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STATISTICAL METHODS IN HEALTH ECONOMICS

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Abstract. In order to stimulate the improvement of the quality of health management, there are used economic, juridical, sociological or ethical methods. The involvement of economic theory in health care systems is made by a series of tools, judgments and models to help the medical decision making process. This paper offers an example of such method that combines economics, statistics and mathematics techniques. The Romanian medical education system needs to use such methods giving a real support in the optimization of the resource allocation to a greater extent.
Keywords: costs, benefits, economics, health, Cost-Benefit Analysis

Rezumat. În eficientizarea actului managerial, pe lângă abordările medicale, s-au impus şi celelalte analize de natură economică, sociologică, etică. Implicarea teoriei economice în domeniul alocării resurselor din sistemul de sănătate s-a concretizat în instrumente, raţionamente şi modele care ajută la adoptarea justificată a deciziilor. Lucrarea de faţă prezintă un exemplu al unei astfel de metode, care îmbină tehnici şi modele economice, statistice, şi matematice. Sistemul educaţional medical ar putea oferi o atenţie sporită acestor metode de optimizare a alocării resurselor.
Cuvinte cheie: costuri, beneficii, economie, sănătate, Analiza Cost-Beneficiu

INTRODUCTION

Cost-Benefit Analysis is a methodology intended to improve the efficient use of the allocated resources. It is part of the economic theory on the so called "rational individual behavior". A rational behavior is described decisions as based on costs and benefits.

A complete definition of the Cost-Benefit Analysis process is given by Prest and Turvey: using such an analysis it is possible to "maximize the present value of all benefits less that of all costs, subject specified constrains" (1). Cost-Benefit Analysis is a method for evaluating the desirability of a proposal as well as for comparing alternative proposals being designed to promote efficient use of scarce resources. The main points and questions of such analysis are:

- which costs and which benefits are included in the model;
- how the costs and benefits are evaluated;
- what are the relevant constraints;
- what are the interest rate of evaluation of future costs and benefits.

METHOD

Any health care program is aimed to improve the health status of the patients. Cost-Benefits Analysis wants to maximize this objective. The basic idea is to take the costs and benefits and disaggregate them into their component parts and, then to apply unequal weights to those who have different significance.

The aim is to maximize the difference between costs (C) and benefits (B), underlying the idea of lower costs and higher benefits: B-C.

In our case the methods are based on determining the Lagrange multipliers. The objective and the constraints, relevant to the particular decision making process are in the domains of budgeting, economic or marketing.

RESULTS AND DISCUSSION

We have described an application of Cost-Benefit Analysis from a health-care planning (2). The aim of our program was to improve the health status of a child population by saving lives. There were two options in order to achieve this purpose:

- hiring additional medical persons (first option, x_1);
- buying additional food supply (second option, x_2).

Our previous medical research has concluded that the first option can avoid death in 163 cases and the second one can save 100 lives per year. The objective function, by which the number of saved lives is showed is the following:

$$N = 163 \cdot x_1 + 100 \cdot x_2$$

It is obvious, that from a mathematic point of view, N function is a family of isoquants which combines the two health-care possibilities that produce the same quantity of saved lives.

The coefficients reflect the research's preferences: first option (hiring medical personal) is 1.63 times more productive that the second one (buying additional food supply) and are technically determined. A life saved using the first intervention has the same value as in the case of second intervention.

The health program must face a budget constrain: a fixed amount of 200 monetary units is available the two medical interventions. If the price for the first intervention x_1 is 20 and the price of the second intervention x_2 is 5, then the budget constrains is:

$$20 \cdot x_1 + 5 \cdot x_2 \le 200$$

In addition to the budget constrains there is the market one. Therefore we know that the maximum available medical personal is 5, the maximum possible food supply is 30. In this case these inputs are integer and positive.

This set of constrains are expressed by the following inequation:

$$\left\{ \begin{array}{l} x_1 \le 5 \\ x_2 \le 30 \\ x_1 \ge 0 \\ x_2 \ge 0 \end{array} \right\}$$

The Cost-Benefit problem is presented in figure 1, where:

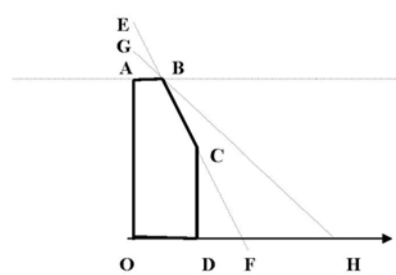

Fig. 1 The Cost-Benefit Analysis represented in an orthogonal space

- AB line (x_1=<5), the horizontal line, represents the constraint function of the first intervention (medical personal);
- CD line (x_1=<30), the vertical line, represents the constraint function of the second intervention (food):
- EF line (200 monetary units) represents the budget constraint;
- all the variables are positive with non-negativity constraints.

The possible solution of this problem is in the OABCD surface, which is a potential solution in all O, A, B, C, D corners. There is necessary to choose, the optimum solution. Analyzing all the possibilities, it was concluded:
- O point means 0 interventions and 0 lives saves;
- A point (with x_1=0 and x_2=30 coordinate) means 0 first intervention and 30 second interventions. The object function N became:

N=163*0+100*30=3000 lives saves.

In this point of analysis the solution is N=3000 lives saves. Could be improved this number? If we consider:
- D point (with x_1=5 and x_2=0 co-ordinate) represents 5 first interventions and 0 second intervention, the obtained function N is:

N=163*5+100*0=815 lives saves
- B point (with x_1=2.5 and x_2=30 co-ordinate) which give us the maximum number of lives saves, the obtained function is:

N=163*2.5+100*30=3407 lives saves
- C point (with x_1=5 and x_2=20 co-ordinate) and the objective function:

N=163*5+100*20=2815 lives saves

The optimum solution is given by the maximum saves lives of 3407.

This problem could be solved using the linear programming as table 1 shows (3):

Table 1 The Cost-Benefit Analysis reduced as a linear programming problem

B	X_1	X_2	X_3	X_4	X_5	b
X_3	20	5	1	1	0	200
X_4	1	0	0	0	1	5
X_5	0	1	0	0	0	30
f	-163	-100	0	0	0	0
X_1	1	1/4	1/20	0	0	12,5
X_4	0	-1/4	-1/20	1	0	-5
X_5	0	1	0	0	1	4/237
f	0	-237/4	163/20	0	0	1630
X_1	1	0	1/20	0	-1/4	5
X_4	0	0	-1/20	1	1/4	2,5
X_2	0	1	0	0	1	30
f	0	0	163/20	0	4/237	**3407**

CONCLUSIONS

In Cost-Benefits Analysis either negative or positive effects are expressed in units of money and is suitable to answer some of the important questions of the health care such as the total amount of money that should be spent for prolonging life and enhancing its quality (4,5).

Cost-Benefit Analysis as a tool in assigning monetary values is of a great importance, especially with health care management, performing changes of health status and length of life.

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