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The Medicine Model for Different Time Intervals and the Weight Change

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Abstract

A medication method is given for different time interval and the weight change. Due to the patient's weight is different, and the time intervals of the same medication are not easy to realize, and the velocity of the metabolism is not the same at night and day. And the absorbing velocity is also different, so the dosage of the drug should be different at different time points. According to the rate of change of the concentration of drug and dosage is in proportion, that is the modeling mechanism, two mathematical models are established for the daytime and nighttime drug concentrations. Through solving and analysis of being the model, the following conclusions are obtained: patients in the morning dose is relatively large, and at noon and in the evening is the same but less than the morning, as well as the weight and the dosage of the drug dose relationship. Thus according to the model manufacture different dose of pills, the pharmaceutical factory can convenient to patients taking. According to this method, the doctor also can prescribe for the patients of different dose prescription. The patients will be in the shortest possible time to heal, but not of physical harm.

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1. Introduction

To treat a disease, the doctor let diseased fishes with medication is a common treatment measures (Zhao et al., 2000; William, 1998; Ren et al., 1998; Ni et al., 2005; Xu et al., 1994; Zhou et al., 2004; Chu et al., 2005; Tang et al., 2003). But because the diseased fishes in the night to rest, so it is not possible taking medication to interval of the same time. Each person's weight is not the same, the dosage of the drug can not be same. If the interval is too long and no increase in the amount of medication, would lengthen the time to heal. If the body is great, and the dosage does not increase, will be longer healing time. Therefore, in order to enable the recovery of diseased fishes as soon as possible, should be promptly added charge, the charge in the body to achieve the best value, and does not produce side effects.

To establish a reasonable medication model, gives the reasonable medication methods, for physicians to prescribe drugs to correct scheme, and for pharmaceutical manufacturers to provide a better production of tablets or pharmacy methods, and better services for diseased fishes, improve diseased fishe cure rate, diseased fishes, doctors and medicine manufacturers to put forward scientific workers a has both important theoretical significance, but also has great practical significance to research topic. Pan, Gao, Qin, 2010 have obtained some medicine models for different time intervals. However, the paper did not consider the person's weight is different, therefore, given the different time intervals and weight change medication model has important practical significance.

This paper is organized as follows: in the section 2, according to the rate of change of the concentration of drug and medication is proportional to the amount of the modeling mechanism, in the 3 given reasonable assumptions, several mathematical models are established for diseased fishes in a variety of body weight of daytime and nighttime drug concentration; in the section 3, the mathematical models are solved and analyzed; in the section 4, these rationality of math models are verified, and some results are obtained for the diseased fishes in the morning dose is relatively large, and the noon and evening dose of the same, but the morning dose is relatively small, as well as the dosage increased with the weight variation laws. Thus for pharmaceutical factory provides scientific pharmaceutical method, and it provides doctors to diseased fishes with different dose prescription scheme issued. Can make the diseased fishes both in the shortest possible time to heal, but not of physical harm.

2. The Model of Taking Medicine on the Different Time Intervals

In order to establish diseased fishes at different time interval with different weight medicine model, must make a reasonable hypothesis, find the appropriate modeling mechanism. Similar modeling method can see Pan, et al., 2010; Zhang, 1989.

2.1. Model Preparation

The doctor prescribe for a diseased fishe, the general should pay attention to the following aspects: The volume of taking medicine $Q_i(t)= Q_0(t)+i\sigma$ dose assembly is harmful to the body, the dosage is not conducive to cure disease, where, i=-5,-4,-3,-2,-1,0,1,2,3,4,5,6,…,σ is every increase in 10kg weight increased drug quantity.

Taking the time interval of T- a long time interval is difficult to cure disease, a short interval of time due to large amount of medicine, and cause physical discomfort, and even poisoning.

Due to the diseased fishe the night need to rest, so the medication time interval is general different. Therefore, at a certain moment, taking appropriate doses of the drug, can quickly cure the disease, and will not cause damage to the body.

