

**Factors that Influence Doctors' Career Choices and Shortage of Doctors**  
**-Physicians' workplace conditions and supply and demand balance of physicians**  
**dealing with serious conditions-**

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**Abstract**

The root cause of “doctor shortage,” a wide spread social phenomenon in recent years, is thought to lie in the decreased number of doctors specializing in serious medical conditions, even though the number of patients in such cases has been increasing due to the aging of society (Supply and demand SD model of physicians, pp.49-62, System Dynamics, Vol.11, 2012). So what is causing the decrease in number of hospital doctors dealing with serious conditions? The study discusses the factors affecting junior doctors when they choose their careers and how these factors affect their future careers. Factors were extracted by a questionnaire survey. Four workplace conditions were considered to affect doctors' career paths today. These conditions, which are working hours, rewarding, sense of mission, and risk, were set as the effects in a workplace conditions model and a workplace condition effects and relation diagram was created. Using a supply and demand SD model of physicians, and by changing a part of the whole career path that affects physicians' future career choice as well as an effect from the workplace conditions, a simulation of the supply and demand balance of doctors, limited to those who would not choose the career path to become physicians dealing with serious conditions, is now achieved. Using the simulation, factors and workplace condition effects that may balance the supply and demand of the physicians dealing with serious conditions in future were identified. It is hoped that these findings may lead to policy proposals to solve shortage of doctors.

Key words: shortage of doctors, career choice, workplace conditions, supply and demand balance of physicians dealing with serious conditions

**Introduction**

Japan is facing an unprecedented demographic change of the society in which the proportion of the elderly population is increasing while the birth rate falls. Rebalancing the system of medical provision has been a national topic in the last few years, with the mismatch between the public medical needs and supply of doctors identified, and continuing discussion from various sides.

For example, with the global economic crisis that started in 2007 as the background, austerity measures for public expenditure are drawing attention, and medical cost is one of the targets marked out. However, while the discussion continues, medical professionals on the ground, who pride themselves that they have contributed to the economic development of Japan as well as achieving the world number one longevity society, feel differently. It is true that Japanese medical system is supported by publicly funded universal health care, but it is also true that medical

professionals in the field have been working hard to improve medical services by advancing the technologies and reforming hospital systems. Even so, the recent climate is that medical professionals feel insufficiently appreciated despite their maximum effort while service users are not satisfied with the medical provision they receive. Why? The answer seems to be the change in the social environment surrounding medical care. The problem cannot be solved by the simple and conventional thinking that emphasizes only the economic side, such as securing the numbers of doctors to provide medical services and medical fees. The perception of doctors being closely involved in the society is essential for the nation's future health policies.

With this in mind, the study firstly categorized medical specialties into 3 groups of serious conditions, mild conditions, and others, as well as career paths into 3 groups of resident physicians, employed physicians, and private physicians. An assumption was made that the so called "shortage of doctors" is in fact the shortage of employed physician of departments dealing with serious conditions (including emergency patients) of which the public perception of the needs is high, and the hypothesis was investigated by identifying factors that affect career paths of employed physician of departments dealing with serious conditions. Factors affecting choice of career paths were extracted by interviews with doctors in each stage, with the generality validated by a questionnaire survey (online survey conducted in February 2011).

### Workplace conditions of physician and the demand and supply balance of physicians dealing with serious conditions

In the previous study, we considered the career path of physician as single system (see Figure 1) to analyze a demand and supply balance of physicians by developing a supply SD model of physicians for the number of physicians and a demand SD model for the number of patients and fitting them together with a population model of Japan. The results are shown in a graph of Figure 2.

Figure 1. A career choice of physicians (career-path model)

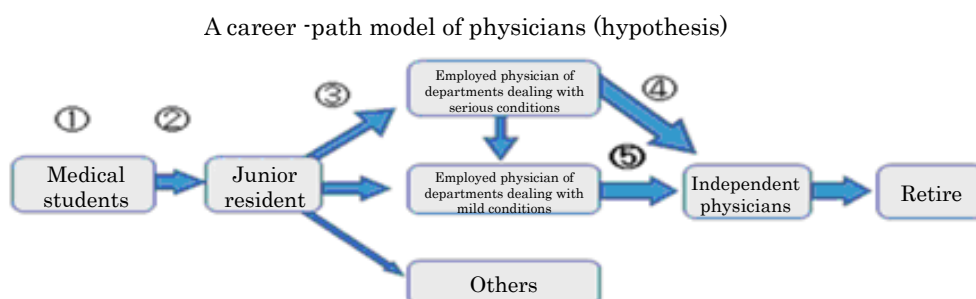
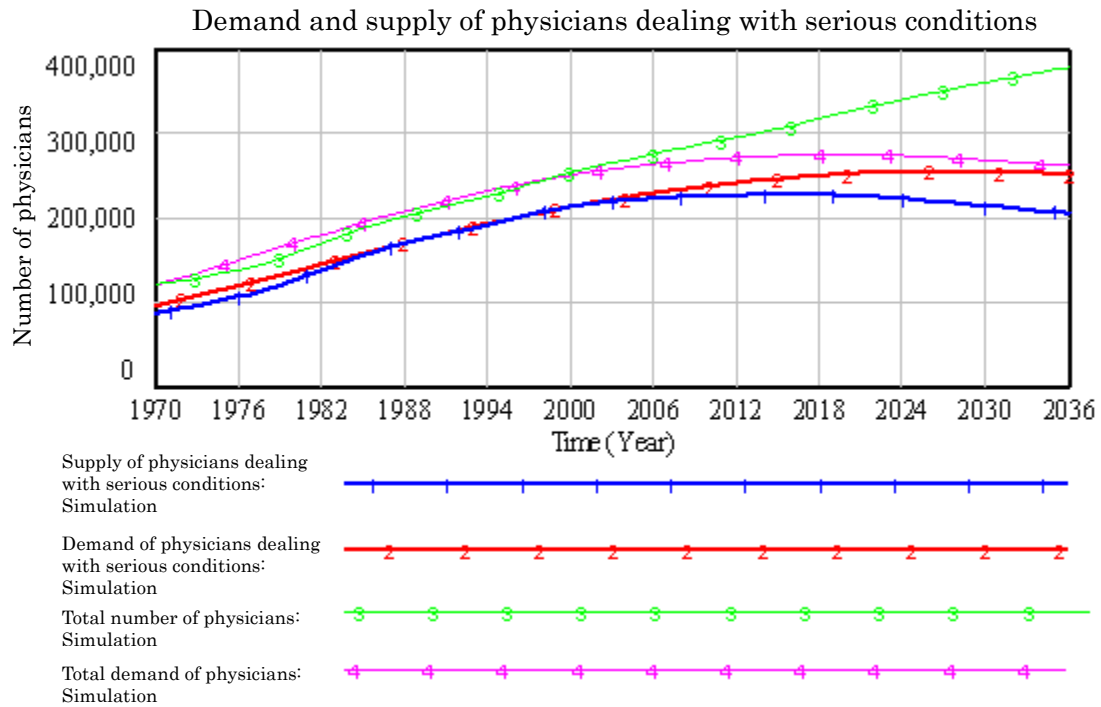


