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A System Dynamics Evaluation of SARS Preventing Policies in Taiwan

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Abstract

The early year in 2003, Severe Acute Respiratory Syndrome（SARS） has brought the global panic, and caused 8,422 SARS patients including 916 deaths. In Taiwan, SARS has affected 665 persons including 180 deaths. In order to control SARS situation, each area took several policies. Because SARS was an emerging infectious disease, we didn't have the immunity and treatment method in the short-term. Therefore, the most important point was to prevent the spread of SARS.

We evaluate the policy effectiveness on preventing transmission of infectious disease from the flow and feedback viewpoint. Generally speaking, there are two ways to prevent the spread of SARS. One is "Quarantine policies"（isolate healthy persons who may contact the virus, isolate the infected persons who has still no symptom during incubation period, and isolate and cure the symptomatic patients）.The other is "Protection policies"（reduce the opportunity for the healthy persons to contact others to avoid being infected, and purchase and use protection equipment such as face masks）. In this research, we build SARS transmission model for evaluating policies by system dynamics.

In our investigation, we proved that "Protection policies" are more effective than "Quarantine policies" on preventing diffusion of infectious disease. As a result, we advise that we need to eradicate any contact to deal with similar emerging infectious disease. But, even if we did that well, the epidemic situation still could not stop. Any countermeasure can only postpone the epidemic situation eruption but can't make the reinforcing loop to the end. Fortunately, SARS situation terminated because of virus variation.（He, Jian-Feng et al., 2004）, and our simulation also supports this point of view. Consequently, we ought to ponder the way to live with viruses in the long-term, and not to resist any virus reactively.

Keywords：Infectious Disease, SARS, System Dynamics

Introduction

Since the first American businessman got sick in Hanoi, Vietnan on February 26th, 2003, dead during the process of therapy in Hong Kong. The SARS cases are founded in Hong Kong and Vietnan. It was confirmed by the World Health Organization（WHO）that the disease is related to the pneumonia epidemic happened in Canton, Chinese, November 2002. In the early time of the epidemic, people doubt that the atypical pneumonia is caused by unknown virus. Compare with the atypical pneumonia caused by the virus and germs we have known the new one more dangerous. The characteristic is that once you are infected, uncommon pneumonia and breathe exhaustion will occur. On the March, 15th, World Health Organization（WHO）give the new disease a new name, Severe Acute Respiratory Syndrome, SARS. On April, 16th, 2003, one month after the World Health Organization laboratory net was set, it is confirmed that the pathogen of SARS is a new one: It is new coronavirus compare with the other members in coronavirus family. The epidemic is spread all over the world. From November 2002 to August 2003, the disease has been spread 32 countries. There are 8422 are infected, and 916 of them are dead. As for Taiwan, 665 are infected, 180 are dead.（WHO, 2003）

Because we are not familiar with the new disease, it is difficult to develop vaccine or therapy method in such a short time. Therefore, it is relative important to prevent the epidemic from spreading. Nowadays, the transportation is very convenient so that the virus can be carried more easily and convenient. That's why it is such a challenge to stop the epidemic under such an environment.

After finding the SARS epidemic spread in Taiwan, people take different strategies. We must understand that the resource must put on the really important things. However, what kinds of strategies are really important and efficient？ Epidemic prevention is so difficult so we need to consider the variables among the system and the relationship between the subsystems. In order to deal with the dynamic and complicated problems, we should develop a new way to do the policy testing and comparison. The goal of the research is trying to introduce the system dynamics to deal with the dynamic and complicated problems. We hope that by comparing with different strategies used in the SARS epidemic prevention, we can find much efficient and more important policies to prevent the new epidemic in the future. In additions, we also hope that we can simulate why the epidemic is spread and stop, and understand the situation at that time.

Severe Acute Respiratory Syndrome

On March, 12th, in order to response the epidemic happened in Canton, Vietnam, and Hong Kong, it is the first time for World Health Organization to give definition to SARS case and start the global scrutiny. The strengthened monitor system has significant meanings because it can monitor the trend of SARS around the world and take corresponding preventive control policy.

No matter it is for some areas or the whole world, case definition has key meaning for efficient sanitation scrutiny and interferes. This part we will list the definition announced by WHO on 2003, May 1st. And then we will discuss the way SARS spread and talk about the strategies we are using right now. In additions, we would also introduce when the epidemic started and stopped in Taiwan. By doing these, we can clarify the direction we are going to and build the model.

Definition of SARS patients：

Accounting to the definition announced by WHO on 1 May 2003：

Suspect case：

1. A person presenting after 1 November 2002 with history of：
   －high fever（>38 °C）
   AND
   －cough or breathing difficulty
   AND
   －one or more of the following exposures during the 10 days prior to onset of symptoms：

   (1) close contact[1] with a person who is a suspect or probable case of SARS；
   (2) history of travel, to an area with recent local transmission of SARS；
   (3) residing in an area with recent local transmission of SARS.

2. A person with an unexplained acute respiratory illness resulting in death after 1 November 2002, but on whom no autopsy has been performed AND

[1] **Close contact:** having cared for, lived with, or had direct contact with respiratory secretions or body fluids of a suspect or probable case of SARS

one or more of the previous exposures during to 10 days prior to onset of symptoms

Probable case：

1. A suspect case with radiographic evidence of infiltrates consistent with pneumonia or respiratory distress syndrome （RDS） on chest X-ray （CXR）

2. A suspect case of SARS that is positive for SARS coronavirus by one or more assays

3. A suspect case with autopsy findings consistent with the pathology of RDS without an identifiable cause

As SARS is currently a diagnosis of exclusion, the status of a reported case may change over time. A case should be excluded if an alternative diagnosis can fully explain their illness. In addition to this, WHO emphasized that a patient should always be managed as clinically appropriate, regardless of their case status. Except for uncommon pneumonia and breathe exhaustion, other symptoms may follow by sickness like headache, rigid muscle, poor appetite, fatigue, skin eruption and diarrhea.