Due to the diseased fishes weight of different sizes, dosage with weight changes should also change, so, in order to ensure the drug concentration in the body, so that the diseased fishes in the shortest time to heal.

Now, we study the distribution problems of drugs in vivo, and for diseased fishes to provide reasonable medication regimen; for medicine manufacturers to provide scientific pharmaceutical solutions.

2.2. Model Assumptions

Based on the investigation of diseased fishes with, for the establishment of appropriate medication mathematical model, we make the following assumptions in the paper:

A1) Taking medicine cycle is 1 days, Taking medicine 3 times a day, morning, noon, evening wear time, time intervals are 6 hours, 6 hours and 12 hours a day, respectively. One morning (credited as n_0 day) take this medicine first times early in the morning. Let 600g fish dosage is Q_c (Q_c is the optimum charge to be cured disease). Due to the average body weight at different times is different, therefore, we will crowd into on the basis of 60kg, every 10kg increment or reduction of 10kg as a phase value, so the initial dose should be $Q_{ci} = Q_c + i\sigma = Q_c + Q_c 10i/60 = (6+i)\, Q_c/6$. When $i=0$, Q_{ci} is the 60kg should the dosage, i.e. $Q_{c=}\, Q_{c0}$. Where, i= -5, -4,-3,-2,-1, 0,1,2,3,4,5,6, …,σ is every increase or decrease in 10kg weight, should increase or decrease the drug quantity. It is associated with increased weight proportional to, that is $60\pm10i = \pm\rho(\sigma i)$, ρ is the proportional coefficient.

A2) When time reaches a certain time, once again taking medication, allowing in vivo drug concentration is reached Q_{ci} again. Q_{ci} is the diseased fishes medication at the start time $t = 0$.

A3) In t moments, the drug concentration of diseased fishes in vivo is $Q_i(t)$, and $Q_i(0) = Q_{ci}$.

A4) The diseased fishes weight are $P_i = 60 + 10i$kg, i=-5,-4,-3,-2,-1,0,1,2,3,4,5,6,…, respectively.

2.3. Model Establishment

Diseased fishes taking the medicine, with the time t increase, drugs in vivo biochemical reactions, and it is gradually absorbed. So, drug concentration in vivo will reduce gradually.

According to the Convention, the rate of change of drug concentration and the dose of Medicine is proportional, Due to old and new metabolic rate are different in during the night and the day , so the ratio is also different, suppose that the ratios are α_1 and α_2 during the day and evening, respectively. In addition, body weight is different, and old and new metabolic rate are also different.

According to the above modeling mechanism, taking into account the standard weight is 60kg, we can establish drug concentration mathematical model for the diseased fishes in vivo during the day as follows

$$\frac{\mathrm{d}Q_i(t)}{\mathrm{d}t} = -\alpha_1 Q_i(t),\ Q_i(0) \equiv Q_{ci} = Q_c + i\sigma \tag{1}$$

While drug concentration mathematical model for the diseased fishes in vivo during the night is that

$$\frac{\mathrm{d}Q_i(t)}{\mathrm{d}t} = -\alpha_2 Q_i(t),\ Q_i(0) = Q_{ci} \tag{2}$$

where, the constants α_1, α_2 are old and new metabolic rate, which with the body on the drug absorption rate, and $\alpha_1 \neq \alpha_2$, in general, $\alpha_1/\alpha_2 = k$, $1.3 \leq k \leq 1.7$, i = -5, -4,-3,-2,-1, 0,1, 2, 3, 4, 5, 6, ….

