Applied Mathematics 30

Student Project: Medical Mathematics

Case Study: Huntington Disease

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Introduction

Huntington disease is a neurological disorder characterized by uncontrolled movement, emotional disturbances, and dementia. An abnormal or mutated gene causes Huntington disease. The impact of a gene depends partly on whether it is dominant or recessive. If a gene is dominant, then only one copy is required to produce an effect. Huntington disease results when one copy of the defective gene is inherited from either parent.

Part A

1. In addition to the terms introduced in the paragraph above, the following terms will be helpful in completing this project:

Punnett square
heterozygous
homozygous
genotype

Research the definition of any terms in this project that you do not understand.

2. A couple is planning to have children. One of the couple is heterozygous (*Hh*) for Huntington disease, and the other is homozygous (*hh*) for the normal gene.

- Construct the sample space (Punnett square) for the possible genotypes of the children of this couple.
- What is the probability that this couple will have a child who has Huntington disease?
- If this couple were to have three children, then what would be the probability that **none** of these children would have Huntington disease?

3. A sample of 1007 people, each of whom has only one parent who is heterozygous for the Huntington disease gene, was taken. Determine the symmetric 95% confidence interval for the number of people in this sample who would have Huntington disease.

4. A different couple, both of whom are heterozygous for the Huntington disease gene, is planning to have children.

- Construct the sample space (Punnett square) for the possible genotypes of the children of this couple.
- What is the probability that this couple will have a child who has Huntington disease?
- If this couple were to have three children, then what would be the probability that **at least** one of these children would have Huntington disease?

5. Although the dominant gene for Huntington disease is present at birth, the symptoms of the disease usually do not appear until much later. The age at which symptoms appear is normally distributed with a mean of 44 years and a standard deviation of 10.3 years. What is the probability that symptoms of the disease will appear before age 35?

Part B

Although there is currently no cure for Huntington disease, most patients are prescribed medication to take regularly. The patient's body excretes the medication at a certain rate. If the patient takes the medication as prescribed, over time the mass of medication in the body will be maintained at a constant level. It is common practice to begin the dosage at a lower mass, and then increase the dosage over time until the desired mass is attained.

1. A particular doctor prescribes medication for a certain patient to be taken daily over an extended time. The doctor starts the patient at 50 mg per day, and then increases the dosage by 50 mg per day at the beginning of each successive week until the dosage has reached the desired amount of 200 mg per day. Each day, 40% of the total mass of the medication in the patient's body is excreted.

Construct a spreadsheet to determine the mass of medication that remains in this patient's body after each dose. Remember that your spreadsheet should reflect the increase in dosage at the beginning of each week. Extend your spreadsheet until it shows that the total mass of medication in the body levels off (i.e., the medication is maintained at a constant level). Supply two printouts of your spreadsheet: one showing all applicable amounts of medication and the other showing the formulas within the cells. Save your spreadsheet.

2. When does the total mass of medication in the patient's body level off? What mass of medication is in the patient's body at this point? Justify your answers.

3.
- If the patient forgets to take the second dose of the medication, then when does the level of medication in the patient's body level off? Justify your answer.
- The patient forgets to take the twenty-fourth dose of the medication. Describe the effect that this missed dose will have on how long it takes for the medication to level off in the patient's body.
- Missing the twenty-fourth dose affects the total time for the medication to level off in the body differently than missing the second dose. Explain why this difference might occur.

4. After the patient has taken the prescribed medication for 10 days from the day the medication has levelled off, the doctor decides to change the method of treatment. Before a new treatment can be started, all the current medication must be excreted from the patient's body. Use a spreadsheet to determine the number of days it will take for the patient's body to excrete all the current medication.

Part C

1. Create a pamphlet that a pharmacy could give to customers who are prescribed this medication to emphasize the importance of taking all the medication prescribed and of taking each dose on time. Use the data you have gathered to provide evidence.

2. Research some of the new therapies and treatments for Huntington disease that are being tested and write a one- or two-page report. The following web sites may help in your research.

www.biobasics.gc.ca/english/View.asp?x=643
www.medicalnewstoday.com/medicalnews.php?newsid=22301
www.medicalnewstoday.com/medicalnews.php?newsid=20061
www.hsc-ca.org
www.hda.org.uk

Note: Web site addresses sometimes change. If the sites above are not available, type key phrases such as "Huntington disease" and "treatments for Huntington disease" into a search engine.