American Water Works Association

Future Needs and Uses of Quantitative Microbial Risk Assessment (QMRA)

The Water Utilities' Perspective

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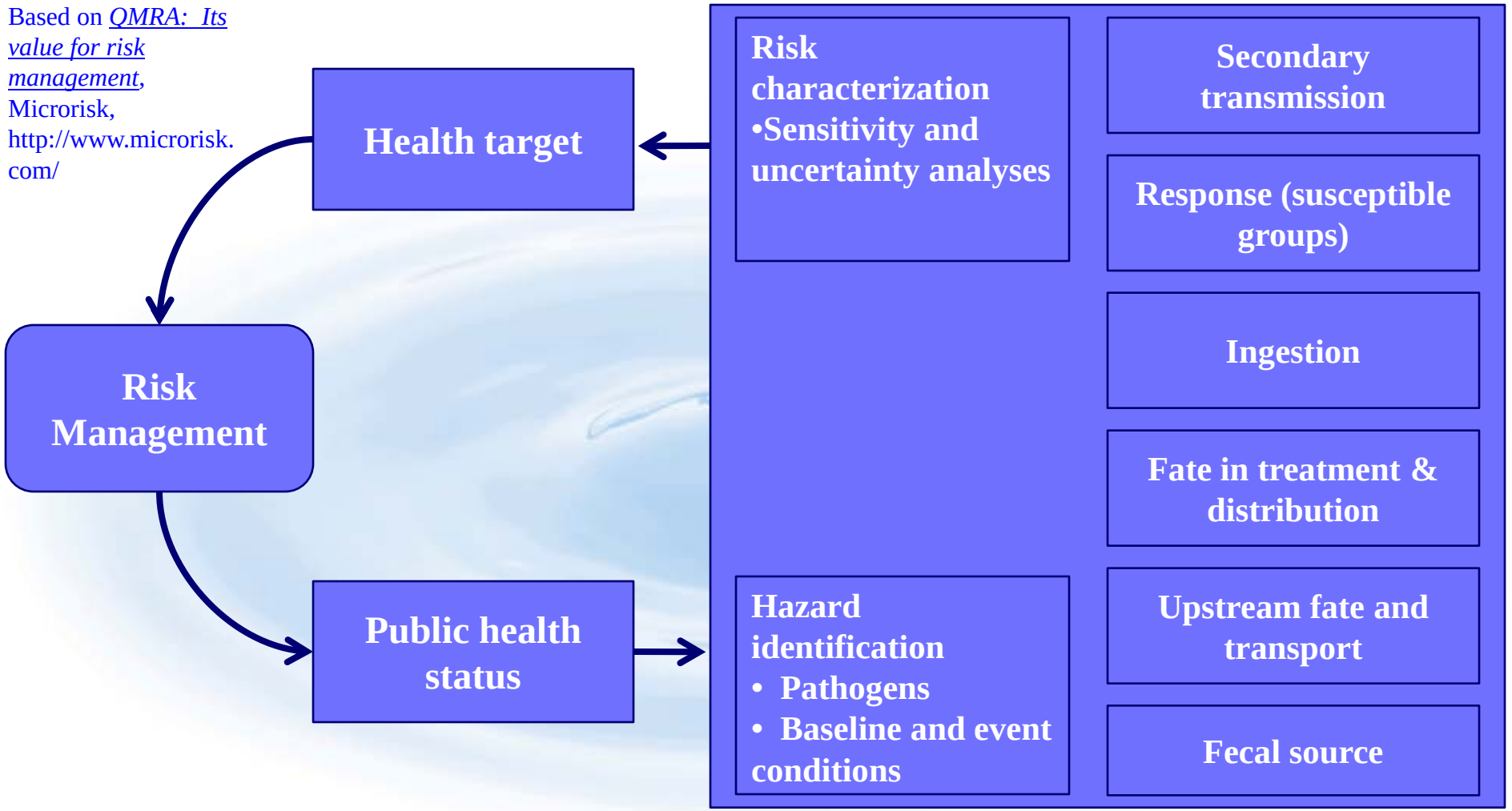
Drinking Water Utility Needs & Requirements

- **QMRA can play a role for water utilities**
  - Reduce reliance on safety factors via direct treatment of variability and uncertainty
    - Identify processes that are underprotective OR overprotective
  - Improve use of monitoring and laboratory data
  - Aid in evaluating new or modified treatment processes and scenarios

