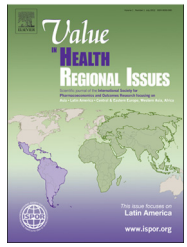
Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/vhri



Optimization Approach for Estimating the Required Amount of Pharmaceuticals in the Russian Federation

A.V. Prasolov, DSc[1,2], *A.S. Kolbin, MD, PhD*[1,3], *Yulia E. Balykina, PhD*[1,*].

[1]*Saint Petersburg State University, Saint Petersburg, Russia;* [2]*Higher School of Economics, National Research University, Saint Petersburg, Russia;* [3]*Pavlov First Saint Petersburg State Medical University, Saint Petersburg, Russia*

ABSTRACT

Objectives: To propose an algorithm that relates the effectiveness of drugs for a wide range of diseases with the financial capabilities of patients. **Methods:** Estimates of the volume of pharmaceuticals that are consumed in the Russian Federation by all segments of the population regardless of household income were considered. These were calculated using statistically valid probabilities of the appearance of various diseases, official state data on the structure of expenditures of various strata of the population, and the optimal choice of the most effective medicines with income restrictions taken into account. The main idea was to introduce the utility function of the drug and the cost of treatment. For each disease, its own set of drugs was selected. **Results:** On the basis of the real-world data for several diseases, optimal estimates were calculated using the proposed algorithm. In the process of approbation, some weak points of the algorithm were found, such as the methods of packaging pharmaceuticals and associated cost of a packaging unit. These characteristics should be discussed separately, introducing conventional units of drug volumes. A unit of quantity corresponding to the maximum effect of the drug in question is proposed in the work. **Conclusions:** The proposed algorithm for estimating the amount of medicines can be successfully used by both pharmaceutical (or dealer) companies and government agencies for objective population provision. The usual sources of such estimates are based either on market surveys or on pharmacy network data. Both ways are very expensive and do not allow predicting mass demand in the future, for example, with an unexpected epidemic or the emergence of new medicines. In addition, the proposed algorithm can be successfully applied to the pricing problem: a variation in price may show a change in the volume of use.

Keywords: health technology assessment, optimal choice of treatment plan, pharmacoeconomics.

Introduction

One of the main goals in the pharmaceutical market is to determine the production volumes of different drugs and to assess the dynamics of these volumes. Within this framework, pharmacoeconomic studies in the current period of the health care economy development are one of the challenging areas allowing to optimally solve the problem of drug assistance for patients receiving treatment, with scarce financial resources [1]. Management and effective planning of the drug supply system cannot exist without information support, which forms the decision-making process at all levels. The pharmaceutical market undergoes various changes; for example, the technology of drug production and distribution is changing and conditions for monitoring are emerging. At present, information on the structure and volume of the pharmaceutical market is disparate and incomplete. This applies both to different regions and to the Russian Federation (RF) as a whole. This information can be considered either as an expert assessment of individual market players or as data from regulatory bodies. In this article, the use of drugs in the RF is formalized in mathematical terms with respect to some "major" diseases; that is, a mathematical model for the optimal drug choice (treatment plan) is proposed with a budget allocated for treatment. We consider a household member (HM), who achieves the highest effectiveness (utility) of drugs, as the decision maker. Results of the selection of optimal treatment plans are combined into a macroeconomic problem of estimating the necessary volumes of medicines throughout the country. In this regard, official statistics on the disease likelihood were used. Solving these issues has a wide utility of the pharmaceuticals used. Obtained results might be useful at the producer level, as an opportunity to forecast the production and sale of medicines, as well as at the state level.

Different aspects of demand and need for drugs have been considered in research studies by Dremova [2], Dzhuparova and Sboeva [3], Kobzar and Avetisyan [4], and many others. The offered methods allow carrying out an analysis of the necessity for different medicines in individual market segments: certain

Conflicts of interest: The authors have indicated that they have no conflicts of interest with regard to the content of this article.

* *Address correspondence to:* Yulia E. Balykina, Saint Petersburg State University, Universitetskaya nab., 7/9, Saint Petersburg 199034, Russia.

E-mail: julia.balykina@gmail.com..

2212-1099$36.00 – see front matter © 2018 Published by Elsevier Inc. on behalf of International Society for Pharmacoeconomics and Outcomes Research (ISPOR).

https://doi.org/10.1016/j.vhri.2018.04.002

categories of patients, various prevention and treatment institutions, different pharmacotherapeutic categories, and so forth. Dremova [2] distinguishes the following methods for studying the assortment of medicines, depending on the goals. The first method is a marketing analysis of the range of drugs at the regional or local level, which creates an array of marketing information about drugs. The drugs are then systematized according to their international nonproprietary names, trade names, volumes, pack forms, and so forth. Production is analyzed on the basis of the number of foreign and domestic drugs, original drugs, and generics, as well as other characteristics. The second method is an analysis of drug assortment by prescriptions, which can be made on the basis of the following information sources: prescriptions, ambulatory medical records, and case records. The sample is either taken for a certain period of time (month, quarter, or year) or is specific (for certain medical specialists, certain types of diseases, etc.). This information is processed by calculating statistical characteristics of the sample and the consumption intensity factors. The third refers to sociological methods, which provide an opportunity within a short time to obtain information based on public opinion. Major techniques used are survey questionnaires and interviews. Expert judgments are also considered because these are necessary for obtaining and studying the opinions of certain specialists in an industry related to the drug market.

