In February 1977, a 42 year old woman was admitted to the hospital with deep jaundice, shivers and hemolytic anemia - a type of anemia where her red blood cells were being destroyed faster than her body could make them. She had developed a “hepatic precomatose condition,” - a type of impairment of consciousness you see in severe liver disease. The doctors found she had a shrunken liver and an enlarged spleen.

With multiple red blood cell transfusions, the woman recovered, but the cause of this mysterious liver disease eluded doctors for quite a while. One day the husband suddenly brought over some cooked blackberries. This was a bit odd since he rarely visited her and in fact, hospital staff advised her not to accept any outside food. They decided to feed the blackberries to some mice. ...The mice died. They sent the blackberries off for analysis and found that they contained about 300milligrams of the nitrosamine N-Nitrosodimethylamine, NDMA.
Unfortunately the woman’s recovery was only temporary. After discovering the details of her assasination, her mental and physical state progressively worsened over the following months. The husband was convicted but unfortunately the woman died.

[Source: *Lethal Exitus of a Patient with N-Nitrosodimethylamine Poisoning, 2.5 Years following the First Ingestion and Signs of Intoxication]*

So what does this have to do with bacon? In fact, Nitrosamines are the cancerous compounds suspected to form from the nitrate and nitrites found in processed meat. But the dose the woman was given was 300 milligrams - just how big is that? We’ll get to that in a moment.

“The alarming warning from the World Health Organization’s cancer research arm that goes like this: processed meats cause cancer and red meat probably does too.”

In 2015, the IARC declared that processed meat is a carcinogen, a cancer causing agent, and that red meat is a *probable* carcinogen. The IARC identified suspect harmful compounds in processed meat like nitrates and nitrites, and analysis of more *than 800 observational studies* is what led them to their conclusion.

Billowing Backpacks radioactive man, that’s a lot of studies! However, in the report, all the 127 studies on colorectal cancer, as shown in table 2.2, used questionnaires as the data collection method.
Actually this type of study, an observational study, is very very common in nutrition research.
The questionnaires usually have a similar format - Here’s one from Cambridge University.
Do you happen to know what your average use of bacon was for all of last year?
Then, what these questionnaires have difficulty taking into account is: Do you eat your bacon like this or like this? Or like this?

Back in 1994, a study “found” that hot dogs increase brain cancer risk in children.
I thought this newscaster had a decent point - think about the type of people who eat the most hot dogs - what other foods are they likely to eat more of? Maybe more potato chips, more coca

cola or more french fries?

For the record, I'm not here to say processed meat is some great health choice. I'd say if you're going to eat meat, then make it good quality fresh meat. But, let's be realistic: is a breakfast of an egg, avocado, and some bacon really that bad for you?

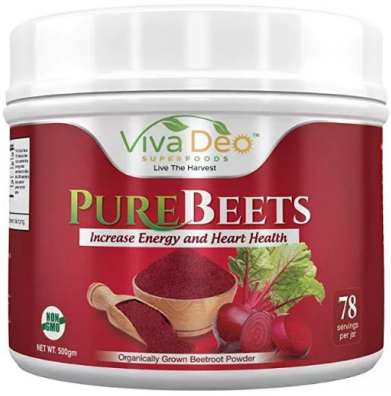
The main suspect bad compounds put specifically in processed meat, not fresh meat are nitrates and nitrites. During heat processing of the meat, a small portion of the additive sodium nitrite is suspected to turn into the cancerous **nitrosamines** like the earlier mentioned NDMA. But not only that, the acidic nature of our stomach is suspected to allow nitrates and nitrites to turn into nitrosamines *in the body* during digestion.

Now, there are some major issues with the nitrate nitrite idea.
First, both compounds are found in vegetables. This study found that 42% of the dietary nitrate in women from Shanghai was coming from greens.[1,2] This study found that in italians vegetables provided *5.5 times* the nitrate and nitrite of cured meat.[R] In fact celery juice which has very high concentrations of nitrate, and is used to make the all natural "no added nitrates or nitrites" processed meat.

In fact, there is a cycle in the body where nitrate is turned into nitrite and nitrite is turned into nitric oxide then nitric oxide is turned back into nitrate. Part of this cycle takes place in the mouth, so there is naturally plenty of nitrite in our saliva.

OK So nitrite is reduced to nitric oxide in the body… and Nitric oxide is regarded as essential for health because your body uses this molecule to relax blood vessels. This paper refers to both nitrate and nitrite as nitric oxide ***therapeutics***. As the paper explains, nitrate and nitrite have been shown to be good for blood pressure, mitochondrial efficiency, exercise performance, and have a therapeutic effect on pulmonary hypertension.[R]

Which is why, you'll find nitrate *supplements* like these beet root powder ones designed to improve blood flow and heart health, reduce blood pressure and improve exercise performance.



