DRUG DOSAGE MODEL PROJECT

This simple model of drug dosage is called a one-compartment model of drug dosage. The model assumes that the drug achieves instantaneous distribution throughout the body. It also assumes that the level of the drug in the blood plasma is the same of that in the organs and tissues that the drug is used to treat. Other models of drug dosage implement a two-compartment model where the absorption of the drug from the plasma to the organs and tissues is modeled in a separate step.

There are several starting reference to provide additional background on this topic. The Dhillon and Gill book chapter 1 is an good review of the model background and mathematics. The other references also have similar sections. You should complete some background research using these or other related references before you start modeling to ensure that you understand the underlying system.

For the starting version of the model, you can use the equations below for your implementation.

Basic Drug Dosage Model Equations

*Absorption (i) = time_step * absorption_rate *medicine_in_intestines(i)*
Where i is the time that is iterated from 0 to 48 hours by the time step

*Excretion (i) = (time_step * excretion rate * plasma level(i)*

Medicine_in_intestines (i+1) = medicine in intestines (i) – absorption(i) + intake(i)

Plasma_level (i+1) = plasma _level(i) - excretion(i) +absorption(i)

Plasma_concentration (i+1) = plasma_level(I + 1) /blood volume

In this model, you are given both a medicinal and toxic level of concentration. The goal is to find the dosage and number of doses that achieve a steady state at the medicinal level without going to the toxic level.

You should begin using these parameters:

doses_per_day = 1
dosage_per_day = 6000 mg
absorption_rate constant= 0.25
half_life of drug= 6 hours
blood_volume = 4.6 liters
medicinal_level = 800 mg/l
toxic_level = 1000 mg/l

Once you have the basic model working and verified, you may choose to implement one or more of the optional additions to your modeling effort.

1. Dosage directions tend not to be followed when the number of doses in a day is more than two. Drugs can be manufactured to time release the medicine over a 12 hour period to reduce the total number of pills one needs to take. Rework the model to provide two doses of time released capsules and figure out what the hourly dosage needs to be to maintain the correct drug levels in the plasma.

2. People vary in size and thus in plasma volume. Change the model to simulate the changes in dosage that would be required for people ranging from 20% smaller (and proportionally less plasma volume) up to 20% larger than the volume given in this model.

3. Doctors could use a model such as this to alter their prescription so that the dosage and response was set correctly for each person's relative size. Find a reasonable estimate of the relationship between body weight and blood plasma. Alter the model so that it interactively asks for the patient's weight as an input and then searches a set of solutions that include the dosage appropriate for that person's weight.

4. Find a specific drug and look up its published pharmacokinetics. You can use a website such as webmd.com or http://www.nlm.nih.gov/medlineplus/ to search for the drug or do a search for a brand name. Once there, find the link to the manufacturer's site and look up the full prescribing information. Alternatively, use the brand name and search for the name and prescribing information. It should have a section on the pharmacokinetics. Use that information to change the model parameters to match the published rates for absorption and excretion. What does the altered model predict about the steady state concentration of the drug? Some possible candidates: mesalamine (Apriso), Celebrex, Lotensin HCT, synthroid.

References

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