :

bed cost/yr       : 3145.00 : 3300.00 : 3400.00 : 3500.00 : 3600.00 :
                            *****************************************
cnslts/epsd       :    3.50 *    3.59 :    3.77 :    3.96 :    4.16 :
*****************************
bds rqrd, total   :  400164.:  343781.:  296344.:  251917.:  213307.:

fnds rqrd, total  : 1964.65 : 1802.11 : 1678.47 : 1564.13 : 1460.81 :

doc eqvts rqrd    :  42366. :  38017. :  35229. :  32876. :  30777. :
```

Figure 3. Format of displayed results.

Here, the summary of input file CTL is placed above the line of stars and the summary of computation is placed below the line of stars. If the user needs more output information, File A should be displayed (see Figure 3a).

SIMULATION RESULTS: IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION: TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT.DOCTOR EQUIVALENTS TOTAL	OUTPAT.DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	14668.5	24326.1	38994.6	319919.7
20	46486.0	43787152.0	13377.1	25291.7	38668.8	291754.4

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION: TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT.DOCTOR EQUIVALENTS RATE	OUTPAT.DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	983.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.315	0.522	0.837	6.86
20	46486.0	941.94	0.288	0.544	0.832	6.28

Figure 3a. Format of displayed results with more output information.

More detailed output information is contained in file OTPR (see sample OTPR file in Appendix 4). The file can be printed on a line-printer if needed by the user.

9. Now, if the user would like to try other input data, the standard program EDITOR should be called and the necessary changes in file CONT should be made. Then the procedure is repeated. The user-model dialogue procedure scheme is shown in Figure 4.

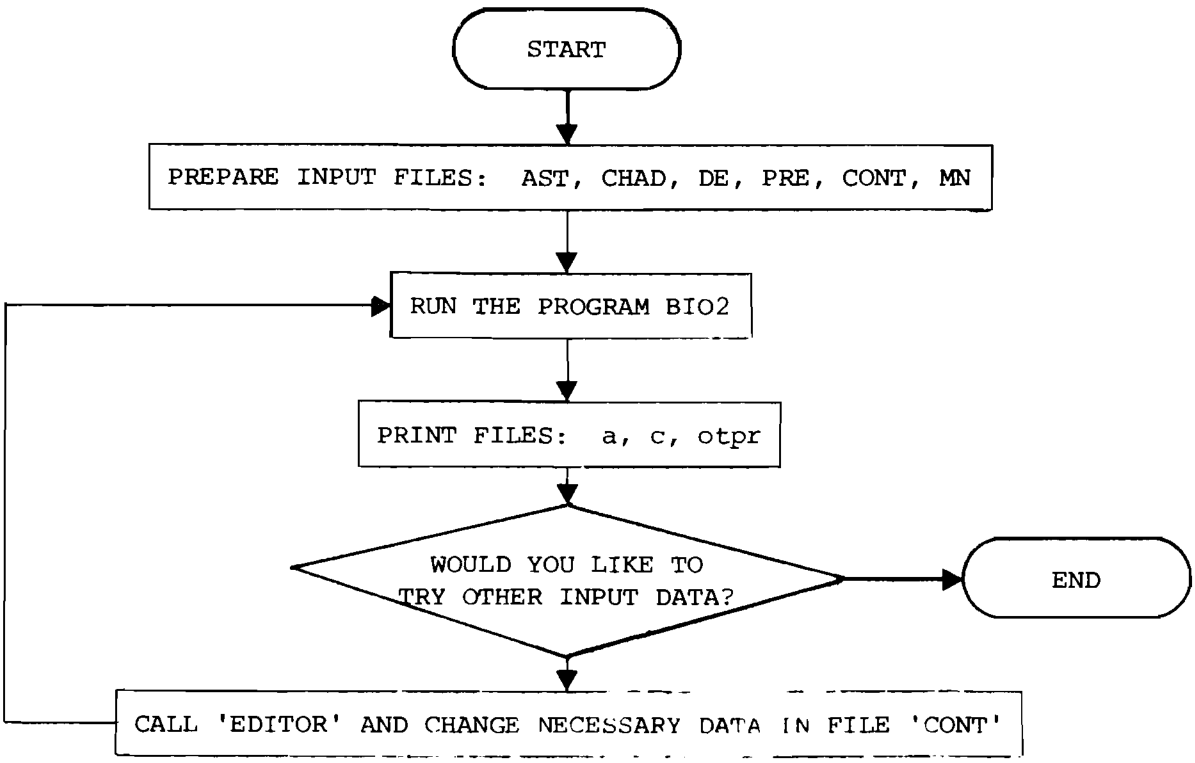

Figure 4. Dialogue scheme 'USER-AMER'.

SUMMARY

The AMER model will help the national level decision maker, working in an interactive regime, to test different policy options and to select the best among them. This model also makes it possible to forecast population structure changes and mortality and morbidity trends, which are very important to health care.

Let us refer to the "best" mortality rate among those of the IIASA member countries as the "ideal" mortality rate. If we replace the actual mortality of some test country with this "ideal" mortality rate, we achieve some very interesting results related to health care resources (beds, staff, etc.) and finances.

For the World Health Organization, this methodology may be used to help eliminate the differences in health statistics (definitions, methods of calculation, data processing, etc.), thus allowing for better comparison among countries and more accurate allocation of international resources.

Although the AMER model is designed for forecasting aggregate health resources, in some cases this principle can be used for specific classes of disease with precise medical resources. Let us consider oncology. With the help of the population submodel it is possible to estimate population trends. Cancer mortality statistics exist in many developed countries. Prevalence rates can be estimated by means of periodic comprehensive studies, risk ratios (mortality/morbidity), or the computer model for terminal degenerative diseases, also developed at IIASA [4,5]. From the routine statistics we can obtain such data as hospitalization rates and average length of stay in hospital. All this makes it possible to estimate the requirements for oncological beds, oncologists, etc.

In the AMER model only some of the health care resources have been used so far. However, this model can be developed to describe the use of other resources--nurses, auxiliary personnel, facilities, and laboratories. All of these are control variables of multifactorial complexity and depend on many factors which can be measured quantitatively.

It is clear that in order to build a model such as the AMER model it is necessary to have many kinds of medical data (routine, scientific, etc.). Some of the data may not exist or it may be difficult to obtain (e.g. substitution rates). Thus the use of such a model will create new requirements for medical information and suggest medical policy issues. The development of models and information systems in health care are closely connected, interrelated, and they influence each other.

References

[1] Popov, G.A., *Principles of Health Planning in the USSR*, WHO, Geneva, 1971.

[2] Willekens, F., and A. Rogers, *Computer Programs for Spatial Demographic Analysis*, RM-76-58, International Institute for Applied Systems Analysis, Laxenburg, Austria, 1976.

[3] Keyfitz, N., Age Distribution and Stable Equivalent, *Demography*, 6 (1969), 261-269.

[4] Kaihara, S., et al., *An Approach to Building a Universal Health Care Model: Morbidity Model of Degenerative Diseases*, RM-77-6, International Institute for Applied Systems Analysis, Laxenburg, Austria, 1977.

[5] Klementiev, A.A., *On the Estimation of Morbidity*, RM-77-43, International Institute for Applied Systems Analysis, Laxenburg, Austria, 1977.

Appendix 1

Specification of Variables

ALS(I)	- Average length of stay for sick individuals from I-th age stratum.
BDS(I)	- Number of beds occupied by sick individuals from I-th age stratum.
BDSTO(J)	- Total number of beds at step J.
BETA	- Constant rate of substitution of percent hospitalization by outpatient consultation.
BTI	- Bed turnover interval.
COEP(I)	- Number of consultations per episode for patient from I-th stratum.
DEA(I)	- All causes death rate.
DPERB	- Number of beds per inpatient doctor equivalent.
DPYR	- Number of days per year bed is occupied.
DRIN	- Inpatient doctor equivalents required.
DRIN(J)	- Total number of inpatient doctor equivalents at step J.
DROUT	- Outpatient doctor equivalents required.
DRSUT(J)	- Total number of outpatient doctor equivalents at step J.
GAMMA	- Constant rate of substitution of bed-days by outpatient consultation.
I	- Age stratum index.
J	- Time index.
M	- Maximal forecasting time index.
N	- Number of age groups.
PREV(I)	- Prevalence rate.

REC(I) - Percentage of hospitalized sick individuals from I-th age stratum.

RISK(I) - Ratio of all causes death rate to general morbidity rate.

SI(I) - Absolute number of sick individuals from I-th age stratum.

SISUM - Total number of sick individuals.

SISUM(J) - Total absolute prevalence at step J.

WL - Number of consultations per one outpatient doctor equivalent per calender year.

Appendix 2

Computer Printout Listing

