NONLINEAR DYNAMIC RESEARCH OF CHINESE COMMUNITY HEALTH CARE-----A DELIVERY OF SIMULATION AND PREDICTION

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ABSTRACT

Grey GM(1,1) model is one of the most commonused prediction method. A number of studies have shown that a series of significant achievement have been gained in natural science and social science for simulation and prediction of equidistant monitoring data sequent. However, relatively little is done about the application of Grey GM(1,1) model in relevant medical resources simulation and prediction for Chinese community health care. The aim of this study is to investigate the tendency of the numbers of China health service expenditure, health revenue, the number of visits and health personnel, which may provide the base and reference for the development of China health plan. Despite the great achievement associated with the use of grey GM(1,1) model, the prediction of nonequidistant and high growth data sequent through complex transformation , and usually has larger lagging error equidistant treatment of non-equidistant data may have larger lagging error. In this study, we built the GM(1,1) grey majorized model, which increases accuracy of background value and is proved successfully in simulation and prediction of equidistant or non-equidistant and low or high growth data. The results we obtained demonstrate that the nonlinear dynamic research of Chinese community health care using GM(1,1) grey majorized model, will contribute to the base and reference for the development of China health plan.

Keywords: *GM(1,1) Grey Majorized Model, Nonlinear Dynamics, Community Health Care*

1. INTRODUCTION

Grey GM (1,1) model is extensive used in grey forecasting study[1],[2],[3]. Equal interval conception was introduced when set up GM (1,1) model. As a result, premises condition of using GM (1,1) model is that the modeling sequence must be contented equal interval demand(Tan,2000). In geo-mechanics field, non-equidistant monitoring sequence depend time often exist. Some scholars had built the grey GM (1,1) model through equidistant treatment of non- equidistant data and usually had larger error. Others had built directly nonequidistant grey model through complex transfer and usually had more complicated computation, though the precision is high. The GM (1,1) grey majorized model was based on grey majorized model background value Z(1) (k+1).

The grey majorized model is provided not only with the merits of concise formation and simple calculation but also with the wider application. It can be applied to the simulation and forecasting of equidistant, nonequidistant and high growth data sequent, which is more accurate in calculating and forecasting than traditional GM (1,1) model[4].

The forecasting and analysis of Chinese community health service is important to construct perfect primary health service network throughout city and countryside[5]. The research of the chaos dynamics indicated that all of the time sequence which determines long-term evolution of the system includes all variables long-term evolution information. The complex characteristics of time sequence is the evolved result of one certain trace, which produced by the chaos system [6],[7]. Now there are so many methods of the health service forecasting, such as linear and non-linear regression prediction, displacement-time curve forecasting, neural networks and so on. All ways have their own features and limitations. Study proves that grey memorized model have general adaptation to the prediction of the health system.

The number of convenient and low-fee health care department for Chinese has diminished in the 1990s, indicating that access to medical care is

becoming an increasing problem. Therefore, this requires that the government and primary health care institution must make a long-term plan to enhance service items and improve service quality based on present situation and future demands.

2. GREY MAJORIZED MODEL

Suppose primary accumulating generating (1-AGO)sequence X(1) =(x(1)(1), x(1) (2), ⋯ , x(1)(n)) of source data sequence X(0) =(x(0)(1),x(0)(2),⋯,x(0)(n)),(x(0)(k) ⩾ 0, k=1,2,⋯ ,n),X(0), Z(1) =(z(1)(2),z(1)(3), ⋯ ,z(1)(n)) are mean generation consecutive neighbors of X(1), Z(1) (k+1)=0.5 x(1)(k)+0.5 x(1)(k+1), k=1,2,⋯ ,n-1. Suppose $\hat{a} = (a,b)^T$ are parameter matrix, and GM(1,1) grey differential equation x(0)(k) + az(1)(k) =b smallest second-multiplication estimated should be met with(Deng 1998)

$$\hat{a} = (B^T B)^{-1} B^T Y \qquad (1)$$

The whiten equation is

$$\frac{dx^{(1)}}{dt} + ax^{(1)}(t) = b \qquad (2)$$

The time-responding sequence GM(1,1) grey differential equation can be written as:

$$\hat{x}^{(1)}(k+1) = (x^{(0)}(1) - \frac{b}{a})e^{-ak} + \frac{b}{a} \quad (3)$$

Then the simulation value of source sequence:

$$\hat{x}^{(0)}(k+1) = x^{(1)}(k+1) - x^{(1)}(k) =$$
$$(x^{(0)}(1) - \frac{b}{a})(e^{-a} - 1)e^{-a(k-1)} \qquad (4)$$

