

CHEMOPHOBIA

The excessive fear of small amounts of chemicals

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INTRODUCTION

In the early 1800's, about the time Wohler discovered how to synthesize organic compounds, people lived an average of about 30 years and it was a hard life. Now, because of chemistry and the fine chemicals produced by chemists, the life span is approaching 80 years and the quality of life is much, much better. Why then are so many people so afraid of "chemicals"? It is amazing how many people believe that only those compounds made in a laboratory are "chemicals" and that trees, coffee, clothing, soils, fruits, and vegetables are something else. This fear of "chemicals" is making life for individuals unnecessarily scary and is hurting the productivity of our entire nation.

EXAMPLES

A few examples will illustrate the magnitude of the problem. Several years ago, the traffic on a freeway near San Diego was held up for nearly four hours because of a "chemical spill." It was a sack of flour. A similar incident near Seattle turned out to be iron oxide (rust) used in magnetic tapes and paint pigment.

An auto accident occurred at an intersection and several rescuers got a white powder on them from the inside of one of the cars. A portable shower was set up in the intersection and 22 people made to shower. The powder was talcum powder used as a dry lubricant in the air bag that had opened.

A plant had a leaking 5 gallon unlabeled can of a "chemical". Six workers complained of headaches and nausea and were taken to a hospital. The plant management closed the plant and sent over 600 workers home. The "chemical" turned out to be ethanol. Were the six workers really sick, or were they just trying to make it look like it so they could sue later on?

A lady called an EPA office during the Alar scare and said she had part of a bottle of apple juice left and wanted to know if she had to take it to a toxic waste dump to dispose of it.

An additional fear is that of asbestos. If you worked building ships installing asbestos on the steam lines during WWII and smoked two packs of cigarettes a day then you have a problem with asbestos. However, the problem from environmental asbestos compared to other problems is not a problem.

Smoking (cancer only)	8,800/100,000 deaths
Motor vehicle deaths	1,600
Skiing deaths	220
One beer/day	150
Drowning	140
Frequent airline passenger	110
Diagnostic X-rays	75
Cycling	75
Drinking New Orleans water	7
1 Transcontinental flt/yr	4
Lightning	3
1 Charcoal grilled steak/wk	3
Environmental asbestos risk	1

If a person (a school child) spent 6 hrs/day, 5 days/wk, 36 wks/yr in a room with an asbestos ceiling producing 0.001 fibers/cc (a high value) for 10 years, that person would have the same risk of cancer as if they had smoked a total of 5 cigarettes or lived in a brick building for 7 months. Furthermore, the form of asbestos that causes the problem is only 10% of our asbestos.

Relative risk

Alar Apple	Chlorinated Water	Peanut butter sandwich	Mushroom
1	10	60	600

Let us compare an Alar treated apple, a glass of chlorinated water, a peanut butter sandwich and a mushroom. Set the risk of getting cancer by eating one Alar treated apple a day for a generation as 1. If you drank one glass of chlorinated water a day for a generation your risk would be 10 due to the chloroform present. A peanut butter sandwich a day, which contains aflatoxins, would be 60, and the mushroom a day, which contains unsymmetrical dimethyl hydrazine, the same as in the Alar, would be 600. Guess which one has been banned?

HOW DID THIS START? WHAT KEEPS IT GOING? WHAT ARE THE FACTS?

What kind of fear must be installed in a person so that if they are driving down a highway and see a white powder on it that they call 911 and report an emergency? What kind of education do the people that respond to these "emergencies" have that forces them to close a highway?

There are six factors, taken together, that seemed reasonable at the time, that I believe have created the problem. (1) the fear of getting cancer, (2) people living longer, (3) accelerated feeding studies and cancer, (4) belief by some that only one molecule is necessary to cause cancer, (5) the Delaney amendment of 1958, and (6) the development of analytical techniques that can detect almost unbelievably low levels of any element or compound.

The fear of cancer.

Cancer has always been a dreaded disease. You can have it at a fatal level before you know it, you can linger for years, it can be painful, we really don't know exactly what causes it, and for a long time there was not much hope.

Living longer.

After WWII the chemical industry began producing pesticides and herbicides in large quantities and developed many new drugs. Taken together, these chemicals were a major reason for people living longer. They had better food and more variety and if they got sick there was usually a cure. The average life span began increasing significantly. The incidence of cancer also seemed to be increasing. Why was it increasing? What had changed? The answer seemed to be that the chemical industry was making all of these toxic substances and spraying them on our food and it must be related. Increased smoking was also implicated.

