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To Investigate the Impact of Medicare, Part D on the Cost Effectiveness of Diabetes Medications and Health Outcomes with SAS®

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Abstract

The purpose of this paper is to estimate the cost effectiveness of diabetes medications and the health outcomes in Medicare in 2005 and 2006 to examine the impact of Medicare, Part D.

In this study, data from the Medical Expenditure Panel Survey are used, providing information on the prescribed drugs, physician visits, home health care and inpatients. A period life table is utilized to calculate QALY (quality adjusted life years). The analysis is based on the Medicare drug plan used by patients with diabetes who are also insured by Medicare in 2005. They are discovered in the data by the SAS SQL procedures. Cost effectiveness is evaluated by Medicare expenditures per QALY gained from the year 2005 to the year 2006. The means procedure in Base SAS® is used to compare the utilizations of health care services in these two years. The Decision Tree Model in Enterprise Miner™ is mainly used to predict the health outcomes.

Results show that from the year 2005 to the year 2006, insulin becomes the most cost-effective treatment and the combination of glyburide and metformin is the most inefficient. Glipizide and insulin users highly decrease the length of hospitalization at the cost of increasing the number of prescriptions filled. Metformin users increase their length of stay in the hospital and the frequency of prescriptions by 200 % and 73 % respectively. In 2006, drugs begin to account for a large number of the Medicare expenditures and have a decisive role in patients' health status.

Introduction

Medicare, Part D is the optional prescription drug program. It uses competing private plans to provide beneficiaries access to appropriate drug therapies. As of January 2008, almost 90 percent of Medicare beneficiaries were enrolled in the Part D plan, or had other sources of creditable drug coverage.

The data used in this paper are from the MEPS (Medical Expenditure Panel Survey) data, collected by the Agency for Healthcare Research and Quality. They contain lots of information such as utilization of various kinds of medical resources and healthcare costs; therefore, they are very useful for cost-effectiveness analysis and outcome studies. However, such data have some disadvantages; for instance, some information is incomplete.

In this study, our research targets are diabetes patients in Medicare under survey. Although there are several types of diabetes, we only focus on type II, which is common to Medicare enrollees. We only examine the generic oral diabetes medications, without considering any brand-name drug.

Cost effectiveness analysis is a current popular topic. The classical measurement of cost effectiveness is the ICER (Incremental Cost Effectiveness Ratio), which compares the costs and health effects of an intervention to assess the extent to which it can be regarded as providing value for the money. In this study, the costs are based on total Medicare expenditures; different interventions refer to the two years examined and effects are evaluated by QALY (Qualified Adjusted Life Years), which is calculated by life quality multiplied by life expectancy.

The decision tree model in Enterprise Miner 6.1 is a hierarchical tree structure that is used to define classes based on a series of questions (or rules) about the attributes of the class. In this study, we used the decision tree to display the important factors to the target. In the tree diagram, the first segment is divided on the most important factors; the next split is based upon the second vital factor until the least decisive factor is at the bottom.

Method

In this study, several data sets from the MEPS, collected by the Agency for Healthcare Research and Quality are utilized and they cover information about prescription drugs, outpatients, inpatients and home health. Additionally, a life table is also used.

Before analysis, we needed to discover our research subjects who were Medicare drug plan enrollees in 2006 and also joined Medicare in 2005. For a better comparison, we did not consider the Medicare beneficiaries of age 65 in 2006; we also did not consider the patients who switch their drugs from the year 2005 to the year 2006. To do so, we used SQL conditional selection to sort out the patients with diabetes according to the ICD9 condition code. Then we used an SQL inner join to combine the full year consolidated data file and prescription drug file by the ID variable,

DUPERSID. After we found out the beneficiaries who joined in Medicare, Part D, we used these DUPERSID to match the patients in 2005. Then we got a dataset that we needed. Figure 1 shows the data for the year 2006.