While studying the literature on the subject, it was observed that most often the analysis issues are considered from the viewpoint of the policy of the pharmaceutical organizations. There are, however, many works devoted to individual diseases or groups of diseases. For example, in the study by Dzhuparova and Sboeva [3], stratification of patients diagnosed with diabetes mellitus was carried out using questionnaires. As a result, three main groups were identified: patients with low, middle, and high income. The coefficients of income elasticity were then found, as well as the willingness of patients to participate in partial payment for medicines, self-monitoring, and insulin administration. Other examples of studies devoted to the analysis of the drug market for certain groups of diseases include forecast of the development of drugs assortment for the treatment of bronchial asthma in children by Kobzar and Avetisyan [4] and the marketing analysis of the sedative drugs market by Andreeva et al. [5]. In these studies, analysis usually refers to sociological methods of data collection and its statistical analysis. If forecasting is necessary, the basic econometric methods are used. For example, in the study by Frolova and Tulyakov [6], a short-term forecasting of the demand for pharmaceutical products based on sales data for previous periods is made using a mathematical apparatus of artificial neural networks.

It should also be noted that there are many analytical agencies working in the Russian pharmaceutical market: Pharmexpert, DSM, COMCON-Pharma, IMS, RMBC, and so forth. All these companies carry out monitoring and publish analytical reviews with comprehensive analysis of market volumes, dynamics, structure, and so forth. For example, the DSM Group releases monthly analytical reviews, which reflect the overall situation and changes that occurred in the pharmaceutical market during the reporting period. The information presented in the reports is based on the data of the retail audit [7]. Needless to say, companies do not disclose their methods of analysis, but the general methodology for collecting, processing, and analyzing data, using the example of Pharmexpert, is as follows [8]. First, a data collection system is developed. Data are collected in cooperation with pharmacy institutions. They provide data on drug purchases. The characteristics of the sample are then gathered. The sample has three stages of stratification: with respect to the regions, the cities within each selected region, and the pharmacies inside each city. This is followed by calculations. The data are extrapolated to restore sales volumes across all pharmacies of the city, region, and market in general. Thus, having analyzed various studies on the subject, it can be summarized that for the most part, the question of analyzing the pharmaceutical market is based on the empirical data from pharmacy institutions with the involvement of econometric methods.

In a study by Smith et al. [9], the construction of a planning and promotion strategy for business in the pharmaceutical market is considered. The Protek company shares its experience. For example, at one of the stages of strategic analysis, namely, the analysis of sociodemographic positions, the authors show that the growth of the average income level in the country entails a change in demand in favor of drugs of higher price categories with greater efficiency. Similar issues were described by Prasolov and Kolbin [10]. The present article examines the changes in drug demand depending on the structure of income and expenditure. For the first time, the problem is taken up on the possibility of estimating the drug market on the basis of the utility and available budget, when the consumer has budget constraints and chooses the optimal “recovery” regime.

Methods

Adoption of an Optimal Strategy for One Disease and Several Drugs

Let us consider a situation in which a person falls sick and is needed to choose a drug from the set that is suitable for the disease. At the same time, we need to remember that every person has a budget limit and that each drug has its own effect on the body. The problem of estimating the need for certain drugs can be solved with help of econometric methods: the pharmacy system is monitored and, after appropriate extrapolations, estimations of the consumption amount of a given medicine are deduced, as described earlier. In this article, we proceeded from the consumer task (one of the most developed models in microeconomics [11]), in which the HM solves the problem of optimizing the treatment strategy, taking into account his budgetary constraints.

Data on the budget expenditures of an HM were obtained from the Federal State Statistics Service [12]. First, the entire population of the RF was divided into 10 equal parts, called deciles, which were united by one (medium) income level. The structure of expenditures in deciles is different, in particular with respect to health care. Table 1 presents official statistical data [12] of the average RF income and some expenses per month for one HM (in rubles [R]), as well as the annual drug consumption. Because the official statistics combine the costs of medicines and hygiene items, in further calculations we proceeded from the assumption that for any category of consumer security, hygiene items account for one-quarter of the total expenditure. This is reflected in the last row of Table 1.

The “utility function” of medicines was introduced to assess the effect of the chosen drug. To describe the drug effects, we were guided by the fact that when using small doses, the drug almost does not affect a patient's body; then there is a dose that delivers the greatest possible effect (which can be obtained from this medicine), and there is also the amount after which the harmful effect begins (overdose). We suggest the following dependence as a function of the effectiveness of one drug for one disease [13]:

$$\phi(x) = ax^2(m - x), \tag{1}$$

where x is the drug volume (measurement units and the corresponding prices will be addressed later), a is the parameter characterizing the maximum level of drug efficacy, and m is the parameter equal to such a drug quantity at which it ceases to be useful and becomes harmful. The behavior of the effectiveness