Decision Tree Role in Health Economics Problems of Influenza

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***Abstract*— Decision tree is an outgrowth of tree concept from mathematic discrete. Decision tree has been implemented in many field, one of them is health economic. In this papers, is discussed about decision tree in Health economic problems of an epidemic disease, Influenza A. Influenza A, is the most common and the most popular type of influenza. Swine flu, Bird flu, and Hong Kong flu.**

In this context, decision tree is use as a support tool to make a decision. By using the Decision tree in this problems, we can get the rational result. We can also get the more effective result and get the probability, effective cost, and utility of each result.

***Index Terms*—Decision Tree, Health Economic, Influenza, Epidemic**

1. INTRODUCTION

Many years ago health care was done for short time health economic benefit. For example, when someone sicks, they will get some medicine, and when healthy, they do nothing for their health. But nowadays, long time health economic benefit is become popular and many long term health care invention are developed, such as pace maker and daily consumed vitamin.

There are 2 structural method of developing health economic modeling, that is Markov model and decision tree. Markov model is used to show a long term rational based on statistic, in this context Markov model show long term rational of someone health, where as decision tree is used to provide short term effectiveness rate.

There are some advantages by using decision tree for health economic problems, that is : decision tree is easy to understang, decision tree easy to be interpreted, decision tree can be combined with other decision techniques, and the result of decision tree is easy to be explained by simple mathematic. There also some disadvantage of using decision tree, that is : decision tree is unstable and in a complex problem, decision tree should contain several duplication of the same subtree in order to represent the classifier as in a boolean function : Y = (A3∪A4)∩(A1∪A2) .

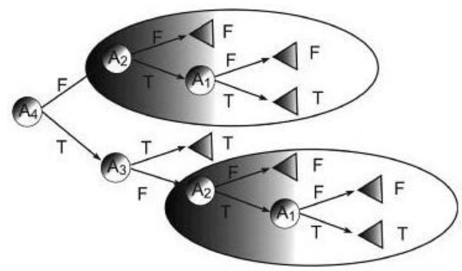

Fig1.Realization of function Y= (A3∪A4)∩(A1∪A2)

2. THEORY

2.1. Decision Tree

Decision tree is development from tree concept on discrete mathematic that is use as decision support tool that every branch of the tree may have their own probability, resource costs, and utility. By using Decision tree, more effective result can be obtain. Decision tree has been used in many field, there are : economic development, real estate, conservation and environtment, sustainable economy, etc.

There is some ste, public health, elections and advocacy, p to make a decision tree, that is :

1. Develop a decision table that consist of all variables that you'll weigh in making your decision and make scale for every variables from 1 to 10.
2. Determine what the outcome will be, based on the rating of your variables and factors.
3. Determine the probabilities, resource costs, utility, or other things you need to know from the outcome.

Probabilities

Parameter	Base case	Low	High	Source
Sensitivity	0.829	0.744	0.897	Blanks et al 1998
Specificity	0.855	0.839	0.901	Blanks et al 1998
Prevalence	0.004	0.002	0.006	NHSBSP annual report, 1999

Fig2. Decision table with probability

Fig3. Cost and utility for every outcome

Payoffs

Outcome	Cost	Utility
True positive	£4974	0.48
False negative	£9108	0.45
False positive	£96	0.79
True negative	£12	0.94
Cancer	£9096	0.48
No cancer	£0	0.89

4. Make the decision tree based on the decision table.

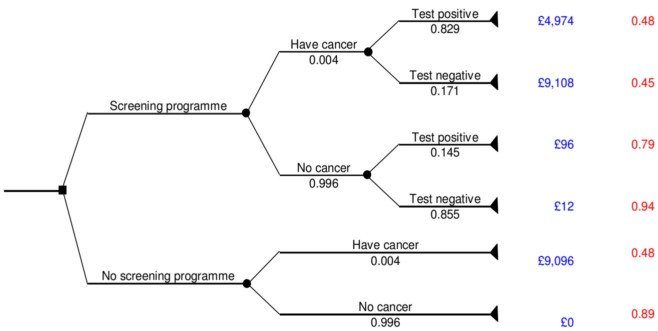

Fig4. Decision Tree

2.2. Health Economics

Health is the general condition of a person in all aspect, whereas economics is social science that analyzes the production, distribution, and consumption of goods and services. Health economics is a branch of economics incorporates the thingking of additional disciplines both within health field and beyond, especially economics.