When interval is divided by n equally, the total areas of n little intervals is:

$$S_n = \frac{1}{2n}[(n+1)x^{(1)}(k) + (n-1)x^{(1)}(k+1)] \qquad (5)$$

Define

$$z_n^{(1)}(k+1) = S_n = \frac{1}{2n}[(n+1)x^{(1)}(k) + (n-1)x^{(1)}(k+1)], n = 2,...,N \qquad (6)$$

Then

$$\lim_{n \to \infty} z_n^{(1)}(k+1) = \frac{1}{2}(x^{(1)}(k) + x^{(1)}(k+1)) \qquad (7)$$

3. SIMULATION AND PREDICTION IN CHINA COMMUNITY HEALTH CARE

Chronic illness has already become one of the most terrible challenges for human health in any country. The incidence of chronic disease grows rapidly and invades on more and more younger in China[8]. Now, although China is unquestionable in the forefront in developing medical and technological advances for the treatment of disease and illness, these diseases already covered 85 percent of human dead cause in china, 69 percent of disease burden. And it brings so large pressure on family, health service system and public finance. Total expenditure for public health of China will rise dramatically in the last few years, even more so rapidly after 2010. During 1990-2005, increasing scope of health spending is not striking, while since 2005, especially 2010, the curve begins to grow slope, which hints the expenditure will be asked in a large scale. To 2015, total expenditure for public health will be 500, 000,0 million yuan. The result is shown as Fig.1
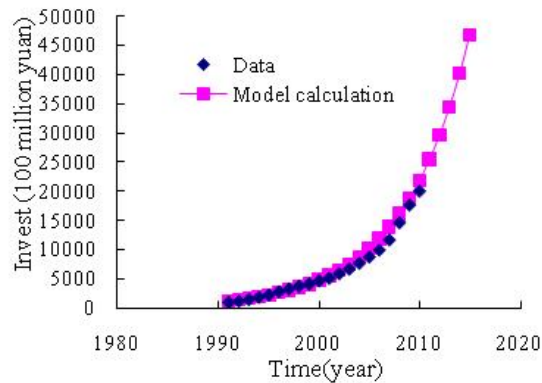

Fig.1: Total Expenditure For Public Health

From 2004, community health service center and stations in China developed normality, the amount is 1382 and 15746 separately, the number of patient visits of community health service center and station is only about 9711 million persons[8]. To 2010, two faculties have covered every street in the number of 6903 and 25836 in china, visitors have already arrived to 48451 million persons in all, about three times than that in 2005. Number of inpatients varies unobvious, However ,since 2010, the data will become a great increase yearly, In 2015,Number of patient visits of community health service center will get the peak of 3,500 million persons or so, this number is eleven times more than that before five years. And numbers of inpatients will twelve times far more than that in 2010. As shown in Figs.2-3
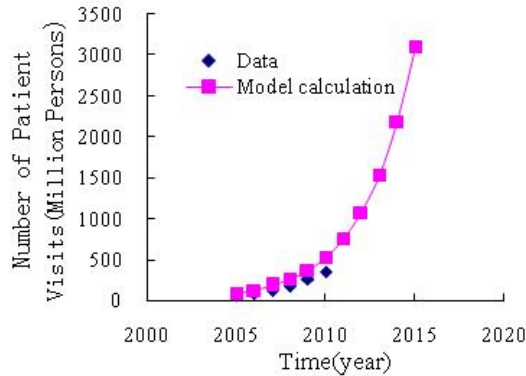
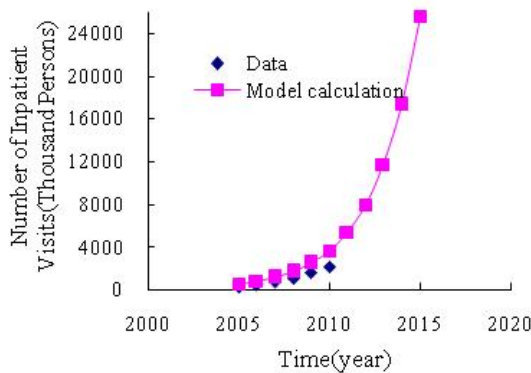*Fig.2: Number Of Patient Visits Of Community Health Service Center*