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Hold on a minute, because the point is not that you should be scared of bacon and celery sticks and beet powder . A Chemist and Biochemist who has published relevant research in several journals like the American Journal of Physiology, Dr. Mark Miller, says that nitrate and nitrite are not nitrosating species - that is, these molecules cannot directly form cancer causing nitrosamines, so whether your bacon contains inorganic sodium nitrite or all natural nitrate from celery juice, it's not getting turned into the cancerous nitrosamines in the body. I won't get into the details, but in the description I'll link to an article where he clearly lays out the chemistry and biochemistry.

Moving on, here's a study where researchers wanted to see how processed meat affected the development of colon cancer. They first injected the rats with azoxymethane, a compound known to cause colon cancer. Surprisingly, they found that not only did a bacon diet not cause cancer, it actually consistently protected them from the cancer- bacon *reduced* the number of precancerous lesions in rats injected with the azoxymethane. I guess NBC wasn't told about this "bacon prevents colon cancer study." But of course this is just one study, so let's move on.

What about cancerous Nitrosamines already present in bacon, frankfurters or salami thanks to heat processing. Nitrosamines are definitely bad for you, that's not in question - in high enough doses they mess up your liver, and can cause cancer. But precisely how much can a human tolerate without having any issues? After all, few people would suspect a daily half glass of wine to be bad for you. In fact, we've been told it is good for us. But, 50 half glasses of wine in one night could cause serious injury to your liver. The dose is important.

So, we need to use some logic to get an idea of how much nitrosamine a person can tolerate:

This is a table from the IARC report looking at nitrosamines in processed food. The LD-50 is a measure of toxicity looking at what dose will kill half of the people given that dose. Based on LD50 data, the nitrosamine NDMA appears to be the most toxic.[R,R2,R3,R4] Ironically red wine contains this nitrosamine too.

NDMA - this is the same compound given to the woman mentioned at the start of the video.

300 milligrams of NDMA is the amount she was given in the blackberries - how much processed meat do you have to eat to get that amount? Based on the highest value provided in the table from the IARC, 84 micrograms per kilogram of Frankfurters, you would need to eat 3500 kilograms, more than the weight of a Hummer H2 of frankfurters to get the same dose as the woman with the liver issues.

But we don't want to know how much to eat to die, we want to know how to not get cancer. This study put various doses of NDMA in the drinking water of over 4000 rats and found that "*since the experiment continued on into extreme old age, effects became measurable at doses of only 0.01 to 0.02 mg/kg/day,*" that is, they only got the cancerous tumors at .01 mg/kg per day and higher.

Using Anroop Nair's human equivalent dose conversion, we can estimate that a 70kg human would need a dose of .0013mg or 1.3 micrograms per kilogram of NDMA. So, assuming we can apply this mouse data to humans, you would have to eat 1.1 kilos or about 2 and 1/2 pounds of Frankfurters a day for several years to develop a cancerous tumor at some point in probably the second half of your life. That is 80 times the amount of Nitrosamine the average American actually consumes daily.

To give you some perspective, the LD50 of Oxalate is 25 grams, boiled spinach is about 0.60% oxalate, meaning 4.3kg of boiled spinach, eaten once, has a 50% chance to kill you.

I'm not trying to say Nitrosamines are harmless. The point is, if we're going to point at a substance in some food as a mechanism for that food being bad, we need to be realistic with the dose - *how much* of that substance is bad for a person? And, what is a realistic intake of that substance?

There are many other ideas for why processed meat is bad for us that I didn't explore, but most of these can be applied to red meat in general, so we'll take a look at those in my next video.

One more thing, the IARC report concluded that "*Each 50 gram portion of processed meat eaten daily increases the risk of colorectal cancer by 18%.*" That doesn't mean people who eat processed meat raise their absolute risk of colon cancer from zero to an 18% chance. What that really means is, for example for 100 Australians not eating processed meat, over their lifetime, 8

(7.9%) will get colorectal cancer. For 100 Australians eating 3 slices of bacon a day, 9 (9.2%) will get colorectal cancer.

The other thing about this report, if you're familiar with epidemiology you'd know that a study with a relative risk under 2 is probably noise and should be thrown out. More than 2/3rds of the studies did not find a relative risk over 2.

For the record, I'm not saying we should all eat more processed meat. I rarely choose to eat processed meat and I think meat quality needs to be prioritized much more by those who can afford it. I just wish arguments for or against foods were more realistic.