Figure 2. Simulation: Demand estimation of the number of physicians (1970-2036)



The essence of doctor shortage is shortage of employed physician of departments dealing with serious conditions. It was revealed in the previous SD model that there is a mismatch between demand and supply of physicians dealing with serious conditions. Then, now we tried to examine why physicians choose such carrier path causing doctor shortage, in other words, what is the cause of not choosing to be a physician dealing with serious conditions, or what kind of factors influence such career choice, by using the SD models.

First, following four major conditions were set as workplace conditions surrounding physicians: (1) working hours, (2) risk, (3) rewarding, and (4) a sense of mission. We call the influence on workplace conditions as "workplace condition effect", and developed following effect expression and relationship diagram model:

$$\text{Workplace condition effect} = \text{Working hours} \times \text{Rewarding} \times \text{Sense of mission} \times \text{Risk}$$

In addition, we used a table function specific to SD as an approach to show consistency with data to dynamically understand how changes in each effect influences the workplace conditions as well as demand and supply balance of physicians dealing with serious conditions as the results of the changes, using the model. Then, we used the model to demonstrate that the workplace conditions effect can be enhanced, in other words, the rate choosing to become a physician dealing with serious conditions increases by not only effect of single factor but also effects of multiple factors.

Following parameters were set based on the premise mentioned above.

**Factor 1: Effect of working hours:**

According to an empirical analysis in Chapter 4, it was considered that working hours is the largest factor with high loading among these several working conditions in both phases of resident

physician and employed physician of departments dealing with serious conditions, as the results of factor analysis. Therefore, in workplace environment, working hours was especially selected to develop a model.

**Factor 2: Effect of risk:**

According to the empirical analysis in Chapter 4, a result was indicated that physicians tend to continue to be employed physician of departments dealing with serious conditions in the environment with higher number of hospital beds. Here, it is considered that a number of staff with a variety of occupations work in a hospital with higher number of hospital beds, and as the results, potential lawsuit decreases due to adequate patient care, then potential lawsuit would be avoided. In addition, the results of questionnaire survey in Chapter 3 indicated that about more than half of physicians feel the potential lawsuit risks regardless of their sex, age, and working form. We heard such comment, "Medical services always face risk of lawsuits." in individual interview with employed physicians. Actually, employed physicians recognized risks in the practice of consultation and procedure, and about 7 of 10 employed physicians recognized risk of lawsuits. Here, a model was developed using the number of medical lawsuits, which is easily-available actual data (published in a website of the Supreme Court of Japan), as an index indicating the effect of risk.

**Factor 3: Effect of a sense of mission:**

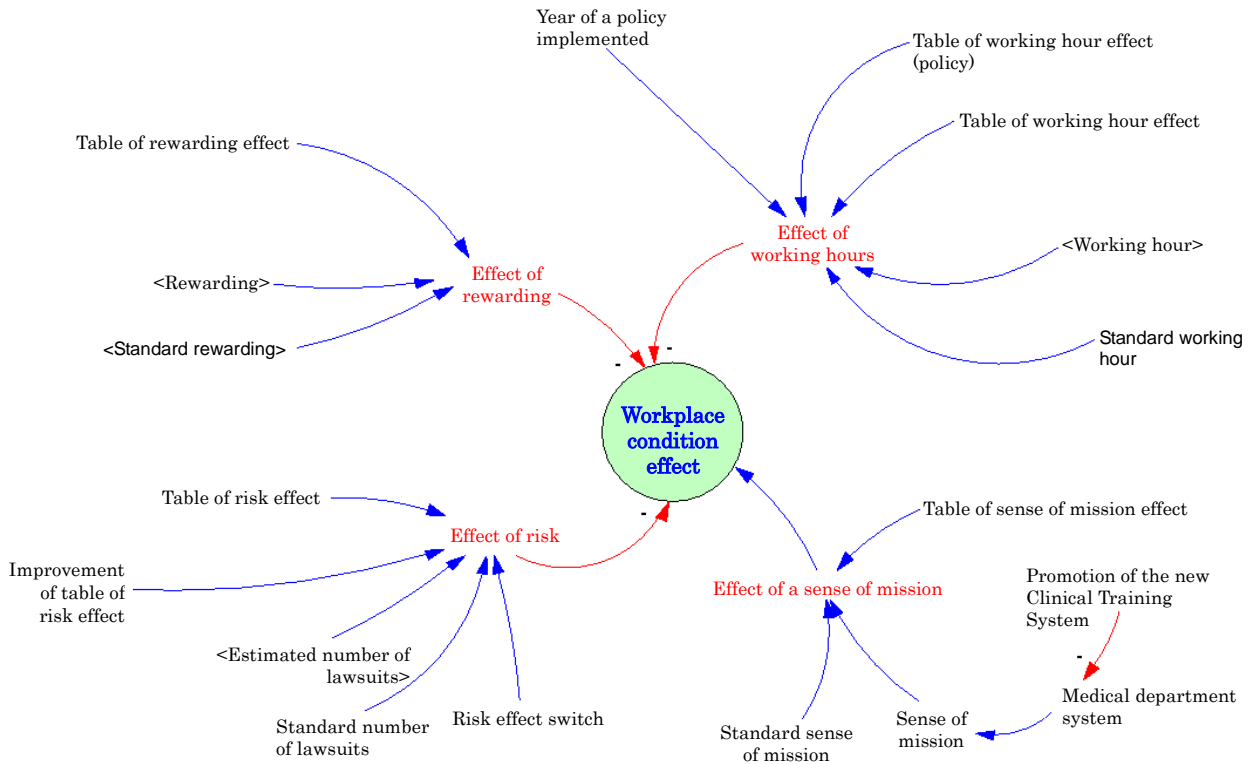
A sense of mission is a feeling of human beings, and is somewhat difficult to digitize. However, it was clear that the sense of mission affects career choice according to the results of Chapter 4; therefore, the model was developed focusing on whether the subjects have a sense of mission.