```
c    definitions
c    j-time index
c    sisum(j)-total absolute prevalence at step j
c    bdsto(j)-total number of beds at step j
c    drin(j)-total number of inpatient doctor equivalent at step j
c    drsut(j)-total number of outpatient doctor equivalents at step j
c    bds(i)-number of beds occupied by sick individuals from i-th age stratum
c $ rec(i)-percentage of hospitalized sick individuals from i-th age stratum
c $ als(i)-average length of stay for sick individuals from i-th age stratum
c    dpyr-number of days per year bed is occupied
c    drin-inpatient doctor equivalents required
c    si(i)-absolute number of sick individuals from i-th age stratum
c $ bpd-number of beds per inpatient doctor equivalent
c    drout-outpatient doctor equivalents required
c $ coep(i)-number of consultations per episode for patient from i-th stratum
```

```
c $ wl-number of consultations per one doctor per calendar year

c $ bti-bed turnover interval

c   gamma-constant rate of substitution of bed-days by outpatient consultation

c   beta-constant rate of substitution of percent hospitalization by
c   outpatient consultation

c    mark '$' identifies standards in comments listed


      dimension dea(90),prev(90),risk(90),si(90),pop(20,5)
     -,p(20),dko(20,5),de(20),pre(20),bds(90),rec(90),als(90),
     -dout(90),coep(90),sisum(10),bdsto(10),drin(10),drsut(10),
     -topop(10),gmr(10),dinra(10),dutra(10),dosum(10),
     -dosura(10),bdsra(10),fund(10),fini(20,5),coe(10),dpyr(10),
     -zals(10),zrec(10),bpd(10),bti(10),wl(10),cost(10),fnds(10),
     -dutsa(10)
```

