The Worried Well – health testing

Introduction

Students are asked to consider the use of health testing kits and the significance of results. They have to discuss how false positives and negatives arise and the effects they may have.

This activity makes use of excerpts from a document produced by the organisation "Sense about Science" called Making Sense of Testing. The full document can be found at http://www.senseaboutscience.org.uk/index.php/site/project/232/

The Activity

Students will read extracts from the 'Making sense of testing' document, and answer questions about what they have read.

Suggested answers

Q1. For each of the seven methods given above suggests how random or systematic errors might occur.

- *Direct questioning: memory is not perfect, so people may remember things that didn't happen, or forget things that did happen*
- *Clinical measurements: Patient could be nervous, or have just walked briskly to clinic – leading to increased pulse*
- *Physiology: Machine could be incorrectly calibrated, patient moves too much.*
- *Pathology measurements: hormones raised due to medicines being taken, potentially cancerous cells misidentified in lab, contamination from other sources*
- *Imaging: Need a lot of training to interpret the images, they are not always clear.*
- *Endoscopy: Incorrect positioning of tube, may be hard to interpret the images, requires training and practise.*
- *Psychological measurements: patient could be more tired than usual, poor memory due to other conditions.*

Q2. Why is it important for a doctor to use more than one test, or to repeat measurements on more than one occasion?
Need to make sure that the diagnosis is reliable. If there is more than one result on different occasions which all point to the same condition then it is more likely to be correct.

Q3a. What is DNA and where is it found?
DNA contains all the genetic information for an individual. DNA is found in nucleus of the cell.

b. Explain why two siblings using a medical test to identify a particular genetic sequence may get different results.
Siblings may not have the same genetic make-up as each other.

Science explanations

Ce Most characteristics are determined by an interaction between several genes as well as by the effect of the environment. The environment can influence gene expression.

How Science Works

Aa We can never be sure that an observation is accurate or that a measurement tells us the 'true' value of the quantity we are measuring. We may be influenced by what we expect. Random and/or systematic errors can arise from limitations of the measuring equipment used, or our skill in using it. A single measurement of anything is therefore inherently risky.

Ab If we make repeat measurements of the same quantity, the values are likely to vary. This might be because the quantity we are measuring is changing, or because of measurement error. If errors are random, the average of several measurements is the best estimate of the value of the quantity. The smaller the spread of the measured values and the larger the number of repeat measurements, the more confident we can be that the mean is close to the 'true' value.

Gf To make an informed decision about the management of a given risk, we need to take account both of the probability of the event occurring, and the seriousness of the consequences if it did. This is particularly difficult in the case of events of very low probability, but with very serious consequences if they occur

Gh Reducing the risk of a given hazard costs more and more, the lower we want to make the risk. Individuals or governments have to decide what level of risk is acceptable, by weighing up the probability of harm and the cost of reducing it further

It will depend on the chromosomes that were passed on from their parents.

c. How might a genetic biomarker be present in a person's DNA, but not affect their health?
It might be a recessive characteristic – present but not expressed, or it may be that the genetic biomarker gives a stronger likelihood of a particular disease only if certain environmental conditions are also present. If they are not present, then the biomarker will not affect their health.

Q4. There may be a correlation between the level of a biomarker and a particular disease.

a. What is the difference between a correlation and a causal link?
Correlation - a consistent relationship between two factors. Causal link – change in one factor is directly related to a change in a second factor.

b. What would scientists do to investigate the relationship between the biomarker and the disease.
They could set up a study to look at different groups of people, some who had the marker and some who didn't and look at the incidence of the disease in each group.

Q5a. What do we mean by a false positive?
The patient is told they have a disease/condition when they don't
false negative result?
The patient is told that they are clear of the disease/condition, when in fact they have it.

b. Give an example of how each type of result could be harmful to the patient.
False positive: patient may be given drugs they don't need, and suffer from the side effects, they may become depressed and family relationships suffer.
False negative: disease continues to progress so that treatment is started later, and disease is harder to treat.

Q6. If 1000 people were tested for a biomarker, using the reference range figures given above, how many people would receive 'abnormal' results?
50 people – 25 abnormally high, and 25 abnormally low.

Q7. Does the presence of abnormal results mean that the individual will have a medical problem? Explain your answer.
No. Results are compared across the whole population, and so some people will always have high or low results. The shape of the curve means that there will always be some people who are outside the 'normal' range.

Q8. If a doctor thought a patient should have a whole body CT scan for a particular condition what factors would she, and the patient, need to take into consideration?
Lifestyle and genetic factors, any indications that the condition is present, severity of the condition, how useful early detection would be, increased risk of cancer due to the additional radiation.

Q9. Give an example of a lifestyle change that could be made to reduce the likelihood of developing a) Cancer and b) Coronary heart disease.

a. stop smoking, change diet
b. increase exercise, change diet, stop smoking.

