

Plastic bottles and cancer

Introduction

This activity looks at two cancer scares relating to plastic bottles, one an 'urban myth' and one where the evidence is still disputed by scientists. Students have to consider evidence and explain their conclusions. In part 2 two groups are deliberately given different evidence. When they come together to discuss their conclusions they will see how important it is to consider different sources.

Part 1

This should be seen as a fairly light-hearted activity but people do take these 'urban myths' seriously and this should help students have the confidence to discuss them when they encounter them.

List of evidence:

- *This is how Sheryl Crow got breast cancer, she said so. (1 personal anecdote)*
- *This has been identified as the most common cause of the high levels in breast cancer, especially in Australia (2 this sounds better but no indication of who identified it. It might be a summary of a scientific study but it might not)*
- *The doctor said that the heat and the plastic of the bottle have certain chemicals that can lead to breast cancer. (2 this is one person's opinion though as a doctor it may be more informed)*
- *The heat causes toxins from the plastic to leak into the water and they have found these toxins in breast tissue. (1 this sounds more scientific but in fact is probably based on the one unpublished study. No information on how often they have found these toxins in breast tissue)*

Part 2

This is a more difficult activity. Groups may require support to understand the information. It will probably be best organised by handing out the first two pages and spending a few minutes checking that they understand the background information with some questions about:

- hormones,
- the units used to measure dose
- dose-response relationship
- the differences between in vitro studies, in vivo animal studies, and studies on humans.

Then divide into small groups designated either A or B and give out the relevant information page. The students have deliberately been given rather less guidance on how to debate the information. You may wish to suggest some of the following points to them if they do not raise them themselves.

How Science Works

Bi It is very difficult, in complex situations, to obtain convincing evidence that a factor does **not** cause an effect (to 'prove a negative'). There will inevitably be differences between the samples studied, due to chance – which are difficult to separate from 'real' effects.

Eb Findings reported by an individual scientist or research group, and their interpretations of these, are carefully checked by the scientific community before they are accepted as reliable scientific knowledge. This process of 'peer review' is essential both for detecting invalid claims and adding weight to valid ones.

Ec Scientists publish their work in technical journals, in conference papers and on the internet. This enables other scientists to see and comment on the data collected, the methods used, and the interpretations made.

Ed Scientists value observations and measurements that are replicable (on different occasions and/or by different people), and are generally sceptical of findings that cannot be repeated.

Gi Regulators and individuals sometimes take a precautionary approach to a new device or process – and pressure groups often advocate doing so. The precautionary principle says: if we think something may cause harm to human health or the environment, we should not use it even though there is no clear evidence that it causes harm (i.e. we should act on the principle: 'better safe than sorry').

- The issue can be seen as very similar to the low dose radiation issue and the difficulty of proving a negative. Can one ever show that BPA is not a risk factor? What level of evidence is accepted as adequate?
- It is possible that the “low dose effect” is a real one and that the normal dose response assumptions do not apply to hormones.
- A key factor here is the validity of animal studies. Those who think the BPA risk is low believe that rodents are not a good model and also that observed changes in size or development of different organs do not, on their own, prove that the animal will get cancer. Those who believe BPA is harmful believe that animal studies are relevant.
- Many of the studies have not been independently repeated. On the other hand should the precautionary principle apply?
- If we did use the precautionary principle would the alternative materials be any safer, might they introduce more risk?

Group A and Group B are likely to reach different conclusions based on the information provided. It may well be that they find it impossible to reach a consensus, the information is very contradictory and researchers in the field do not agree.

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Part 1 - PET bottles

There are regular scares about the use of plastic bottles. The one below was recently circulated by email to groups of women friends, some of whom obviously took it seriously and sent it on again to their friends.

WARN ALL FEMALES & husbands to tell their wives

Bottled water in your car.....very dangerous to women!!!!

This is how Sheryl Crow got breast cancer. She was on the Ellen show and said this same exact thing. This has been identified as the most common cause of the high levels in breast cancer, especially in Australia.

A friend whose mother was recently diagnosed with breast cancer. The Doctor told her: women should not drink bottled water that has been left in a car.