- **To do so, the QMRA community should**
  - Base models on data that
    - Adequately represent pathogen occurrence
    - Account for method uncertainty
    - Account for
      - Regional differences,
      - Source water differences
      - Site characteristics
  - Focus research on areas of greatest concern to utilities
    - Risks posed to susceptible groups
    - Use of new analytical techniques
    - Decontamination
    - Validation of complex QMRA models

Overview of QMRA Roles for Drinking Water

Based on *QMRA: Its value for risk management*, Microrisk, http://www.microrisk.com/



Future QMRA Research Categories

- **Analytical methods**
- **Occurrence**
- **Health risk**
- **Treatability**

Analytical Methods

Utility Perspective

- **Analytical methods are the basis for prioritization of pathogens for regulation, and establishment of monitoring protocols to meet compliance requirements.**
  - Methods have multiple inherent sources of uncertainty and variability.
  - Current regulations are based on extreme observations and the use of safety factors
  - These regulations are not necessarily protective, may be overprotective
  - Associated monitoring schemes are costly
- **Establish a distribution of potential outcomes for use in selecting methods and regulatory constructs .**
- **Use of safety factors replaced by approach that avoids under- and over-protective criteria.**
- **Relevant QMRA research:**
  - Quantifying and characterizing method uncertainty and variability
  - Relating method uncertainty to knowledge of finished water quality
  - Assessing and developing monitoring schemes

http://www.cityofithaca.org/

Role for QMRA – Align regulations and priorities with actual risks

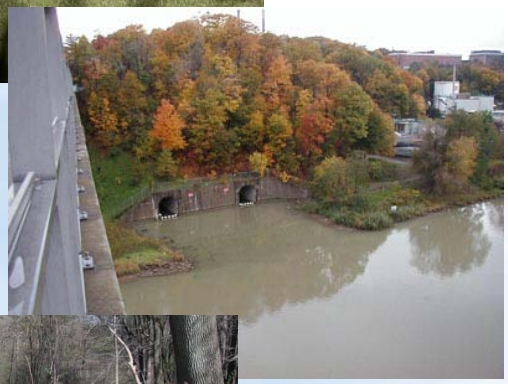
Effective and objective use of QMRA

- **Evaluate sensitivity of models to method uncertainties**
- **Move beyond point estimates; represent variable quantities with distributions**
- **Validate models**

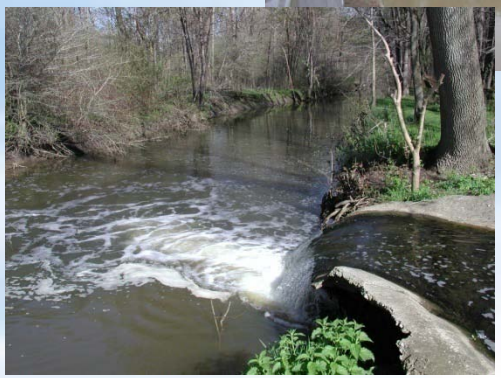
Occurrence

- **Utility perspective**
  - Pathogen loading is highly variable and poorly understood
  - Risks associated with specific fecal pollution sources are poorly characterized
- **Role for QMRA**
  - The QMRA framework allows improved characterization of source water quality and loadings
    - Pathogen loading from animal and human sources, other reservoirs
    - Seasonal variations in pathogen loading
    - Hydrologic processes
    - Incorporation of source water monitoring data into risk models
- **Effective and objective use of QMRA**
  - Sensitivity analyses
  - Use of distributions instead of extreme values

http://gallery.usgs.gov/photos/aeu2Xkj87R_0



http://www.epa.gov/glnpo/aoc/rochester.html



http://www.usgs.gov/newsroom/article.asp?ID=2083

Health Risks

Utility perspective

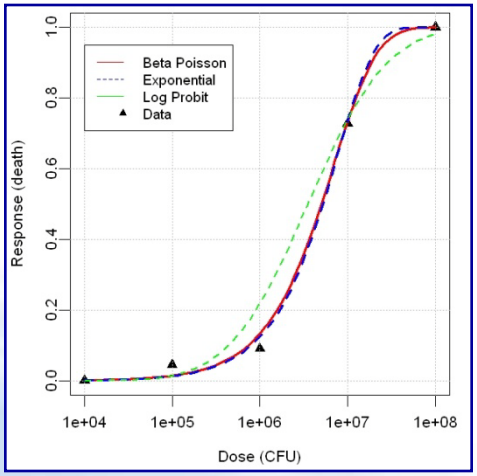
- Tools for evaluating health risks are limited
  - *Many, many potential bugs*
    - Validated dose-response models are available for only a subset of the bug universe
    - Virulence can vary among strains
  - *Many, many potential sources*
    - Human and animal sources – are their pathogens different?
    - Point and non-point sources
  - *Several potential exposure routes*

