How Risky is Risky?

The Use of Risk Assessment in Establishing Safety

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What This Talk Will Cover

- Definition of risk and risk assessment as applied to food
- How differences in risk perception color the analysis
- Dioxin
- Nitrate – from villain to essential nutrient?
- Heat-produced toxins in food
Lifetime ~ 80000 meals

- 600 chickens
- 1500 lbs. beef
- 4000 loaves of bread
- 1200 lbs. potatoes

No wonder we all think of ourselves as food experts!
I eat, therefore I know.

Top Food Safety Stories 2012

- 27 microbial - Salmonella, Listeria, E. coli, Yersinia
- 2 involved foreign objects – metal, plastic
- 1 cow with BSE in California
- 1 involved chemical contamination
  - Pickles in Poland – used road salt
  - Not food grade - a mixture of Na, K, Mg, Ca chlorides
- Other selling of expired goods, bribery, pink slime etc

N=38
Premature Deaths/Year

Poor diet related

- 33% ↑ risk for cancer and coronary heart disease

Texting while driving

- 6000

Food-borne illness

- ( > 1,600 – known agent)
- 48 million people (1 in 6) get sick – 128,000 are hospitalized
- Poultry 19% of the deaths
- Fruits-Nuts, Fungi vegetables, Leafy vegetables, Root vegetables, Sprout vegetables, Vine-Stalk vegetables - 46% illnesses

http://www.oddee.com/item_98002.aspx
Premature Deaths / Year

Getting in or out of bed: 100
Choking children <10yr: 77
Accidental pesticide poisoning: 27
Vending machines toppling: 13
Pesticides and chemicals in food?:
GMOs or veterinary drugs in food?:

http://www.oddee.com/item_98002.aspx
Food Risk & Public Perception

- Under-assesses the risk associated with some microbiological hazards
- Over-assesses the risk associated with other hazards, pink slime, pesticides, GMO, arsenic, most chemicals

Media have the ability to improve awareness and knowledge but information is incomplete or misleading.

**Risk - WHO**

<table>
<thead>
<tr>
<th>Risk Assessment</th>
<th>Risk Management</th>
<th>Risk Communication</th>
<th>Risk Analysis</th>
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<tbody>
<tr>
<td>is using scientific</td>
<td>includes all activities undertaken to control a hazard</td>
<td>is the exchange of information and opinions about a hazard among concerned parties.</td>
<td>is accomplished through the efforts of separate but integrated assessment, management and communication teams</td>
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<td>information to describe the likelihood and magnitude of harm attributed to a specific hazard</td>
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**Toxicology and Epidemiology**
Risk Assessment of Food Chemicals

The process of quantifying the probability of a harmful effect to individuals or populations from chemical X added directly or inadvertently or leached into food. No formal process is used for naturally occurring substances in food.

The real issue is determining whether a hazard might occur from chronic consumption of a low level of X. Toxicology and epidemiology
Risk Assessment of Food Chemicals

- Requires knowledge of **special susceptibility by vulnerable groups**
  - If the susceptible group is small, how should their needs be addressed

- Special treatment of **carcinogenic, mutagenic, genotoxic**
  - 1973 FDA - Concentrations not allowed if it increases risk greater than 1 in a million lifetime
Determining Acceptable Level of Risk

“Acceptable" if 1 in 10,000 lifetime risk
- Provide some protection for exposure to multiple chemicals

1 in 1,000,000 in a lifetime –1973 FDA - carcinogenic, mutagenic
- Still a number of adverse events in a large population

Lower or zero-risk may not be technologically feasible or may be prohibitively expensive
- Possible only with the suppression of the risk-causing chemical which may introduce an unintended consequence
- The problem with chasing zero
Case Studies
Dioxin Recommendations

- **EPA reassessment in 2010**: <0.7 picograms (<1 trillionth g/kg bw/d)
- **WHO**: 2.3 picograms/kg bw/d
- **EU**: 1-4 picograms/kg bw/d
- **Ave. US intake**: 0.5–3 picograms/kg bw/d

“The Most Toxic Chemicals Known to Science”
www.ejnet.org/dioxin/
Dueling Experts - Dioxin

1. **High levels dioxins in farmed salmon** - especially Scottish salmon
   Group of scientists recommended eating no more than 2-3 sv/yr (2004 report)

2. **FDA FSA WHO** - no cause concern for people eating salmon 1X/wk
   - Levels of current average consumption far below level of concern
     - Dioxins do not bond DNA directly → bind to a receptor site
     - Likely a level at which there is no effect and allow normal cell functioning
     - People need the health benefit of oily fishes

3. **EPA** - dioxins can cause cancer at any dose and this is a linear dose relationship
   - → Adherence to the EPA position - difficult to eat a balanced diet because of the ubiquity of dioxins in food.

