

'Toxins' in vaccines: a potentially deadly misunderstanding

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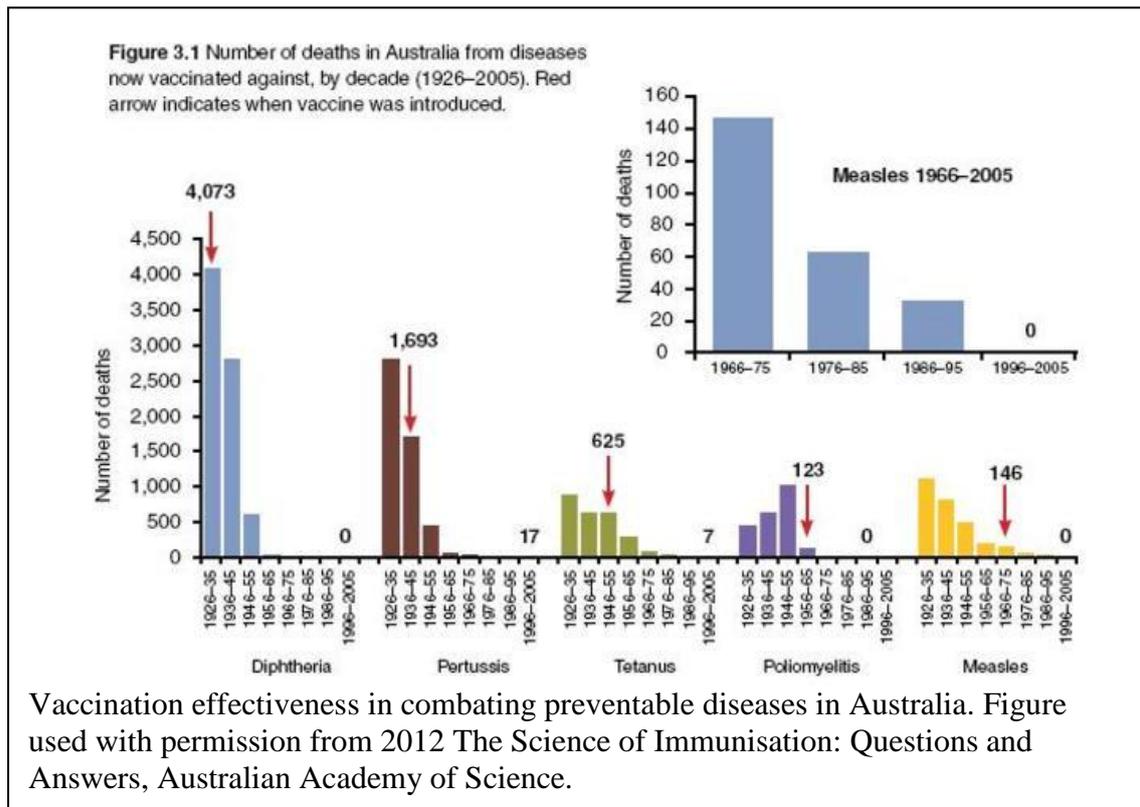
Vaccination is one of the most important preventative measures against serious illness, but its very success may be working against it.

With parents no longer having the experience of the devastating diseases it prevents, fear of vaccines has crept in, aided and abetted by groups that exaggerate and distort their possible harms. Vaccination rates are falling, and the scientific and medical communities are alarmed about the growing possibility of devastating epidemics of preventable diseases.

chemistry and toxicology. So let's have a close look at some of the "bad boys" the anti-vaxxers love to hate.

Formaldehyde

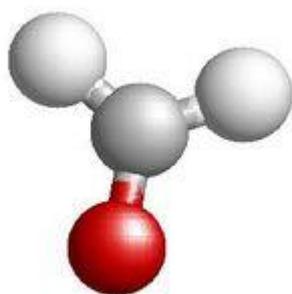
Formaldehyde has many uses – you may be familiar with its use in biology to preserve tissue. Formaldehyde is used in vaccine preparation to kill viruses or inactivate the proteins used. And traces of it can be found in some vaccines.



One contributor to the fear of vaccines is the notion that they contain toxins. But "it's the dose that makes the poison" and it's distressing that people's fears are being stoked by a lack of basic understanding of

Now, while drinking embalming fluid concentrations of formaldehyde is seriously bad for you, the amount present in vaccines never exceed 0.1 milligrams (mg) per dose, and are typically much less than

that. To put this in perspective, every time you eat an apple, you are eating between one and six milligram of formaldehyde. Yes, there is formaldehyde in fruit – plants make it as part of their normal metabolism (pears are by far the worst).



Formaldehyde, Molecule visualized in RasMol by Ian Musgrave

You also make formaldehyde as part of your normal metabolism. It's an essential part of the synthesis of amino acids and some of the components of DNA. At any given time, you have something like 2.5 mg of formaldehyde in every litre of your blood. This formaldehyde is being continuously generated as the enzyme formaldehyde dehydrogenase rapidly breaks it down.

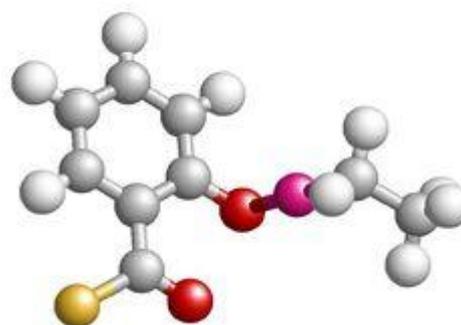
A typical two-month-old child has around 1.1 mg of formaldehyde in its body from normal metabolism, ten times more than the maximum possible dose she could get from vaccines. And less than what she would ingest from mashed apples.