Transmission of SARS

Routes of transmission

The majority of new infections occurred in close contacts of patients, such as household members, healthcare workers, or other patients who were not protected with contact or respiratory precautions, indicates that the virus is predominantly spread by droplets or by direct and indirect contact.（Kamps & Hoffmann, 2003）

The airborne spread of SARS does not seem to be a major route of transmission. However, the apparent ease of transmission in some instances is of concern. In particular, the cases in the original Hong Kong cluster that originated at the Metropole hotel and in the Amoy Gardens Outbreak indicate that the possibility of airborne transmission of the SARS virus, although probably a rare event, cannot be ruled out. Clusters among healthcare workers exposed during high-risk activities （i.e., endotracheal intubation, bronchoscopy, sputum induction） seem to confirm airborne transmission via a contaminated environment （i.e. re-aerosolization when removing protective equipment, etc.）（Kamps & Hoffmann, 2003）

Patient factors in transmission

There is no direct evidence of transmission from an asymptomatic person. WHO epidemiologists maintain the view that asymptomatic transmission does not appear to occur（WHO, 2003）.It is now generally believed that only symptomatic patients may spread the SARS virus efficiently.（Kamps & Hoffmann, 2003）

Transmission sometimes appears not to proceed in an explosive way. For instance, 81% of all probable SARS cases in Singapore had no evidence of transmission of a clinically identifiable illness to other persons.（Center for Disease Control, CDC, 2003） And a report from the Philippines describes a patient who became symptomatic on April 6, had close contact with 254 family members and friends, traveled extensively in the Philippines and attended a prayer meeting and a wedding before becoming hospitalized on April 12. The contacts were placed under home quarantine for 9 days, with twice-daily temperature monitoring by health workers. Only two individuals（and questionably a third person）developed SARS, which represents an infection rate of less than 1% for the non-hospital contacts.（WHO, 2003）

However, some patients are called “Super-spreaders”, who has directly infected a large number of other people. For example, in the Singapore epidemic, of the first 201 probable cases reported, 103 were infected by just five source cases. And in Taiwan, a 43 years old man affected 137 persons to develop SARS（CDC, 2003）.Therefore there are lots of factors in transmission we don’t quite understand.

Unhappily, SARS patients with chronic illnesses occurring concurrently with fever and/or pneumonia and who have a plausible diagnosis are the most challenging to the public health and healthcare systems. Early symptoms of SARS are non-specific and are associated with other more common illnesses. Unrecognized cases of SARS have been implicated in recent outbreaks in Singapore, Taiwan, and Toronto. （Kamps & Hoffmann, 2003）

Most countries reported a median incubation period of 4-5 days, and a mean of 4-6 days. The minimum reported incubation period of 1 day was reported from China (4 cases) and Singapore (3 cases) and the maximum of 14 days was reported by China. But, Four Centers stated that the maximum observed incubation period was 10 days. Luckily, only symptomatic patients may spread the SARS virus efficiently. This is significant characteristic of the epidemic situation.

Table 1 Strategies for preventing SARS from spread

Units / Strategies	Taiwan authority	Medical institutes	The masses
Epidemic prevention strategies	1. Case classification and announcement 2. Case investigation 3. External management 4. Isolation or quarantine policy 5. Medical protective net 6. Infection control 7. Laboratory examination, virus studying, vaccine and therapy method 8. Materials and goods' control 9. Education and proposal	1. Infection control within the hospital 2. Protection equipment and policy within the hospital 3. Isolation policy within the hospital 4. Control the medical resource 5. Policy for pollutant treatment 6. Disinfection 7. Sound the medical method	1. Decrease the unnecessary contact with other people 2. Wear protection equipment such as mask, and gloves. 3. Disinfect by different kinds of ways 4. Wash hand frequently 5. Take exercise frequently

Strategies for preventing SARS from spread

The strategies Taiwan authority, medical institutes, and the masses take during the SARS time are arranged in Table 1.

From the strategies mentioned above we can understand that except for studying virus, developing vaccine and therapy methods, the other methods are used to lower the chance from being infected. According to the classification stated below, we can use the foundation for policy simulation and evaluation.

1. "Quarantine policies"：Isolate healthy persons who may contact the virus, isolate the infected persons who still no symptom during incubation period, and isolate and cure the symptomatic patients

2. "Protection policies"：The health reduce the opportunity to contact others to avoid infected, and purchase and use protection equipment like face masks

The SARS situation in Taiwan

While the SARS virus spread out from the southern China, Hong Kong, Singapore and Vietnam, Taiwan was not involved in the disaster yet. After one Taiwanese businessman who was infected in the last month of February fell in ill in the early month of March and then the SARS virus started to spread out in Taiwan. Although there were so many people who has been infected in the Mainland China and Hong Kong, we did not understand the virus certainly, we did not know the way it spread out, we did not know how long the incubation period it was, we did not know how powerful it would infect human beings, and we did not know how to remedy the infected people in the beginning of the epidemic situation in Taiwan. At that time, many ways to cure the infected patients lost apparently. In the middle day of March, although there were only few case studied been spread out, fewer sanitarians and medical public figures felt worried about the case because of the unknown and new virus. Of course, most of Taiwanese and the public institutes are not alert to the fatal virus.

To Refer to Figure 1, in the last month of March, the amounts of the suspect cases attended to 10 and some were the investigated cases in Taiwan. At this time, the epidemic situation was likely to extend in the Mainland China and Hong Kong, and some dead cases were announced. It seemed that Taiwan authorities didn't take any new policies except that they actively found the people who might contact the SARS case apparently. The government only lasted to use the past monitor systems, but this kind of methods was much passive. The original symptom of SARS seemed the same as the general respiratory syndrome, so it was difficult for basic level of doctors and the masses to tell it correctly. It appeared that Taiwan authority, medical institutes and the masses didn't control the epidemic situation well and effectively.

Until the middle day of April, the amounts of the infected probable cases in Taiwan has added up to be close to 30 and the amounts of suspect cases attended to 40. In the last month of April, a collective infection erupted at Taipei Municipal Hoping Hospital. After two days Taiwan authority sealed Taipei Municipal Hoping Hospital off without warning in advance, and this action shocked Taiwan society.

Following the eruption in Hoping Hospital, the amounts of the infected probable cases were not piecemeal but there were an average amount of over 20 people who were announced to be infected the SARS virus everyday in Taiwan. And the accumulation of the amounts of the infected patients were adding up and up everyday.

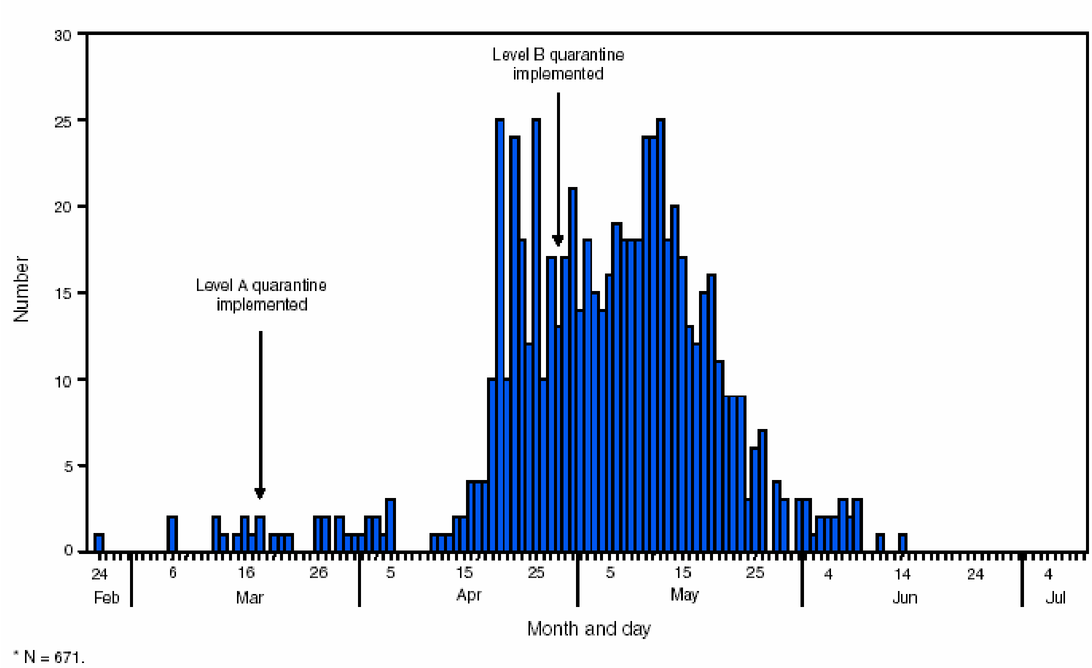

Figure 1 The pattern of new reported probable SARS cases per day in Taiwan（From CDC）

After the event in the Hoping Hospital, Taiwan authority, the masses, and medical institutes were alert as time goes on. Then there were several collective infections occurred in many medical centers one after another. SARS scared Taiwanese enormously during the period.