The doctor said that the heat and the plastic of the bottle have certain chemicals that can lead to breast cancer. So please be careful and do not drink bottled water that has been left in a car or somewhere hot. Pass this on to all the women in your life. This information is the kind we need to know and be aware and just might save us!!!! The heat causes toxins from the plastic to leak into the water and they have found these toxins in breast tissue. Use a stainless steel flask or a glass bottle when you can!!!

LET EVERYONE WHO HAS A WIFE / GIRLFRIEND / DAUGHTER KNOW PLEASE

1. If a friend of yours sent you this how would you respond?
 - a) Laugh and assume it is a hoax
 - b) Thank her and be much more careful about water in plastic bottles
 - c) Consider the evidence in the message and discuss it with your friend
 - d) Do more research on the issue.

If you are to get a qualification in Science and Society you should be able to help your friends handle such stuff and we might expect that you would choose (c) or (d).

2. The claim made is that 'the heat and the plastic of the bottle have certain chemicals that can lead to breast cancer'.

Several pieces of evidence are given to support the claim in the message. List four pieces and give each a rating from 1 to 5, with 5 as best, on how well it supports the claim.

3. Write a reply to your friend explaining why the email does not prove that plastic water bottles are dangerous. You may wish to use some of the information below to support your claim as well as criticising the evidence used in the email.

- The origin of this story seems to be a single unpublished report from a student's thesis which claimed that a chemical DEHA, once thought to be a carcinogen, had been found in water stored in PET plastic bottles. DEHA is not part of the plastic used in PET water bottles so it may have been found as a result of contamination in the laboratory.
- There is no evidence that any of the components of the PET plastic used in water bottles have either carcinogenic or hormone activity.

Part 2 - polycarbonate plastic bottles

Suspicion lingers over bisphenol A and breast cancer

Bisphenol A (BPA) linked with breast cancer

EU food agency finds BPA safe

Found in many products BPA causes cancer, diabetes, ADHD in lab animals

Trace amounts of BPA found in the urine of 93% of people studied

Introduction

Bisphenol-A, BPA, is a chemical found in polycarbonate plastic bottles and other food packaging. People receive very low doses of BPA from these sources. It is known that high doses are harmful. Some groups are campaigning to ban the use of BPA in plastic bottles because of suspicions that they increase the risk of breast cancer. Others believe that the evidence for harm at low doses is not convincing. The headlines above indicate some of the media reactions to research.

You will look at some of the evidence and attempt to reach a conclusion.

The problem is similar to that of low doses of radiation - it is hard to show small effects when there are so many other causes of cancer. It is also hard to prove a negative, that BPA does not cause cancer.

Background information

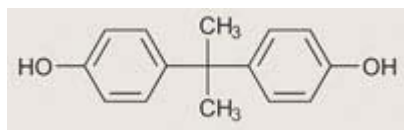
- Polycarbonate is used to make baby bottles, reusable water bottles and as the lining in metal food and drink cans. It is labelled with a recycling symbol as shown below, sometimes with PC next to it.

OTHER



- BPA is known to mimic the human hormone oestrogen and has been found to stimulate the growth of cancer cells in vitro.

- Tolerable Daily Intake, TDI, recommended by the EU is 0.05mg/kg body weight/day. This is 100 times lower than the dose at which any effect of harm has been definitively shown in animal or in vitro studies.
- Normal exposure ranges between 0.01 and 0.0015 mg/kg body weight/day, depending on diet.



The chemical formula of bisphenol-A
(only for those who are studying chemistry)

- The low-dose effect is a hypothesis that, for some substances, the dose response relationship is non-linear and very low doses can produce harmful effects not seen at higher doses. This effect is explained by the hormone activity of BPA.

The activity

In either group A or group B you will be given some evidence about harm from BPA at low doses. You have to present a summary of the evidence to students in the other group. They are studying the same problem but have been given different evidence. They will then summarise their evidence.

It is important that you consider whether Bisphenol-A is harmful at the sort of doses people might receive as result of using polycarbonate bottles and other food packaging. These very low doses are well below the usually assumed safe dose of 0.05mg/kg body weight/day.