```
       uxillary variables, file no.14, file name MN

      read(14,1Ø2) m,n,kpri,beta,gamma

c     control prameters file user plays with, file no.4, file name CTL

      read (4,1Ø7)(zals(i),i=1,m),alsid,
     -             (zrec(i),i=1,m),resid,
     -             (bpd(i),i=1,m),bpdid,
     -             (bti(i),i=1,m), btid,
     -             (wl(i), i=1,m), wlid,
     -             (cost(i),i=1,m),
     -             (dutsa(i),i=1,m),
     -             coepiØ


c initial population age structure /in 1ØØØ/, file no 5, variable pop(i),
c file names are:astuk/the UK/,astjp/JAPAN/,astsu/the USSR/

      do 1ØØ i=1,m
      read(5,22)  (pop(j,i),j=1,n)
  1ØØ continue


c all causes death rate,file no 7, variable dea(i), file names are:
c deuk/the UK/,dejp/JAPAN/,desu/the USSR/

        read(7,25)  (dea(i),i=1,n)
c       write(11,5ØØ)  (dea(i),i=1,n)

c prevalence structure, file no 8, variable prev(i), file names are:
c pruk/the UK/,prjp/JAPAN/,prsu/the USSR/

      read(8,25)  (prev(i),i=1,n)
```

```
c death rate evolution over time,proposed. file no.9, file name is 'chade'

      do 101 i=1,m
      read(9,24) (dko(j,i),j=1,n)
 101  continue

      mfor=m*5-5

        do 11 i=1,n
        risk(i)=dea(i)/prev(i)
  11    continue
      write(3,370) (risk(i),i=1,n)

      do 51 j=1,m
      topo=0.
      sisu=0.
      bdt=0.
      drout=0.
      do 52 i=1,n
      dpyr(j)=(365.*zals(j))/(zals(j)+bti(j))

      als(i)=zals(j)
      rec(i)=zrec(j)
      coepi=coepi0-beta*(zrec(j)-zrec(1))-gamma*(zals(j)-zals(1))
      coe(j)=coepi
      p(i)=pop(i,j)
      topo=topo+p(i)
      de(i)=dea(i)*dko(i,j)
      fini(i,j)=de(i)
      pre(i)=de(i)/(risk(i)*1000.)
      si(i)=p(i)*pre(i)*1000.
      bds(i)=si(i)*rec(i)*als(i)/(dpyr(j)*100.)
      dout(i)=si(i)*coe(j)/wl(j)
      sisu=sisu+si(i)
      bdt=bdt+bds(i)
      drout=drout+dout(i)
  52  continue
```

```
      coe(j)=coepi
      topop(j)=topo
      gmr(j)=(sisu/topo)
      sisum(j)=sisu
      bdsto(j)=bdt
      fund(j)=(bdsto(j)*cost(j))/1000000.
      drin(j)=bdsto(j)/bpd(j)
      drsut(j)=drout
      dinra(j)=(drin(j)/topo)
      dutra(j)=(drsut(j)/topo)
      dosum(j)=drin(j)+drsut(j)
      dosura(j)=(dosum(j)/topo)
      bdsra(j)=(bdsto(j)/topo)
      fnds(j)=fund(j)+drsut(j)*dutsa(j)/
     -1000000.0

c     writing intermidiate output file out:

      jx=j*5-5
      write(1,33) jx
      write(1,31)

        do 13 i=1,n
        ia=5*i-5
        ib=5*i-1
        write(1,32) ia,ib,p(i),si(i),de(i),risk(i),pre(i)
   13 continue

   51 continue

c     intermidiate summary file:
```

```
      write(1,368)
      write(1,369)
      do 113 j=1,m
      ja=5*j-5
      write(1,349) ja,topop(j),sisum(j),gmr(j),drin(j),dinra(j),
     -                drsut(j),dutra(j),dosum(j),dosura(j),bdsto(j),
     -                bdsra(j)

  113 continue

c     file 12=fini, to display death rate evolution suggested

      write(12,365) fini

c    input-output summary file

      write(11,177)(zals(i),i=1,m),alsid,
     -             (zrec(i),i=1,m),resid,
     -             (bpd(i),i=1,m),bpdid,
     -             (bti(i),i=1,m), btid,
     -             (wl(i), i=1,m), wlid,
     -             (cost(i),i=1,m),
     -             (coe(i),i=1,m),
     -             (bdsto(i),i=1,m),
     -             (fnds(i),i=1,m),
     -             (dosum(i),i=1,m)

c     file 2=a is created here

      write(2,363)
      write(2,36)
      write(2,360)
```

```
      do 15 j=1,m,2
      ja=5*j-5
      write(2,34) ja,topop(j),sisum(j),drin(j),
     -                drsut(j),dosum(j),bdsto(j)



   15 continue

      write(2,362)
      write(2,36)
      write(2,361)

      do 151 j=1,m,2
      ja=5*j-5
      write(2,341) ja,topop(j),gmr(j),dinra(j),
     -                ,dutra(j),dosura(j),
     -                bdsra(j)
  151 continue

   22 format(7f10.2)

   24 format(18f4.2)

   25 format (5f11.1)

   31 format(2x,3hage,5x,10hpopulation,3x,10h general  ,13x,
     - ,'death rate',8x,'risk',5x,'number of episodes'/
     -'stratum',3x,'forcasted',4x,'morbidity',41x,'per capita, per yea
     -r'/'(years)',3x,'(in 1000)',4x,'(in 1000)'/)

   32   format (i2,'-'i2,4x,f10.2,5x,f10.2,10x,f10.6,5x,f9.3,12x,
     -  f3.1)

   33 format(///5x,'forecasting for period',1x,i2,1x,'years'/)