After the middle day in May, SARS epidemic situation in Taiwan seemed to be controlled. Since the last new case happened on June 14, the epidemic has been lasted approximately 110 days. According to the definition of the possible case, 665 are the sick and 180 of them are dead.（WHO, 2003）

It seems that there are no corresponding answers to explain why people stop the SARS Generally speaking, the possible answers could be：

1. Virus can’t survive in high temperature.

2. Quarantine policies work effectively（We have been warned, 2003）

3. Protection policies work effectively（Effectiveness of precautions against droplets and contact in prevention of nosocomial transmission of severe acute respiratory syndrome, 2003）

4. The possibility affect human body become low because of virus variation（Molecular Evolution of the SARS Coronavirus During the Course of the SARS Epidemic in China, 2004）

Items 1 and 4 are about the virus themselves, and are the variables we can’t control. As for Items 2 and 3, they are the policies we are working for.

The idea of item 4 comes from the paper, Molecular Evolution of the SARS Coronavirus During the Course of the SARS Epidemic in China. According to the report, experts think that SARS virus have been changed three times. The fastest time virus variation is the early stage. In the middle stage, viruses have the strongest infectious power among people. When it comes the last stage, the viruses will choose to fit the genotype of human being.

In the early stage, the possibility to be infected is not high. Only 3% of people who directly contact can be infected. However, when it comes to the middle stage, the possibility to be infected is pretty high. 。Once you directly contact the viruses, 70% you will be infected. At last, the viruses will change to predominant genotype which can survive with human being. Hence, these experts argue that the variation of virus is the reason why SARS terminated.

Our research is based on the ideas we have mentioned above to build models and policies testing. In additions, we would also evaluate the effectiveness of the policies and simulate the reason why SARS stop.

Research Method

Preventing the spread of the infectious disease is not only concerned with epidemiology, medical science, public hygiene sections, but also concerned the government policy, social culture, and mental factor etc. Moreover the transmission is involved in complicated and dynamic relationship, including flow and feedback loop. Hence there are many researches study the spread and policy design by the systemic view.（For example：Ritchie-Dunham, James and Méndez Galván, 1999；Dangerfield, Fang, and Roberts, 2001）

SARS is the first emerging infectious disease in the 21th century. Human beings have declared we had defeated all infectious diseases in 20th century, but we faced the challenge of the new virus in the beginning of 21th century. Therefore we hope to analyze the transmission and end of infectious disease from systemic viewpoint.

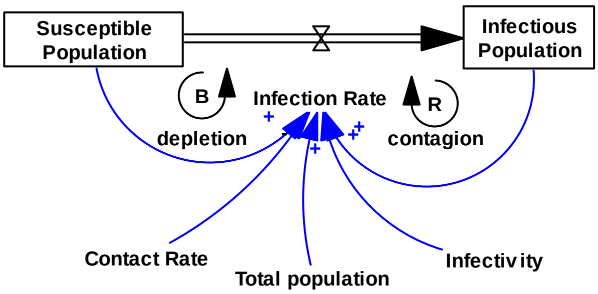

Figure 2 SI Model

Our model-building is based on the view from feedback loop, level, and rate characteristic.（Forrester, 1961 ; Lyneis, 1980 ; Richardson, 1991 ; Sterman, 2000） These methods excel in dealing with complicated and dynamic issues. In order to understand the coherent pattern beyond the complicated and dynamic structure, the professionals of system dynamics developed many studies in industrial, corporate, societal, and ecological system all the time.（Forrester, 1961 ; Richardson, 1991）We can develop assumption and theory, then build up model in computer to simulate different scenarios.（For example：Forrester, 1961 ; Lyneis, 1980）。As the Figure 2 indicates, Sterman（2000）has built a module about the infectious disease, and we can understand the view from rate and feedback loop from the module.

The model of SARS transmission and discussion

Before we start building the model, we can use casual loop diagram first to observe the infectious disease, SARS.

Causal Loop Diagram（CLD）of SARS transmission

We use the reinforcing loop and balancing loop to be the boundary for the systems of SARS spread in model. Our research tries to understand the preventive effect for the transmission of viruses, so we won't discuss the part of vaccine development and therapy. By doing that it is useful for helping us to clarify how SARS spread and terminate, and the control effect of these policies.

The CLD for the systems of SARS is shown in Figure 3. The domain-reinforcing loop of SARS is that the more numbers of people who get sick（Fall ill population）, the more people who contact the viruses and more people get sick. It becomes a reinforcing loop to explain why SARS transmit. Another reinforcing loop is referring to Hospital SARS population. Hospital SARS population in the reinforcing loop can infect the healthy people in hospital, and then make more people get sick.

We have mentioned that during the SARS period, government authority, hospitals, and the masses usually use quarantine and protection policies to prevent the transmission of SARS. Both of these policies are used to lower the chance we contact the viruses. As shown in Figure 3, the balancing loops are used to lower the chance from being affected. For example, the government authority, hospitals, and the masses are aware of the danger of SARS so that they isolate all the sick who could be affected, and protect those who are not sick.