**Factor 4: Effect of rewarding:**

According to the previous study, it was indicated that resident physicians tend to choose to become a physician dealing with serious conditions when rewarding is low during clinical training. It was shown that high rewarding not always attracts the choice to become a physician dealing with serious conditions. However, medical service fees have been incentive for them under the present circumstances; therefore, we considered rewarding as a factor and developed the model.

The following figure represents the modeled relationship diagram (see Figure 3). In Figure 3, blue arrows indicate increase of the effect, and red arrows indicated decrease of the effect. Influence of each factor was examined below:

Figure 3A relationship diagram model of workplace condition effect



As previously described in Section 5-1 (p.96), supply of physicians dealing with serious conditions is determined by the rate choosing to become a physician dealing with serious conditions in the SD model of physician supply. We considered factors influencing the rate choosing to become a physician dealing with serious conditions as "Four effects" in the workplace condition effects and expressed as below:

$$\text{Workplace condition effect} = \text{Working hours} \times \text{Rewarding} \times \text{Sense of mission} \times \text{Risk}$$

In addition, we used a table function, which is a model specific to SD as an approach to show consistency with data. Furthermore, results of factor analysis, which were based on a web survey conducted by the authors, were employed for the number set in the model. Each effect was expressed with an expression shown below. Settings of each effect in the hypothesis of workplace environment conditions shown in Figure 3 are described below.

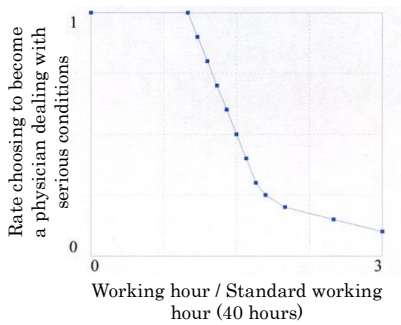
Meanwhile, table function defines a customized relationship between two variables. When a variable X is input, a variable Y is output through a table function with a specified (nonlinear) form. This is also called a graph function because this is generated in a graph editing dialogue.

The following graph shows a change of a variable Y, which is the vertical axis, representing the rate for choosing to become a physician dealing with serious conditions, as a function of a variable X which is the horizontal axis representing changes of each effect.

(1) **Effect of working hour = Table of working hour effect (Working hour / Standard working hour)**

A standard working hour was set as 40 hours a week. We assumed that the effect of working hour decreases if working hour exceeds the standard working hour.

Figure 3-1 Table of working hour effect



The horizontal axis represents working hour / standard working hour (40 hours).

The vertical axis represents the rate choosing to become a physician dealing with serious conditions.

In short other words, the effect was estimated based on an assumption that the rate choosing to become a physician dealing with serious conditions decreases when working hour increases.

**(2) Table of rewarding effect (Rewarding / Standard rewarding)**

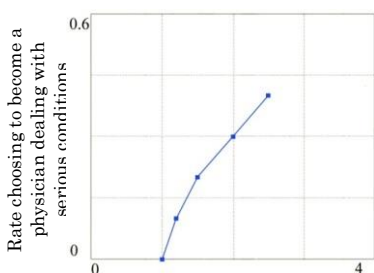
A reference year of the standard rewarding was set as 1970, and as a standard amount at the year was defined as a standard rewarding (1970). In addition, elapsed years after the reference year are (Time - 1970). Accordingly, standard rewarding at that time can be expressed with the following expression.

$$\text{Standard rewarding} = \text{Standard rewarding (1970)} * \text{EXP}(\text{Increase in rewarding} * (\text{Time} - 1970))$$

In this expression, the increase in standard rewarding represents increase of the standard rewarding per unit of time.

Rewarding naturally increases when working hour increases. Let's suppose that a standard rewarding of employed physicians in 1970 is 7.15 million yen. Increase of the standard rewarding have an influence on the rewarding and standard rewarding because both prices of commodities and salary elevate every year. Based on the results of Chapter 4, it was revealed that physicians who had low income during clinical training would choose to become a physician dealing with serious conditions, and then, physicians who had wanted to be economically stable tended to continue to be a physician dealing with serious conditions when they became employed physician. Accordingly, we assumed that the rate choosing to become a physician dealing with serious conditions increases when rewarding increases, and developed a table of rewarding effect.

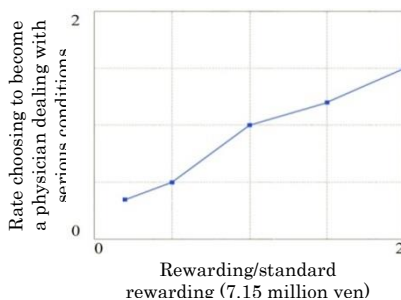
Figure 3-2 Table of rewarding increase



The horizontal axis represents inflation rate, and the vertical axis represents increase of rewarding.

It was assumed that prices would become 2-times higher, then rewarding increase would become 0.4 times higher.

Figure 3-3 Table of rewarding effect



The horizontal axis represents rewarding / standard rewarding (7.15 million yen).

The vertical axis represents the rate choosing to become a physician dealing with serious conditions.

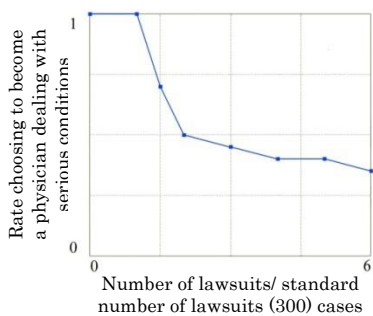
It was assumed that the standard rewarding, which is the horizontal axis, would become 2-times higher, then the rate choosing to become a physician dealing with serious conditions,

which is the vertical axis would become 1.5 times higher.

(3) It was set as **Effect of risk = Table of risk effect [ Estimated number of lawsuits (Time) / Standard number of lawsuits]**.

According to medical affair data of the Supreme Court of Japan, the number of lawsuits increases from 400 cases of 1990 to 800 cases of 2000 and 1,100 cases of 2004. The standard number of lawsuits was set as about 300 cases per year, which is an average number of lawsuits in the 1980s.

Figure 3-4 Table of risk effect

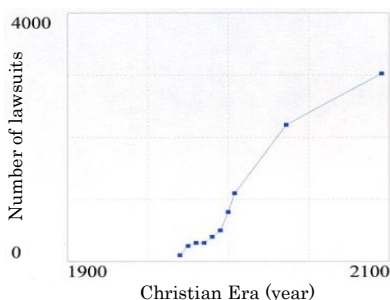


The horizontal axis represents number of lawsuits/ standard number of lawsuits (300 cases).