   34 format(3x,i2,5x,f8.1,2x,f11.1,5x,f7.1,7x,
     -f7.1,5x,f7.1,2x,f9.1)
```

```
 36 format(80('-')/
   -'forecast:population:',2x,'general',2x,':inpat.
   -doctor:outpat.doctor:all doctor',1x,
   -':',1x,'hospital'/' period :   total  : morbidity',
   -1x,': equivalents: equivalents',1x,':',
   -'equivalents:',3x,'beds'
   -/7('-'),' : ',8('-'),' : ',
   -9('-'),' : ',10('-'),' : ',11('-'),' : ',9('-'),' : ',8('-'))
 37 format(31x,'summary of results',///)

102 format(3i6,2f10.7)

107 format(/////5(19x,6(f9.2,1x,)//),2(19x,5(f9.2,1x,)//),19x,f9.3)

177 format('#INPUT-OUTPUT SUMMARY#'/19x'  year 0   year 5    year 10
   -   year 15   year 20   ideal'/79('-')/
   -'averg lngth stay  :',6(f8.2,' :',)//
   -'prcntge hsptlsd   :',6(f8.2,' :',)//
   -'bds/inp doc eqvt  :',6(f8.2,' :',)//
   -'bed trnvr intrv   :',6(f8.2,' :',)//
   -'cnslts/otp doc/yr :',6(f8.0,' :',)//
   -'bed cost/yr       :',5(f8.2,' :',)/28x,41('*')/
   -'cnslts/epsd       :',f8.2,' *',4(f8.2,' :')/29('*')/
   -'bds rqrd, total   :',5(f9.0,':',)//
   -'fnds rqrd, total  :',5(f8.2,' :',)//
   -'doc eqvts rqrd    :',5(f8.0,' :',))

341 format(3x,i2,5x,f8.1,4x,f7.2,6x,f5.3,9x,
   -f5.3,7x,f6.3,5x,f6.2)

349 format(3x,i2,7x,f8.1,4x,f11.1,' /',f5.1,5x,f7.1,' /',f5.3,9x,
   -f7.1,' /',f5.3,10x,f7.1,' /',f5.3,5x,f9.1,' /',f6.3/)

360 format(' (years):(in 1000) :',3x,'total
   -   :',3x,'total',4x,': ',3x,'total',
   -4x,':',3x,'total ',2x,':',3x,'total'/)
```

```
361 format(' (years):(in 1000) :',3x,' rate
   -    :',3x,' rate',4x,': ',3x,' rate',
   -4x,':',3x,' rate ',2x,':',2x,' rate'/)

362 format(/15x,'## SIMULATION RESULTS: in rates (per 1000
   -population) ##'/)

363 format(15x,'## SIMULATION RESULTS: in absolute
   - numbers ##'/)

365 format(10f7.2)

368 format(/////35x,'summary'///)

369 format(1x,129('*')/
   -' forecast * population *',5x,'general',8x,'*',1x,'inpatient
   - doctor    *   outpatient doctor   *',6x,'all doctor',5x,
   -'*',7x,'hospital'/'  period  *    total   *    morbidity',
   -7x,'*    equivalents',5x,'*      equivalents',6x,'*',
   -6x,'equivalents',4x,'*',9x,'beds'/1x,8('-'),' * ',10('-'),' * ',
   -18('-'),' * ',18('-'),' * ',21('-'),' * ',19('-'),' * ',17('-')/
   -'  (years) * (in 1000)  *',6x,'total
   - /rate   *',4x,'total /rate',5x,'* ',5x,'total /rate',
   -6x,'*',6x,'total /rate',4x,'*',6x,'total/rate'//)

370 format(9f8.4)

500 format (10x,'dea(i)=',f7.2)
      stop
      end
```

Appendix 3

Examples of Input Files

File ASTUK

```
3825.1,4065.4,3740.7,3373.6,3541.3,3498.8,2866.8,
2739.0,2895.1,3042.3,3028.3,2887.8,2835.0,2444.2,
1832.5,1309.5, 718.9, 440.0,
3389.1,3784.7,4059.9,3732.2,3362.2,3522.5,3471.7,
2826.7,2686.4,2786.3,2869.3,2732.4,2477.7,2241.2,
1664.0,1066.2, 540.6, 184.0,
3495.9,3353.4,3778.8,4049.7,3719.6,3344.4,3495.3,
3423.1,2772.5,2585.5,2627.9,2589.0,2344.4,1958.8,
1525.9, 968.2, 440.2, 138.4,
3645.5,3459.1,3348.1,3770.2,4036.1,3699.9,3318.5,
3446.4,3357.5,2668.3,2438.5,2371.2,2221.4,1853.4,
1333.6, 887.8, 399.7, 112.6,
3743.3,3607.0,3453.7,3340.5,3757.5,4014.8,3671.3,
3272.1,3380.3,3231.3,2516.6,2200.3,2034.5,1756.2,
1261.8, 776.0, 366.5, 102.3
```

File CHADE

```
1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0
 .9  .9 1.0 1.0 1.0 1.0  .97 .98 .97 .96 .95 .94 .94 .94 .94 .95 .96 .97
 .8  .8 1.0 1.0 1.0 1.0  .94 .95 .94 .92 .89 .87 .87 .87 .88 .90 .92 .94
 .7  .7 1.0 1.0 1.0 1.0  .90 .92 .90 .88 .83 .80 .79 .80 .81 .85 .87 .90
 .58 .571.0 1.0 1.0 1.0  .86 .89 .86 .83 .77 .73 .71 .73 .74 .79 .82 .86
```

<u>File DEUK</u>

```
  3.87,    0.35,    0.28,    0.63,     0.72
  1.40,    1.71,    3.94,    3.80,    11.67
 11.73,   30.31,   30.87,   66.91,    89.25
134.05,  244.18,  288.73
```

<u>File PRUK</u>

