Artificial Neural Networks In Prevention Of Nosocomials Infections

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Abstract: These In terms of medical safety, the parameters affect nosocomial infections are characterized by their complexity. They become less amenable to direct mathematical modeling based on physical laws since they may be distributed, stochastic, non-linear and time-varying, uncertain, etc. The purpose of our study is to develop a predictive model of prevention these diseases. Like the data involved in the growth bacteria process occur in an uncertain environment due to their complexity, it becomes necessary to have a suitable methodology for the analysis of these variables. The basic principles of artificial neural networks perfectly suited to this process. As input variables, we consider the respiratory metabolism, temperature, water activity, sensitivity, and resistance to antibiotics. The bacterial genus is formulated and applied using MATLAB simulation for the system. The result output variable is the bacterial genus planned. It becomes possible to predict bacterial genus capable to proliferate in these conditions. Therefore, this will take the necessary decisions as a precautionary.

Index Terms: Nosocomial infections, Bacteria growth, Predictive model, Artificial neural networks.

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1 Introduction

The nosocomial infections are defined as "a disease caused by microorganisms incurred by any patient in hospital after admission. Infections are clinically recognizable (symptoms) or microbiological (antibiotic resistance, including serological data, or both at once) [1]. Each bacterial species is characterized by its specific growing conditions (Temperature, oxygen content, water activity, resistance to antibiotics). Nosocomial infections are a function of several factors related to the bacteria itself and also to patients and even susceptible body to be achieved. In this paper, we try to establish a draft study of these parameters to start with the most answered bacterial species (*Escherichia coli, Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Klebsiella)*, and the main parameters involved in the process. Given the specificity of the environment and its complexity we give an overview on the fundamentals of the analyze technical data that are used (Artificial Neural Networks). Among the microorganisms responsible for nosocomial infections include the Escherichia coli which is the main agent of infections instrumental manipulation (catheter). It is also the cause of septicemia, meningitis in infants and intestinal manifestation. Strains of E. coli can be very sensitive or resistant to a wide range of antimicrobial resistance to aminopenicillins which is mainly due to the production of a psalm-lactamase neutralized by clavulanic acid. Staphylococcus aureus is specific for the species S-aureus. represents 20% of nosocomial infections. This species is found in the environment (water, air, soil, food), the skin, the digestive tract of the newborn, the mucous membranes of humans are the main tank. The transmission of this organism is due to healthy carrier (30% to 50% of the population) in the nasal cavity, contact with discharge from the lesions or purulent secretions, ingestion of contaminated food, the transmission from mother to child during childbirth or equipment (probe) contaminated by the caregiver. *Pseudomonas aeruginosa* has a major role in nosocomial infections (11%). This germ is wide spread in wet environments (sink, faucet, shower...) and can contaminate the surgical medical hospital equipment (probe), surface thermometers oral ... (instruments, prosthetic materials), the antiseptic fluids, injections, drug products. This bacterium is responsible for serious infections (pulmonary and urinary sepsis). In intensive care units, respiratory and longer stays requiring the use of expensive antibiotics and often in combination which increases the rate of resistance of this organism per modification of porins and production of inactivating enzyme [2]. Klebsiella is mainly transmitted either manually or by instruments range. The transmission can also be due to auto-infection. This type accounts for 4.4% of nosocomial infections. The species most frequently isolated K. pneumoniae is the basis of urinary tract infection and pneumonia among vulnerable (newborn, diabetes, old age...) in the ICU. Many strains have become resistant to penicillins and aminoglycosides by the acquisition of certain plasmids [3].

2 RISK FACTORS FOR NOSOCOMIAL INFECTIONS

2.1 Microbial source

It is made primarily by the mass of other patients who obviously some are infected. It must be added that the hospital staff can also be carriers of infectious microorganisms [4].

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2.2 The vectors of the infection
The principal factors of contamination are the direct contact that medicine and nursing have with the patient and the equipments that their sterilizing is difficult. Air conditioning systems are dangerous reservoirs of germs if required maintenance is not guaranteed.