The vertical axis represents the rate choosing to become a physician dealing with serious conditions.

It was assumed that the rate choosing to become a physician dealing with serious conditions, which is the vertical axis, decreases according to multiplying factor of increase from the standard number of lawsuits, 300, which is the horizontal axis.

Figure 3-5 Estimated numbers of lawsuits (Time)

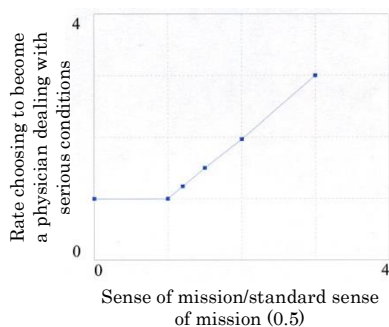


When look at the horizontal axis (Christian Era), the average number of lawsuits increases from 300 cases in the 1980s to 800 in 2000 and 1,100 in 2004. It is presumed that the number doubles by 2036.

(4) **Effect of a sense of mission = Table of sense of mission effect (Sense of mission / Standard sense of mission)**

Standard sense of mission was set as 0.5. It was assumed that the effect of the sense of mission would increase when the standard sense of mission exceeds 0.5.

Figure 3-6



The horizontal axis represents sense of mission/standard sense of mission (0.5).

The vertical axis represents the rate choosing to become a physician dealing with serious conditions.

It was assumed that the rate choosing to become a physician dealing with serious conditions, which is the vertical axis, would increase according to multiplying factor of increase of the sense of mission.

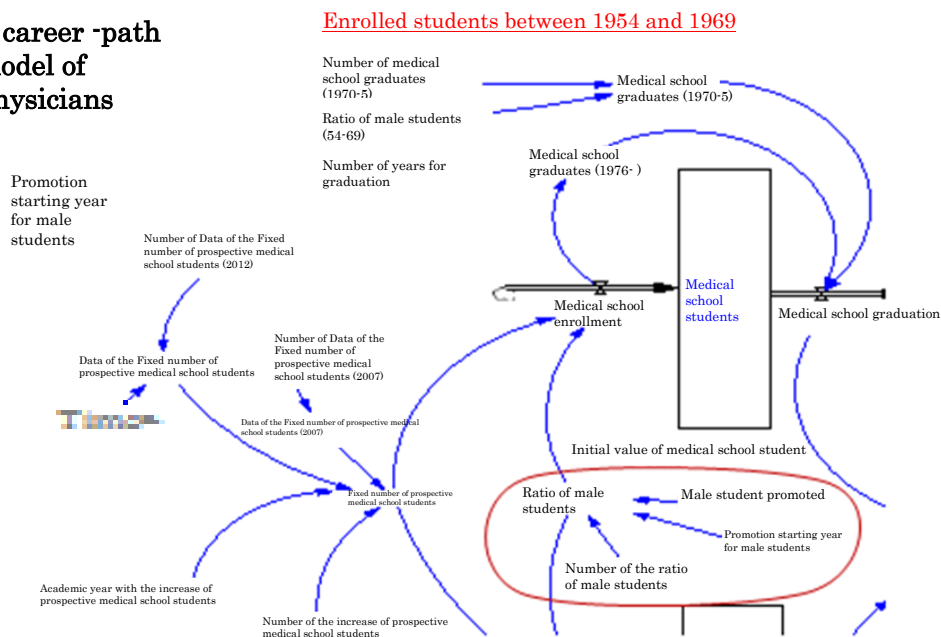
By the way, four factors (1. sex, 2. timing of choosing to be a physician, 3. social vocation, 4. annual income) were identified as factors influence the workplace environment that influence the career choices after employed physician of departments dealing with serious conditions, based on the

results of analysis in the previous study. In addition, three factors (1. social vocation, 2. economical incentive, 3. number of hospital beds) were identified as factors that influence the career choices after employed physician of departments dealing with serious conditions for the next career. Based on these results, with four factors, i.e., **sex**, **social vocation**, **social vocation**, **annual income (rewarding)**, and **number of hospital beds (risk)**, were employed to examine effects of these factors on physicians dealing with serious conditions as well as changes in the demand and supply balance using a **SD model for demand and supply of physicians and a relationship diagram model of workplace condition effect** mentioned above.

### 1. Sex

It was clarified that males tend to choose to become a physician dealing with serious conditions as the results of analysis; therefore, a simulation was conducted using male student ratio as a parameter in the SD model for demand and supply of physicians.

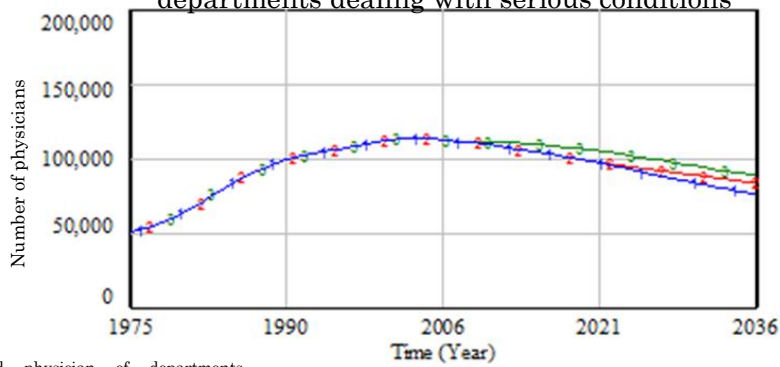
#### A career-path model of physicians



- When male student ratio at school entry remained in the current level. → Student ratio
- When male student ratio at school entry was set at 0.9 (90%) → Student ratio (promoted)
- When the male student ratio at school entry was set at 0.9 in 2000 → Student ratio (promoted)



Estimated number of employed physician of departments dealing with serious conditions



Employed physician of departments dealing with serious conditions: Student ratio (blue line with triangles)

Employed physician of departments dealing with serious conditions: Student ratio (promoted) (red line with squares)

Employed physician of departments dealing with serious conditions: Student ratio (promoted) 2000 (green line with circles)

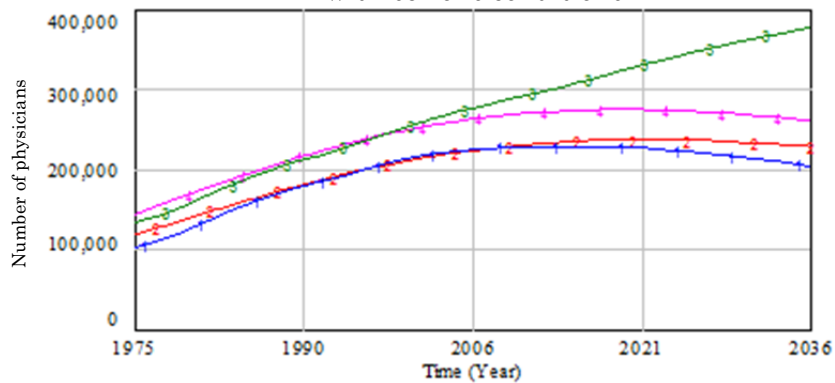
Results of a simulation of the supply of physicians dealing with serious conditions by sex (male student ratio was increased).