```
1340.0,  680.0,  680.0,  770.0,  770.0,
 770.0,  770.0,  770.0,  770.0, 1130.0,
1130.0, 1130.0, 1130.0, 1360.0, 1360.0,
1670.0, 1670.0, 1670.0
```

Appendix 4

File OTPR

FORECASTING FOR PERIOD 0 YEARS

AGE STRATUM (YEARS)	POPULATION FORCASTED (IN 1000)	GENERAL MORBIDITY (IN 1000)	DEATH RATE	RISK	NUMBER OF EPISODES PER CAPITA, PER YEAR
0- 4	3825.10	5125634.50	3.870000	0.003	1.3
5- 9	4065.40	2764471.75	0.350000	0.001	0.7
10-14	3740.70	2543676.00	0.280000	0.000	0.7
15-19	3373.60	2597672.00	0.630000	0.001	0.8
20-24	3541.30	2726801.00	0.720000	0.001	0.8
25-29	3498.80	2694076.00	1.400000	0.002	0.8
30-34	2866.80	2207436.00	1.710000	0.002	0.8
35-39	2739.00	2109030.00	3.940000	0.005	0.8
40-44	2895.10	2229227.25	3.800000	0.005	0.8
45-49	3042.30	3437799.00	11.670000	0.010	1.1
50-54	3028.30	3421979.00	11.730000	0.010	1.1
55-59	2887.80	3263214.00	30.309999	0.027	1.1
60-64	2835.00	3203550.00	30.870001	0.027	1.1
65-69	2444.20	3324112.00	66.910004	0.049	1.4
70-74	1832.50	2492200.00	89.250000	0.066	1.4
75-79	1309.50	2186865.00	134.050003	0.080	1.7
80-84	718.90	1200563.12	244.179993	0.146	1.7
85-89	440.00	734800.00	288.730011	0.173	1.7

FORECASTING FOR PERIOD 5 YEARS

AGE STRATUM (YEARS)	POPULATION FORCASTED (IN 1000)	GENERAL MORBIDITY (IN 1000)	DEATH RATE	RISK	NUMBER OF EPISODES PER CAPITA, PER YEAR
0- 4	3389.10	4087254.75	3.483000	0.003	1.2
5- 9	3784.70	2316236.25	0.315000	0.001	0.6
10-14	4059.90	2760732.00	0.280000	0.000	0.7
15-19	3732.20	2873794.00	0.630000	0.001	0.8
20-24	3362.20	2588893.75	0.720000	0.001	0.8
25-29	3522.50	2712325.00	1.400000	0.002	0.8
30-34	3471.70	2593013.00	1.658700	0.002	0.7
35-39	2826.70	2133027.75	3.861200	0.005	0.8
40-44	2686.40	2006472.12	3.686000	0.005	0.7
45-49	2786.30	3022578.00	11.203199	0.010	1.1
50-54	2869.30	3080193.50	11.143499	0.010	1.1
55-59	2732.40	2902355.50	28.491400	0.027	1.1
60-64	2477.70	2631812.75	29.017801	0.027	1.1
65-69	2241.20	2865150.25	62.895405	0.049	1.3
70-74	1664.00	2127257.50	83.894997	0.066	1.3
75-79	1066.20	1691526.25	127.347504	0.080	1.6
80-84	540.60	866689.87	234.412781	0.146	1.6
85-89	184.00	298061.59	280.068115	0.173	1.6

FORECASTING FOR PERIOD 10 YEARS

AGE STRATUM (YEARS)	POPULATION FORCASTED (IN 1000)	GENERAL MORBIDITY (IN 1000)	DEATH RATE	RISK	NUMBER OF EPISODES PER CAPITA, PER YEAR
0- 4	3495.90	3747604.75	3.096000	0.003	1.1
5- 9	3353.40	1824249.37	0.280000	0.001	0.5
10-14	3778.80	2569584.00	0.280000	0.000	0.7
15-19	4049.70	3118268.75	0.630000	0.001	0.8
20-24	3719.60	2864092.00	0.720000	0.001	0.8
25-29	3344.40	2575187.75	1.400000	0.002	0.8
30-34	3495.30	2529898.50	1.607400	0.002	0.7
35-39	3423.10	2503997.50	3.743000	0.005	0.7
40-44	2772.50	2006735.50	3.572000	0.005	0.7
45-49	2585.50	2687885.75	10.736401	0.010	1.0
50-54	2627.90	2642879.00	10.439699	0.010	1.0
55-59	2589.00	2545246.00	26.369699	0.027	1.0
60-64	2344.40	2304779.25	26.856901	0.027	1.0
65-69	1958.80	2317652.00	58.211704	0.049	1.2
70-74	1525.90	1826197.12	78.540001	0.066	1.2
75-79	968.20	1455204.50	120.644997	0.080	1.5
80-84	440.20	676323.37	224.645599	0.146	1.5
85-89	138.40	217260.31	271.406219	0.173	1.6

FORECASTING FOR PERIOD 15 YEARS

AGE STRATUM (YEARS)	POPULATION FORCASTED (IN 1000)	GENERAL MORBIDITY (IN 1000)	DEATH RATE	RISK	NUMBER OF EPISODES PER CAPITA, PER YEAR
0- 4	3645.50	3419478.75	2.709000	0.003	0.9
5- 9	3459.10	1646531.62	0.245000	0.001	0.5
10-14	3348.10	2276708.00	0.280000	0.000	0.7
15-19	3770.20	2903054.00	0.630000	0.001	0.8
20-24	4036.10	3107797.00	0.720000	0.001	0.8
25-29	3699.90	2848922.75	1.400000	0.002	0.8
30-34	3318.50	2299720.50	1.539000	0.002	0.7
35-39	3446.40	2441429.75	3.624800	0.005	0.7
40-44	3357.50	2326747.25	3.420000	0.005	0.7
45-49	2668.30	2653357.75	10.269600	0.010	1.0
50-54	2438.50	2287069.00	9.735899	0.010	0.9
55-59	2371.20	2143564.75	24.247999	0.027	0.9
60-64	2221.40	1983043.62	24.387300	0.027	0.9
65-69	1853.40	2016499.38	53.528004	0.049	1.1
70-74	1333.60	1469093.75	72.292503	0.066	1.1
75-79	887.80	1260232.00	113.942505	0.080	1.4
80-84	399.70	580724.19	212.436600	0.146	1.5
85-89	112.60	169237.80	259.856995	0.173	1.5

FORECASTING FOR PERIOD 20 YEARS

AGE STRATUM (YEARS)	POPULATION FORCASTED (IN 1000)	GENERAL MORBIDITY (IN 1000)	DEATH RATE	RISK	NUMBER OF EPISODES PER CAPITA, PER YEAR
0- 4	3743.30	2909292.75	2.244600	0.003	0.8
5- 9	3607.00	1398073.12	0.199500	0.001	0.4