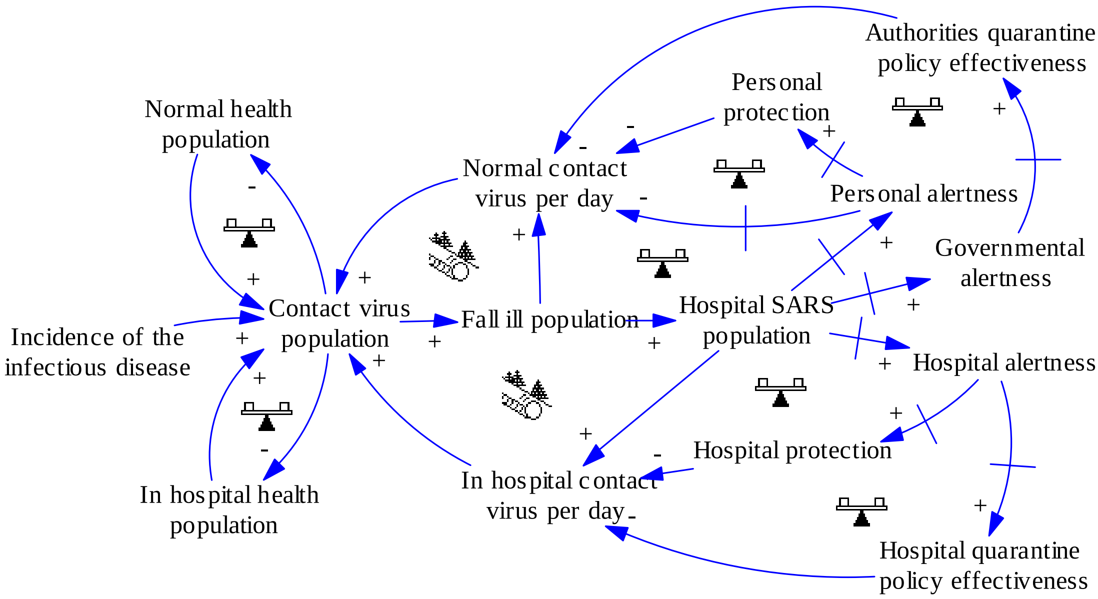

Figure 3 Causal loop diagram of SARS transmission

In this study the main stress falls on the people who affected, then fell ill, and then infect others. And we don't think that some people who are infected but not fall ill are called the patients of SARS, and people who are merely infected but not fall ill won't affect other people. For the reason the point we wish to emphasize is that we combine the "infection rate" with the "incidence of a disease", and then we call the new variable "Incidence of the infectious disease" in this study. Therefore in our model we use the variable "Incidence of the infectious disease" to exclude the people who infected but not fall ill.

SARS model and assumption

Sterman（2000） thought the process of building models by system dynamics is very inventive. Everyone has his own styles and methods However, the successful model builders follow the same criteria：Define the boundary of the problems, form the dynamic hypotheses, build system dynamic models, test models repeatedly, and design and evaluate the policies.

The research is based on Sterman's criteria of model building and SI model to establish the system dynamic model of SARS transmission. As for the main model of SARS transmission, please refer to Figure 4 at page 15.

First we introduce the reinforcing loop. In the model we building, we divides the healthy people into two categories, “The general masses”（”Normal health population” in the model） and “the health population in hospital”（”In hospital health population” in the model）. When “The normal population” contacts the “Fall ill population” in the general environment（not in hospital）, they will be infected by SARS viruses and become “Normal contact population”. When “The normal population” is viewed as infected by SARS viruses, they will be isolated and become “Isolation population”. If they are infected but haven’t been isolated effectively and outside the hospital, they will become the “infectious population” in the model. At the same time, those people still have no symptoms and are in the incubation period. However, after the incubation period, people will get sick and become the “Fall ill population” and are infectious. When these people have the respiratory syndrome and fever, it is possible for them to go to the hospital or not. Those people who don’t go to the hospital may think that the symptoms are cause by common cold.

Meanwhile, many SARS patients go to the hospital and won’t influence the public outside. However, another healthy population, “In hospital health population”, such as doctors, nurses, administrators, cleaners, patients, and their friends will face the threat of SARS because of the SARS patients. As soon as the SARS patients get into the hospital, during the processes of diagnosis, identification, therapy, and hospitalization, it is very dangerous to transmit viruses. When SARS patients get into the hospital one by one, it is very easy for a group of people to be infected within the hospital. If people contact the viruses or are dubious should be isolated. If those sick can’t be isolated effectively, they will threaten the general masses, ”Normal health population”, after they left the hospital.

In the model we can find that as the “Fall ill population” appears, the reinforcing loop starts. When the patients contact other healthy people, or the healthy people touch the infectious things, the Normal health population will become SARS patients in general environment. In addition, because the patients need diagnosis, and therapy, they will contact others. As for the reasons, the reinforcing loop starts in hospital. We can interpret the reinforcing loop through Figure 3 and Figure 4.

After discussing reinforcing loop, we will introduce the balancing loop in the model. The balancing loop is constituted by “Quarantine policies” and “Protection policies”.

There are two quarantine policies appear in the model, one is “Authorities quarantine policy effectiveness”—the effectiveness of track, notify, announce, and isolate the infected by government authority, and another one is “Hospital quarantine policy effectiveness”—the effectiveness of track, notify, announce, and isolate the infected by all medical institutes.

And there are two protection policies shown in the balancing loop. One is that contact among people is getting less and less because of the alertness of the masses and hospitals. Another is that people and hospitals are buying and using protection equipment because of the alertness. In the model we call them the decreases of “FIP transmit person” and “HSP transmit person”.

Therefore we can lower the chance the SARS patients pass the viruses to other people due to “Quarantine policies” and “Protection policies”.

The assumption of model

1. In the early stage, we can’t handle the problems such as the prevention of viruses and therapy efficiently. Government authorities, medical institutes, and the masses could only do two things：Isolate the possible sick and avoid contacting the viruses. These actions are influencing effectiveness of the isolation factor and people of being contacted with. So there are four independent variables in this model, and the balancing loop for the policy is controlled by these variables.

2. Generally speaking, the general healthy population（the masses） will interact with the healthy population in the hospitals. The infectious patients will pass the viruses to the masses through doctors, nurses, cleaners, employees in the hospitals, patients’ relatives, and the patients. All of them will go home so that they may take viruses outside hospital.

3. Even if the infection is spread all over the hospital, in order to take care the SARS patients, the government authorities will send the healthy population to the hospital. Moreover, we assume recourses are infinite.