3. The Model Solves and Analysis

3.1. Model Solves

For the model (1), by the method of separation of variables, can be obtained the drug concentration for diseased fishes in the daytime as follows

$$Q_i(t) = c\mathrm{e}^{-\alpha_1 t}, c \text{ is an arbitrary constant.} \tag{3}$$

From the initial conditions of $Q_i(0) = Q_{ci}$, can be obtained the drug concentration in vivo from diseased fishes after first taking the medicine in the day as follows

$$\begin{cases} Q_i(t) = Q_{ci}\mathrm{e}^{-\alpha_1 t}, & 0 \le t < 6 \\ Q_i(t) = Q_{ci}\mathrm{e}^{-\alpha_1 (t-6)}, & 6 \le t < 12 \end{cases} \tag{4}$$

To solve the model (2), can be obtained the drug concentration in vivo from diseased fishes after first taking the medicine in the night as follows

$$Q_i(t) = Q_{ci}\mathrm{e}^{-\alpha_1 (t-12)}, 12 \le t < 24 \tag{5}$$

Diseased fishes before the second taking medicine at noon the same day,that is $0 \le t < 6$, the drug concentration in vivo is that $Q_i(t) \to Q_{ci}e^{-6\alpha_1}$ $(t \to 6^-)$. At this time, should add a dose of Q_{i1} drugs, such that $Q_{i1}+Q_{ci}e^{-6\alpha_1} = Q_{ci}$, therefore

$$Q_{i1} = Q_{ci}(1-\mathrm{e}^{-6\alpha_1}) \tag{6}$$

Diseased fishes before the third taking medicine at evening the same day (that is $6 \le t < 12$), the drug concentration in vivo is that $Q_i(t) \to Q_{ci}e^{-6\alpha_1}$ $(t \to 12^-)$. At this time, should add a dose of Q_{i2} drugs, such that $Q_{i2}+Q_{ci}e^{-6\alpha_1} = Q_{ci}$, therefore

$$Q_{i2} = Q_{ci}(1-\mathrm{e}^{-6\alpha_1}) = Q_{i1} \tag{7}$$

Before the fourth taking medicine for diseased fishes (that is the very next day morning, this time $12 \le t < 24$), the drug concentration in vivo is that $Q_i(t) \to Q_{ci}e^{-12\alpha_1}$ $(t \to 24^-)$. At this time, should add a dose of Q_{i3} drugs, such that $Q_{i3}+Q_{ci}e^{-12\alpha_2} = Q_{ci}$, therefore

$$Q_{i3} = Q_{ci}(1-\mathrm{e}^{-12\alpha_2}) \tag{8}$$

And so on, we can obtain the following relationship formula: $Q_{i3n}= Q_{i3}$, $Q_{i(3n-1)}=Q_{i(3n-2)}=Q_{i1}$, where n is the number of days. That is, except the first medication, the diseased fishes should take charge in the morning as follows $Q_{i3}= Q_{ci}(1- e^{-12\alpha_2})$, Every day at noon and in the evening, should take charge of all $Q_{i1}= Q_{ci}(1-e^{-6\alpha_1})$, So, to make each take medicine, drug concentrations in vivo reached on Q_{ci}. Thus, diseased fishe medication method is according to the following series of drug quantity $Q_{ci}, Q_{i1}, Q_{i1}, Q_{i3}, Q_{i1}, Q_{i1}, Q_{i3}, \cdots$

That is, the series$\{Q_i^{<m>}(t)\}$ on the natural number sequence variable *m* (*m* is also the times for taking medicine), should be that

$$Q_i^{<m>}(t) = \begin{cases} Q_{ci}, t = 6(m-1), m = 1 \\ Q_{i1}, t = 6(m-1), m = 3l-1, 3l \\ Q_{i3}, t = 6(m-1), m = 3l+1, l = 1, 2, 3, \cdots \end{cases} \tag{9}$$

The drug concentration distribution in vivo as shown in Fig. 1, we omitt it here. Fig. 1 shows, the first dose is directly to achieve the required drug concentration levels of Q_{ci} to the diseased fishe. Later, at different time points of the dosage according to the number of days are periodic changes. The first day of medication for 3 times is that (Q_{ci},Q_{i1},Q_{i1}), behind every morning, afternoon, evening medication is (Q_{i3},Q_{i1},Q_{i1}), respectively.