10-14	3453.70	2348516.00	0.280000	0.000	0.7
15-19	3340.50	2572184.75	0.630000	0.001	0.8
20-24	3757.50	2893275.00	0.720000	0.001	0.8
25-29	4014.80	3091396.00	1.400000	0.002	0.8
30-34	3671.30	2431135.00	1.470600	0.002	0.7
35-39	3272.10	2242369.75	3.506600	0.005	0.7
40-44	3380.30	2238434.75	3.268000	0.005	0.7
45-49	3231.30	3030636.25	9.686100	0.010	0.9
50-54	2516.60	2189693.75	9.032100	0.010	0.9
55-59	2200.30	1815027.75	22.126301	0.027	0.8
60-64	2034.50	1632279.12	21.917700	0.027	0.8
65-69	1756.20	1743555.25	48.844303	0.049	1.0
70-74	1261.87	1269875.62	66.044998	0.066	1.0
75-79	776.00	1023776.87	105.899506	0.080	1.3
80-84	366.50	501885.09	200.227585	0.146	1.4
85-89	102.30	146923.27	248.307816	0.173	1.4

Summary

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL /RATE	INPATIENT DOCTOR EQUIVALENTS TOTAL /RATE	OUTPATIENT DOCTOR EQUIVALENTS TOTAL /RATE	ALL DOCTOR EQUIVALENTS TOTAL /RATE	HOSPITAL BEDS TOTAL/RATE
0	49084.3	48263112.0 /983.3	18347.7 /0.374	24018.3 /0.489	42366.0 /0.863	400163.5 / 8.153
5	47397.1	43557376.0 /919.0	15762.5 /0.333	22254.3 /0.470	38016.9 /0.802	343781.0 / 7.253
10	46611.0	40413048.0 /867.0	13587.5 /0.292	21641.9 /0.464	35229.4 /0.756	296343.9 / 6.358
15	46367.8	37833212.0 /815.9	11550.5 /0.249	21325.5 /0.460	32876.0 /0.709	251917.4 / 5.433
20	46486.0	35478332.0 /763.2	9780.3 /0.210	20996.9 /0.452	30777.2 /0.662	213307.4 / 4.589

Appendix 5

Results of Experiments (With Comments to Some Examples of Interactive Work with the AMER Computer Model)

Considering the real socio-economic situation, specifically that of health care organization, the health manager is able to test different alternatives during interactive work with the AMER model.

The control variables are presented in the input file in Table A1. By altering these control variables, it is possible to forecast the final health care resource requirements. At the same time population-, morbidity-, and mortality trends can be forecast.

Table A1

* FILE CTL *

	BASE YEAR	FUTURE YEARS / TRIAL FUGURES YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.8	23.8	23.8	23.8	23.8	19.0
PRCNTGE HSPTLSD	10.53	10.53	10.53	10.53	10.53	9.5
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.0
BED TRNVR INTRV	4.94	4.94	4.94	4.94	4.94	4.0
CNSLTS/OTPT DOC/YR	7033.0	7033.0	7033.0	7033.0	7033.0	6000.0
BED'S COST/YR	3145.0	3300.0	3400.0	3500.0	3600.0	
COST/OTPT DOC/YR	29400.0	30000.0	31000.0	32000.0	33000.0	
CNSLTS/EPSD	3.5					

In the output file presented in Table A2, the average length of stay is decreased from 23.8 to 19.6 days over time, with all other variables remaining constant. Such a situation is possible if the majority of inpatients undergo laboratory tests in outpatient health centers before admission to the hospital. Taking into account the interrelationship between inpatient and outpatient services, an increase in the workload of outpatient establishments would occur in such a situation.

Table A2

INPUT-OUTPUT SUMMARY

	YEAR 0	YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.80	22.00	21.60	20.00	19.60	19.00
PRCNTGE HSPTLSD	10.53	10.53	10.53	10.53	10.53	9.50
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.00
BED TRNVR INTRV	4.94	4.94	4.94	4.94	4.94	4.00
CNSLTS/OTP DOC/YR	7033.	7033.	7033.	7033.	7033.	6000.
BED COST/YR	3145.00	3300.00	3400.00	3500.00	3600.00	
CNSLTS/EPSD	3.50	3.59	3.61	3.69	3.71	
BDS RQRD, TOTAL	400164.	354007.	339511.	315147.	309997.	
FNDS RQRD, TOTAL	1964.65	1865.74	1859.91	1838.40	1878.23	
DOC EQVTS RQRD	42366.	39482.	38327.	37431.	37312.	

SIMULATION RESULTS: IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION: TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT. DOCTOR EQUIVALENTS TOTAL	OUTPAT. DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	15566.7	22760.6	38327.3	339510.7
20	46486.0	43787152.0	14213.5	23098.3	37311.8	309996.5

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION: TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT. DOCTOR EQUIVALENTS RATE	OUTPAT. DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	983.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.334	0.488	0.822	7.28
20	46486.0	941.94	0.306	0.497	0.803	6.67