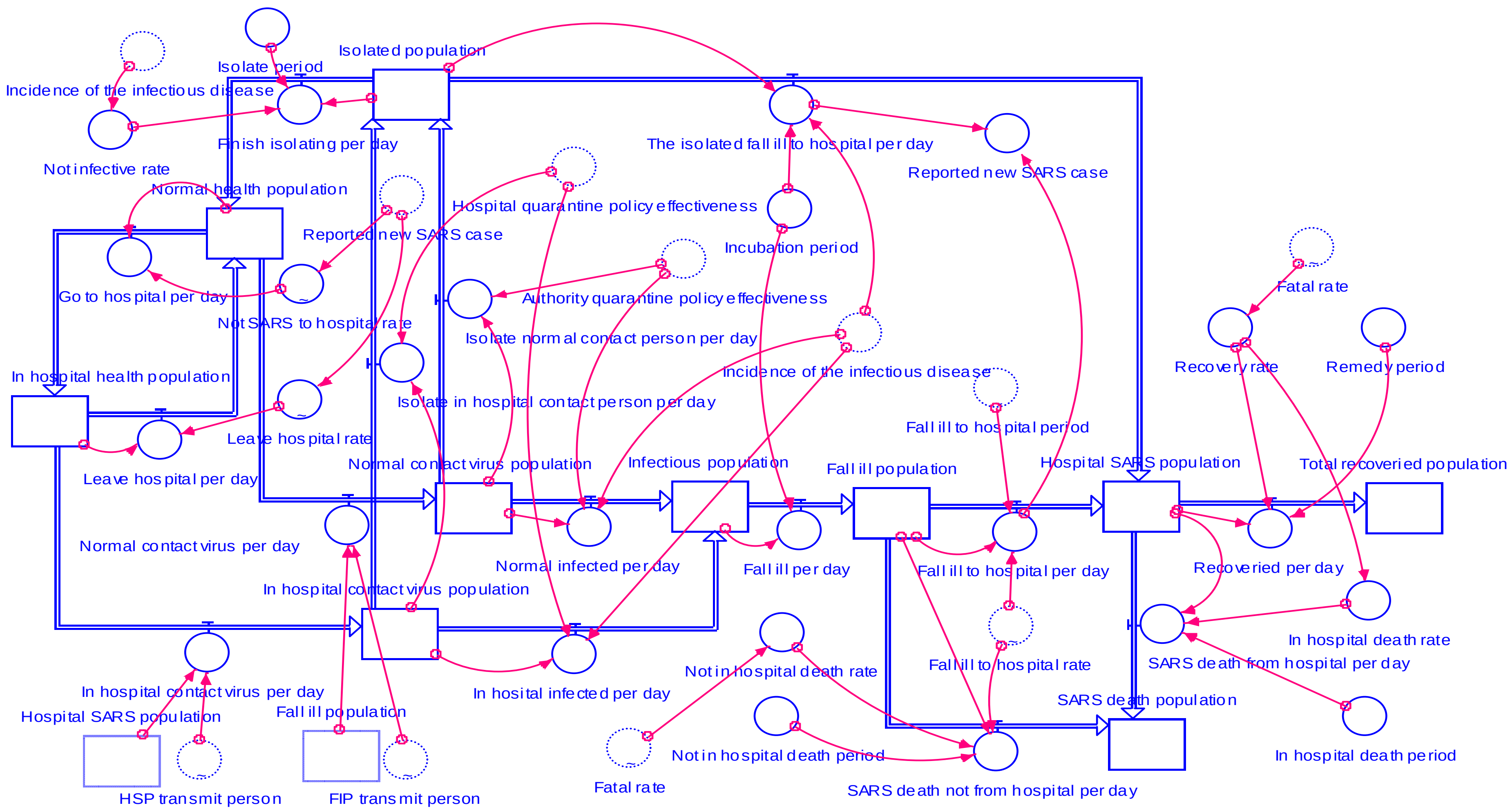

Figure 4 the model of SARS transmission

SARS in Taiwan and scenario simulation

We compare with the epidemic situation, do some correction continuously, collect lots of data related with the epidemic situation to be the researching fundamental in the process of studying and use the related data to establish the model. Then we use the model to test policies and evaluate the outcomes. This study is going to proceed with some simulations with the above-mentioned policies on preventing SARS from spread. And then we are going to simulate what let the infection of SARS stop.

Scenario simulation I：Effectiveness of Quarantine policies

We want to test the preventing effectiveness of Quarantine policies adopting by Taiwan authority and medical institutes first. Assume the “Incidence of the infectious disease” is fixed to 10%, and it means that a SARS patient contacts ten persons in one day will cause one new SARS case in ten（incubation period） days. Furthermore, the government authority and medical institutes are aware of the danger of SARS gradually, and then strengthen the quarantine policies with time. Similarly the masses and the healthy people in hospital are aware of the danger of SARS gradually, and then they are more careful to protect themselves by buying and using protection equipment, such as face masks and gloves. They can also protect themselves by lowering the chance contact with others, whether others are healthy or not. Thus, whether the SARS cases in hospital or not, they may transmit viruses to fewer persons with time because of the protection actions adopting by the masses.

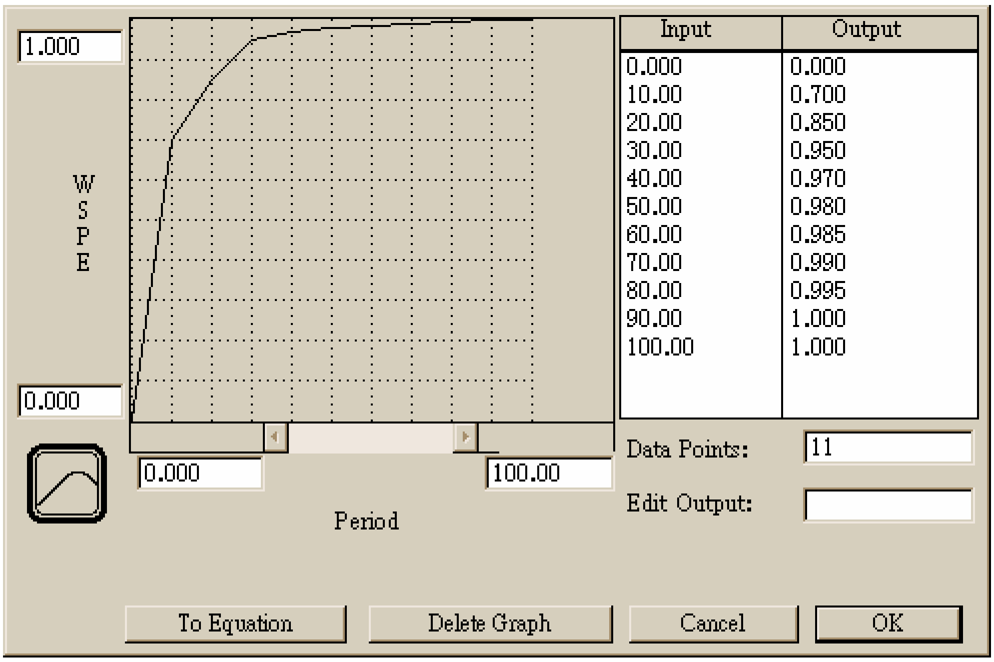

Figure 5 Authorities quarantine policy effectiveness

We set that the “Authorities quarantine policy effectiveness” in model as a curve, and it can be strengthened to 100%, as Figure 5. And “Hospital quarantine policy effectiveness” is similar to Figure 5. Besides “Hospital SARS patients” lower the contact with others because of the alertness and protection of “In hospital healthy population”, as Figure 6. And “Fall ill population” is similar to Figure 6.