In your group spend about 15 minutes reading the information you will be given and then deciding what you think about BPA. Include the following in your summary:

- Do you think BPA is a health risk?
- Evidence for your claim:
 - Give two pieces of direct experimental evidence for your claim.
 - Are the sources you have credible, might they be biased?
 - Are these animal or human studies? Does this matter?
 - Do you know if this research has been repeated?
 - Has it been published in peer review journals?
- Any further support for your claim
- Did you have any doubts about the evidence you have been given? Was there any counter-evidence?
- What action do you recommend?

Now share your claims and evidence with students in the other group.

Can you reach a consensus with the other group by sharing and discussing all the evidence?

If you can't reach a consensus what course of action would you collectively recommend?

Group A

1. Information from Breast cancer UK - BPA and breast cancer

Because BPA can mimic hormones there is a possibility that it can cause changes within the brain, the prostate and mammary glands, and can alter the age at which females attain puberty. Early puberty and potential changes to the mammary gland are risk factors for breast cancer.

Some animal studies have shown that pre-birth and early exposures to BPA can lead to changes in the mammary gland. The timing of the exposure to BPA may be more important than the dose. This is why baby bottles may present a particular risk.

2. Information from Friends of the Earth on the low dose effect

The "low dose" effect of BPA is now well established.

- About 85% of peer reviewed scientific studies show that low doses of BPA can cause harmful effects.
- Many of the studies that showed no low dose effect were funded by the plastics industry.
- One study showed that a low dose of BPA (relevant to human exposure) produced a 70% higher growth rate in prostate cancer cells than 100 times higher doses.
- Animal studies have also shown that early life exposure to BPA increases the risk of breast and prostate cancer

3. Information from the Royal Society of Chemistry

A review written by experts in the field and published in a respected peer-reviewed journal concluded 'the wide range of adverse effects of low doses of BPA in laboratory animals exposed both during development and in adulthood is a great cause for concern with regard to the potential for similar adverse effects in humans'.

A respected researcher is quoted as saying '[We have shown] that foetal exposure at environmentally relevant levels, down to 25 ng^{*}/kg-body-weight, increases the propensity to mammary cancer in rats, and alters the development of the mammary glands.'

Information taken from the following sources:

<http://www.breastcanceruk.org.uk/>

http://www.foeeurope.org/safer_chemicals/Blissfully_unaware_of_BPA_report.pdf

<http://www.rsc.org/chemistryworld/Issues/2008/April/BisphenolABabyBottleDebate.asp>

* 25ng = 0.000025mg

Group B

1. Information from the chemical industry - Bisphenol-A Low-Dose Hypothesis Not Confirmed

Two large scale studies clearly demonstrated that there is no low-dose effect from BPA. One of these was a three-generation study published in 2002. This study used 30 male and 30 female rats for each of 6 different doses of BPA ranging from 0.001 to 500 mg/kg body weight/ day. They followed three generations of rats with the same exposure. No effect on growth rate, reproductive success or survival of pups was found at any dose.

2. Conclusions from the US National Toxicology Program

Some reports of low dose effects are credible. However these all used doses at the high end of the low dose range and the dose was not given orally but by injection or release from implants. The findings would provide greater support for the low dose effect if they were able to be repeated at lower doses and using oral administration. The findings which showed an effect all used only one dose level not a range of different doses. There are more studies showing no low dose effect than showing an effect. Because there is so much variability in results it is vital that all studies should be repeated.

3. Evidence from the European Food Safety Authority

Human metabolism of BPA is different from that of rats. Humans metabolise and eliminate the substance much more rapidly than rats do. This means that a human fetus would have almost no exposure to any BPA taken in by the mother.

A newborn baby is able to rapidly metabolise and eliminate BPA at doses below 1 mg/kg body weight/day. This is a much higher dose than the safe limit of 0.05 mg/kg body weight set.

The differences between humans and rodents in metabolism of BPA mean that low-dose effects reported in rodents are of limited relevance to risk assessment in humans.

Information taken from the following sources:

<http://www.bisphenol-a.org/human/herLowDose.html>

<http://ntp.niehs.nih.gov/ntp/htdocs/liason/LowDosePeerFinalRpt.pdf>

http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1211902017373.htm