In order to investigate the influence of hospitalization changes on the health care resources, one can change the value of percent hospitalized in the model while keeping all other control variables constant over time, as in Table A3. This would reflect, for example, the case when the decision maker would have non-serious patients remain at home under outpatient center supervision and hospitalize only serious patients. It is clear that this would influence, for example, the average length of stay in hospital.

Table A3

#INPUT-OUTPUT SUMMARY#

	YEAR 0	YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.80	23.80	23.80	23.80	23.80	19.00
PRCNTGE HSPTLSD	10.53	10.20	10.00	9.90	9.60	9.50
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.00
BED TRNVR INTRV	4.94	4.94	4.94	4.94	4.94	4.00
CNSLTS/OTP DOC/YR	7033.	7033.	7033.	7033.	7033.	6000.
BED COST/YR	3145.00	3300.00	3400.00	3500.00	3600.00	
CNSLTS/EPSD	3.50	3.64	3.72	3.76	3.88	
BDS RQRD, TOTAL	400164.	365824.	349149.	341437.	330988.	
FNDS RQRD, TOTAL	1960.65	1913.54	1913.66	1944.03	1988.99	
DOC EQVTS RQRD	42366.	40317.	39446.	39061.	39341.	

SIMULATION RESULTS; IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT.DOCTOR EQUIVALENTS TOTAL	OUTPAT.DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	16008.7	23437.1	39445.8	349149.1
20	46486.0	43787152.0	15176.0	24164.8	39340.8	330987.6

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT.DOCTOR EQUIVALENTS RATE	OUTPAT.DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	983.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.343	0.503	0.846	7.49
20	46486.0	941.94	0.326	0.520	0.846	7.12

In Table A4, the decision maker is testing the influence of decrease in bed turnover interval (or functionally related bed occupancy rate) on the final health care system resource requirements. Comparison of these rates among different countries, or among different regions of the same country, shows that there are many possibilities in this direction.

Table A4

INPUT-OUTPUT SUMMARY

	YEAR 0	YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.80	23.80	23.80	23.80	23.80	19.00
PRCNTGE HSPTLSD	10.53	10.53	10.53	10.53	10.53	9.50
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.00
BED TRNVR INTRV	4.94	4.90	4.80	4.70	4.50	4.00
CNSLTS/OTP DOC/YR	7033.	7033.	7033.	7033.	7033.	6000.
BED COST/YR	3145.00	3300.00	3400.00	3500.00	3600.00	
CNSLTS/EPSD	3.50	3.50	3.50	3.50	3.50	
BDS RQRD, TOTAL	400164.	377134.	365863.	360132.	357494.	
FNDS RQRD, TOTAL	1964.65	1924.57	1928.01	1957.98	2006.08	
DOC EQVTS RQRD	42366.	39959.	38842.	38310.	38182.	

SIMULATION RESULTS: IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT.DOCTOR EQUIVALENTS TOTAL	OUTPAT.DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	16775.0	22067.1	38842.1	365863.1
20	46486.0	43787152.0	16391.3	21790.8	38182.1	357493.8

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT.DOCTOR EQUIVALENTS RATE	OUTPAT.DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	983.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.360	0.473	0.833	7.85
20	46486.0	941.94	0.353	0.469	0.821	7.69

Each of the above examples illustrates a situation in which the decision maker is testing the influence of only one control variable on the health care resource requirements. But in some cases it is possible to alter all variables in a step-by-step manner. In Tables A5a-A5c, first the percent hospitalized is decreased from 10.53 to 9.50, then the average length of stay in hospital from 23.8 to 21.0, and finally the bed turnover interval from 4.94 to 4.6.

Table A5

#INPUT-OUTPUT SUMMARY#

	YEAR 0	YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.80	23.80	28.80	23.80	23.80	19.00
PRCNTGE HSPTLSD	10.53	10.53	10.53	10.53	10.53	9.50
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.00
BED TRNVR INTRV	4.94	4.94	4.94	4.94	4.94	4.00
CNSLTS/OTP DOC/YR	7033.	7033.	7033.	7033.	7033.	6000.
BED COST/YR	3145.00	3300.00	3400.00	3500.00	3600.00	
CNSLTS/EPSD	3.50	3.50	3.25	3.50	3.50	
BDS RQRD, TOTAL	400164.	377660.	431616.	363164.	363052.	
FNDS RQRD, TOTAL	1964.65	1926.31	2102.71	1968.60	2026.09	
DOC EQVTS RQRD	42366.	39984.	40281.	38449.	38437.	

SIMULATION RESULTS: IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT.DOCTOR EQUIVALENTS TOTAL	OUTPAT.DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	19789.8	20490.8	40280.7	431616.0
20	46486.0	43787152.0	16646.1	21790.8	38437.0	363052.1