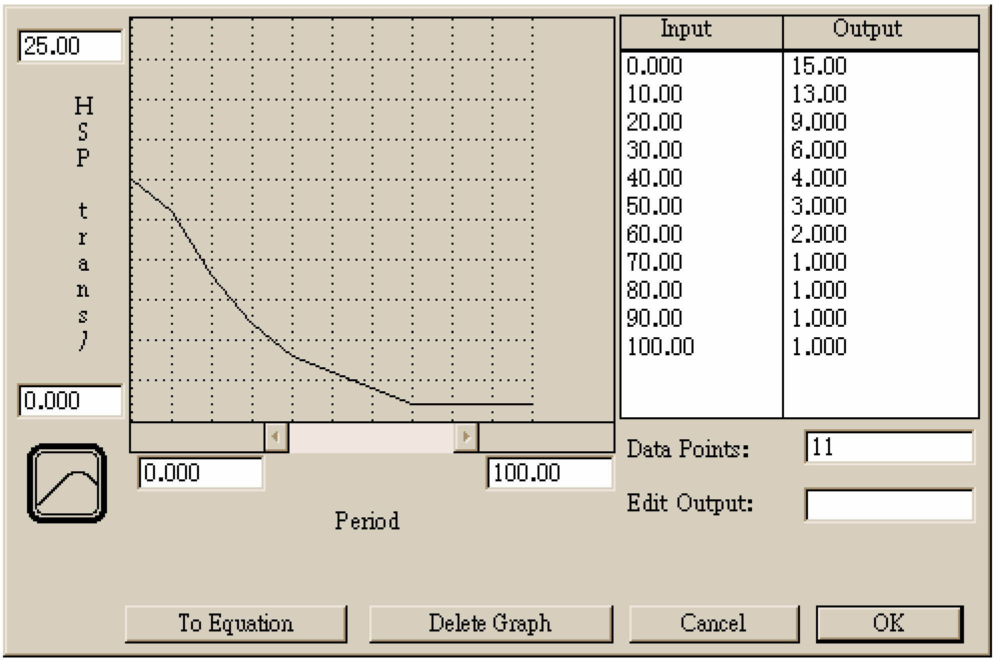

Figure 6 the amount of persons Hospital SARS Persons can transmit virus per day

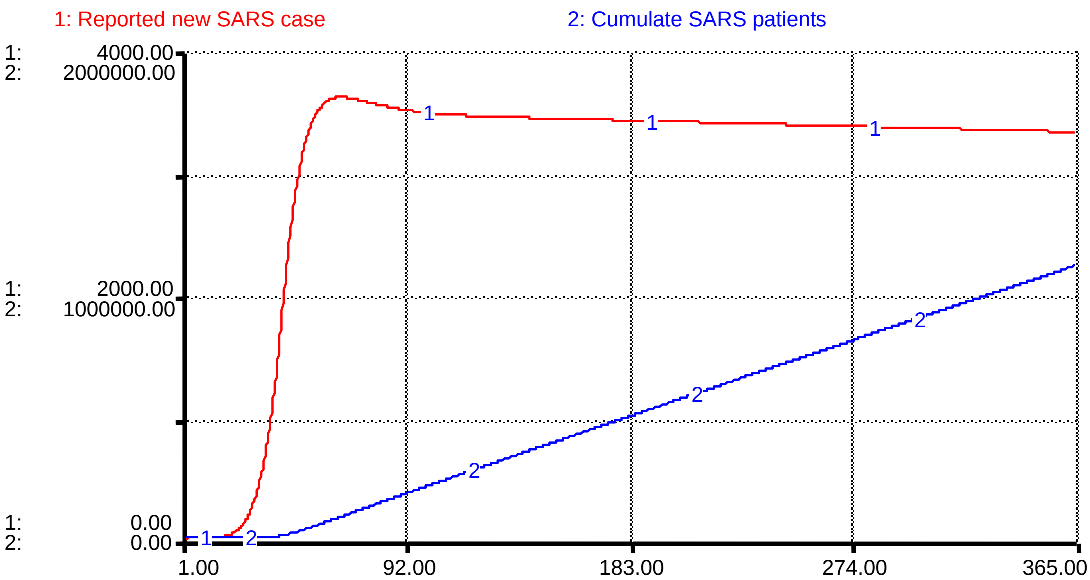

Figure 7 Incidence of infectious disease=10%；strengthen “Quarantine policies” and “Protection policies” with time

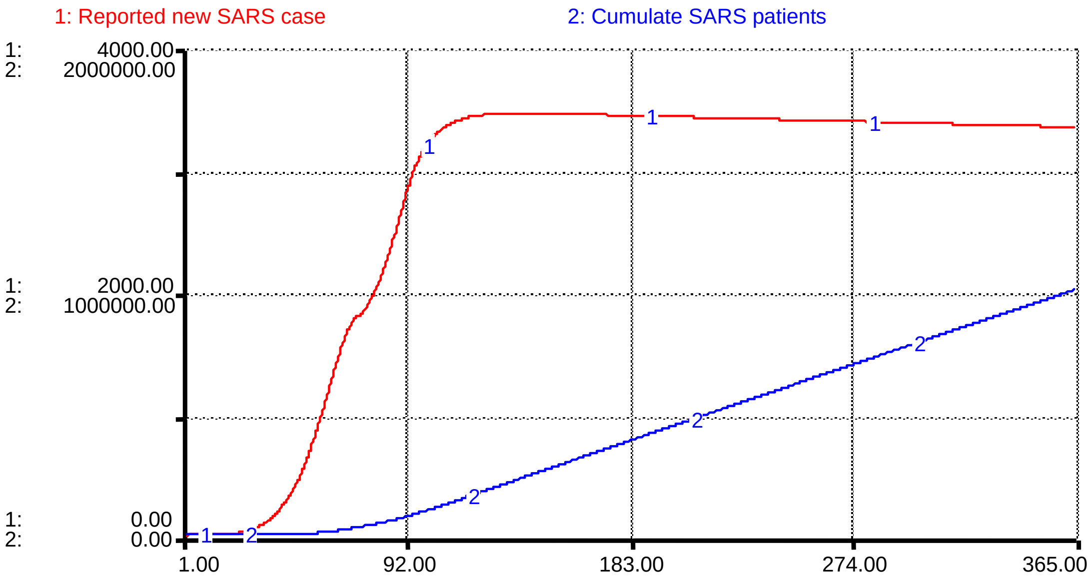

Figure 8 Incidence of infectious disease=10%；adopt "Quarantine policies" immediately；Adopt "Protection policies" with time

The simulation result is as Figure 7. We can find that the SARS situation can not be terminated, and there are 1,118,841 get sick after one year. Maybe we can argue that we do not adopt policies well and quickly. So we test the situation — "Authorities quarantine policy effectiveness" and "Hospital quarantine policy effectiveness" are strengthened to 100% without delay. And the simulation result is as Figure 8. The condition did not improve lots, and there are 1,008,329 get sick. It means that the quarantine policies are not quite useful on preventing the transmission of SARS, but we believe they can lower the amount in the beginning stage.

Scenario simulation II：Effectiveness of Protection policies

In the following study, we want to discuss the effectiveness of protection policies. We first evaluate the outcome by decreasing the contact and increasing the protection. Then, we evaluate the effectiveness when the government authorities enforce people from contacting with anyone.