Fig.3: Numbers Of Inpatients Of Community Health Service Center

From 2005 to 2010, Bed utilization rations community health service center expresses decline homogeneously. It predicts that itwill continue low in the next five years. Reason of the trend is be rightly interpreted by growing number of patient visits of community health service center. This shows that the service quality of basic health institution has been improved. Number of patient's visits per physician per day community health service center maintains almost 13 persons per day from 2005-2015. Nevertheless, the figure of service station has been raised unceasingly. This phenomena is because that most medical graduates choose to work in community health service center, but station with the size difference of two organization, which enhances the service level of health center and increase the staff's burden in station. As shown in Fig.4.
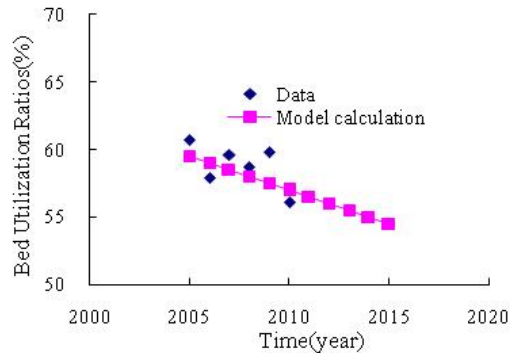

Fig.4: Bed Utilization Rations Of Community Health Service Center

Today, chronic illness has became the killer of human health in the place of acute disease, including malignant tumor, psychotic and neurological disorders, heart and cerebrovascular sickness, respiration system as well as neoplasm and argental diseases. These causative agent or dangerous factor is all related to our daily life style, for example diet, sports and sanitation habits. In the long term even whole life, the therapy and nurse are needed. The sick people are willing to see the doctor in nearby health service institution, exactly community health service center and station. They ask more advice, direction and drugs than staying hospital. From 1995 to 2010, constituent ratio of disease mortality rate in rural undergo apparent change, malignant tumor, neurological disorders, and heart disease are still main dead causes for most citizen, this trend will continue in future. Adversely, the rank of psychotic disorders, cerebrovascular sickness, respiration system diseases and neoplasm and argental diseases present downward, furthermore decline. The reason is maybe that compared to others chronic illness, major organ is easy to suffer directly and serious injury without survive by malignant tumor, neurologi-cal disorders, and heart disease. As shown in Figs.5-6.
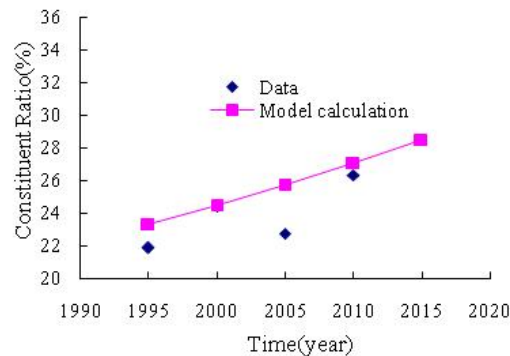

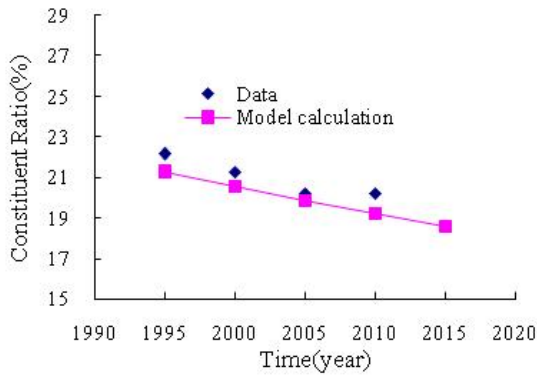*Fig.5: Constituent Ratio Of Malignant Tumor Mortality Rate*

Fig.6: Constituent Ratio Of Mortality Rate From Cerebrovascular

In general, quality of a nation's primary health care is assessed by several indexes, including Maternal health, Children health care, rates of establishing, system administration rate etc. In particular, the maternal health is demonstrated by the number of live births, proportion of high risk, prenatal check rates, postpartum visit rates. The results predicted explain high risk of maternal are more and more, covered 18% in 2010. As time goes by, this ratio will become higher. The number of live baby is also increase, but the grow scale is so obvious as proportion of high risk, which cues further improved treatment and care are required by high risk of maternal for community health service. Since birth control policy were issued, people in whatever city or country emphasizes prenatal check and postpartum visit, meantime, health agency also afford many service content, such as maternal school, pre-marital check-ups, regular health care in pregnancy and postpartum visit, etc. Therefore, generally speaking, this two rates keep up now and then. As shown in Figs.7-8.

