Practical Application of Bayesian Network and Genetic Algorithm for Optimizing Antibiotic Management in Hospital Settings

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Abstract: With the widespread use and misuse of antibiotics, there's a lot of talk about antibiotic resistance crisis these days. Researching the antibiotic resistance crisis have become pressing. In the first five years, the market share of antibiotics and anti-drugs increases, while that of other drugs declines. However, after the first five years, the trend of anti-drugs and other drugs decreases, that of antibiotics blooms up meanwhile. If development of market is supported , early rising share of antibiotics and other drugs, not containing antibiotics continue to decline, in twentieth years the market is stable, with antibiotics having the advantage over others.

Keywords: Antibiotic Management System; Hospital Settings; Advanced Healthcare

1. Introduction

Since penicillin was used in clinic, a variety of antimicrobial agents have emerged, so that the global mortality of infectious diseases can be reduced. Yet with the widespread use and misuse of antibiotics, antibiotic resistance crisis has become the focus of global attention. Resistant bacteria could lead to serious consequences and some researchers are worried that we will enter a postantibiotic age, in which we are infected by bacteria that can defeat every drug medicine has to offer.

Actually, in 1945, Alexander Fleming warned that penicillin might become useless. Nevertheless, Scientists thought it just didn't seem to matter very much. Nowadays, the true threat of antibiotic resistance was growing even clearer. Because of the antibiotic resistance crisis, the United Nations will convene a highlevel meeting to coordinate the global fight against these invisible enemies. And our team,the ICMFDA will help develop a better understanding of the factors involved with antibiotic resistance crisis.

The misuse of antibiotics results from treatment of diseases and animal feed. The existence of the interest chain of antibiotic intensifies the antibiotic resistance crisis. Thereby to develop a model that provides a interest chain for use of antibiotics and the sensitivity of parties is needed. It is important to consider the dynamic nature of the factors that affect both supply and demand in our modeling process. The interest chain can determine reform targets and the sensitivity can help us realize how to cope with antibiotic resistance crisis. Perfect competitive market is a market structure in which competition is adequate without any hindrance or interference. It is critical to predict the developing trend towards the crisis under perfect competitive markets by set a model. By analyzing data, the trend towards the crisis with no government intervention and the trend can reflect the importance of the government intervention is gained.

Because of the emergence of super-bacterium, how to control the use of antibiotics has threatened the social health. And our term is asked to design a portable management system for the use of antibiotics which is the most urgent affair for

super-bacterium. Besides, it is a must to write a report on our model and propose a set of policies.

2. Materials and Methods

2.1 Bayesian Network

Let G≝IE represents a directed acyclic graph (DAG), which sets the I represents all the nodes in the graph, and E represents a connection to a collection of line segments, and let X=XiI and I for the random variable I of a node in the directed acyclic graph the representative, if the joint probability distribution of node X can be expressed as:

$$P(X)=i\in IPXiXpa(i) \quad (1)$$

Then X is called a Bayesian network with respect to acyclic graph G.

For arbitrary random variables, the joint distribution can be obtained by multiplying the local conditional probability distribution:

$$P(X1=x1,\cdots, Xn=xn)=i=1nPXi=xiXi+1=xi+1,\cdots, Xn=xn \quad (2)$$

In accordance with the above formula, a joint probability distribution of a Bayesian network could be assigned:

$$P(X1=x1,\cdots, Xn=xn)=i=1nPXi=xiXj=xj \quad (3)$$

The above two said of difference is that the conditional probability of the part in the Bayesian network, if its “cause” variables are known, some nodes with “because” and “only independent variables, dependent variable nodes will” conditional probability of existence. Markov blanket is a minimal feature subset that satisfies the following characteristics: a feature in its Markov blanket condition, and all other features in the feature domain

are independent. A Markov blanket feature of T MB(T), then this can be expressed as:

$$PTMB(T)=PTY,MB(T) \quad (4)$$

The Y for all non Markov blanket node characteristics in the domain. This is the most direct definition of Markov blanket. Form a Markov blanket feature in Bayesian network is the feature (i.e. the nodes) parent nodes, child nodes and child nodes of the parent node.

The maximum likelihood estimation method (MLE) is used to get the parameters. Its log likelihood function is:

$$L=1Ns=1ni=1slogPXipa(Xi),Di \quad (5)$$

Where pa(Xi)represents the Xi dependent variable, Di represents the first observation, N represents the total number of observations data.