- Line 1 (blue line): When male student ratio remained in the current (2013) level.
- Line 2 (red line): When male student ratio was set at 0.9 (90%) from 2014. The supply would increase from around 2021.
- Line 3 (green line): When male student ratio was set at 0.9 (90%) from 2000. The supply would increase from around 2008.

Changes in demand and supply balance of physicians dealing with serious conditions in these situations were simulated, respectively.

1. When a male student ratio remains at the current status in 2013, demand and supply did not balance.

Demand and supply of physicians dealing with serious conditions



Supply of physicians dealing with serious conditions: Student ratio (blue line with triangles)

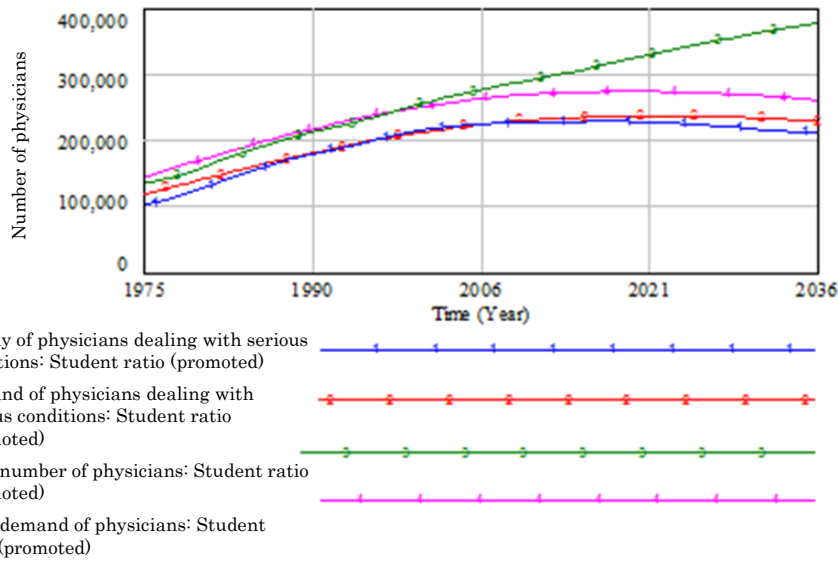
Demand of physicians dealing with serious conditions: Student ratio (red line with squares)

Total number of physicians: Student ratio (green line with circles)

Total demand of physicians: Student ratio (pink line with diamonds)

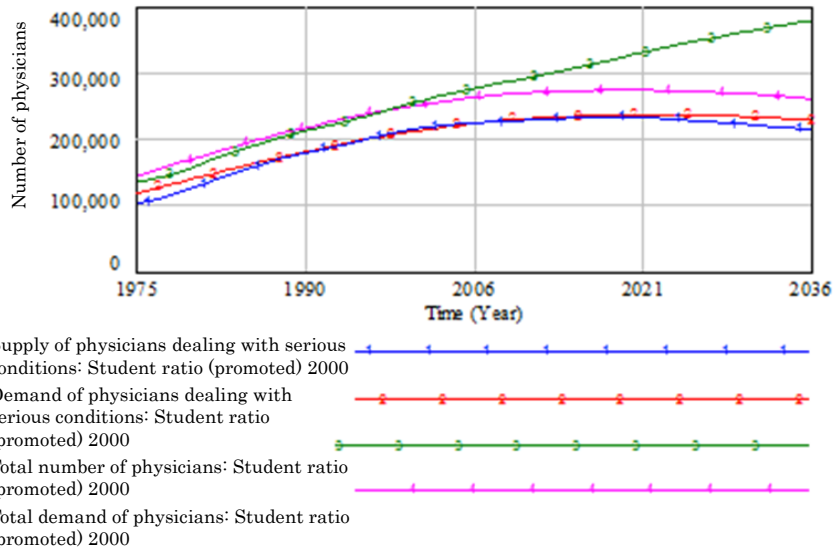
2. When a male student ratio was set at 0.9, demand and supply also did not balance.

Demand and supply of physicians dealing with serious conditions



3. When a male student ratio was set at 0.9 in 2000, demand and supply also did not balance.

Demand and supply of physicians dealing with serious conditions

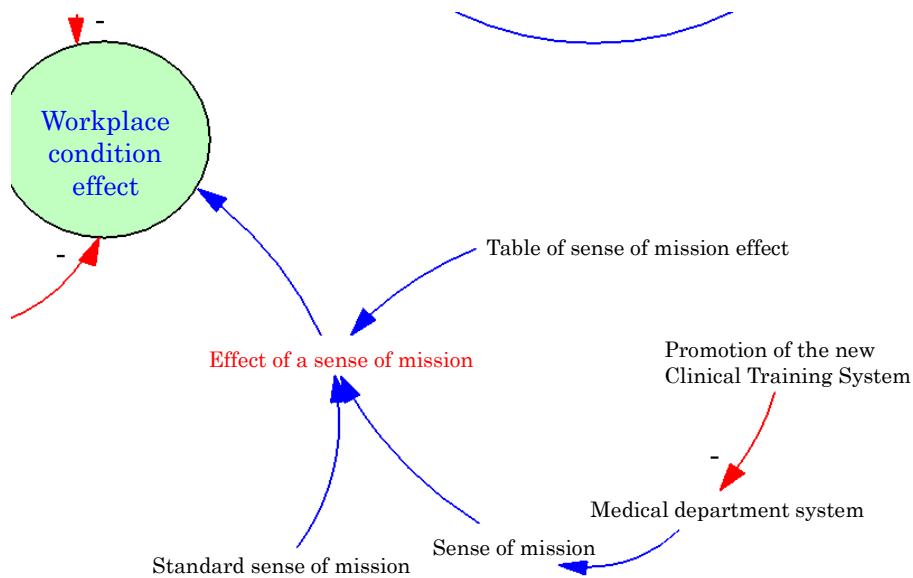


If increase of male physicians is attempted by changing a male student ratio at school entry to 90%, it was indicated that the change cannot satisfy the demand for physicians dealing with serious conditions. Therefore, it is impossible to solve the problem of doctor shortage through changing sex ratio of students.