It was not known at the time, but the incidence of cancer in mammals increases naturally as the fourth power of age and this was in large part why more cancers were being observed. Because of adequate high quality food and drugs, people were living longer, out to where the curve began to rise naturally, so you would expect more cancers. Our natural immune system begins to wear out. This is why we now have age corrected statistics. However, the damage was done. Initially, chemists thought it was so ridiculous that no one would believe it and didn't refute the charges, but they were wrong. When you now try to refute the charges, they say you have a vested interest so you are not to be trusted. I do have a vested interest. I have three children and six grand children and I want a safe world for them to grow up and live in.

Accelerated feeding studies and cancer.

The statisticians determined that to detect the weakest carcinogens would require about 2,000 rats for a control and 2,000 for the test and they should be tested for two-thirds of their natural life or about 78 weeks. Combine this with all of the dissections and organ examinations and this becomes expensive, from several hundred thousand to several million dollars per test. The net result was that only

about 100 compounds were tested worldwide annually.

Based on the effects of concentration on kinetics, it was decided to increase the dosage to reduce the number of rats and the length of time. Now a standard first test is 50 males and 50 females for 30 days at 75-100 times the normal dosage. Cancers at the site of injection are not counted. I guess we should be grateful that they didn't discover that a 10°C temperature increase would double the rate or they would be putting the rats in muffle furnaces!

The first compounds tested were the pesticides and heavily used industrial chemicals. The results indicated that about 50% of the compounds were carcinogenic to rats. Nonetheless, the news media gave this much attention and the general public began to fear "chemicals." The cry went out to remove those compounds from the market place.

It is now believed that cancers start when cells divide rapidly, such as in a healing process after a disease or a wound and the immune system breaks down. Because of the irritation caused to the system by the chemicals ingested during the accelerated feeding rates, and cancers at the point of injection are ignored. There is much doubt now as to the validity of the tests. However, these tests in some form will be with us for a long time.

The one molecule theory

This was further complicated by a group that insisted that if you were exposed to even one molecule of the compound it was only a matter of time until you got cancer. One line of reasoning is that if a molecule of the carcinogenic compound adds to the DNA instead of one of the four normal bases then the DNA cannot bond with what it is supposed to. When the DNA then replicates this is the beginning of a cancerous cell. We know that the body repairs its cells to remove such additions about 100 times a minute so the one molecule theory is incorrect. We also shed the outermost layer of cells daily so any effected cells are disposed of. If the one molecule theory were true, then the human race would have expired long ago because of all of the natural carcinogens in our foods. What this proposal did however, was to instill more fear in the general populace since it received much attention by the news media. The concept of a no effect level, which is present for all compounds in other situations, was not accepted by them. Again as chemists, we thought this was so ridiculous that no one would believe it and we did nothing to refute it at the time. We were wrong, a great number of non-chemists believed it.

The Delaney amendment

About this time (1958) Congress was revising the Food, Drug, and Cosmetic Act and congressman James Delaney, whose wife had just recently died from cancer, added an amendment to the bill which in principle sounds correct, but which has caused much grief in practice.

The amendment said essentially that "No chemical known to cause cancer in any test animal in any amount can be added to our food supply." This sounds reasonable; certainly no one would want to add something that under normal circumstances would cause cancer or any disease. Who would have believed how "any test animal and in any amount" would be interpreted. They now have inbred animals that are susceptible to cancer and by using accelerated feeding studies, you can increase the incidence of cancer, then using the one molecule theory many compounds now must be removed from the market place even though there is no real evidence that they have ever caused a problem.

Some of the items that have been taken off of the market because of the Delaney amendment and what you would have to eat to have a risk equivalent to that of the rats.

Cyclamate - 552 10 oz glasses of soft drink/day.

Oil of calamus - 250 quarts of vermouth /day.

Safrole - 613 12 oz bottles of root beer or 220 lbs of hard candy/day.

1,2-dihydro-2,2,4-trimethylquinoline: plasticizer used in packaging material.

If all foods were wrapped in it; 300,000 x daily diet.

4,4'-Methylenebis(2-chloroaniline) plastic curing agent in food contact surfaces; 100,000 x daily diet.

Diethylstilbestrol - used as a growth promoter in animals and an abortion inhibitor in humans. It has since been found that if 75 mg are taken within 72 hours of pregnancy that it will cause an abortion and this treatment can be prescribed in cases of rape. Based on findings of 5% of liver samples containing 2 ppb of DES and assuming that 2% of the average diet is beef liver, a person would have to consume 5,000,000 pounds of liver for 50 yrs to equal the intake from one treatment of the day-after oral contraceptives.