Whether children health care is good or bad, it is evaluated through parental infant mortality, the incidence of neonatal, newborn visit rate, malnutrition in children under 5 years of age, system administration rate in children under 3 and 7 years of age. Just because maternal increasing health realization and medical condition, the charts tells us more and more newborns and children were treated in past decades, upward not downward in future. Besides, the government's making much of preventive health care and physical nutrition, the incidence of falling in acute infectious illness declined to 0.2 /ten thousands in 2010, closing to zero in 2015.The rate of malnutrition in children less than 5 years of age is dropping all the time. Part of calculated results is shown in Figs.9-11.
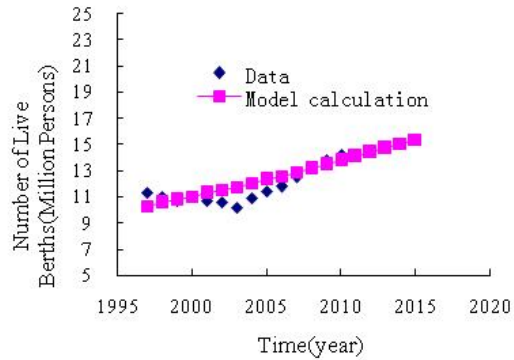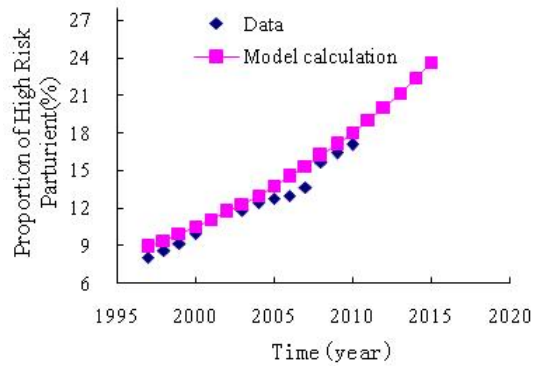

Fig.7: Number Of Live Births
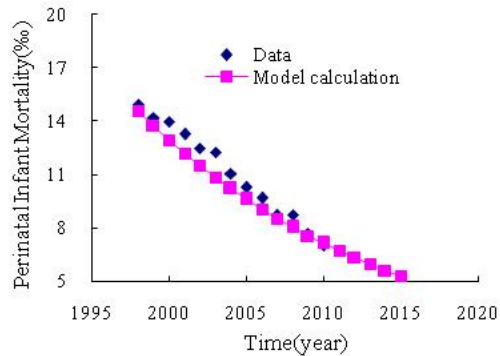

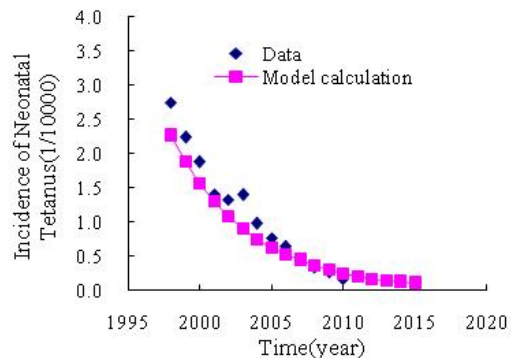*Fig.8: Proportion Of High Risk*

Fig.9: Perinatal Infant Mortality
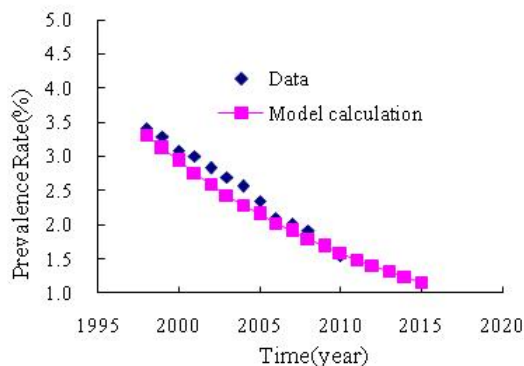

Fig.10: Incidence Of Neonatal

Fig.11: Malnutrition In Children Under 5 Years Of Age

4. RESULTS AND DISCUSSIONS

The grey majorized model is provided not only with the merits of concise formation and simple calculation but also with the wider application. Data sequent characters of the health resources can be simulated and predicted better by the grey majorized model, and the model had higher simulation and prediction accuracy and there are important theory value and practice meaning in the deformation prediction of the settlement. Furthermore, the grey majorized model can be applied to the simulation and forecasting of equidistant, non-equidistant and high growth data sequent. According to the prediction data, it can be indicated that, under the influence of the history and tradition, irrational allocation of health resources has caused the phenomenon that health resources are insufficient and waste coexists, a series of preferential policies to health care of rural areas do not implement due to wrong ideas, the sustainable development of health service by perfecting related assisting measures should be pushed. In future, whether community human resource is fit for more and more chronic disease demands maybe be a big problem.

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