## 2. Social vocation

Here, we considered that when the new Clinical Training System is promoted, then the medical department system becomes disrupted, and social vocation effects on a sense of mission. The medical department system influenced cultivation of the sense of mission in conjunction with professional education for physicians from the cultural and psychological aspect. In other words, promotion of the new Clinical Training System caused the role that the medical department system played to have disappeared. In this case, we presumed that, for example, if professional education is promoted under the medical department system, then the sense of mission as well as the workplace condition effect are reinforced.

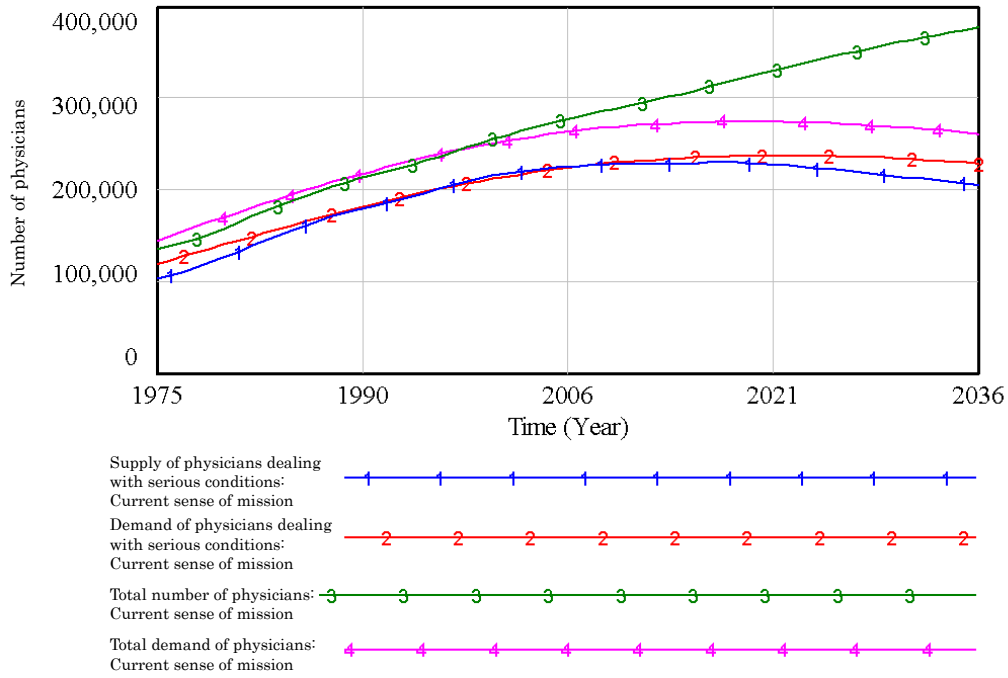
A relationship diagram of workplace condition effect is shown below.



Demand and supply balances when the effect of sense of mission remained in the current status and when the sense of mission was increased were examined.

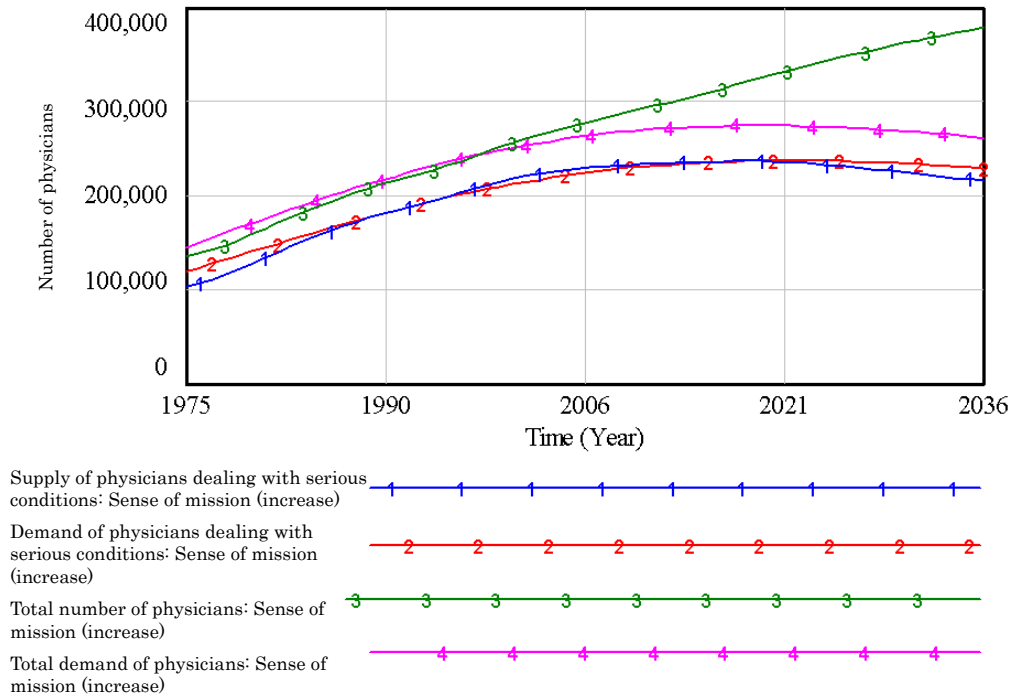
When sense of mission remained in current status.

Demand and supply of physicians dealing with serious conditions



When sense of mission increased.