2.2 Results

2.2.1 Genetic Algorithm and Its Characteristics

Genetic algorithm is a kind of reference biological evolutionary laws (survival of the fittest, survival of the fittest genetic mechanism) evolved random search method. This method aims to optimize the fitting function and get the result we need.The main characteristic is to operate directly on the structure of the object, there is no derivation and limited function continuity with global internal implicit parallelism and better optimization ability using probability optimization methods,automatically obtain and optimize the search space and adaptively adjust the search direction, not need to determine the rules. Finally, genetic algorithm is used to optimize the results.

Its steps are as follows:

1. Chromosome coding. Using binary code to encode the independent variables.
2. Initialization groups. The fitness value of the chromosome is calculated.
3. Copy operation.

4. Crossover operation.

5. Mutation operation.

6. Stop criterion.

2.2.2 Solving Bayesian Network

We construct the above relationship, each factor and the success rate will be one of the factors influencing the success, so we think that each factor of only two possible values: T (success) or F (failure).

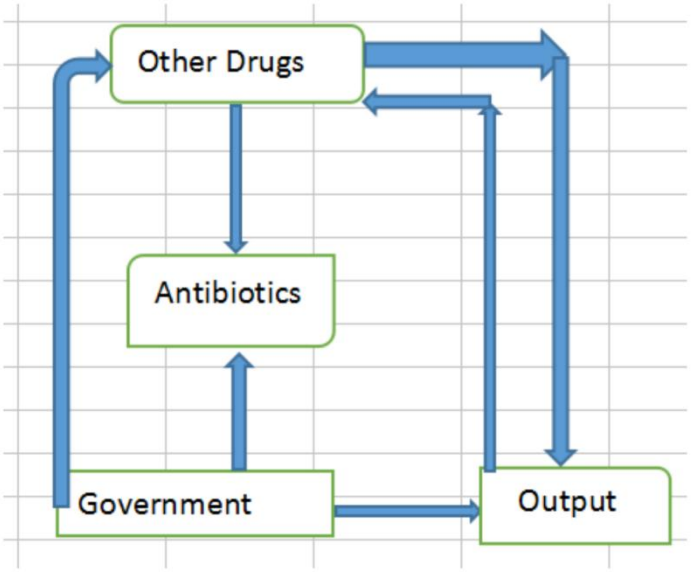

Figure 1 This caption shows the results of relationship between various factors.

The structure and parameters of Bayesian network is known, it is a must to use the maximum likelihood estimation method to calculate the probability of each node, and this probability is the degree of impact. Based on the data we have previously obtained, these probabilities is not difficult to get:

$$PX1=x1X2=x2=0.63 \quad (1)$$

$$PX2=x2X3=x3=0.45 \quad (2)$$

$$PX3=x3X1=x1=0.52 \quad (3)$$

Where X1 is for government, X2 for other drugs X3 for output.

3. Conclusion

With the development of science and technology,antibiotics has been widely used in the animal husbandry.Nowadays,the misuse of antibiotics in the animal husbandry is an important factor that effect the antibiotic resistance crisis. So we need to solve the problem of antibiotic abuse. Through the above analysis, we know that government intervention makes an important impact.

1.Encourage people to use antibiotic substitutes. Antibiotics can be regarded as growth stimulant and drugs. Many people misuse antibiotics to get more interest. Government has to find the antibiotic substitutes, and then set a reward policy. Generally, the antibiotic substitutes are more expensive, so the government must subsidize price differences. In order to encourage more farmers to use antibiotic substitutes, they should be given extra reward.

2.Control the dosage of antibiotics. The amount is also important. When antibiotic is used as growth stimulant, we can determine a specialized range. We know that growth cycle and profit are inversely proportional, and we should reward

farmers who use antibiotic in specialized range. In another hand, when it is used as drugs, farmers can increase the initial dose appropriately.

3.Control the usage of antibiotics. That is to say, we should determine the objects, usage, use period and withdrawal time. Proper usage and withdrawal time can not speed up the antibiotic resistance crisis. As for antibiotic drug residues, if it reach the standard, people should be rewarded.

4.Control the type of antibiotics. The government should divide illicit drugs and common drugs. If people use illicit drugs,they will be punished.

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