



Risk Modelling in Health Care

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Abstract

The most vital problems of health care and health sector, which is one of the most rapidly growing sectors in the business world are the deficiencies of data and sex groups. Therefore, the present health expenditure pricing plans unfortunately are not arranged reasonably. This study aims risk for care area.

Many of the studies for health care reform include system of risk adjustment payments among health plans and health applications. These systems are like as the insurers should improve an emergency plan in which financial helps are minimized and the people who are enrolled are assigned mostly to low-risk people.

According to this topic and purpose of the study, the health care services companies can cover the needs of people enrolled with using their minimum possible financial resources. They obtain this process via two steps: Forecasting the health care cost of people enrolled(risk assessment) and transferring funds from plants that have less than their share of high-risk enrollees to plans that have more than their share of high-risk enrolles(risk adjustment).

Keywords: Health Care, Forecasting, Risk Assessment

Introduction

One of the most important problems seen in health care services, a field that progresses very rapidly in the last years, is the insufficiency and unreliability of the statistics and data related with this service sector. Therefore, the existing risk is marketed and priced wrongly and the net risk premiums are not determined accurately. In this study, with a flexible and effective model, it is aimed to calculate the net risk Premium actually by defining the variables affecting the prices of present healthcare services products and by making the necessary statistical analysis.

Grouping of Benefit Types

Although there are some distinctions among current healthcare packages in Turkish Market, the benefits and assurances offered show similarities in almost all of the policies. These benefits can be classified into two main groups. The first ones are the benefits named "Hospital Benefits" and the second group is "On foot Medical Treatment-Diagnosis Benefits". In general, Hospital Benefits including Surgical Operations, Room-Meal, Intensive Care, Accompanier and Urgent Transportation expenses are paid 100% in return. On the other hand, the latter benefits containing Doctor, Medicine, X-Ray, Analyses and Physical Treatment expenses are paid 80% in return. Furthermore, it may be secured another group of benefits called "Additional Benefits" including Birth, Glasses, Teeth, Air Ambulance and Check-Up. However, "On foot Medical Treatment-Diagnosis Benefits" and Additional Benefits cannot be given alone, whereas the insurance products of the health care services covering "Hospital Medical Treatment Benefits" can be allowed to given separately. The definitions and contents of the benefits are detailed below[11-12].

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a) Medical Treatment On-foot and In Hospital

All types of expenditures realized in health insurance for diagnostic and treatment purposes including Doctor, X-ray, Tomography, Advanced Operations, Analyses and Medicine are paid unlimitedly up to benefit limit with the 20% monetary participation of the claimant(i.e. patient).

b) Surgical Operations

This benefit incorporates all types of Operator, Assistant, Narcosis, Medicine-related and Angiography expenses associated with Surgical Operations

c) In-Hospital Medical Treatment

All types of Consultation, Blood and Plasma Transfusion, Medicine, Oxygen, Anesthesia, Plaster, Bandage, Wound Dressing, Cardiographs, X-ray, Diagnostic Laboratory Tests and Nursing costs concerned with In-Hospital Medical Treatment.

d)Room-Meal

All kinds of room, meal and nursing services expenses for the period that a patient stays in the hospital.

e)Intensive Care

Expenses that come out as result of intensive care services in the same unit.

f)Urgent Transportation

Expenses of ambulances that carry out the patients.

g) Medicine

Pharmaceutical expenses of the patients arising from the pharmacological needs prescribed by doctors.

h)X-Ray & Tomography

All kinds advanced examination made by X-Ray, Tomography, MR, Sintigraphy, Endoscopy etc. expenses determined by the doctor for the medical treatment of illnesses.

i)Analyses

All kinds of necessary analyses and chemical substance usage for diagnostic purposes expenses related with analyses[2, 5]. The most crucial factors affecting the net risk Premium of a specific health insurance product are as follows: Age&Sex, Benefit Type, Benefit Limit, Cost of Benefit, Patient Monetary Participation Rate, Inflation

These companies market their standard product as both on an individual and a group health insurance basis. The greatest problem occurring in group marketing is the different kinds of benefits demanded by the different groups rather than the standard products offered by the insurers.