OBTOTV06	ERTOT06	IPFMCR06	HHTOTD06	HHAGD06	HHAEXP06	RXTOT06	RXMCR06
57	1	21796	0	0	0	78	223
3	0	8589	0	0	0	39	118
7	0	0	0	0	0	79	1698
12	0	0	336	336	7452	31	2401
2	0	0	0	0	0	71	1758
27	0	0	240	240	4447	36	2424
8	0	0	-8	-8	636	37	1521
6	0	0	0	0	0	62	2168
3	0	0	0	0	0	11	644
9	0	2007	0	0	0	61	722

DUPERSID	SRXNAME	ICD9CODX	AGE06X	HL06	SEX	RACEX	RUSIZE06	IPNGTD06	HHINDD06	TOTMCR06
30121012	GLIPIZIDE	250	76	0.4	1	2	2	14	0	76057
30136026	GLIPIZIDE	250	66	0.6	1	2	1	7	0	11084
30180024	GLYBURIDE	250	75	0.4	1	1	2	0	0	1947
30363015	GLIPIZIDE	250	77	0.4	1	1	1	0	0	4578
30386013	GLIPIZIDE	250	69	0.8	1	1	2	0	0	1782
30392041	GLYBURIDE	250	71	0.4	1	1	4	0	0	6140
30437028	GLYBURIDE	250	85	0.6	2	1	4	7	0	2434
30489011	STARLIX	250	74	0.6	2	1	1	0	0	3952
30507010	GLYBURIDE_...	250	73	0.4	2	4	1	0	0	783
30516018	GLYBURIDE	250	66	0.4	2	2	3	6	0	2737

Figure1. Medicare Drug Plan Enrollees' Information

Here we redefine the health status variable, RTHLTH53, as the variable, HL06, in the following way shown in Table 1, in which the higher the number, the healthier the patient. In other words, 1 stands for pretty healthy, 0.2 means very ill.

RTHLTH53	HL06
1	1
2	0.8
3	0.6
4	0.4
5	0.2

Table 1. Health Status Conversation Table

Next, we imported the life table and conditionally combined it with the previous data as displayed in Figure 2. We also used the same method to get the data for the year 2005. After combining these two QALY tables, we could calculate the ICER (Incremental cost-effectiveness ratio) shown in Figure 3. The SAS code is shown below.

```
/*Combine the life table and 2006 Medicare part D beneficiary table */
PROC SQL;
CREATE TABLE SASUSER.LE06 AS
SELECT *
FROM SASUSER.LIFETABLE1 AS LT,
SASUSER.BCHWLQ06 AS BC
WHERE LT.AGE=BC.AGE06X;
QUIT;

/*Calculate the 2006 QALY for different genders*/
DATA SASUSER.QALY06;
SET SASUSER.LE06;
IF SEX=1 THEN QALY06=MALE*LQ06;
IF SEX=2 THEN QALY06=FEMALE*LQ06; RUN;
PROC SORT DATA=SASUSER.QALY06;
BY DUPERSID; RUN;

/*To calculate the ICER */
PROC SQL;
CREATE TABLE SASUSER.CICER AS
SELECT DUPERSID, SRXNAME, QALY05, QALY06, TOTMCR05,TOTMCR06,
((TOTMCR06 - TOTMCR05) / (QALY06-QALY05)) AS ICER1
 FROM SASUSER.ICER ;  QUIT;
```

Age	Male	Female	DUPERSID	SRXNAME	ICD9CODX	AGE06X	HL06	QALY06	TOTMCR06
76	9.89	11.78	30121012	GLIPIZIDE	250	76	0.4	3.956	76057
66	16.28	18.94	30136026	GLIPIZIDE	250	66	0.6	9.768	11084
75	10.46	12.43	30180024	GLYBURIDE	250	75	0.4	4.184	1947
77	9.34	11.14	30363015	GLIPIZIDE	250	77	0.4	3.736	4578
69	14.22	16.64	30386013	GLIPIZIDE	250	69	0.8	11.376	1782
71	12.91	15.18	30392041	GLYBURIDE	250	71	0.4	5.164	6140
85	5.56	6.68	30437028	GLYBURIDE	250	85	0.6	4.008	2434
74	11.05	13.1	30489011	STARLIX	250	74	0.6	7.86	3952
73	11.65	13.78	30507010	GLYBURIDE_M...	250	73	0.4	5.512	783
66	16.28	18.94	30516018	GLYBURIDE	250	66	0.4	7.576	2737