Demand and supply of physicians dealing with serious conditions



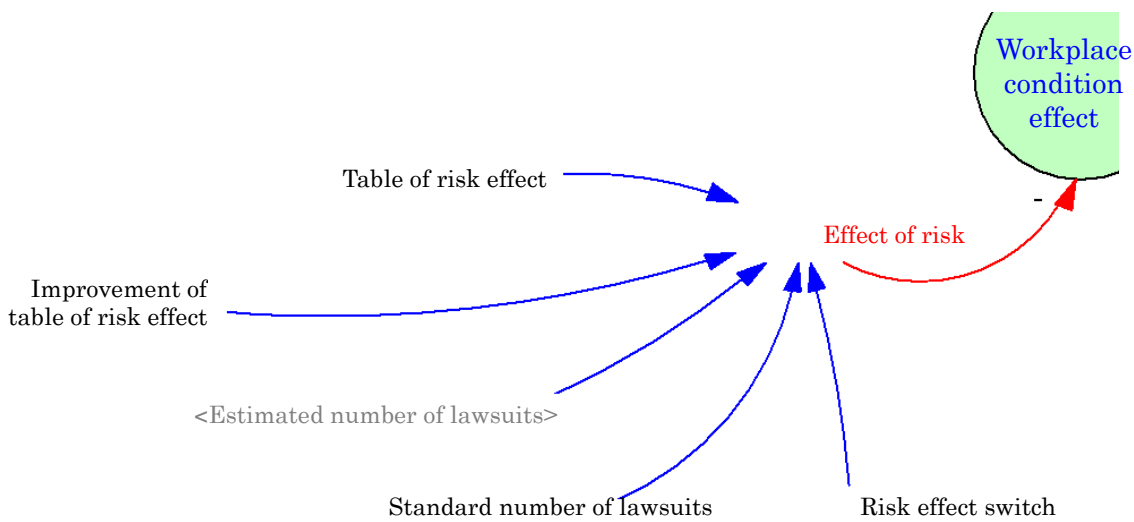
Demand and supply of physicians dealing with serious conditions did not balance if a sense of mission increased. The demand will be in excess of the supply after 2021. If the effect of sense of mission is improved, shortage of physicians dealing with serious conditions could not be completely resolved, and the excess of supply would be further expanded at the same time.

### 3. Effect of the number of hospital beds → Effect of risk

According to the results of analysis, it was indicated that physicians tend to choose to become physician dealing with serious conditions when the number of hospital beds is higher. This is because that a number of staff with a variety of occupations work in a hospital with higher number of hospital beds, and as the results, potential lawsuit decreases due to adequate patient care, then potential lawsuit would decrease, in short, the risk would be avoided. Accordingly, we consider the effect of the number of hospital beds as risk effect in this study. Here we examined with apprehending the effect of the number of hospital beds as one of risk reducing effects.

In this model, it was set that when risk effect switch is 1 means that the risk is improved, and the workplace condition effect is increased.

A relationship diagram of workplace condition effect and expressions are shown below.



IF THEN ELSE (Risk effect switch = 0, Table of risk effect (Estimated number of lawsuits (Time)/Standard number of lawsuits),

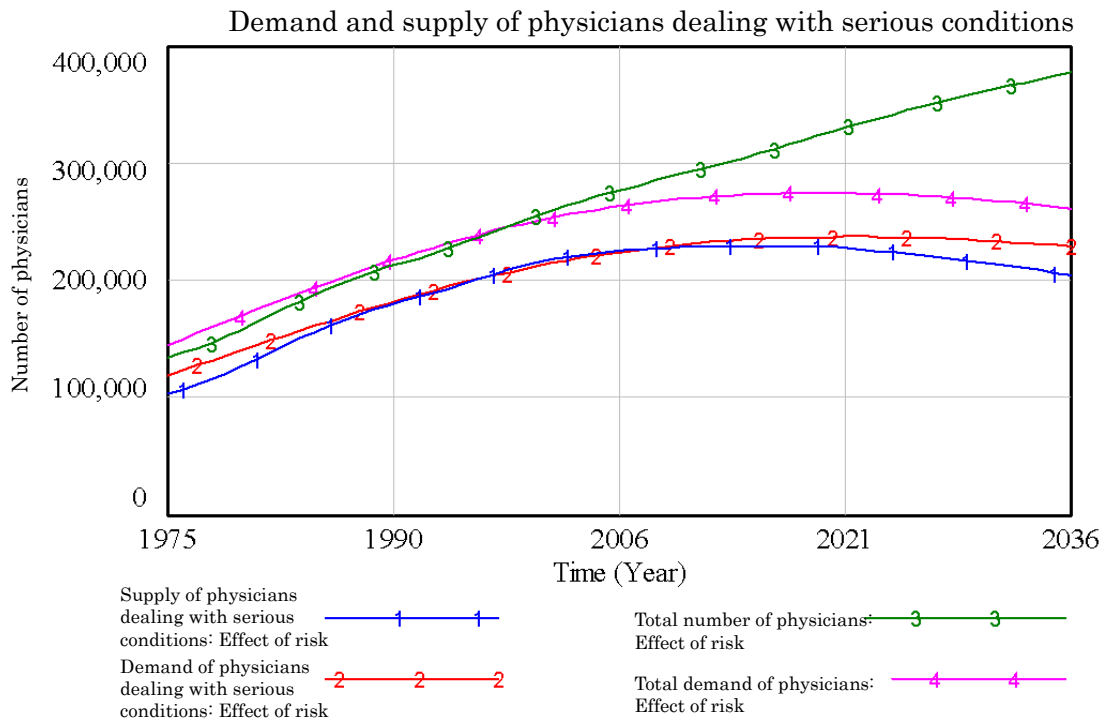
Risk effect switch = 1 Table of improvement of the table of risk effect (Estimated number of lawsuits (Time)/ Standard number of lawsuits))

Risk effect switch = 0 When risk was unchanged.

Risk effect switch = 1 When risk was improved.

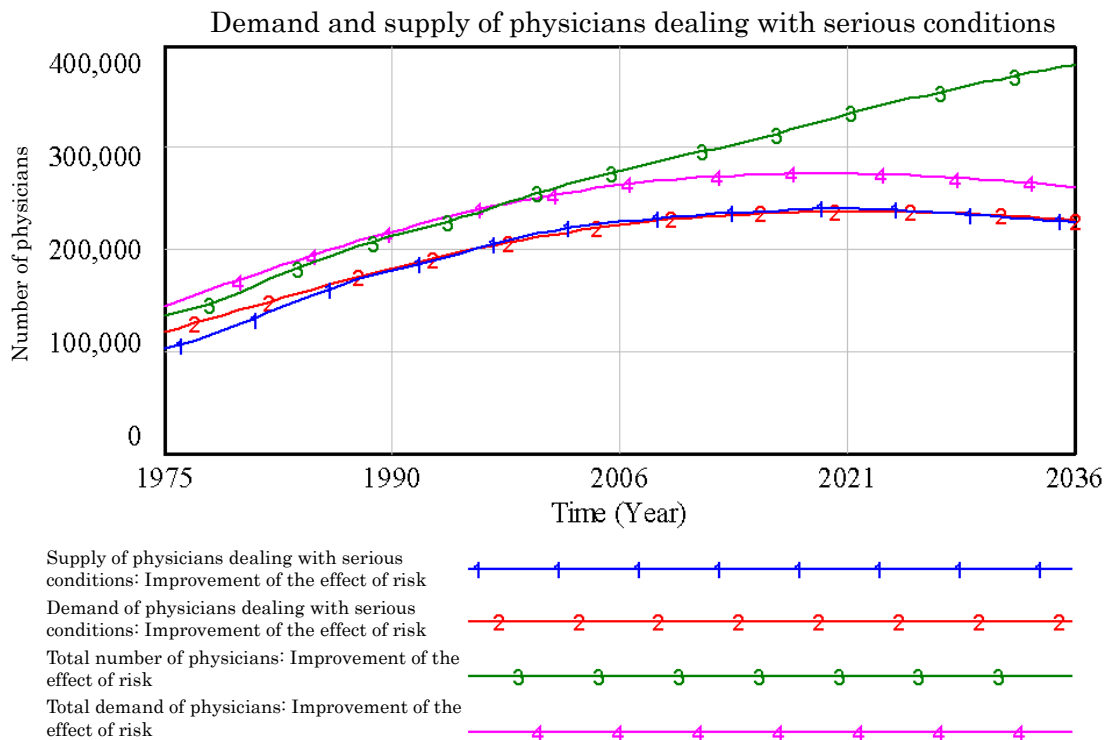
Meanwhile, the expressions for the estimated number of lawsuits (Time) use table functions. That means that when the horizontal axis represents time (Time), the vertical axis represents the estimated number of lawsuits. (See Figure 3-5)