The disiplines of the health field are health services research, medicine, medical ethics, psychology, and public health. The disiplines beyond health are economics, finance and insurance, labor economics, industrial organization, public policy, sociology, and statistical methods.

Health economic divided into 8 distinct topics:

1. What influences health?
2. What is health and what is its value
3. The demand for health care
4. The supply of health care
5. Micro-economic evaluation at treatment level
6. Market equilibrium
7. Evaluation at whole system level
8. Planning, budgeting and monitoring mechanisms.

2.3. Influenza

Influenza (commonly reffered as flu) is an infectious disease caused by RNA viruses of family *Orthomyxoviridae* that affects birds and mammals. Influenza usually affect mainly the nose, throat, bronchi, and lungs. Influenza last for about a week. Most common symptoms of influenza are fever, chills, sore throat, headache, non-productive cough, aching muscle, and rhinitis. Influenza spread around the world in seasonal epidemics, resulting in deaths between 250.000 and 500.000 people every year.

Influenza divided into 3 type :

1.Influenzavirus A (most common)

2.Influenzavirus B (less common than A, more common than C)

3.Influenzavirus C (least common)

Swine flu (also called pig flu) included in Influenzavirus A. Swine flu is constructed from some hydrogen atoms and some nitrogen atoms (H_1N_1, H_1N_2, H_2N_3, H_3N_1,and H_3N_2).

3. DECISION TREE ROLE IN HEALTH ECONOMY PROBLEMS OF INFLUENZA

3.1.Determining flu or not

Decision tree be used to determine if someone ill or not. Figure 5 below shows how to determine someone is influenza or not, based on the symptoms. The symptoms is sorted from top to bottom, from the most usual to the less usual.

Symptoms	Usual Scale
High Temperature	10
Aching Muscle	9
Headache	8
Extreme Tiredness	7
Sore Throat	6
Stuffy Nose	5
Chronic illness	4
Hard to Breath	3
Feel drowsy	2
Wheezing	1

Fig 5a.Influenza symptoms decision table

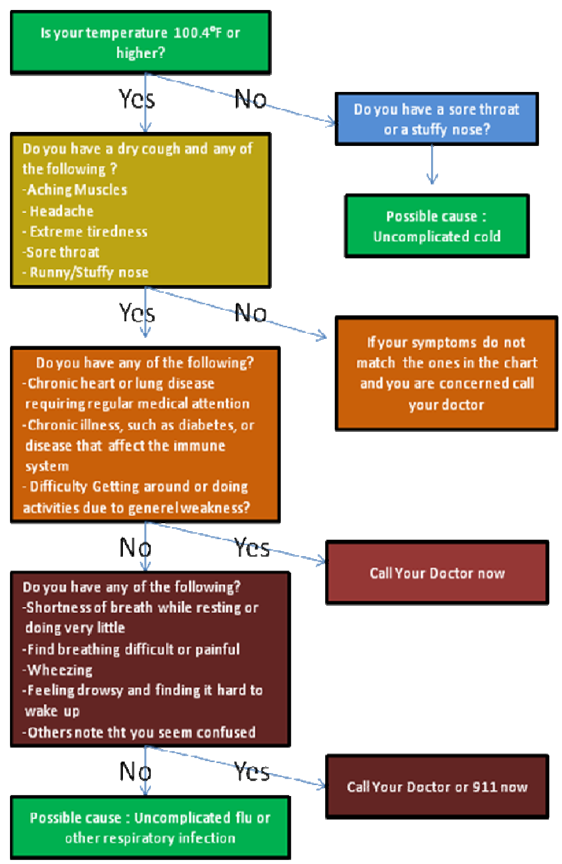

Fig5b. Influenza Diagnotic Decision Tre

3.2 Determining subtype of Influenza A

Determining subtype of influenza A can be done by look at the position of hydrogen atom. And the nitrogen atom. There are 78 most informative positions to identify H subtypes, and 63 informative positions for N subtypes. By using software package Weka (Waikato Environtment for Knowledge Analisys) the decision tree analisys can be made.
(The data below is from "Cutting-Edge Research Topics on Multiple Criteria Decision Making: 20th International Conference, MCDM 2009, Chengdu" books.)