Figure 2. Quality-adjusted Life Year Table 2006

	DUPERSID	SRXNAME	QALY05	QALY06	TOTMCR05	TOTMCR06	ICER1
1	30121012	GLIPIZIDE	4.184	3.956	766	76057	-330223.68
2	30136026	GLIPIZIDE	6.8	9.768	0	11084	3734.50135
3	30180024	GLYBURIDE	4.42	4.184	6974	1947	21300.8475
4	30363015	GLIPIZIDE	3.956	3.736	710	4578	-17581.818
5	30386013	GLIPIZIDE	8.934	11.376	0	1782	729.72973
6	30392041	GLYBURIDE	2.71	5.164	2120	6140	1638.14181
7	30437028	GLYBURIDE	1.336	4.008	224	2434	827.095808
8	30489011	STARLIX	11.024	7.86	0	3952	-1249.0518
9	30507010	GLYBURIDE_M...	5.788	5.512	149	783	-2297.1014
10	30516018	GLYBURIDE	7.888	7.576	179	2737	-8198.7179

Figure3. ICER Table

Next, we used the proc means procedure, classifying the variable, ICER, by diabetes medications; the results are displayed in Table 2. In this study, we wanted to examine the impacts that the drug plan brings on the cost-effectiveness of the diabetes drugs from the year 2005 to the year 2006. However, Medicare did not cover prescription drugs in 2005, so we used Total Medicare expenditures as costs. The ICER can be expressed by how much Medicare costs per QALY gained and calculated in this way:

ICER = (2006 Total Medicare expenditures – 2005 Total Medicare expenditures) /(2006 QALY- 2005 QALY)

Here, a negative ICER means that there are savings for the year 2006 over the year 2005. For example, the comparison between the year 2006 and the year 2005 for insulin treatment shows a cost saving of $14,203.62 in 2006. For a positive ICER, the bigger the ICER, the less efficient the new method. Therefore, table 2 demonstrates that insulin becomes the most cost-effective in 2006, while Glyburide-metformin is the most inefficient treatment, and metformin is just next to it.

SRXNAME	Mean	N
GLIMEPIRIDE	-1268.78	4
GLIPIZIDE	-12573.77	49
GLYBURIDE	-4728.05	45
GLYBURIDE_METFORMIN	1934.47	10
INSULIN	-14203.62	16
METFORMIN	896.1215818	44
STARLIX	-590.0887749	3

Table 2. ICER by Different Diabetes Drugs

Next, we needed to evaluate the utilizations of the healthcare resources by comparing the frequencies of office-based visits, outpatient visits and times of prescription drugs filled as well as the length of stay in the hospital or home health providers separately. Consider the office-base visit, for example. We first found the data containing the times of office-based visits in these two years shown in Figure 4, then we used the times of visits in 2005 as the denominator; the difference of the times in these two years was used as numerator to calculate the increasing or decreasing rate. Finally, we utilized the proc means procedure to get the average rates for each drug. In the same way, we also got the increasing/decreasing rates in the other cases. The results are displayed in table 3.

	DUPERSID	SRXNAME	OBTOTV05	OBTOTV06	OBTRATIO
1	30121012	GLIPIZIDE	6	57	8.5
2	30136026	GLIPIZIDE	2	3	0.5
3	30180024	GLYBURIDE	9	7	-0.2222222
4	30363015	GLIPIZIDE	13	12	-0.0769231
5	30386013	GLIPIZIDE	1	2	1
6	30392041	GLYBURIDE	14	27	0.92857143
7	30437028	GLYBURIDE	6	8	0.33333333
8	30489011	STARLIX	2	6	2
9	30507010	GLYBURIDE_M...	4	3	-0.25
10	30516018	GLYBURIDE	6	9	0.5

Figure 4. Office-based Visit Frequency

SRXNAME	OBTRATIO	OPTRATIO	RXTRATIO	LOSRATIO	HHDRATO
GLIMEPIRIDE	0.03	0	0.66	.	.
GLIPIZIDE	0.52	0.19	0.22	-0.61	0.50
GLYBURIDE	1.30	0.82	0.33	0.65	-0.01
GLYBURIDE _METFORMIN	-0.12	0.80	0.20	.	-1.0
INSULIN	0.01	-0.29	0.17	-0.8	-0.07
METFORMIN	0.54	0.29	0.73	2.0	-0.40
STARLIX	0.61	.	0.45	.	.