1. When the effect of risk remained in the current status.



As the results of simulation, demand and supply of physicians dealing with serious conditions did not balance.

2. When the effect of risk was improved.



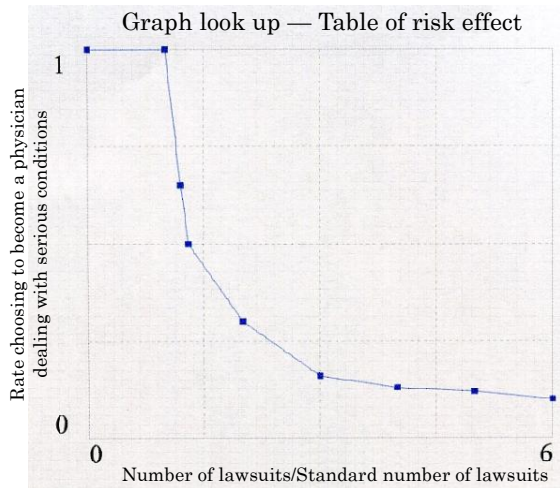
As the results of simulation, demand and supply of physicians dealing with serious conditions

balanced.

The effect of risk itself were:

INPUT	0	1	1.2	1.3	2	3	4	5	6
OUTPUT	1	1	0.65	0.5	0.3	0.16	0.13	0.12	0.1

The above data can also be indicated in a graph as below.

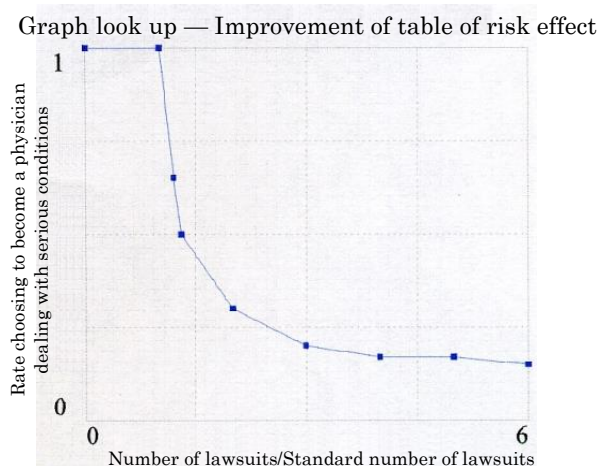


Horizontal axis (INPUT) represents the number of lawsuits/Standard number of lawsuits, and vertical axis (OUTPUT) represents the rate choosing to become a physician dealing with serious conditions.

Effect of risk improvement

INPUT	0	1	1.2	1.3	2	3	4	5	6
OUTPUT	1	1	0.65	0.5	0.3	0.2	0.17	0.17	0.15

The above data can also be indicated in a graph as below.



It was shown that demand and supply balance would match if a ratio choosing to become a physician dealing with serious conditions increased by 0.4-0.5 when the number of lawsuits become 3 times or higher. In other words, small improvement of the risk can balance the demand and supply of physicians dealing with serious conditions. To realize this, it may be useful to conduct the clinical training in a large hospital with a high number of beds.

#### **4. Annual income, economical incentive**

Here both annual income and economical incentive are considered as effect of rewarding. However, increase of rewarding also means increase of working hours; therefore, the number of employed physician of departments dealing with serious conditions not always increases in this case. There were also comments that physicians want free time rather than rewarding in questionnaire survey and interviews in the previous study.

#### **Discussion**

As mentioned above, we used the SD models to examine how variation of four factors (sex, social vocation, social vocation, rewarding, and risk) effecting on career choice of physicians impacts on the demand and supply balance of physicians dealing with serious conditions.

For sex, given the existing circumstances that female medical students are increasing (1/3 of candidates for the national exam accounts for females), we simulated the demand and supply balances. For example, when the male student ratio was remained at current status of 70% and when the ratio was set at 90%, the demand and supply did not balance in both cases. It was clarified that the increase of female physicians had been said to be a reason of shortage of physicians dealing with serious conditions, but that was not always true.

For social vocation, the demand and supply also did not balance even if the sense of mission was increased by promoting a professional education, etc. In the current situation the new Clinical Training System (established in 2004) has took root in the field, the conventional medical departments system could not be applied again. However, we simulated that even if an education reform to improve the sense of mission was conducted, the demand and supply did not balance.

On the other hand, the demand and supply of physicians dealing with serious conditions did not balance if the effect of risk remains in the current status; however, it was indicated that the demand and supply would balance when the effect of risk was improved. In this case of the effect of risk, we used the number of lawsuits/standard number of lawsuits as an index. The risk exists elsewhere, but particular social scientific actions including compliance is required also in the medical field. Therefore, the government should provide some human supports from that perspective.

Based on the results mentioned above, the reality of a problem of doctor shortage is actually shortage of employed physicians of departments dealing with serious conditions. The rate choosing to become a physician dealing with serious conditions should be increased to increase the number of employed physicians of departments dealing with serious condition. However, the effect of risk, which is a factor preventing such career path, effects on the rate. Therefore, this study applying the SD models clarified that concrete measures to improve the risks are eagerly anticipated.