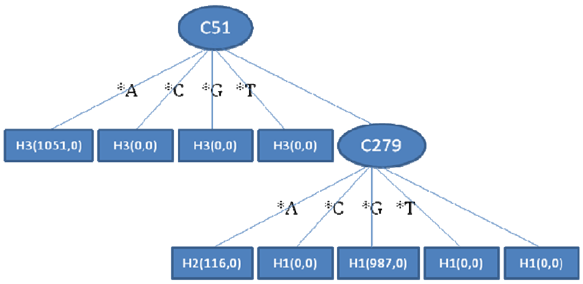

Fig6.Decision table of position C51 and C279

The decision tree is use to divide the H subtype influenza A.For further detemine, Markov model is used Tto identify the N subtype influenza A, by using software package HMMER.

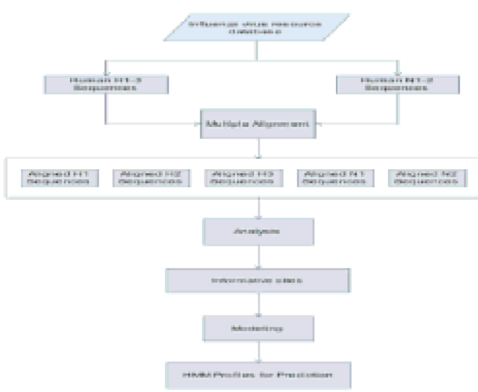
Fig7. Markov Model to identify subtype influenza A

3.3. Find the effective cost from Influenza vaccination

(The data below is taken from "Cost-effectiveness Analysis of Influenza and Pneumococcal Vaccinations among Elderly People in Japan " papers)

The software use in this research is Crystal Ball 2000 Proffesional Edition (v5.2), that apply Monte Carlo simulation. about cost-effectiveness analysis with 3 strategy comparison, that is between:

1.Elderly people that get influenza vaccination by increasing the patient with systematic strategy
2.Elderly people that get Influenza & pneumococcal vaccination
3.Elderly people that get no vaccination

Below is the data use for simulation:

Variables	Vaccination Strategies			Assumed distribution
	Influenza vaccination only	Combined vaccination	No Vaccination	
Mortality of inpatients with Influenza	0.045	0.022	0.048	Normal
Hospitalized proportion of incident with influenza	0.071	0.061	0.040	Normal
Incident probability of Influenza	0.021	0.021	0.050	Normal
Mortality of inpatients with pneumonia	0.140	0.139	0.150	Normal
Hospitalized proportion of incident with pneumonia	0.890	0.890	0.890	Normal
Incident probability of pneumonia	0.024	0.018	0.026	Normal
Hospitalization days of influenza	13.3 days	13.3 days	13.3 days	Normal
Hospitalization days of pneumonia	43.3days	43.3days	43.3days	Normal

Table 2.1 Variable used in simulation with initial value

Constants	Base Estimate
Labour force participation rate	20.2%
Life expectancy of aged ≥ 65 years people	13.3years
Monthly working time of elderly people	153.1hours

Table 2.2 Constant use in simulation

Cost	Base Estimate (JPY)
Cost of influenza vaccine	4,300
Cost of pneumococcal vaccine	7,000
Inpatient cost of influenza	201,664
Inpatient cost of pneumonia	335,578
Cost of influenza (not inpatient)	6,238
Cost of pneumonia (not inpatient)	24,964
Medical treatment cost till death	1,000,000
Hourly wage of employed elderly people	535