1. People and hospitals decrease contact and increase protection without being enforced immediately.

We assume the incidence of the infectious disease is fixed to 10%. In order to compare the effectiveness of protection with the quarantine policies, we assume the quarantine effect is getting stronger with time. Besides, people will move to different places, or patients need therapy. From the point of view, those people will contact others so that the opportunities of passing viruses are not 0. When we simulate the patients whether inside or outside the hospital have chance to meet one person every day, the situation is as Figure 9. The epidemic situation still spreads all over, but take more much time than we simulate in simulation I. After one year, there are 60,206 get sick, but it is still dominated by reinforcing loop.

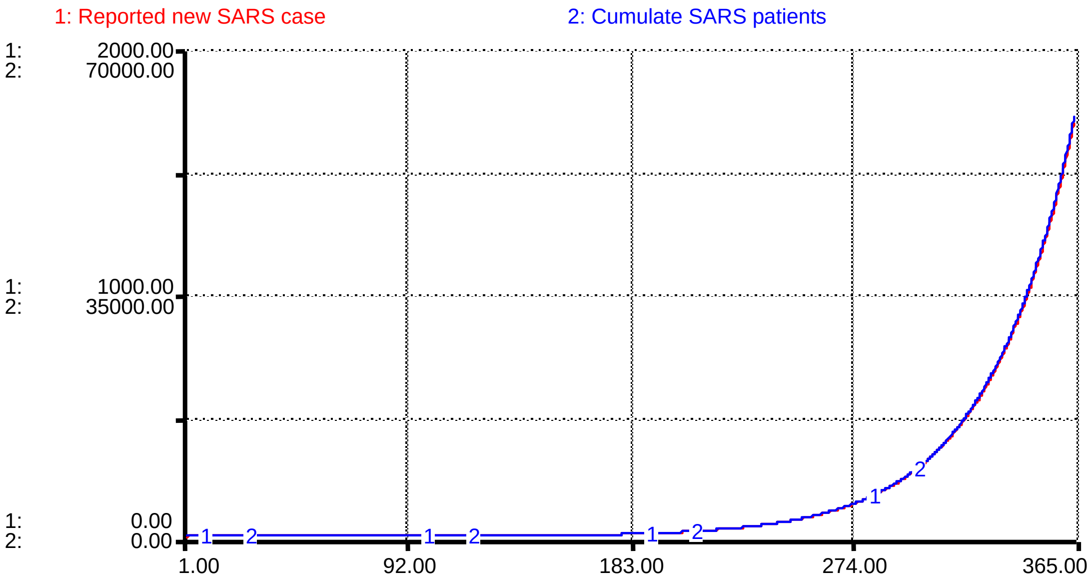

Figure 9 Incidence of infectious disease=10%；adopt “Quarantine policies” with time；Adopt “Protection policies” immediately

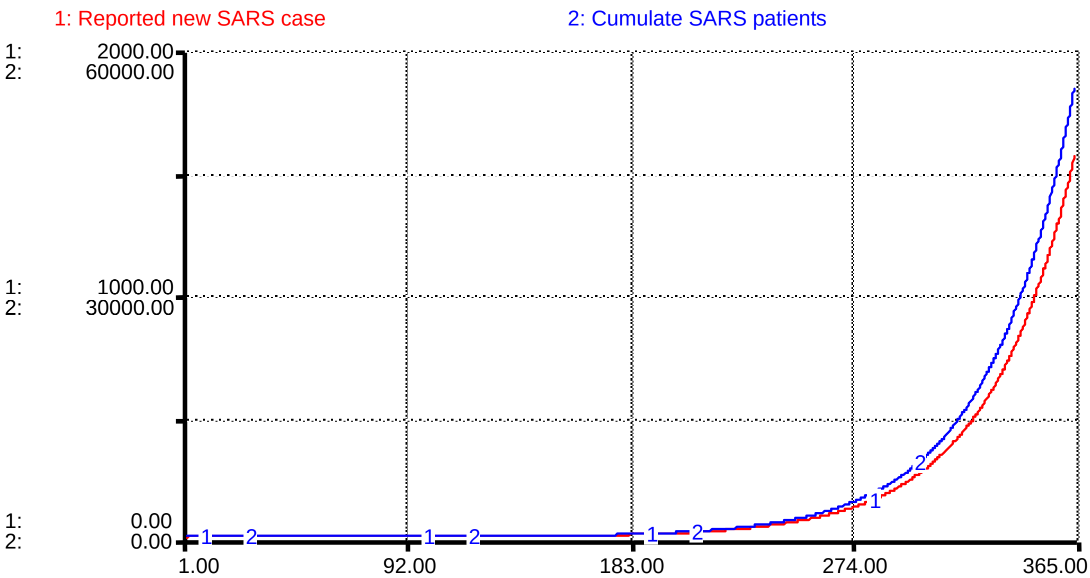

Figure 10 Incidence of the infectious disease=10%；adopt “Quarantine policies” with time；Adopt “People stay still for 10 days” immediately

2. The government authorities force the masses stay still for 10 days

Some scholars have mentioned a policy, “People stay still for 10 days” when the epidemic situation in Taiwan is very urgent. During the 10 days, people can't go out, can't contact people. Government authorities manage all the daily life. The goal of this policy is trying to prevent people getting contact with each other. We assume here if we execute the policy in the beginning of the epidemic, the result is as Figure 10. After 1 year, there are 55,394 get infected. What does it means？

Refer to Table 2, it means that the policy is a relative effective method we can take until now. However, as long as we keep on putting human resource into the hospitals, it is possible to transmit the viruses even though the chance is quite low. The epidemic is hard to stop whether we adopt "Quarantine policies" or "Protection policies".

Therefore, if we can take the policy "People stay still for 10 days" and add "Quarantine policies", we can get the best result.

Table 2 Simulation I & II

Items / Scenario	The highest amount of "Reported new SARS case" in one year	The amount of "cumulate SARS patients" after one year	Dominant loop
I.I.D.[2]=10%；strengthen "Quarantine policies" and "Protection policies" with time	3,624	1,118,841	Reinforcing loop
（Evaluate "Quarantine policies"） I.I.D.=10%；adopt "Quarantine policies" immediately；adopt "Protection policies" with time	3,468	1,008,320	Reinforcing loop
（Evaluate "Protection policies"） I.I.D.=10%；adopt "Quarantine policies" with time；adopt "Protection policies" immediately	1,669	60,206	Reinforcing loop
I.I.D.=10%；adopt "Quarantine policies" with time；adopt "People stay still for 10 days" immediately	1,536	55,394	Reinforcing loop

[2] I.I.D is abbreviated form "Incidence of the Infectious Disease".

Scenario simulation III：The end of SARS in Taiwan

Even if "Authorities quarantine policies effectiveness" and "Hospital quarantine policies effectiveness" all reach 100% and people stay still for 10 days, we all can't totally control the SARS epidemic situation. SARS epidemic situation could swiftly stop unless two situations happened. The first one is the protection within the hospital is 100% sound, and all doctors, nurses, and employees can't be threatened by the sick. The second one is about the viruses themselves. If the viruses can't survive or lower their influence, the reinforcing loop can't be triggered.