Hites et al. 2004
Toxicologists and Dioxin

Evenly mixed
- Even split - use of animal studies to estimate human toxicity

Data Compared
- Pacific wild salmon compared with farmed Atlantic salmon
- No difference in levels when fish were drawn from the same ocean

Political, ideological and personal issues/ agendas
- American scientists stirring up trouble for Scottish industry
- Environmental concerns mixed with food safety
Dioxin

Recommendations

If people try to meet the EPA 2010 level of <0.7 picograms (<1 trillionth g/kg bw/d)

Any potential unintended consequences?

Food Industry Dioxin Working Group - International Dairy Foods Association, the American Frozen Food Institute, and the National Chicken Council wrote “EPA’s proposal… nearly every American – particularly young children – could easily exceed the daily RfD after consuming a single meal or heavy snack....”

What should the risk assessment be?
Heat-Induced Toxins

Claes Oldenburg  1960s
Whitney Museum NYC
Heat - Induced Toxins

- High heat and deep frying
- Formation of potentially carcinogenic agents
  - Polycyclic aromatic hydrocarbons
  - Aldehydes
  - Acrolein
  - Heterocyclic amines
  - Acrylamide
Heat-Induced Toxins
Prostate Cancer Attributing the Cause

• Prostate cancer case 1545 control 1492

• Tertiles of intake - deep fried food
  • Low <1 wk vs high > 21 x/wk (3X/d)

• OR > 1.3 French fries, Fried chicken, Fried fish, Doughnuts

• No assoc. snack chips (OR = 1.08)

• ??? Regular intake of deep fried foods and/or other aspects of the Western lifestyle?

Stott-Miller et al, 17 JAN 2013 Prostate DOI: 10.1002/pros.22643

From pizza and burgers to scorpions and jelly beans, you can deep fry almost anything. - Chicago Tribune
Fried food - Risk

- Fried food - No association all cause mortality
  - HR 0.93  ns

- No difference olive oil vs sunflower oil - Myocardial Infarction (MI)

- No association non-fatal MI - case-control Costa Rica

- INTERHEART - positive association with acute MI
  - case-control study conducted in > 50 countries

- Associated with obesity (Italian and Spanish studies)

Spanish EPIC 40,757 adults aged 29-69
Guallar-Castillón et al.  BMJ 2012;344:e363
Fat and Fried Food - Risk

- Reused oils - higher prevalence of arterial hypertension
  - Industrial deep fryer at 190 °C. 40 hours (8 hours a day)
  - unsaturated aldehydes
  - Linked to some cancers & neurodegenerative diseases such as Alzheimer’s and Parkinson’s.

- Random inspections of 5,995 food items such as deep-fried chicken, sausages, fried chips, meatballs and pork snacks
  - ~10% had polar compounds >> limit of 25% of the used oil

Heterocyclic Amines (HCA)

- 20 HCAs formed during cooking
  - mutagens & risk factor for human cancer

Well done meats, pan drippings, and crispy meat surfaces
- HCA well-done meat - 3.5 X > than medium-rare
- Well done assoc. with cancer risk, rare no assoc.
- Amts and species highly dependent on conditions
- Chicken breast
  - Charcoaled 112 ng/g > Pan fried 8-27 ng/g > Roasted 4 ng/g
- Fried bacon 17.59ng/g fried pork 13.9ng/g

Heterocyclic Amines (HCA)

- No effect of meat, meat cooking preferences, meat mutagens or heme iron on lung cancer risk in the prostate, lung, colorectal and ovarian cancer screening trial
  - N=99,579 ages 55-74

- NIH-AARP Diet and Health Study
  - Afr-Amer subset - red meat at high T° increased risk of prostate cancer
  - Not white meats or processed meats