Table 3. Ratios in Utilizations of Healthcare Resources

Table 3 shows that compared to the year 2005, the Medicare diabetes patients receive more drug treatments in 2006 since the drug refill rates increase by varying from 17% to 65%. At the same time, the average length of stay (LOS) in the hospital of the insulin or glipizide users is largely decreased by 80% or 61%, which means that adequate insulin or glipizide usage saves considerable hospitalization resources. However, the average of the prescription frequency and LOS of metformin users increases by 73% and 200 % respectively from the year 2005 to the year 2006. It is also true for glyburide users. In other words, the drug plan makes these two drug treatments more inefficient. The relationship between the LOS in the hospital and the home health provider for most drug users is negative; the longer the stay in home health providers, the shorter the stay in the hospital. Considering the costs of hospitalization are higher than those of home health, the patients should sufficiently utilize the home health agency services.

Finally, we would use the decision tree model to find the important factors to the Medicare costs and health status. To predict the costs, we used the data shown in figure 5. We used the default setting of the model shown in figure 6.The results displayed in figures 7 & 8.

	DUPERSID	HHAMCR061	TOTMCR06	OBVMCR06	IP06	OP06	RXMCR06	ER
1	30121012	0	76057	49515	23913	411	223	1994
2	30136026	0	11084	78	10588	300	118	0
3	30180024	0	1947	249	0	0	1698	0
4	30363015	0	4578	2177	0	0	2401	0
5	30386013	0	1782	24	0	0	1758	0
6	30392041	0	6140	3716	0	0	2424	0
7	30437028	130	2434	527	256	0	1521	0
8	30489011	0	3952	339	0	1446	2168	0
9	30507010	0	783	139	0	0	644	0
10	30516018	0	2737	8	2007	0	722	0

Figure5. Various Medicare Costs in 2006

Splitting Rule	
Interval Criterion	ProbF
Nominal Criterion	ProbChisq
Ordinal Criterion	Entropy
Significance Level	0.2
Missing Values	Use in search
Use Input Once	No
Maximum Branch	2
Maximum Depth	6
Minimum Categorical S	5
Node	
Leaf Size	5
Number of Rules	5
Number of Surrogate R	0
Split Size	
Split Search	
Exhaustive	5000
Node Sample	20000
Subtree	
Method	Assessment
Number of Leaves	1
Assessment Measure	Decision
Assessment Fraction	0.25