In a very competitive market, insurance companies may suffer from the strategies that do not take the group's age&sex distribution and their characteristics into consideration[8, 9].

Another problem encountered by insurance companies is the inability of accurate evaluation of data and statistics. This is because there is no adequate professional insurance analysts in the companies staff and as a result of these the data associated with health subjects are analyzed by the life actuaries who have not any statistical analysis knowledge[8].

It is desired for a health insurance product-pricing model as to be flexible and simple to be easily understood and pursued by users(i.e.marketing, accounting and reinsurance units).



HEALTH CARE SERVICES AND RISK History of Health Care Services Based on a Risk

Health Care Services(Insurance) is a prepayment plan providing services or cash indemnities for medical care needed in times of illness or disability. It is effected by voluntary plans, either commercial or nonprofit, or by compulsory National Insurance plans, usually connected with a social security program[6, 7].

Although health care service programs vary from country to country and from nation to nation, nowadays there are usually three types of it either commercial or nonprofit, usually encouraged by the government, or mix of two[7].

Basic Health Insurance

Hospital Insurance

A hospital insurance policy indemnifies for necessary hospitalization expenses, such as room costs, laboratory fees, nursing care, use of the operating room and certain medicines and supplies[9, 10].

Surgical Insurance

Surgical insurance covers fees of physicians associated with covered surgeries. To prevent unnecessary hospitalization, both inpatient and outpatient surgical procedures are covered. Some policies may only pay only fees charged by the doctor who actually performs the surgery, whereas some may also pay charges of the assistant surgeons and anesthesiologist[9, 10].

Regular Medical Expense Insurance

Regular Medical Expense Insurance policies mostly cover services of physicians other than surgical procedures. These policies do not require the hospitalization of the insured, whereas some may require[9, 10].

BACKGROUND of HEALTH SYSTEM in TURKEY

Fundamentals of Health System

The Turkish health sector is characterized by extreme complexity. A large number of public, semi-public and private institutions are engaged in the financing and delivery of health services. The public sector is not limited to the Ministry of Health.

The Social Insurance Organization(SSK) operates not only its own hospitals; it also purchases services for its members from public and private facilities. Medical schools, through their university hospitals, cover a substantial part of demand for health services. The Army has a large network of facilities and covers the health needs of its active members, retirees and their dependents. Other ministries(Education), public organizations (PTT, railways) and state economic enterprises still operate their hospitals. In addition to the very active private for-profit sector, there are many foundations and hospitals for religious groups and foreign communities [12, 13].

Most of health services are however supplied under three largely autonomous systems:

The Ministry of Health, The Social Insurance System(SSK) and Medical schools.

While the Ministry of Health is formally responsible for the design and implementation of the country's health policies, its authority over other health services providers remain rather limited.



Nowadays, the ministry assumes a regulatory and policy function and through a national network of hospitals, clinics, health care centers and polyclinics, provides preventive services as well as inpatient and outpatient treatments. The institution also operates schools for the training of nurses, technicians and midwives. However, it has a limited control over the activities of the Social Insurance Organization (SSK) which provides medical care for its members and their families in its own hospitals. Likewise, the Ministry of Health has practically no authority over the medical schools, which, in addition to providing graduate and postgraduate training, operate large training hospitals, which cover an increasing share of country's medical care[12,13].

Majority of the health care centers and health care providing services are under probation of the Ministry of Health. The State Planning Organization plans health services needs in next five years' development schedule. The budgetary issues and investment plans are designed and controlled by the Ministry of Finance, while the Ministry of Health has collaborative effect in it.

At the most general level, health sector policy is formulated within the framework of Constitution. The Constitution further states that in order to establish wide spread health services general health insurance may be introduced by law.

Essentials of Health Care System

All citizens should equally benefit from the health care services. Each health center will have a health team that consists of one physician, one nurse, one male health officer, 2 to 4 village midwives and one medical secretary, under the directorate of a physician. Health services within a province will not be limited to the borderline of a district but will cover a certain size of population regardless of the border. Health center physicians will not be responsible to district official, but to the provincial health directorates, which areas in the past, connected to the respective governors[3,11].