Alternates to Cooking

Raw Thanksgiving Turkey???
Nitrates
From Carcinogen to NO
Nitrate to Nitrosamine

Nitrosamines - a most potent group of carcinogens

Formed during frying, smoking and food preserved with pickling salt and in the acidic conditions of the stomach

Reaction of secondary or tertiary amino compounds and nitrite or nitrogen oxides

Beers, cheeses, sausages, smoked and pickled foods

- N-nitrosodimethylamine
  0.049 - 16.47 mg/kg

- Smoked sausage – highest

300 compounds fed to animals ~ 90% are carcinogenic

Ciemniak A. Rocz Panstw Zakl Hig. 2006;57:341-6
Nitrates and Cancer Risk

NIH-AARP Diet and Health Study  N=490,194

50–71 years of age

Nitrate and nitrite ingestion were NOT associated with stomach cancer risk

But Low intake of vitamin C + high nitrate increased risk
  nitrate    HR = 1.40    nitrite    HR = 1.52

Processed meat nitrite and nitrate were NOT associated with risk among those with either high or low vitamin C intake

Nitrates, NO and Reduced CVD

- **Nitrate-nitrite-NO pathway**
  - Endogenous /dietary nitrate $\rightarrow$ nitrite $\rightarrow$ nitric oxide (NO) in various tissues
    - May reduce inflammation and be antibacterial

- **Impaired bioavailability of NO**
  - Critical regulator of vascular homeostasis $\rightarrow$ a major problem in cardiovascular disease (CVD)
    - In the absence of co-administration of a carcinogenic nitrosamine precursor, no increase cancer
  - “Nitrite (as well as nitrate-rich diet for long-term applications) may hold promise as therapeutic agent in vascular dysfunction and ischemic injury, as well as an effective compound able to promote angiogenesis.”

Nitrate in Vegetables

↑ consumption of vegetables ↓ risk CVD

Vegetables ~80-85% of daily exogenous nitrate intake
⇒ possible contributor to CVD health benefits of vegetables

Nitrate Intake

Mean usual intake: 1.38 mg/kg bw/d (38% ADI)

Highest consumers (97.5%): 2.76 mg/kg bw/d (76% ADI)

- Vegetables (especially lettuce): 50%
- Water/foods prepared with water: 20%
- Meat: 6%
- Cheese: 0.2%
- Highest amount from human saliva, beer etc

Belgian Food Consumption Survey - 3245 respondents, age > 15

What Should the Risk Assessment Be for Nitrate in Meats
Acrylamide

“Bread, buns and coffee can be dangerous as they might contain the chemical compound acrylamide, which the Technical University of Denmark's (DTU) National Food Institute now links to cancer.” EU food safety authorities have been asked to investigate. March 26, 2013

http://www.euractiv.com/health/research-coffee-breakfast-produc-news
Bread and Acrylamide

192 Breads/ Rolls - 5 and 1987 µg/kg  ave. 30 µg/kg

Rye
White
Wholegrain

Fine bakery wares (puff pastry, laminated doughs, fried bread, etc.) ave. 145 µg/kg Range 4 - 3324 µg/kg

UK Food Standards Agency (UK) advises not to alter diets or cooking methods 2010
Bread and Acrylamide

- **Asparagine**
  - High in bran
  - Wholegrain flour > white flour
  - ↑ sourdough

- **Acrylamide - not different**
  - White
  - Wholewheat
  - Rye breads (n=48)
  - Sourdough - Acrylamide formation ↓ pH less favorable

![Graph showing acrylamide formation at different pH levels for two different cooking conditions: 120 C, 40 min and 150 C, 15 min.](attachment:graph.png)
Coffee and Acrylamide

Swedish studies show that 1/3 of the acrylamide from coffee is reduced.

Reduces
- Parkinson’s
- Type 2 Diabetes
- Alzheimer’s
- Various cancers

Increases
- Problem solving ability
- Blood lipids
- Blood pressure
- Insomnia

Overall, a healthy diet was characterized by a high consumption of whole-grain bread, raw vegetables and a low consumption of red meat and possibly butter, which is generally in line with previous findings. The paradoxical findings concerning the potential health benefit of coffee as well as cakes and cookies are interesting. . . .

von Ruesten A et al. 6 February 2013; doi: 10.1038/ejcn.2013.7
Risk Assessment is Difficult

“Never assume the obvious is true.”

William Safire

American author, columnist and presidential speechwriter