Figure 6. Setting of the Model

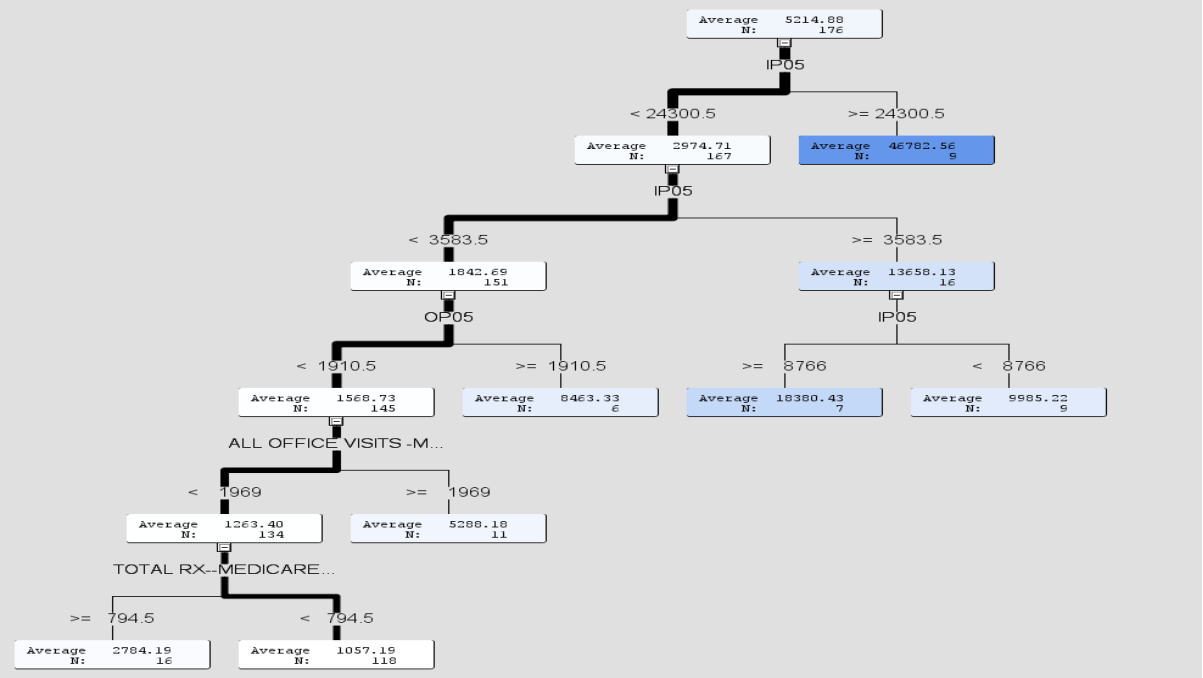

Figure7. Decision Tree for 2005 Medicare Costs

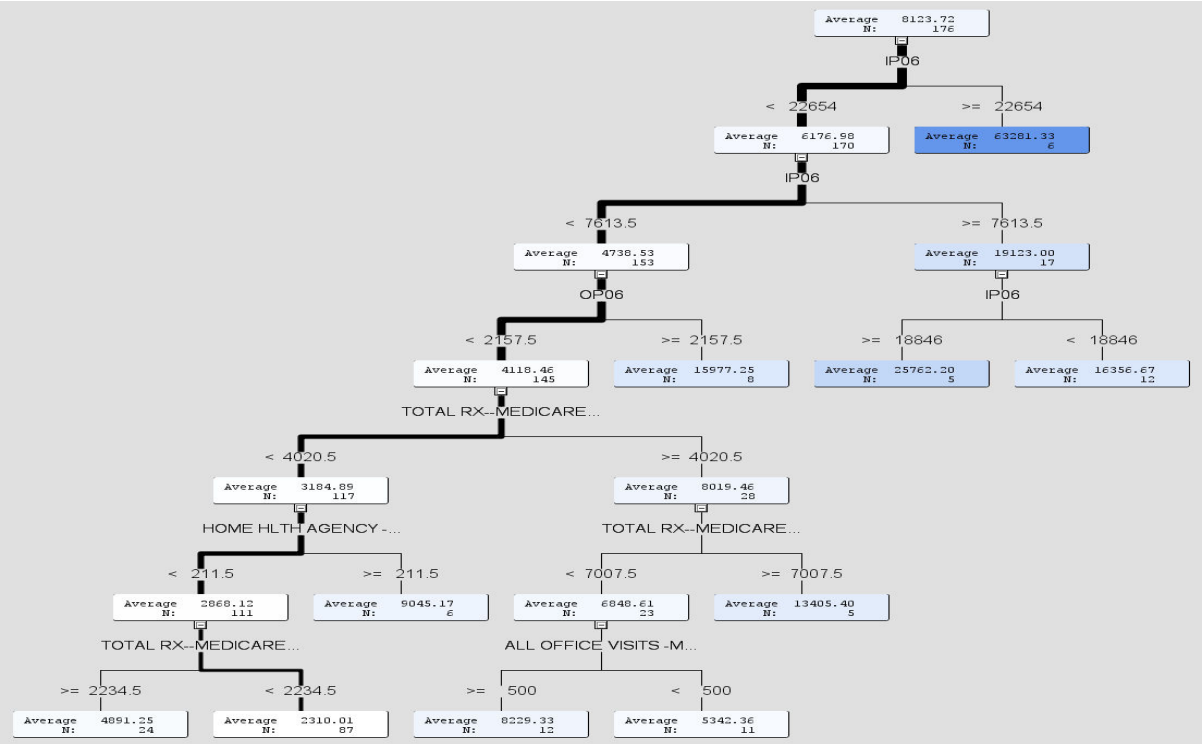

Figure8. Decision Tree for 2006 Medicare Costs

In the decision tree for the year 2005 Medicare costs, the first two layers are split by the inpatient costs; the next two levels are based on physician visits and only the lowest level split is based on the drug costs. That indicates that in 2005, inpatient costs account for a large amount of Medicare expenditures. In the 2006 decision tree, from the middle level, the diagram begins to split based on drug costs, which demonstrates that from the year 2006, drug costs become an essential factor to the Medicare costs, although the inpatients still play a decisive role.