QMRA Roles

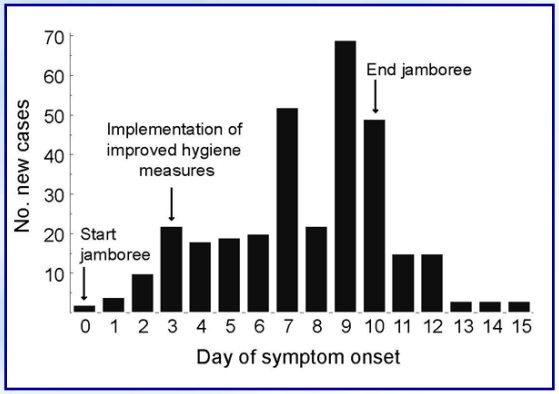
- Develop additional dose-response models for agents of concern
  - Models accounting for Inter-strain variability in virulence
  - New dose-response models for important waterborne pathogens
  - Use novel data sources (e.g., outbreak data or time-to-infection data) and techniques for model development
- Assess the relative importance of exposure route/scenario (drinking water v. recreational water v. food-borne etc).

Effective and objective use of QMRA

- Careful selection of dose-response model, pathogens, surrogates
- Evaluate model sensitivity to choice of dose-response model
- Improve understanding of roles of different sources in risk of outbreaks



Dose-response curves, albino mice, ingestion exposure, *F. tularensis*



Epidemic curve, norovirus outbreak at a scout camp
http://www.cdc.gov/eid/content/15/1/24.htm

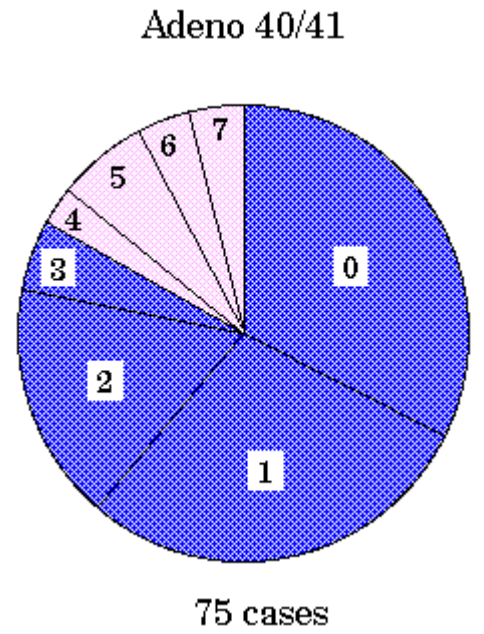
Susceptible Populations

Utility perspective

- Accounting for sensitive populations is mandated under the Safe Drinking Water Act (SDWA)
- There are no robust methods for assessing risks to sensitive populations

QMRA Role

- Incorporating susceptibility into QMRA – fundamental research is needed
  - There are no peer-reviewed dose-response models for susceptible populations for pathogens of interest in drinking water. Can these be developed with
    - outbreak data?
    - mechanistic models?
  - Did prior studies of secondary transmission model susceptible groups adequately?



Age distribution of children yielding adenovirus 40/41, October 1997 – September 1998, Japan

http://idsc.nih.go.jp/iasr/19/225/tpc225.html

Treatability

Utility perspective

- Variability in conventional treatment removal and/or inactivation of pathogens is not well understood; Variability in advanced treatment (ozone, UV, etc.) is even less well understood
- How does a utility decontaminate infrastructure after a contamination event?
  - How would wash water be disposed of?
  - What if the contaminant is difficult to remove from pipes?
  - Clean-up goals and criteria?
  - Risks during clean-up? After clean-up?

QMRA Role

- A robust and validated QMRA model could be used to evaluate treatment options
- QMRA can be used to address the “how clean is safe” question and in risk communication

Effective and objective use of QMRA

- QMRA models of treatment plants must account for regional, source water type, site specific characteristics
- Consider the needs of customers and decision-makers when characterizing risk

http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13754.html