Q10. If a medical test gives a false positive result suggest how this could lead to extra resources being required by the NHS.
Treatment will be started, patient will require drugs, medical appointments and care, possibly lead to hospital stays.

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Introduction

Some people who are well are still concerned about their health. They want to know if they are at risk of a disease, or if they will develop it in later life. A quick search on the internet will show the availability of home testing kits for many different conditions and diseases. These are marketed as providing reassurance to these 'worried well'. How sensible is it to use these kits? How many of them are based on sound science?

The Activity

In this activity you will be given some information about medical testing and answer questions about what you have read.

Part 1: What do medical tests measure?

> Features in the body can be measured in various ways. They include:
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> - **Direct questioning**, like getting a family history;
> - **Clinical measurements**, like feeling your pulse;
> - **Physiology**, such as having an ECG to check heart rate;
> - **Pathology measurements**, processed in the laboratory, like blood samples for cholesterol or hormone levels, cervical smears and cheek swab samples for genetic testing;
> - **Imaging**, like X-rays, CT, MRI and ultrasound scans;
> - **Endoscopy**, where a small, flexible tube with a light and camera lens is used to examine and take biopsies from the stomach and bowel; and
> - **Psychological measurements**, such as object recognition to aid diagnosis of Alzheimer's Disease.
>
> *Making sense of testing, pg 4*

A doctor will use a variety of ways to obtain data (observations and measurements) from a patient. When we make measurements we cannot be sure that they are a 'true' or 'accurate' value of the quantity that is being measured.

Q1. For each of the seven methods given above suggests how random or systematic errors might occur.

Q2. Why is it important for a doctor to use more than one test, or to repeat measurements on more than one occasion?

Laboratory diagnostic tests look for the presence of a **biomarker**, such as a particular genetic sequence in an individual's DNA; or the **amount of a biomarker**, such as the level of cholesterol in blood.

Off-the-shelf testing kits do the same thing. Tests that measure biomarkers can only tell you the levels present. They do not tell you the implications this may have for your health.

Making sense of testing, pg 4

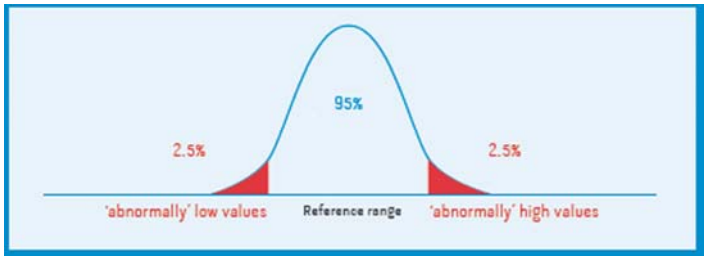
Q3 a. What is DNA and where is it found?
b. Explain why two siblings using a medical test to identify a particular genetic sequence may get different results.
c. How might a genetic biomarker be present in a person's DNA, but not affect their health?

Q4. There may be a correlation between the level of a biomarker and a particular disease.
a. What is the difference between a correlation and a causal link?
b. What would scientists do to investigate the relationship between the biomarker and the disease.

Part 2: The Results

Q5 a. What do we mean by a false positive and a false negative result?
b. Give an example of how each type of result could be harmful to the patient.

A test result is not taken as a number in isolation. It gets compared to a range of values considered 'normal' for a healthy individual. This is called the **reference range**, and it's what a doctor can use to interpret a set of results for individual patients.



(It doesn't apply to imaging tests like CT scans as these are not compared to a reference range.)

Q6. If 1000 people were tested for a biomarker, using the reference range figures given above, how many people would receive 'abnormal' results?

Q7. Does the presence of abnormal results mean that the individual will have a medical problem? Explain your answer.

Most medical tests used by doctors have been developed for use with people who have symptoms of a disease or condition. They are also used by experienced medical staff who are able to interpret the results.

When tests are used by people who have no symptoms of a disease (asymptomatic) then their use can cause harm.

Firstly, the test itself can cause harm. The radiation from a whole body CT scan is believed to produce a fatal cancer in one in every 2000 people investigated; a colonoscopy will produce a perforated bowel in 1 in every 1000.

Secondly, testing healthy people can give a false sense of security, causing people to believe wrongly that they will not get a disease, which may reduce the likelihood of them making the lifestyle changes they ought to.

Thirdly, there is a risk of side effects from unnecessary treatment of a disease that was never going to cause a problem if left alone. Treating slightly raised blood pressure in people with overall low cardiovascular risks can cause significant symptoms (such as erectile dysfunction and tiredness) from the side-effects of medication, without making much of a difference to that person's chance of developing a serious disease.

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Finally, the detection of asymptomatic disease turns people into patients, and this itself causes anxiety and leads to increased consultation rates and decreased perceived quality of life.

Making sense of testing pg 13

Q8. If a doctor thought a patient should have a whole body CT scan for a particular condition what factors would she, and the patient, need to take into consideration?

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