Members of the health care team are allowed to work privately and must be full time employees. Treatment of outpatients or visiting patients at their homes has priority over hospital services. Doctors and the rest of the health personnel are to visit villages where they offer preventive medical services[11].

Up to date, the socialization of the health service established a total of 3267 health centers in 76 provincial and 9 educational areas. However, the number of health personnel in these centers is sufficient, 15 percent having no physicians, 25 percent without a nurse, 9 percent without a male health officer, 15 percent without a village midwife. Considerable improvements have been achieved in the sphere over the past two decades and most Turkish indicators now compare favorably with similar data for other middle income countries[9].

Substantial improvements have taken place in Turkey's health system over the last two or three decades. However, in terms of overall level of public health, fertility levels and access to health services, differences between the east and west; the rural and the urban areas of the country still exist. Large segments of the population still suffer from a surprisingly high rate of child mortality, infectious diseases, malnutrition, and sanitary environmental conditions. Developing countries, especially, are trying to find a feasible way of financing their health services to reach a satisfactory level of health. However, unfortunately, their resources remain insufficient for a goal. The resources allocated to health services are too low in Turkey[9, 10,12]. Turkish Health Sector Master Plan study, which has carried out, some major problems are as follows:

Inadequate information systems, Frequent policy changes, Deficient quality of administrators, Inadequate finances, Lack of inter-sectorial coordination, Qualifications of Problems of Physicians, Shortage of qualified midwives, Shortage of sanitarium, Shortage of vehicles, Shortage of basic equipment, Physical inadequacies, Double authorizations, Duplicate services, Over-Centralization



Range of Benefits

The policies provide coverage for health expenses resulting from illnesses or from injuries due to any accident. In general, the insurer and the policyholder up to annual limits for individual policies agree the reimbursement, sometimes with the contribution of the policyholder.

Table 1. Insurance Coverage Plan Benefit Rates % Limits

IN PATIENT BENEFITS		
Hospital Services	100 or 80%	Unlimited
Maternity&Family Planning	100 or 80%	\$500-\$1500
OUT-PATIENT BENEFITS		
Physician Fee	100 or 80%	6 or 20 visits per policy year
Prescribed Drugs	100or 80%	Annual
Laboratory, X-ray, etc.	100 or 80%	Annual
Minor treatment	100 or 80%	Annual
Dental Treatment	80%	Annual
OUT OF TURKEY BENEFITS		
Hospital Benefits	80%	\$60.000 per event
Unavailable Treatment in Turkey	80%	\$300.000 per event
SUPPLEMENTARY TREATMENT BENEFIT	100%	Excess of \$ 3000

But,for group policies,limits per event are commonly preferred. The individual can buy a policy which is valid abroad by paying an extra premium, but with some of the policies, even with geographical scope as Turkey,one can have a treatment abroad in emergency cases or the treatments not available in Turkey within certain limits.

A fixed daily benefit may be payable during hospitalization when given as a promotion with the life policies, credit insurance policies...etc.

Here are two examples of popular benefit plans of one individual,one-group plan from X medical institution.

Table 2. A Sample of a Group Coverage Plan

BENEFITS	BENEFIT RATES%	LIMITS
Physician Fee	100 or 80%	per visit
Prescribed Drugs	100 or 80%	per prescription
Laboratory,X-ray,etc.	100 or 80%	per illness
Minor Treatment	100 or 80%	Annual
Hospital Room&Board	100 or 80%	per day
Surgical Expenses	100 or 80%	per operation
Maternity	100 or 80%	
OPTIONAL BENEFITS		
Dental Treatments	100 or 80%	annual
Spectacles-Contact Lenses	100 or 80%	annual
Hearing Aids	100 or 80%	annual

There is no compulsory long-term care insurance exercised in Turkey.



By law, life, health and personal accident premiums for all dependents of private plans are tax deductible up to the same level as the Social Security contribution of an employee (approximately US\$ 35-45 per month). A tax called Banking and Insurance Operations Tax, which amounts to 5% of the net Premium, is added to the collected Premium.

An extra 15% of the amount is paid within every claim cost as value added tax. If the amount is not compensated through an insurer, at the end of the year it is reimbursed from the following year's income tax.