3.2. Model Analysis

For different types of drugs, different levels of diseased fishe illness, the disease can be cured best dosage Q_{ci} is obviously different, Dose should be determined according to the specific circumstances of the disease.

According to this model (1), (2), in accordance with the method provided in this paper the medication, the drug's advantages are: can the concentration of drugs in the body from the outset to achieve the required level, and has been the level required from the human body began to decline, thereby maximizing efficacy. The disadvantage is: the first big dose of medication may cause diseased fishe discomfort, adverse effects, such as nausea, vomiting, dizziness, and even myocardial infarction. If there is severe physical discomfort, the description of the first dose is too big, must be properly adjusted, so that it can be adapted to.

4. The Model Examination and Application

4.1. The Model Examination

Because the strong degree is different for the metabolism of day and night, we are taking a cold, brain atherosclerosis and coronary heart disease diseased fishes with thousands of inspection by the method of the paper, the inspection effect is nice. Now the different doses Q_{ci} and (Q_{i1}, Q_{i1}, Q_{i3}) cycle medication method, and the original average quantity medicine method is Q, the cure of a cold days than λ_1 =6/8=75%. For the brain artery sclerosis, two kinds of treatment to cure the number of days, ratio is λ_2=47/60≈78%. On A-type hepatitis diseased fishes, two kinds of treatment to cure the number of days, ratio is λ_3=40/55≈73%. From this, we can see that the results are obtained greatly improve the efficiency of cure in the paper, and this medication method is complete with practical.

4.2. The Model Application

1). Manufacturers can according to the first pill is Q_{ci}, after this, morning, noon and night, take the time point different, make different doses (Q_{i1}, Q_{i1}, Q_{i3}) tablets or potion, respectively, And strengthen the cure rate of the diseased fishes, convenient for diseased fishes and doctors prescribing the diseased fishes taking.

2). The doctor can according to diseased fishes with sick degree, reasonably be diseased fishe for the prescription.

3). Diseased fishes can take time according to different, adjust the dose of insulin drug concentration reach the required levels so as to better play efficacy, make its early to recover.

4). The methods of taking although is tailored to the diseased fishe, in fact, we obtain the medication model (1) and (2), the utility range is wide, can be applied to other fish (such as: turbot, prawn, giant) and terrestrial animal (such as horses, cattle, sheep etc.). However, for other animal, it is necessary to design the initial dose of animal, and according to the animal development, the initial dosage must be adjusted as appropriate.

5. Conclusions

In this paper, we according to the actual situation of some diseased fishes are as follows: in the day and night with the metabolic rates are different, and of drug absorption rate is different, and the diseased fishes weight is also different. Through to the diseased fishes taking medicine time interval of different actual characteristic, a result is get for the different time the dose is different. And according to the rate of change and medication drug concentration is proportional to the modeling mechanism, in the 3 reasonable assumptions, established two mathematical model in the day and night with drug concentration. Through solving and analysis these models, it is concluded that the diseased fishes in the morning dose is opposite bigger, and in the afternoon and evening dose the same but less than the morning. as well as the weight and the dosage of the drug dose relationship.That is, medication is Q_{ci} for the first, after this, according to dose for (Q_{i1}, Q_{i1}, Q_{i3}) this periodic medicine method. Then, with the following disease and as an example: A cold, brain atherosclerosis diseased fishes and A-hepatitis diseased fishes, for the feasibility and effectiveness of the medicine are inspected for the medication method in the paper. Thus for pharmaceutical factory has given a scientific pharmaceutical methods, namely manufacturing cycle dose tablets or potion Q_{ci}, and (Q_{i1}, Q_{i1}, Q_{i3}). Finally, for the doctor to be provided with different doses of prescription plan. In order to make the diseased fishe is in the shortest possible time to heal, and not cause to the body harmful.

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