2.3 The markers used to confirm infection
Bacteriological samples may be positive due to colonization or contamination, the negativity of bacteriological examination does not exclude the presence of infection. And other markers are needed to confirm the infectious origin.

2.4 Growth factors bacteria

Antibiotic resistance
A bacterial species can be resistant to an antibiotic, because of its cellular structure or metabolism. This is called natural or constitutional resistance and the strain is referred to as unmodified wild. Bacteria can also acquire the new means to resist the action of a particular antibiotic. This is called acquired resistance. The strength properties are genetically determined by genes of natural or acquired resistance. These genes are expressed only when the environmental conditions (in vivo or in vitro) permit. For microbiologists, the resistance of a strain to an antibiotic is measured by the minimum inhibitory concentration (MIC) of the antibiotic for this strain. The MIC is the lowest concentration of an antibiotic that prevents bacteria from multiplying. This is the most useful for measuring the in vitro activity of an antibiotic parameter and is expressed in mg /l.

A Temperature:
It is an easily measurable parameter, an increase in temperature and the first sign of infection is the release of bacteria or microbial products in circulation. Typically, each bacteria type grows faster at a certain temperature. The growth rate results when the temperature deviates from the optimum. For bacteria, there is a maximum temperature and minimum temperature 'beyond which growth stops.

* Thermophylic bacteria are those whose optimum temperature is >45°C.
* The optimal growth of mesophylic bacteria requires temperatures between 15 and 45°C.
* Psychrophylic bacteria cross optimally or below -15 °C, do not grow above 20°C and have a lower limit 0°C or less.

Respiratory metabolism
Some bacteria need oxygen to grow. Other do not develop in the absence of oxygen, others can grow this gas is present or not.

* Bacteria that cannot live without oxygen are called aerobic strict.
* Strict or obligate anaerobes grow only if oxygen is absent.
* Bacteria that normally grow in the presence of oxygen but can still grow anaerobically

3 Application of Artificial Neural Networks
Since the parameters that characterize the effects on the body are characterized by imprecision (significantly increase, decrease substantially), we found it useful to analyze these variations by the principles of artificial neural networks. As input parameters of the system, we consider the weights of the organs studied. As an output parameter of the system we consider the bacteria species. The system established, can make the match between the two spaces of the inputs and output.

3.1 ANN Principles
Neural networks are designed to mimic the performance of the human brain. There is inputs level, output level, and a variable number of internal (or hidden) layers. The inputs are connected to hidden layer and they are in turn connected to output. As the neural network learns from a data set, the connection weights are adjusted. Data are fed into the input nodes, processed through the hidden layer(s), and the connection weights to the output nodes are adjusted. Neural nets are categorized based on their learning paradigm. Neural networks can reveal unexpected and otherwise undetectable patterns in large data sets. The major weakness in neural network solutions is the fact that the methods by which a relationship is discovered are hidden and therefore not readily understood or explained [5]. In the simplest way, a cooperative model [6]; [7], can be considered as a preprocessor wherein artificial neural network (ANN) learning mechanism determines the training data [8].

A Expression of the problem
Mapping of the space of parameters involved in the nosocomial diseases, we consider inputs [Antibiotic resistance, Temperature, Activity water, Resperatory metabolism]; the bacteria species is considerate as output of system. Figure 1, describes the topology with eight inputs extensible, two hidden layers, and an output (3-2-1) in the terminology of models of artificial neural networks. Wij et Wjk are weights, which represents the connection between the inputs and the output of the system. Weights contain all the information about the network. The objective is the training of the network to reach the minimum value of the reading error at the output observed [9].

B Model
Using examples consists of 200 tests of 100 different combinations of factors involved in the bacteria species bacterial species that thrive in these conditions with all possible combinations. We choose to keep 100 tests (50%) while 100 tests (50%) are used for learning. A priori, the relationship between these two spaces is complex (in particular non-linear) which justifies the use of a multilayer network.

