Public Perceptions of Risk

Presentation to the Manure Irrigation Workgroup,
November 22, 2013
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Health Officer,
Adams County Health and Human Services

The Heart of the Debate

Luxembourg WHO/EC Workshop, 2003:
“\(\ldots\) important reasons to invoke the Precautionary Principle within a public health policy:

- To be more anticipatory in terms of health and dealing with unknowns,
- To address public concern, which may be more directed at ensuring a potential problem is not ignored, in contrast to scientists who are often reluctant to give credibility to unproven possibilities.”
**Precautionary Principle**

“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.”


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**Central components**

- Taking preventive action in the face of uncertainty
- Shifting the burden of proof/responsibility to the proponents of an activity
- Exploring a wide range of alternatives to possibly harmful actions
- Increasing public participation in decision making (environmental justice)

Purpose/Objectives

- Improve decision making
- Promote integrated assessments
- Promote transparency
- Promote sharing of information
- Examine alternatives
- Examine uncertainties
- Encourage discussion among stakeholders

Risk Management

- Uncertainty
- Perception
- Comparison
- Education
- Regulation
Comparing Risks

- By probability
- By expected value
- By outrage
- By exposure
- By experts

### Annual Risk Of Death In The U.S.

<table>
<thead>
<tr>
<th>HAZARD</th>
<th>RISK PER MILLION</th>
</tr>
</thead>
<tbody>
<tr>
<td>All causes</td>
<td>9,000.0</td>
</tr>
<tr>
<td>Motor vehicle accidents</td>
<td>210.0</td>
</tr>
<tr>
<td>Work accidents</td>
<td>150.0</td>
</tr>
<tr>
<td>Homicides</td>
<td>93.0</td>
</tr>
<tr>
<td>Drowning</td>
<td>37.0</td>
</tr>
<tr>
<td>Poisoning, Solids/liquids</td>
<td>17.0</td>
</tr>
<tr>
<td>Railroads</td>
<td>0.9</td>
</tr>
<tr>
<td>Civil aviation</td>
<td>0.8</td>
</tr>
<tr>
<td>Bits and stings</td>
<td>0.2</td>
</tr>
</tbody>
</table>
### Characteristics of Risk

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Level</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Little known</td>
<td>Food additives</td>
</tr>
<tr>
<td></td>
<td>Much known</td>
<td>Alcoholic drinks</td>
</tr>
<tr>
<td>Newness</td>
<td>Old</td>
<td>Guns</td>
</tr>
<tr>
<td></td>
<td>New</td>
<td>Space travel</td>
</tr>
<tr>
<td>Voluntariness</td>
<td>Not voluntary</td>
<td>Crime</td>
</tr>
<tr>
<td></td>
<td>Voluntary</td>
<td>Rock climbing</td>
</tr>
<tr>
<td>Control</td>
<td>Not controllable</td>
<td>Natural disasters</td>
</tr>
<tr>
<td></td>
<td>Controllable</td>
<td>Smoking</td>
</tr>
<tr>
<td>Dreadedness</td>
<td>Little dread</td>
<td>Vaccination</td>
</tr>
<tr>
<td></td>
<td>Great dread</td>
<td>Nerve gas</td>
</tr>
<tr>
<td>Catastrophic</td>
<td>Not likely</td>
<td>Sunbathing</td>
</tr>
<tr>
<td>potential</td>
<td>Likely</td>
<td>War</td>
</tr>
<tr>
<td>Equity</td>
<td>Distributed</td>
<td>Skiing</td>
</tr>
<tr>
<td></td>
<td>Undistributed</td>
<td>Hazardous dump</td>
</tr>
</tbody>
</table>

Adapted from Kraus and Slovic (1988), Risk Anal., 8: 435.