In the following, we wanted to investigate which factors have vital effects on the beneficiaries' health status. We input all the variables, frequencies of physician visits, drug prescription, A1C tests, ER (Emergency Room), LOS in the hospital or home healthcare agency, gender, age and family size as displayed in Figure 9. We set the health status as a predicted target.

DUPERSID	SRXNAME	AGE06X	HL06	SEX1	RACEX1	RUSIZE06
30180024	GLYBURIDE	75	0.4	1	1	2
30363015	GLIPIZIDE	77	0.4	1	1	1
30386013	GLIPIZIDE	69	0.8	1	1	2
30392041	GLYBURIDE	71	0.4	1	1	4
30516018	GLYBURIDE	66	0.4	2	2	3
30625012	METFORMIN	67	1	1	2	1
30634014	METFORMIN	74	0.6	1	1	5
30870012	GLYBURIDE	69	0.6	1	1	2
30902027	METFORMIN	66	0.4	2	1	2
30903029	GLIPIZIDE	71	0.4	1	1	2
30928010	GLYBURIDE	76	0.6	2	1	1

MARRY06X	DSA1C531	IPNGTD06	HHINDD06	OBTOTV06	OPTOTV06	ERTOT06	HHTOTD06	RXTOT06
1	1	0	0	7	0	0	0	79
4	3	0	0	12	0	0	336	31
1	2	0	0	2	0	0	0	71
1	1	0	0	27	0	0	240	36
3	8	6	0	9	0	0	0	61
5	4	0	0	1	2	0	0	13
2	96	0	0	2	0	0	0	16
3	12	0	0	27	1	0	0	163
1	3	0	0	4	4	0	0	20
1	6	0	0	16	0	0	0	81

