

Quantitative Risk Assessment and Its Use in HACCP: Dose Response Assessment  
PHR 450, C7

Predict probability of disease from number of pathogens ingested?

Codex Alimentarius Commission, of the United Nations' Food and Agriculture Organization

## Risk Analysis

- **Risk Assessment** determines the nature and extent of the risk.
- **Risk Management** decides what to do about the risk.
- **Risk Communication** is the process of telling the public what will be done (and acquiring feedback).

## Risk Communication:

- *Interactive exchange* of information and opinions concerning the risk among risk assessors, risk managers, consumers and other interested parties.

## Risk Management (1)

- Not necessarily to eliminate risk
- Balance level of risk vs.
  - cost of risk reduction
  - competing risks
  - benefits/risks of interventions

## Risk Management (2)

- Differentiate trivial, "tolerable" risk vs. significant, "non-tolerable" risk
- Risk assessment provides a measure of how big (or small) the risk

## Rapid Review of Risk Assessment

- What is risk assessment?
- Why do risk assessment?
- How do we construct a risk assessment?

## Risk Assessment:

- Predicts result of action (or inaction)
- Does not “solve” any problems
- Objective basis for management decisions
- Framework for information relevant to the risk issue

## Three Risk Questions:

- What can go wrong?
- How likely is that to happen?
- What would the consequences be?

Risk = f (hazard, likelihood, impact)

## Chem. & Phys. vs Microbial Hazards

- Physical: present or absent
- Chemical (incl. microbial toxins): “no observable adverse effect level” (NOAEL)
- One microbial unit *might* cause infection.

## Risk Assessment: Hazard Identification

- Qualitative look for problem
- Focus on specific pathogen, food, process, food-handling practice?

## Risk Assessment: Exposure Analysis

- Probability of consumption of a food contaminated with the pathogen AND
- Likely numbers of the pathogen in the food *at the time of consumption?*

Exposure Assessment,  
Modeling the Food Chain,  
*Listeria in raw milk  
cheese* example,  
Hazard Characterization

## LM in raw milk cheese

- On-farm sources
  - Mastitic milk
  - Environmental “filth”
- Contamination in processing & packaging
- Retail & consumer handling: growth?

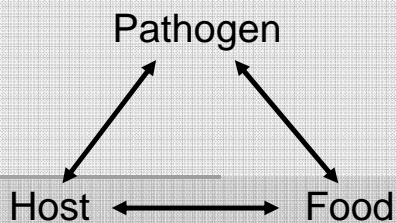
## Risk Assessment classes

- Qualitative: high, medium, low, negligible
- Quantitative:
  - Probabilistic (variation)
  - Deterministic (single values — average or worst-case)

## Consequences of Exposure (“outcomes”):

- None
- Infection without symptoms of illness
- Acute gastroenteritis
- Long-term effects (chronic)
- Mortality

## Dose-Response Relationships:



## Susceptible Populations:

- Very young
- Elderly
- Pregnant women
- Immunocompromised

### beta Poisson:

$$P = 1 - (1 + N/b)^{-a}$$

- P is probability of getting ill
- N is number of organisms ingested
- a and b are constants for different pathogens
- Applies to people with normal resistance

### Probability of infection from one ingested cell

Microbe	a	b	P
<i>Campylobacter</i>	0.039	55	$7 \times 10^{-3}$
<i>Salmonella</i>	0.33	139.9	$2.3 \times 10^{-3}$
<i>Sh. flexneri</i>	0.2	2000	$1 \times 10^{-4}$
<i>V. cholerae</i>	0.097	13020	$7 \times 10^{-6}$

### Risk Assessment elements

- Data: literature, reports from surveillance, outbreaks
- Model: mathematical, not excessively detailed
- Assumptions

### Variability vs Uncertainty

- Variability
  - A property of nature
  - Mean, standard deviation
- *Uncertainty* is our ignorance
  - Measurement, conditions, inadequate models
  - “Precautionary principle”

### HACCP & Risk Assessment (1)

- HACCP is risk management
- What hazards must be controlled?
- “Acceptable level”?
- CCPs valid?

### HACCP & Risk Assessment (2)

- Risk assessment evaluates hazards
- Forecasts human health outcome of HACCP
- Validates CCPs

## Needed for Risk Assessment

- Data
- The right data
- Knowledge of Uncertainty
- Knowledge of Variability
- *International harmonization of data collection methods & risk assessment*

Risk assessment won't provide the solutions to all food safety problems, but should help in decision-making.