Risk Profile

Systematically in this study, a price adjustment is made subject to a certain age and sex groups by calculating the average net risk premium of a particular person [1].

To do this, it must be initially determined a risk profile place for any person existing in a risk profile group. The determination of the risk profile of any person in the insured population is based on the factors occurring as a result of total claim costs and aggregate insurance days in a specific period. Some assumptions are made when determining the risk profile of any group. Because, the existing portfolio may differentiate slightly subject to age, sex, health insurance product and time. In this study, the year as 365 days and calculated the corresponding risk profile values for each sex and age groups based on this.

Risk profile for each sex and age groups can be found according to following formula (1).

$$\text{Risk Profile[Age,Sex]} = \frac{\frac{\text{TotalClaimCosts[Age,Sex]}}{\text{TotalInsuranceDays[Age,Sex]}}}{\frac{\text{TotalClaimCosts}}{\text{TotalInsuranceDays}}} \times 100\% \quad (1)$$

Table 3. Total Claim Costs(\$)

Birth	Men	Woman	Children
	-	-	74282.18
	-	215.64	27783.49
	33854.17	117475.34	3533.99
	71005.81	100857.77	221.12
	52608.43	30767.29	559.86
	21372.95	9153	-
	846.34	490.34	-

Table 4. Risk Profiles(%)

Birth	Men	Woman	Children(5)	Average
	-	-	124.0622	124.06
	-	67.4175	66.78472	67.2
	48.64865	86.92868	59.12331	65.23
	79.85303	123.8071	23.04375	70.18
	193.2155	147.7012	175.0344	175.94
	217.2587	301.2195	-	225.26
	105.8396	76.64961	-	86.54
Average	128.96	133.96	89.61	100.00



In the above formula, the expressions found on the numerator represent the amounts corresponding to the different age and sex combinations, whereas the values in the denominator represent the values for the whole insured claim costs and insurance days.

When we examine Table 3 and Table 4 above, we see that the most risky sex group is women with an average of risk profile about 133.96%. Following, the most risky age group is the people who were born between years

- Furthermore, the most risky age-sex group is the women who born between
- Moreover, the least risky age and sex group is the children who are born between

There are at least two reasons for these events. The first and the most important one is the less usage of benefits rather than other groups. Secondly, the population concerned with this group is small. The averages are not calculated on a linear basis since the population varies from one group to another.

On the other hand, if we look at these tables more thoroughly, we (Table 5) can see that the risk profile for children decreases from 124% to 23% up to period. We can conclude that the people about 45-50 ages have more risk than the other groups. The other age-sex groups show random risk profiles.

Annual Benefit Usage Amount

Two important variables in determining the annual net risk premium of any benefit of a person are the annual usage frequency of a benefit, X and the amount paid for each usage, Y . If the price of a benefit for each usage were the same then the benefit's annual net risk Premium could be obtained by multiplying the frequency of usage of the benefit by the corresponding price. Different statistical models and parameter estimation methods are used to determine the frequency of usage of benefits. The Poisson model may be used for this study:

$$P(X,x) = (\lambda x e^{-\lambda}) / (x!) \quad x=0,1,2,\dots \quad (2)$$

This model may be used because there is no annual limit for the usage of benefits and the provision of the benefits for each treatment and illness.

In this study Binomial distribution could be used alternatively if there were annual limits for the usage of benefits. In this model λ is the annual average benefit usage.

Moreover, unknown λ should be determined for each benefit separately. According to maximum probability method the average satisfactory sample average of this parameter. Expected value is obtained by dividing the total claim cost by the total number of the people. In order this method to be valid and successful all of the people should be insured on the same date, allowances can be made if the dates are within a month, and should also be insured on the same date, allowances can be made if the dates are within a month, and should also be insured during the whole year.

Furthermore, to prevent the data loss and to use the ones that do not completed their use during the year the parameter estimation can be on daily basis and multiplied by 365 to convert to a yearly basis. The annual usage of a benefit can be calculated by the following formula:

$$\lambda = [(Total Claims Amount) / (Total Insurance Days)] * 365 \text{ days} \quad (3)$$

λ , the annual average benefit usage is calculated for each benefit and the results are given in Table 5. The standard deviation of each benefit can be found by property of the Poisson distribution as (Standard Deviation =) Square Root of λ .