Nitrate in bacon - could produce nitrosamines if reduced to nitrite in the intestinal tract or elsewhere. You would have to eat 15,000,000 lbs of crispy fried bacon/day to get up to the beginning effect level.

Improved analytical techniques

If you can't detect it, it either doesn't exist or is not to be worried about is a popular thought in some circles. The Delaney amendment says no amount or "zero." What

was zero in 1958 is no longer true today. When I graduated as an analytical chemist in 1959 I felt that with an emission spectrograph I could detect many metals at one ppm. Today, with a graphite furnace atomic absorption instrument I can easily detect most metals at a ppb and many at a ppt, yet the Delaney amendment concept has not been changed to reflect what zero is.

The flame ionization detector had just come into being for organic chemicals and was also good to about one ppm. Many pesticides were being done by paper chromatography and color development at about one part per thousand. Today with a Hall detector I can detect most pesticides nearly one million times better. Again the law has not been changed to reflect this. We are still chasing zero. As I told my students, our ability to detect has far outstripped our ability to understand.

The sum of these factors on the general public

Cancer is to be feared. It is associated with industrial chemicals, about 50% of which are carcinogenic to animals, never mind the overdose levels. One molecule might be enough to start the process, and we can now detect these "chemicals" in almost everything. These have combined to cause a deep seated suspicion and outright fear of industrial chemicals by the general public.

THE ACTUAL SITUATION

Most chemists did not believe the above summary because they knew that our foods just naturally contained carcinogens, and in high concentrations in many cases, and these might be the major cause for the cancers. However, no large body of data were available to support that belief.

The Ames test

Professor Bruce Ames, head of the UC-Berkeley Biochemistry department, developed a much quicker, although indirect, method for detecting carcinogenic compounds. One theory of cancer production was that there must be a mutation of the cell before cancer would begin. He was working on a method to test for mutations and realized that maybe the test might also detect those compounds that caused cancer. A comparison of those compounds that caused mutations and those that caused cancer in animals showed a 90% correlation. While it wasn't 100%, it was close. Of more importance was the fact that the test could be done in a few days once it was set up and at a cost of only several hundred dollars rather than millions.

Now all industrial chemicals could be tested and most were. Again about 50% were found to be carcinogenic and the cry went up to ban these chemicals. However,

now other compounds could be tested as well and naturally occurring plants and animals were tested. Low and behold, about 50% of all of the compounds in nature were carcinogenic, mutagenic, or toxic; the same as the industrial chemicals.

As professor Ames explained it; plants have no legs to run away, no teeth or claws to fight with so they must rely on chemical warfare to survive. For those plants measured it has been found that from 5-10% of their weight on a dry weight basis are either carcinogenic, mutagenic, or toxic.

Dr. Ames then compared what a person receives from pesticide residues with what they receive from nature. Based on 30 years of FDA pesticide measurements on foods, he calculated that an average person's intake was about 150 micrograms, of which 105 micrograms are known not to be carcinogenic in animals. Comparing that to the amount found to occur naturally in the food you eat, you are getting exposed to 10,000 times more carcinogens, mutagens, and toxic substances naturally than from pesticide residues. You may worry about getting cancer, but industrial pesticide residues will not be a likely source of the problem.

If you drink just one cup of coffee, based on the methylglyoxal and hydrogen peroxide present, you will get 80 times more carcinogens than from the pesticide residues all day. Yet, I don't see groups trying to get coffee banned.

WHAT KEEPS IT GOING?

I can identify three areas at the moment; special interest groups, the news media, and exotic court cases.

Special interest groups

These include groups like the National Resources Defense Council, the Center for Science in the Public Interest, the FDA, EPA, and CDC. These groups get their budgets based on fear. If there is no fear, there is no problem, and no budget.

I understand that contributions to NRDC increased 40% after Alar. They use worst case scenarios and sometimes with selected data. NRDC's model predicted 672 deaths from a salmonella outbreak in the Chicago area; actually there were six. EPA's model estimated 85 tumors from ethylene dibromide (EDB) from 156 Dow Chemical workers, when the average was 30. Dow workers had only 8 tumors.

Alar is an excellent example of how the same data can be interpreted in different ways. It was found that unsymmetrical dimethyl hydrazine was an impurity in Alar and when it was fed to rats at a 29 mg/kg rate, several died, but one got cancer. Subsequent studies from 10 to 23 mg/kg found no cancers. However, NRDC, using

the one study, and assuming a worst case scenario, calculated 240 additional deaths/million population/generation. This was deemed to be too high and Alar should be banned. No matter that a child would have to be exposed to 35,000 times the normal exposure per day for this to happen.