### Risk Perceptions

- **Unknown**
  - Food coloring
  - Saccharin
  - Microwave ovens
  - Aspirin
- **Little Dread**
  - Anesthetics
  - Power Tools
  - Alcohol
  - Motor vehicles
- **Known**
  - DNA Research
  - Nuclear Power
  - Asbestos
  - Herbicides
  - Pesticides
- **Lead**
  - Smoking
  - Dynamite
  - Warfare
- **Dreaded**
  - Dynamite
  - Warfare
- **Knowable**
  - Lack of scientific knowledge
  - Exposure is unknown/unknowable

Catastrophic potential
Involuntariness
Personal risk
Inequity
### Differences in Risk Perception

<table>
<thead>
<tr>
<th>Activity/Agent</th>
<th>Rank by Risk Analyst</th>
<th>Rank by non-Risk Analyst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Vehicles</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Smoking</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Alcohol</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Handguns</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Surgery</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>X-rays</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Pesticides</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Electric Power</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Swimming</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Nuclear Power</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

Adapted from Slovic et al. (1979), Environ., 21: 14.

### Extensions of the View

- People’s assessments of acceptable and unacceptable risks.
  - Controllable v. not controllable
  - Merely injurious v. fatal
  - Equitable v. not equitable
  - Low v. high risk to future generations
  - Easily v. not easily reduced
  - Voluntary v. involuntary
  - Affects v. does not affect me
  - Dreaded v. not dreaded
Risk Assessment

Philip Handler said about balancing risks and benefits:

“A sensible guide would surely be to reduce exposure to hazard whenever possible, to accept substantial hazard only for great benefit, minor hazard for modest benefit, and no hazard at all when the benefit seems relatively trivial.” (Handler, 1979).


Risk Communication:

Key Concepts

When people are stressed, concerned, or worried, they typically:

(1)...want to know that you care before they care what you know
(2)...have difficulty hearing, understanding, and remembering information
(3)...seek out credible information and make rapid decisions that are difficult to change
Risk Communication: Key Concepts – continued

When people are stressed or concerned,
- ...they focus most on what they hear first and last
- ...they focus much more on negative information than positive information
- ...they process information at well below their education level

Risk Assessment

"We should remember that risk assessment data can be like the captured spy: If you torture it long enough, it will tell you anything you want to know."

(William Ruckelshaus - 1st administrator of U.S. EPA 1984.)
Quantitative Microbial Risk Assessment
Planning and Scoping

Manure Irrigation Workgroup Meeting
November 22nd, 2013

Mark Borchardt
USDA – Agricultural Research Service
USGS – Wisconsin Water Science Center

This is the first of many opportunities for input
Email: mark.borchardt@ars.usda.gov
Phone: 715-387-4943

QMRA Definition

QMRA is a process using risk assessment principles for quantifying at the population-level the adverse health effects that result from exposure to pathogenic microorganisms
QMRA Process Steps

**Step 1**
- Pathogen Concentration: \( C > 5 \) Salmonella/L
- Air Volume Inhaled: \( V = 0.5 \) L/breath \( \times 30 \) breaths/min

**Step 2**
- Exposure: 
  \( \text{Dose} = C \times V \)

**Step 3**
- Risk: 
  \( P(\text{illness}) = 15\% \)

**Exposure**
- **Exposure Assessment**
- **Exposure-Response Assessment**
- **Risk Characterization**

Study Objectives

- Define the setback distance at which the risk of illness from airborne pathogens from manure irrigation is acceptable
- Perform sensitivity analyses to identify those variables driving the pathogen transmission process from source (irrigation) to receptor (people) that contribute the greatest uncertainty to the defined setback (e.g. manure pathogen concentration, wind speed, pathogen inactivation rates, etc.)
Study Plan Overview

1) Empirical measurements of pathogen transport during irrigation

2) Air dispersion modeling of pathogen transport

3) QMRA

Study Resources

- One FTE for one year, January 1 – December 31st, 2014
QMRA Study Context

- The current setback distance is 500 feet.
- What studies and data were used to establish this distance?

Scoping Overview

- Define exposure pathways
- Define pathogen hazards
- Define population at risk
- Define health outcome
- Define acceptable level of risk
- Define exposure scenarios
Conceptual Model