Let's consider the situation happened in Taiwan. The effectiveness of quarantine and protection policies will get higher with time. The most important of all, quarantine and protection policies can't be achieved one hundred percent perfect in Taiwan. For instance, in order to avoid being isolated, the masses will deceive the government authorities. For some hospitals, they would also cheat instead of telling the truth because the government will punish them. Therefore, quarantine policy can't be achieved 100%, neither the protection policy. In Taiwan, some SARS patients can't be identified. We can explain why there are so many doctors and nurses are infected because of the lack of protective strategies and concept. In addition, cleaners can be infected when they are cleaning patients' pollutant. From these examples, we can find that it is impossible to achieve 100% perfect under many situations. In the short time, people can't develop vaccine to lower the incidence of the infectious disease and kill SARS viruses totally. So we conclude that the reason why SARS stop comes from viruses themselves. However, viruses are exogenous variables that people can't control.

It is said that viruses can't stand for high temperature, but we have no evidence to improve the hypothesis. For example, the temperature in Singapore is high all the year, but Singapore still faces the threat of SARS. Therefore, the possibility of high temperature is excluding.

We have mentioned that experts think that SARS virus have been changed three times. When it comes the last stage, the viruses will choose to fit the genotype of human being. That means in the last stage "incidence of infectious disease" is quite low, so we set the curve as Figure 11.

Next, according to the incidence of the infectious disease, adjusting the situation of quarantine and protection to the similar of real situation, and put it into simulation. The result is like Figure 12. Comparing Figure 1 and Figure 12, we can tell it matches to the real situation. The more important issue is that the trend of daily increasing numbers of SARS patients and of incidence of the infectious disease is almost the same. We can find that the key variable is the incidence of the infectious disease in our model. It seems that government authorities can't totally restrain the reinforcing loop by its policies.

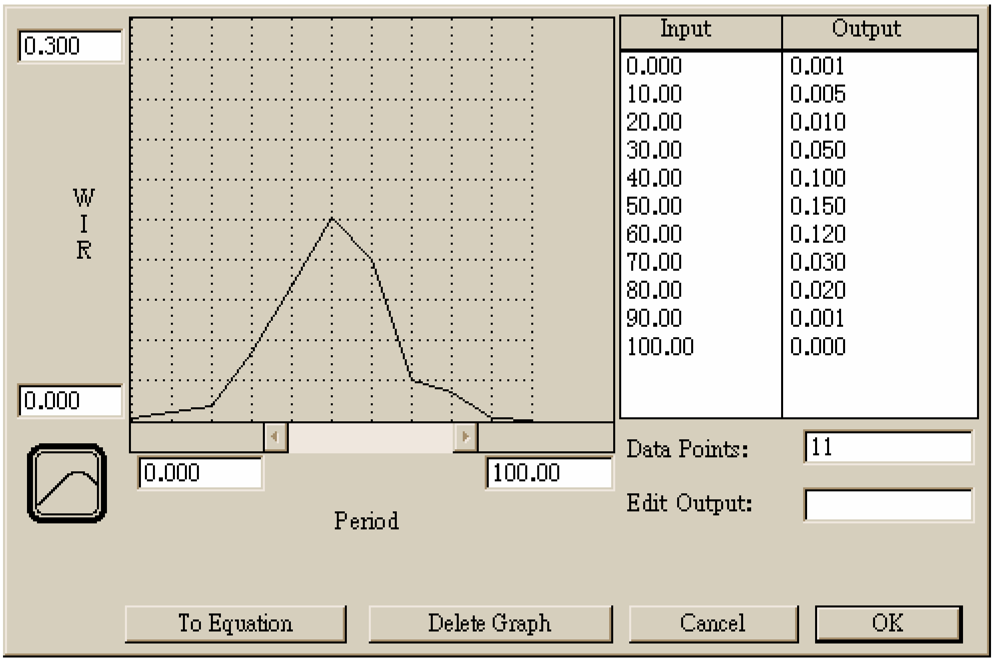

Figure 11 the curve of "Incidence of infectious disease"

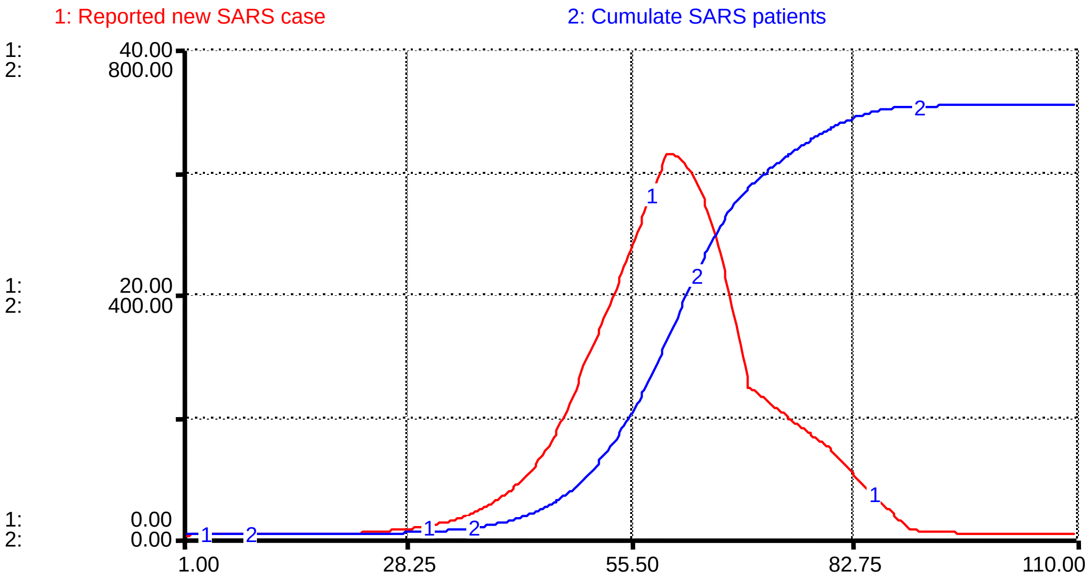

Figure 12 the termination of SARS caused by viruses variation

Conclusion

We believe that "Quarantine policies" and "Protection policies" are all quite important on preventing infectious disease from spread. If we lacked any of them, the spread would be very fast.

We argue that the preventing effectiveness of "Quarantine policies" is more inferior to “Protection policies”, because “Quarantine policies” don’t have many influences on the origin of spread. However, there are lots of factors which affect the transmission mankind can’t control, so all policies only can postpone the eruption of disease. Therefore, we advise that we need to enforce a policy called “People stay still for 10 days” to eradicate any contact to deal with similar emerging infectious disease. Then we can confirm the infected and earn more time to control the epidemic situation.

Finally we proved that the most important and critical factor is incidence of the infectious disease, but it is an exogenous variable we can’t lower it effectively in such a short time. Consequently we firmly believe that what we can do in the short-time is only “People stay still for 10 days” policy when we confront an emerging disease.

In the long-time mankind should ponder on how to live with viruses, and not to resist any virus reactively -- otherwise we will be challenged by stronger virus.

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