Thiomersal

Thiomersal is the preservative ethylmercurithiosalicylate, which breaks down to produce ethyl mercury. Mercury is famously toxic, we only need to remember the disaster at Minamata (methyl mercury) and Lewis Carroll's Mad Hatter (mercury vapour) to realise that it's a potent neurotoxin.

But most of us of a certain age remember Mercurochrome, which was used as an antiseptic on cuts and grazes, turning our knees and elbows red – mercury is also a powerful antibacterial.

Multi-use vials are used during epidemics when there's a need to produce a lot of vaccine in a hurry and you can't afford to make it in single-use vials. When this happens, we need some way to prevent bacterial contamination and thiomersal is one such antibacterial.



Thiomersal, Molecule visualised in RasMol by Ian Musgrave

Most Australian vaccines don't contain thiomersal because we don't use multi-use vials as much as other countries. The mumps, measles and rubella vaccine never contained thiomersal, the diphtheria/pertussis/tetanus acellular vaccine in use since 1997 also doesn't contain thiomersal. Neither do Australian influenza vaccines.

Indeed, the only thiomersal containing vaccines in Australia are for Japanese encephalitis and Q-fever. The amount of mercury you would get from one of these vaccines is less than what you would get from eating a can of tuna (around 85 micrograms of mercury for a standard serve). And the can of tuna would have the mercury in the form of methyl mercury, which is expelled from our bodies much more slowly (half-life of about 50 days) than the ethyl mercury from thiomersal (half-life of about seven days).

Aluminium

Most vaccines contain materials to enhance the immune response to them and aluminium salts are one such material. Aluminium is the third most common element in the earth's crust, and it can be toxic. People on dialysis who have been exposed to higher than normal aluminium levels in their dialysis fluid over a long period of time show a range of adverse effects, including damage to the brain and nervous system.

But these levels (and how long people are exposed to them) are considerably larger than the levels we're exposed to in vaccines. Indeed, the amount of aluminium we are exposed to in our food and drink normally is much larger than any vaccine dose.



The mercury from tinned tuna takes longer to expel from your body than any mercury in vaccines. Keith McDuffee

You may be surprised to know that human breast milk has 40 micrograms of aluminium per litre, and infant formulas contain around 225 micrograms of aluminium per litre. Aluminium is also

rapidly excreted – half of any dose of aluminium will be expelled from the body within 24 hours.



If you weigh 80 kilograms, you could ingest 100 milligrams of aluminium in a day and still remain safe. davidd/Flickr

Guidelines for aluminium exposure (with a 30-fold safety factor built in) are for aluminium exposure to be less than two milligrams per kilogram of body weight per day. That means someone who weighs 80 kilograms could ingest 100 milligrams of aluminium in a day and remain safe.

All vaccines have less than one milligram of aluminium per dose, and most are below half of that. So exposure to aluminium through vaccines is negligible, and well below the already low risk threshold.

Antibiotics

Many vaccines are produced in tissue culture, which requires antibiotics to keep them sterile. The purification process used to produce the final vaccine can't remove 100% of all the antibiotics, so there's a residue.

There's quite a lot of hyperventilating about antibiotics in vaccines. Some antibiotics (such as penicillin) can produce hypersensitivity reactions, but such antibiotics are not used in vaccine production. Those typically used include neomycin, streptomycin and polymyxin B. Of these, only neomycin is present in detectable quantities, typically less than 0.025 mg per dose.

Neomycin can cause adverse events at doses of three grams per day or more. This is over 2,000 times the amount in a typical vaccine dose, which is clearly well below the threshold for adverse events in humans.

Antibiotic resistance also worries some people, but for bacteria to become resistant to an antibiotic, the antibiotic has to kill off some bacteria and let some resistant bacteria survive. The dose of neomycin in a standard shot is also well below that required to produce resistance, and we are generally not giving these vaccines to people with bacterial infections in the first place.

Don't panic

Weblinks for further information (hyperlinks in the original article)

The Science of Immunisation: Questions and Answers, Australian Academy of Science

<http://www.science.org.au/policy/immunisation.html>

Thiomersal and Australian Vaccines:

<http://ncirs.edu.au/immunisation/fact-sheets/thiomersal-fact-sheet.pdf>

Addressing parents' concerns: do vaccines contain harmful preservatives, adjuvants, additives, or residuals?

<http://www.ncbi.nlm.nih.gov/pubmed/14654615>

Diphtheria/pertussis/tetanus acellular vaccine

http://www.gsk.com.au/resources.ashx/vaccineproductschilddatadownloads/378/File/29F657A0F43EA02A5787CDBF0D2EB9FA/Boostrix_IPV_CMI_Version_2.0.pdf

Fact Sheets on Immunization in Australia

<http://ncirs.edu.au/immunisation/fact-sheets/>

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This is not an exhaustive list but it covers most of the toxins that anti-vaxxers are most concerned about. The remainder of the so-called toxins in vaccines bring up exactly the same issues as highlighted here. The presence of low levels of one of the most common amino acids in our body is apparently now a worry, and I will pass lightly over claims that sodium chloride (common salt) is a toxin in vaccines. There's really no reason that these compounds should keep people from getting vaccinated.

Vaccination has been enormously successful in reducing or banishing diseases that used to plague us and our children. It would be sad if these diseases came back because people didn't understand the role of dose in the adverse effects of chemicals.