Table 5. Annual Average Usage Rates of the Benefits

Benefit Code	Description	#of Usage	Usage per Person(l)
1000	Doctor	5585	1.632086
1100	Medicine	5349	1.563121
1220	Modern Diagnostic Methods	1464	0.42782
1240	Analyses	1562	0.456458
1500	Minor Interference	617	0.180304
1530	Physical Treatments	24	0.007013
2048	Other Drugs	1	0.000292
2051	Domestic Hospital Services	143	0.041788
2300	Chemotherapy&Radiotherapy	4	0.001169
2850	Other	1	0.000292
Total		14714	4.299825

Average Benefit Costs

Second stage after determining the annual rate of usage of each benefit to calculate the net risk premium is to determine the distribution and the average value of the benefit costs.Claim costs data and data obtained from the hospital records can be used in order to determine the average benefit costs distribution and consequently its average value.

However,it should be always beard in mind that claim costs are affected and therefore altered as a result of high inflation rate in the country.In order to lessen the inflationary effect in the data,diagnosis and light treatments associated claim costs data should be used.Similary,in determining the benefit costs of benefits like hospital treatments last 6 months claim costs data should be used.Türkiye Tabipler Birliği determines the rates in order to adjust the given data by certain periods a year,which is the primary source for the health organization.

In determining the benefit costs some of the theoretical can be utilized as well.By analyzing the benefit cost distribution of the benefits supplied by the health insurance organization is it quite possible to encounter the distribution of data,which is not distributed normally.In such situation Gamma or/and Chi-Square distribution functions can be practiced.The benefit with their corresponding average costs calculated fort his study is given in Table 6.

Table 6. Benefits Usage Costs

Benefit Code	Description	Total Cost(\$)	Average Cost(USD) Y
1000	Doctor	152401.47	27.28764
1100	Medicine	92889.47	17.36576
1220	Modern Diagnostic Methods	81201.45	55.46547
1240	Analyses	62828.24	40.22294
1500	Minor Interference	25869.69	41.92818
1530	Physical Treatments	3100.83	129.2013
2048	Other Drugs	1.43	1.43
2051	Domestic Hospital Services	124408.08	8.699.866
2300	Chemotherapy&Radiotherapy	2299.40	574.85
2850	Other	37.74	37.74
Total		545037.80	37.74



Conclusion

Health care services in the world and in Turkey are involved in risk and risk analysis more compared to other sectors of the business or even similar nonprofit organizations, therefore sound analysis of risks is requirement factor in order to stay in business for such institutions. Risk is divided into two main groups as pure and speculative risk[4, 11]. Pure risk can be defined as the existence of uncertainty as to whether loss will occur. No possibility of gain is presented by pure risk. Only the potential for loss is presented. Examples of pure risk include the uncertainty of damage by fire or flood or the prospect of that caused by accident for illness. On the other hand, speculative risk refers to the uncertainty about an event that could produce either a profit or loss. Business ventures and gambling transactions are examples of this situation. Gains as well as losses may occur, changing the nature of the uncertainty that is present.

Static and Dynamic risks are two main types of risks into two different groups. Uncertainties due to such random events as lightning, windstorms and dead can be given as examples of pure static risks. Business undertakings in a stable economy illustrate the concept of speculative static risk. Dynamic risks are produced according to changes in society. Examples of dynamic risks involve urban unrest, increasingly complex technology and changing attitudes of legislatures and courts about a variety of issues. Some types of static risks may be caused because of the increase in dynamic risks. Weather-related losses can be considered as an example to the dependency between dynamic and static risks.

Risk, as being a turning point in healthcare system is defined interactively with health insurance premiums and health care services. Related with aim in this study, comparing determined model for risk identification criteria with different models which is supported by statistical calculations and analysis. The people's net risk were calculated taking the benefits limits, claim costs and annual average benefit usage like doctor, surgical operations etc. into consideration.

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