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT.DOCTOR EQUIVALENTS RATE	OUTPAT.DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	983.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.425	0.440	0.864	9.26
20	46486.0	941.94	0.358	0.469	0.827	7.81

Table A5a

#INPUT-OUTPUT SUMMARY#

	YEAR 0	YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.80	23.60	23.60	23.80	23.80	19.00
PRCNTGE HSPTLSD	10.53	10.10	9.90	9.80	9.50	9.50
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.00
BED TRNVR INTRV	4.94	4.94	4.94	4.94	4.94	4.00
CNSLTS/OTP DOC/YR	7033.	7033.	7033.	7033.	7033.	6000.
BED COST/YR	3145.00	3300.00	3400.00	3500.00	3600.00	
CNSLTS/EPSD	3.50	3.68	3.76	3.80	3.92	
BDS RQRD, TOTAL	400164.	362238.	345658.	337988.	327540.	
FNDS RQRD, TOTAL	1964.65	1909.67	1909.80	1940.13	1985.01	
DOC EQVTS RQRD	42366.	40418.	39544.	39159.	39438.	

SIMULATION RESULTS: IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION: TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT.DOCTOR EQUIVALENTS TOTAL	OUTPAT.DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	15848.6	23695.6	39544.2	345657.5
20	46486.0	43787152.0	15017.9	24420.1	39437.9	327539.9

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION: TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT.DOCTOR EQUIVALENTS RATE	OUTPAT.DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	983.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.340	0.508	0.848	7.42
20	46486.0	941.94	0.323	0.525	0.848	7.05

Table A5b

#GLNSR-MSPNSR OSKK?PW#

	YEAR 0	YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.80	22.00	21.80	21.40	21.00	19.00
PRCNTGE HSPTLSD	10.53	10.10	9.90	9.80	9.50	9.50
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.00
BED TRNVR INTRV	4.94	4.94	4.94	4.94	4.94	4.00
CNSLTS/OTP DOC/YR	7033.	7033.	7033.	7033.	7033.	6000.
BED COST/YR	3145.00	3300.00	3400.00	3500.00	3600.00	
CNSLTS/EPSD	3.50	3.77	3.86	3.92	4.06	
BDS RQRD, TOTAL	400164.	339551.	321603.	309763.	295629.	
FNDS RQRD, TOTAL	1964.65	1852.29	1847.56	1865.26	1898.89	
DOC EQVTS RQRD	42366.	39961.	39072.	38612.	38846.	

SIMULATION RESULTS: IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT.DOCTOR EQUIVALENTS TOTAL	OUTPAT.DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	14745.7	24326.1	39071.8	321603.5
20	46486.0	43787152.0	13554.8	25291.7	38846.5	295629.3

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT.DOCTOR EQUIVALENTS RATE	OUTPAT.DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	983.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.316	0.522	0.838	6.90
20	46486.0	941.94	0.292	0.544	0.836	6.36

Table A5c

#INPUT-OUTPUT SUMMARY#

	YEAR 0	YEAR 5	YEAR 10	YEAR 15	YEAR 20	IDEAL
AVERG LNGTH STAY	23.80	22.00	21.80	21.40	21.00	19.00
PRCNTGE HSPTLSD	10.53	10.10	9.90	9.80	9.50	9.50
BDS/INP DOC EQVT	21.81	21.81	21.81	21.81	21.81	17.00
BED TRNVR INTRV	4.94	4.90	4.80	4.70	4.60	4.00
CNSLTS/OTP DOC/YR	7033.	7033.	7033.	7033.	7033.	6000.
BED COST/YR	3145.00	3300.00	3400.00	3500.00	3600.00	
CNSLTS/EPSD	3.50	3.77	3.86	3.92	4.06	
BDS RQRD, TOTAL	400164.	339047.	319920.	306941.	291754.	
FNDS RQRD, TOTAL	1964.65	1850.62	1841.84	1855.38	1884.94	
DOC EQVTS RQRD	42366.	39938.	38995.	38482.	38669.	

SIMULATION RESULTS: IN ABSOLUTE NUMBERS

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY TOTAL	INPAT.DOCTOR EQUIVALENTS TOTAL	OUTPAT.DOCTOR EQUIVALENTS TOTAL	ALL DOCTOR EQUIVALENTS TOTAL	HOSPITAL BEDS TOTAL
0	49084.3	48263112.0	18347.7	24018.3	42366.0	400163.5
10	46611.0	44342180.0	14668.5	24326.1	38994.6	319919.7
20	46486.0	43787152.0	13377.1	25291.7	38668.8	291754.4

SIMULATION RESULTS: IN RATES (PER 1000 POPULATION)

FORECAST PERIOD (YEARS)	POPULATION TOTAL (IN 1000)	GENERAL MORBIDITY RATE	INPAT.DOCTOR EQUIVALENTS RATE	OUTPAT.DOCTOR EQUIVALENTS RATE	ALL DOCTOR EQUIVALENTS RATE	HOSPITAL BEDS RATE
0	49084.3	963.27	0.374	0.489	0.863	8.15
10	46611.0	951.32	0.315	0.522	0.837	6.86
20	46486.0	941.94	0.288	0.544	0.832	6.28

The decision maker, together with health care system experts, must select the best alternative and develop real complex five-, ten-, and twenty-year plans of concrete measures in order to achieve these results.

Papers of the Modeling Health Care Systems Study

April 1978

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