Microbial Inactivation

Irrigation

Aerosols and Droplets

Exposure

Inhalation

Fomite deposition

Garden/Food

Vector

Hazard Characterization

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Occurrence (% of positive manure samples)</th>
<th>Infected Doses</th>
<th>Human-Disease and Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmonella spp.</td>
<td>0.5 - 18</td>
<td>0 - 95</td>
<td>7.2 - 100 cells, Salmonella enterica, Typhoidal fever, Peritonsillar fever (diarrhea, dysentery, systemic infections that spread from the intestinal tract to other parts of the body, abdominal pain, vomiting, dehydration, sepsis, meningeal irritation and other gastroenterological syndromes)</td>
</tr>
<tr>
<td>E. coli-0157:H7</td>
<td>3.9 - 28</td>
<td>0</td>
<td>0.1 - 70 cells, Enteric colitis (diarrhea with or without bleeding), abdominal pain, fever, dysentery, renal failure, hemorrhagic-uremic syndrome, arthritis and other rheumatological syndromes</td>
</tr>
<tr>
<td>Campylobacter spp.</td>
<td>5 - 38</td>
<td>57 - 69</td>
<td>14 - 86 cells, Campylobacter enteritidis (diarrhea, dysentery, abdominal pain, nausea, fever, nausea, vomiting, sepsis, meningitis, Guillain-Barre syndrome (neuromuscular paralysis), arthritis and other rheumatological syndromes)</td>
</tr>
<tr>
<td>Yersinia enterocolitica</td>
<td>-</td>
<td>-</td>
<td>0 - 65 cells, Yersinia enterocolitica (infectious enteritis, appendicitis, diarrhea, fever, headache, anemia, vomiting, pharyngitis, arthritis and other rheumatological syndromes)</td>
</tr>
<tr>
<td>Listeria spp.</td>
<td>0.002</td>
<td>8**</td>
<td>5.9 - 20 cells, Listeria (diabetes, systemic infections, meningitis, headache, stiff neck, confusion, loss of balance, rash, conjunctivitis, gingivitis)</td>
</tr>
</tbody>
</table>

Protozoa

| Cryptosporidium spp.     | 0.6 - 23                                 | 0 - 27         | 0 - 45 cells, Cryptosporidium (infection that can be symptomatic, cause acute but short-lived diarrhoeal illness, cause chronic diarrhoeal illnesses, or be quite severe and cholera-like, with cramping, abdominal pain, weight loss, nausea, vomiting, fever, pneumonia, bile duct obstruction and death) |
| Giardia                 | 0.2 - 46                                 | 3.9 - 18       | 10 - 25 cells, Giardia (diarrhea, abdominal cramps, bloating, fatigue, hypohydration, lactose intolerance, chronic joint pain) |

Focus on cattle manure only?

Source: EPA 820-R-13-002, July 2013
Hazard Characterization (cont)

Infrequent zoonotic pathogens in cattle manure

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Microsporidia</td>
<td>Leptospira species</td>
</tr>
<tr>
<td>Brucella species</td>
<td>Listeria monocytogenes</td>
</tr>
<tr>
<td>Bacillus anthracis</td>
<td>Mycobacterium bovis</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>Apthovirus (foot and mouth disease)</td>
</tr>
<tr>
<td>Coxiella burneti</td>
<td></td>
</tr>
</tbody>
</table>

Sources
Atwill, ER. Et al. 2012. NRCS Technical Note No. 9

Population at Risk

- General population
- Children (Age groups)
- Elderly
- Immunocompromised and immunosuppressed
- Pregnant women
- Populations to be excluded (e.g. farm workers)
Health Outcome

- Illness versus infection
- If illness, which system? Gastrointestinal, respiratory, neurological etc. (Data gaps likely)
- Death

Acceptable Level of Risk

- Probabilistic USA standard for waterborne infectious disease is 1 infection per 10,000 people per year (i.e. 0.0001 infection/person-year)
- Probabilistic World Health Organization standard is 1 Disability Adjusted Life Year (DALY) per 1,000,000 people per year
- Define limits based on exposures currently tolerated
- Define by disease burden (e.g., 5% of illness from irrigation OK)
- Cost benefit analysis where risk reduction costs are weighed against illness costs
- Defined by public health professionals, bureaucrats, or politicians

Adapted from Hunter and Fewtrell, Water Quality: Guidelines, Standards, and Health; World Health Organization, 2001
Exposure scenarios

- Meteorological conditions during irrigation
- Day versus night time irrigation
- Worst case, “mid” case, or best case scenarios
- Others?

Next Steps for QMRA Planning

- Organized literature review
- Inventory of available data
- Revisit QMRA scope