Figure 9. Various Utilizations of Medical Resources in 2006

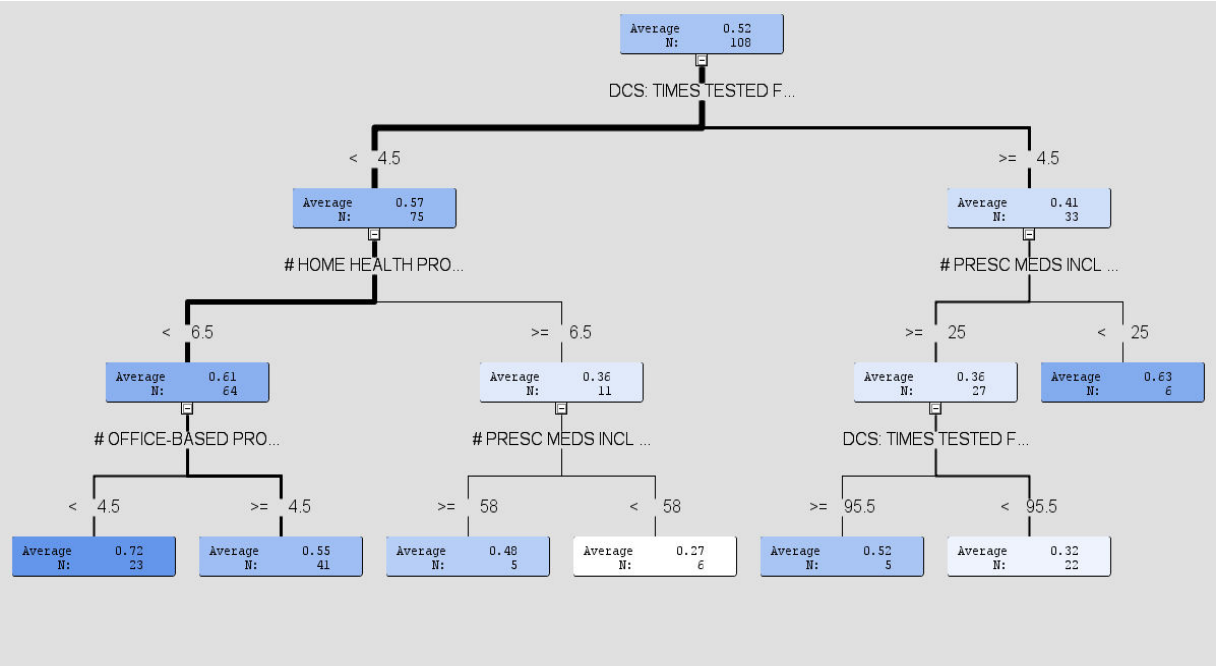

Figure 10. Decision Tree for 2005 Health Status

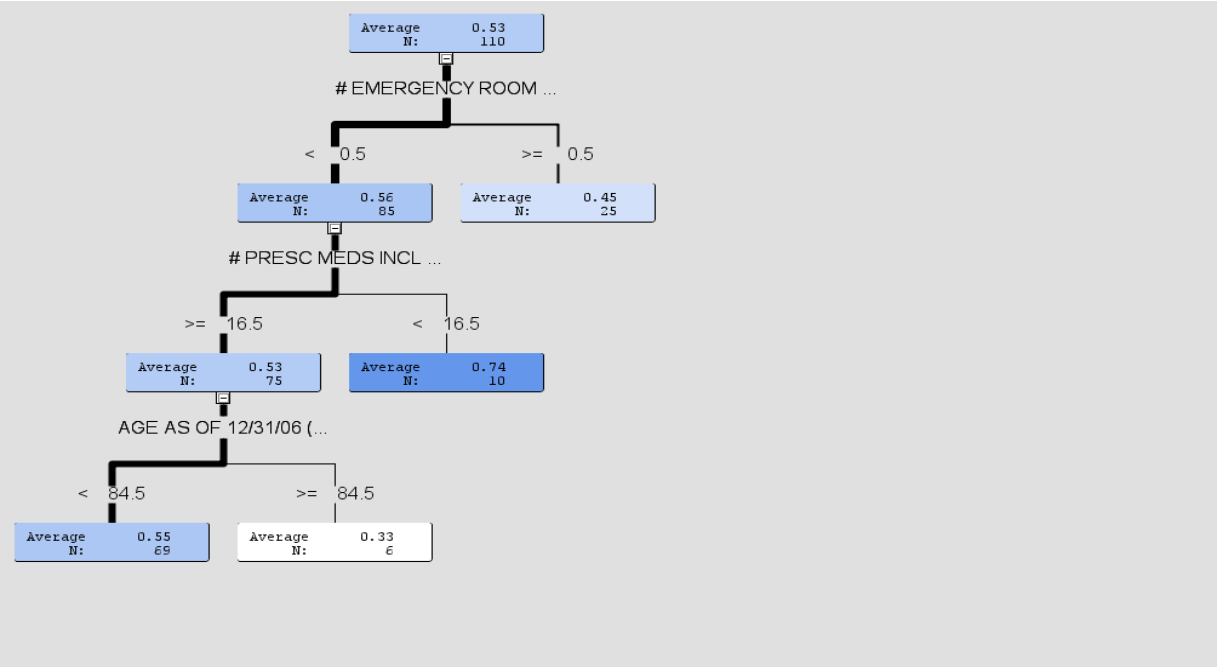

Figure 11. Decision Tree for 2006 Health Status

Figure10 demonstrates that in 2005, the frequency of A1C tests and the physician visits have important effects on the patients' health. In 2006, the frequency of drugs filled becomes a key factor to the patient's health status. However, there is something in common between these two years. LOS in the hospital and family size are not important factors to the health conditions. In other words, the longer hospitalization and living in a large family cannot improve the patients' health status.

Conclusion

Cost-effectiveness analysis suggests that Medicare, Part D makes the insulin treatment the most efficient, while the combination of glyburide – metformin is the least effective. Our results also demonstrate that under this drug plan, the Medicare beneficiaries can receive more sufficient drug treatments than ever before. In the meanwhile, enough usage of some drugs such as insulin can reduce the usage of hospital resources. In contrast, the metformin users were in the hospital for a longer time in 2006. Another discovery is that in 2006, the medication expenditures begin to be an important factor of the Medicare costs and using the drugs properly can improve the patients' health status.

References

Agency for healthcare research and quality,2005 & 2006 data files from http://www.meps.ahrq.gov/mepsweb/data_stats/download_data_files.jsp

Anonymous (Mar.2009), A Status Report on Part D for 2009 in *Report to the Congress: Medicare Payment Policy* (Chapter 4) Retrieved from http://www.medpac.gov/chapters/Mar09_Ch04.pdf

Social Security government (Apr.2010) Period Life Table from http://www.socialsecurity.gov/OACT/STATS/table4c6.html

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