Table 2.3 Key cost and assumed value

Strategies	Cost (Lower limit, Upper limit)	YOLS (Year)	CER (JPY/YOLS)	ICER (JPY/YOLS)
No vaccinations	1,125,362,258 (639019631, 1737952651)	0	-	-
Influenza only	1,445,642,749 (1006363352, 1987630080)	620.3	516,332	0
Combined	1,896,064,977 (1532818110, 2286978986)	1675.9	459,874	426,698

Table 2.4 Result of Monte Carlo Simulation per 100,000 elderly

CER = Cost-effectiveness ratio
ICER = incremental Cost-effectiveness ratio

YOLS = Year of life saved

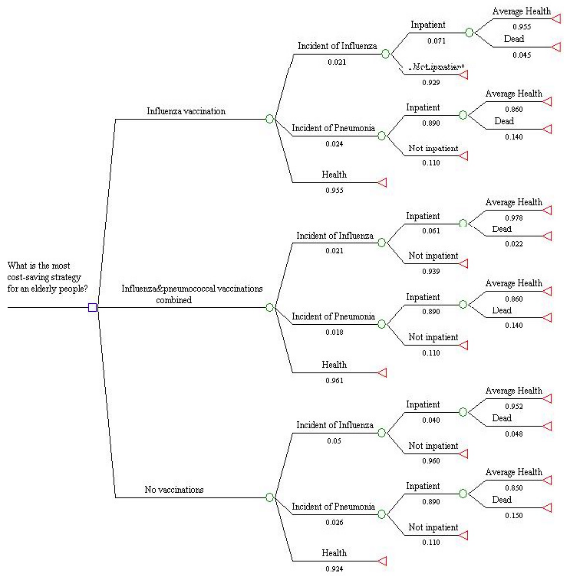

Fig10. Decision table for simulation Influenza and pneumoccocal vaccinations on elderly people

According to the result on Monte Carlo simulation in table 2.4, the strategy giving combined vaccinations has most effective cost, and the strategy giving no vaccinations has the least effective cost.

3.4 Determining more effective cost when epidemic swine flu happen

(The data below us taken from "Targeted vs. systematic early antiviral treatment against A(H1N1)v influenza with neuraminidase inhibitors in patients with influenza-like symptoms: Clinical and economic impact".)

The research take place in France, 2009, with number of population 64,300,000 people and 3% discounted per year of clinical benefit. This research compare between people with early initiation of treatment , by using neuraminidase inhibitors (systematic strategy), and people without early initiation (targeted strategy).

Variable	Baseline value	Range
Cohort characteristics	64,300,0	-
Mean age, years	00	20
Life expectancy, years	40	60
Proportion of patients at high risk of complications, %	41 23	23-40
Attack rate, %	7.5	7.5-15.0
Probability of ILI, %	34.9	34.9-69.8
Probability of presenting to care with ILI, %	5.5	5.5-30.0
Probability of A(H1N1)*v* given presentation to care with ILI, %	21.5	5.0-15.0
Probability of hospitalization given presentation to care with ILI and A(H1N1)*v*, %	5.5	1.4-5.5
Increased hospitalizations in high-risk patients *vs.* low-risk patients ¶	2.7	-
Probability of ICU admission given hospitalization, %	12	6-24
Increased ICU admissions in high-risk patients *vs.* low-risk patients	1.0	1.0-3.0
Probability of death given ICU admission, %	14	-
Proportion of patients who present to care and initiate treatment ≤48 hours after the onset of symptoms, %	50	25-75
Proportion of patients who initiate treatment >48 hours after the onset of symptoms, %	6.1	3.1-9.2
Antiviral treatment efficacy, %	60	5-30
Health care resource utilization and costs		
Clinic visit	21	-
Average length of inpatient stay, days	4	7
Average length of ICU admission, days	13	21
Cost per inpatient day, 2009 €	482€	-
Cost per ICU day, 2009 €	1,319€	-
5-day oseltamivir treatment by age, 2009 €		
<1 year	12.69	-
1-12 years	18.78	-
>12 years	24.85	-