The EPA used all of the data, but also assumed a worst case scenario. They calculated 2.4 additional cancers/million/generation and since 1/million is the goal then this was too high, but controllable. The California Department of Foods and Agriculture used all of the data, but calculated a "most likely situation". They determined 3.5 additional cancers/TRILLION/generation. Yet Alar has been banned because of the Delaney amendment.

What was Alar used for? It kept apples on the tree until they were fully ripened, gave them a firmness that people preferred when eating them and reduced bruising during picking. It also permitted them to develop a full color. In general, it reduced waste considerably and produced a superior product. When I was small we had many apple trees on our farm. To get a completely red apple with no scabs, no bruises, and no worms was a near miracle. The number of "drops" was sometimes over half of the crop. The neighbor's hogs had plenty of bad apples to eat.

News media

The problem here is how it is reported. For example, a TV station in Kansas City reported that there were 55 barrels of deadly dioxin in a Missouri site. Actually there were 55 barrels of PCB's with a few ppm of dioxin in each.

A woman's magazine stated that the FDA and USDA had found diethylstilbestrol (DES) in meat and DES is carcinogenic. I asked my students how they interpreted that and they said that all meat contained DES and that they might get cancer. The facts were that FDA had found DES in 9 out of nearly 1100 livers checked (where DES concentrates) and the USDA had found DES in 6 of 1800 livers with an average of 4 parts per billion. This is clearly not a problem, but it appeared to the readers that meat was unsafe to eat.

Exotic court cases

There is a belief in some quarters that all industries have deep pockets so soak it to them. The fact that many industries are barely hanging on, is not considered. Every time a suit is won by an alleged victim, this gets front page coverage. If the company wins it may not even be reported. The impression is that if you feel you have any medical problems, and have worked with chemicals to some degree, you can sue the company for millions. That you can be counter sued if you lose is never mentioned and some companies are now doing this.

DO YOU WANT TO GO BACK TO THE GOOD OLD DAYS?

There is strong sentiment in some quarters to halt the application of all chemicals on our plants and animals and to do it like we did before WWII. Norman Borlag, who received the Nobel Prize for his work on the green revolution, has calculated that if you went back to the methods and equipment of the 30's, in order to feed our nation with its increased population and in the manner it has become accustomed, it would take an additional land mass equal to all of the land east of the Mississippi river minus Michigan, Wisconsin, and Illinois. We don't have that land.

HOW DO WE STOP IT?

Use truth and common sense. Start fighting back. First we make sure our house is clean. We must insist on the proper application amounts, applied at the proper time, and insist on proper handling techniques. The workers that actually manufacture and apply these chemicals must be well protected. Just because nature is giving you 10,000 times what the residues are, is no reason to act foolish.

Put signs on sprayers stating that the spray is 98% water and not all pesticide. A favorite news item is to show a cyclone sprayer spraying a heavy mist over a wide area. Most viewers believe that this is all pesticide, not a 2-3% solution in water. Write letters to the editor with the facts when someone has misstated something involving chemicals, and don't let George do it - you do it -so first, it gets done, and second, so it gets done correctly.

USING UP OUR MANPOWER AND FINANCIAL RESOURCES

In view of increasing international competition do we want to tie up our best scientists doing research in what are really non-problems? This nation has spent an estimated one billion dollars studying dioxin and yet this compound has not produced one single verified human death in the entire world. It is extremely toxic to ducks and chickens, but humans appear to have a several thousand fold increased tolerance.

It is not limited to this nation. In Winnipeg, the government spent \$20,000,000 to teach chemistry and \$150,000,000 to remove PCB's which are less toxic than aspirin.

HAVE YOU LEARNED ANYTHING?

Would you place this combination of chemicals in YOUR body? A mixture of water, caffeine, tannin, butanol, isoamyl alcohol, hexanol, phenyl ethanol, benzyl alcohol, geraniol, quercetin, 3-galloyl epicatechin, and 3-galloyl epigallocatechin? Iced tea.

Would you eat this? A mixture of starches, cellulose, pectin, fructose, sucrose, glucose, malic acid, citric acid, succinic acid, anisyl propionate, amyl acetate, ascorbic acid, beta carotene, riboflavin, thiamin, niacin, phosphorous, and potassium? Fresh cantaloupe.

Would you put this on your body? A mixture of zirconium-aluminum-glycine-hydroxychloride complex, water, PEB-10, stearate, glyceryl stearate, glycerin, refined paraffin, isopropyl palmitate, magnesium aluminum silicate, and fragrance? Roll-on antiperspirant.