C Learning of the neural network
It is in this case to introduce different data to the input in correspondence with the degree of weight variations. To achieve this, the method is a kind of imitation of the brain: if the answer is correct, it is, but if there is an error, we must modify the network so as not to repeat the mistake. Is repeated several hundred times the operation, until the system has the smallest error value as possible

Note: To change the system, just work on the weights [W] which are in the form of real numbers linking neurons. As these weights involved in the sum made by each neuron (the sum is weighted), it is possible to modify the network by changing their values without changing the network itself. That said, it is not clear how much weight we need to modify these. The goal is to achieve convergence towards a minimum error. In our case, after 500 iterations, the error is 0 with a gradient of 3.4028 at 500 iterations. Fig.1.

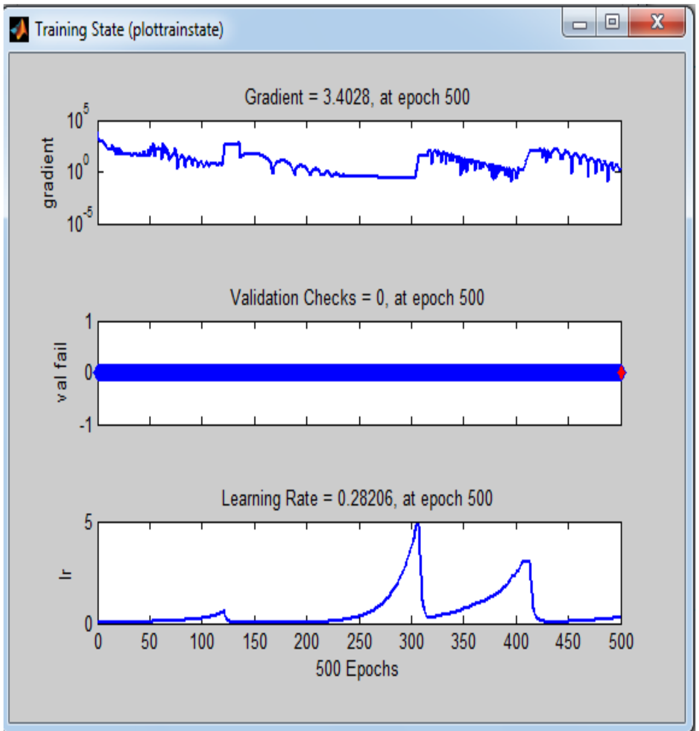

Fig. 1: Error correction functions

The result after training is shown in Figure 2. The proposed program predicts the bacteria species based on the input parameters. Test values are fully consistent with the recorded values just after 54 iterations. Fig. 2.

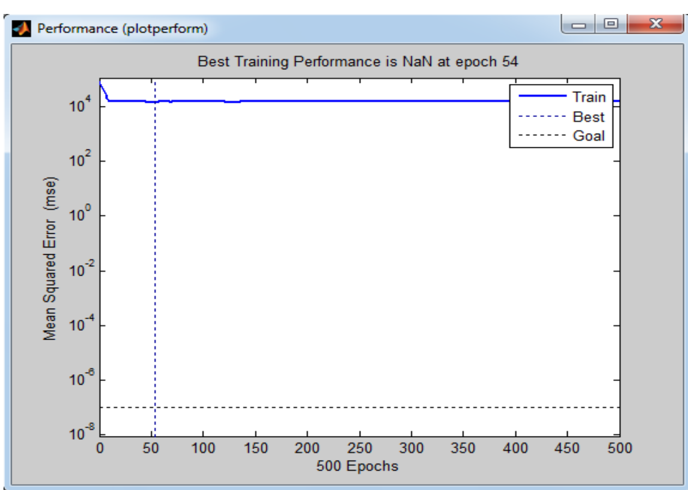

Fig. 2: Example of application between the measured and test values

CONCLUSION

In practice, the factors involved in the process of bacterial growth in hospitals are very complex and very uncertain. Analysis of these factors by a system of neural networks allows us to predict the offending species. From the input parameters as promoting specific bacterial growth variables for each species, we can read the output variable as bacterial identification. **O**nce the system is established, the germs to proliferate may be defined and possible contamination seron expected. It then becomes possible to take such steps as are necessary as a preventive measure to mitigate contamination in hospitals.

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