Table 1.1. Summary of input parameters for a decision model of A(H1N1)*v* influenza treatment

	Hospitalizations		Deaths	Discounted life years	Undiscounted costs (€)*
	Overall	ICU			
Targeted strategy†	14,460	1,696	238	5,573	86,237,980
Systematic strategy‡	12,339	1,447	203	4,755	89,591,030

Table 1.2. Base case results for different antiviral treatment strategies in France

From table 2, we can consider that less patient patients are hospitalized, admit to ICU, and died. systematic strategy increased life expancy by 817 discounted life years for an additional cost of €3,353,050 compared to the targeted strategy, it's leading to a cost-effectiveness ratio of €4,100/YLG. So that the systematic strategy is more cost-effective than the targeted strategy.

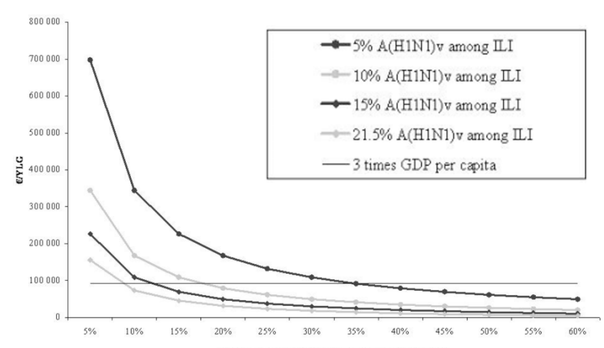

Fig 9. Percent decrement of effective cost

To make the decision tree, software package TreeAge TM 2006 is used in this research. By implementing the decision table in table 1, the decision tree below is constructed :

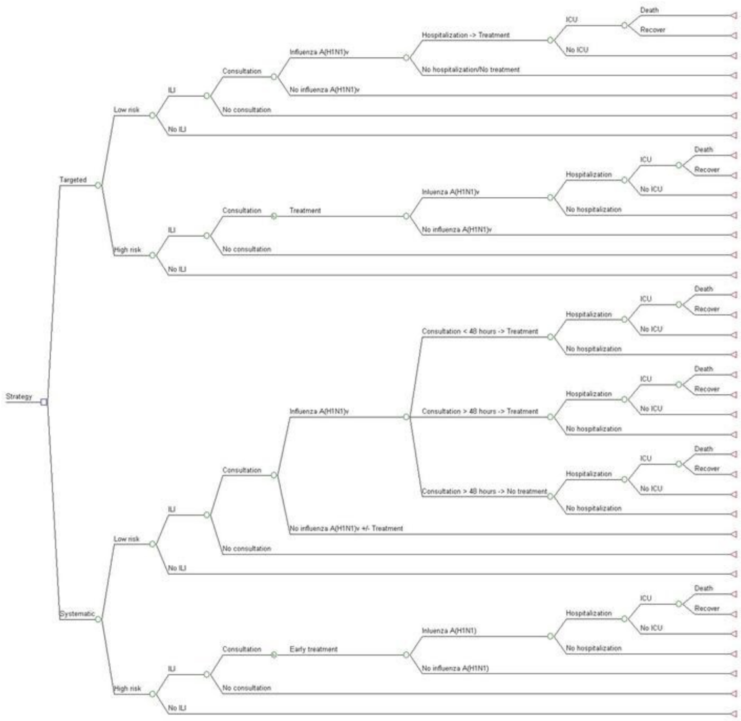

Fig 8. Decision table of systematic strategy and targeted strategy of epidemic Swine flu

4. CONCLUSION

Tree concept has many real apllication, one of them is decision tree. . Decision tree has been used in many field, there are : economic development, real estate, conservation and environtment, sustainable economy, etc.

One apllication of decision tree in health economic is on the how to get the most effective plan of an epidemic disease, how to determine the type of disease, and how to determine the type of disease and it source, where in this context, the disease is influenza A and the source is influenza virus.

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PERNYATAAN

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

Bandung, 29 April 2010

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