Chicago Area Waterways
Epidemiology Study

February 27, 2007
WERF & MWRDGC
Overview

• Recreational water exposure and health
  – What we know
  – What we don’t know
• Local research questions
• Approaches to local questions
• National research needs
• Potential approaches to national questions
Development of knowledge regarding primary contact recreation: Highlights

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
<td>USPHS Studies Stevenson</td>
<td>EPA studies, Cabelli Dufour</td>
<td>EPA standard</td>
<td>UK Randomized trials</td>
<td>BEACHES Act, NEEAR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UK EPA Randlized trials

UK EPA standard
Development of knowledge regarding primary contact recreation: Highlights

- **1950**: USPHS Studies
- **1960**: EPA studies, Cabelli Dufour
- **1970**: EPA standard
- **1980**: UK Randomized trials
- **1990**: BEACHES Act, NEEAR
- **2000**: 1972 National Academy of Sciences can’t recommend criteria: paucity of epi studies
Risks of limited contact recreation
2007: Paucity of epidemiologic studies

1972 National Academy of Sciences can’t recommend criteria: paucity of epi studies
Limited contact recreation 2007:

- Almost nothing known about rates of illness in limited contact recreation
- Almost nothing known about differences in illness rates for limited contact vs. full contact recreation in same body of water
- Nothing known about ingested or dermal dose of water
- Almost nothing known about indicators vs. pathogens as predictors of illness
Characterizing rates of illness due to non-swimming recreational contact with the CAW:

Option 1: Look at rates observed in similar prior studies
## Epidemiologic Studies of Recreational Water Exposure

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alexander</td>
<td>1982</td>
</tr>
<tr>
<td>Appleton</td>
<td>1989</td>
</tr>
<tr>
<td>Cabelli</td>
<td>1983a</td>
</tr>
<tr>
<td>Cabelli</td>
<td>1983b</td>
</tr>
<tr>
<td>Calderon</td>
<td>1991</td>
</tr>
<tr>
<td>Cheung</td>
<td>1990</td>
</tr>
<tr>
<td>Colford</td>
<td>2007</td>
</tr>
<tr>
<td>Corbett</td>
<td>1993</td>
</tr>
<tr>
<td>Dufour</td>
<td>1984b</td>
</tr>
<tr>
<td>Fattal</td>
<td>1986</td>
</tr>
<tr>
<td>Ferley</td>
<td>1989</td>
</tr>
<tr>
<td>Fewtrell</td>
<td>1992</td>
</tr>
<tr>
<td>Fewtrell</td>
<td>1994</td>
</tr>
<tr>
<td>Fleisher</td>
<td>1993</td>
</tr>
<tr>
<td>Fleisher</td>
<td>1996</td>
</tr>
<tr>
<td>Fleisher</td>
<td>1998</td>
</tr>
<tr>
<td>Foulon</td>
<td>1983</td>
</tr>
<tr>
<td>Gray</td>
<td>1997</td>
</tr>
<tr>
<td>Haile</td>
<td>1999</td>
</tr>
<tr>
<td>Jessop</td>
<td>1985</td>
</tr>
<tr>
<td>Jones</td>
<td>1991</td>
</tr>
<tr>
<td>Kay</td>
<td>1994</td>
</tr>
<tr>
<td>Kueh</td>
<td>1995</td>
</tr>
<tr>
<td>Lee</td>
<td>1997</td>
</tr>
<tr>
<td>Lightfoot</td>
<td>1989</td>
</tr>
<tr>
<td>Marino</td>
<td>1995</td>
</tr>
<tr>
<td>McBride</td>
<td>1998</td>
</tr>
<tr>
<td>Medema</td>
<td>1995</td>
</tr>
<tr>
<td>Philipp</td>
<td>1985</td>
</tr>
<tr>
<td>Pike</td>
<td>1994</td>
</tr>
<tr>
<td>Prieto</td>
<td>2001</td>
</tr>
<tr>
<td>Seyfriend</td>
<td></td>
</tr>
<tr>
<td>Stevenson</td>
<td>1953</td>
</tr>
<tr>
<td>Taylor</td>
<td>1995</td>
</tr>
<tr>
<td>Van Asperen</td>
<td>1998</td>
</tr>
<tr>
<td>von Schirding</td>
<td>1992</td>
</tr>
<tr>
<td>Wade</td>
<td>2006</td>
</tr>
<tr>
<td>Wiedenmann</td>
<td>2006</td>
</tr>
</tbody>
</table>
Epi studies, by water type & activity

- Freshwater: Bathing, 12
- Freshwater: Canoe/kayak, 7
- Marine: Bathing, 19
- Marine: Canoe/kayak, 2
# Epidemiologic Studies of Recreational Water Exposure

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Appleton 1989</td>
<td>Fleisher 1996</td>
<td>Medema 1995</td>
</tr>
<tr>
<td>Cabelli 1983a</td>
<td>Fleisher 1998</td>
<td>Philipp 1985</td>
</tr>
<tr>
<td>Cabelli 1983b</td>
<td>Foulon 1983</td>
<td>Pike 1994</td>
</tr>
<tr>
<td>Cheung 1990</td>
<td>Haile 1999</td>
<td>Seyfriend</td>
</tr>
<tr>
<td>Colford 2007</td>
<td>Jessop 1985</td>
<td>Stevenson 1953</td>
</tr>
<tr>
<td>Dufour 1984b</td>
<td>Kay 1994</td>
<td>Van Asperen 1998</td>
</tr>
<tr>
<td>Fewtrell 1994</td>
<td>Marino 1995</td>
<td></td>
</tr>
</tbody>
</table>
Studies: Freshwater, “secondary contact” exposure

Appleton 1989

Gray 1997

Jessop 1985

Taylor 1995

Lee 1997

Fewtrell 1992

Fewtrell 1994
Studies: Drop schistosomiasis, outbreaks, studies without disease rates

Jessop 1985

Lee 1997

Fewtrell 1992
Jessop 1985

- Lake contact among those who visited their doctor for acute gastrointestinal symptoms ("cases") compared to those who didn’t
- Self-reporting of water exposure
- No measures of water quality
- Small number of participants (105)
- Conclusion: no association
Lee 1997: Methods

• Setting: artificial whitewater canoe course fed by the River Trent
• Determined symptoms by questionnaire completed at home by participants 1 week after event
• 8 events, 473 completed questionnaires
• No unexposed controls
• Water: indicators by culture, F-specific RNA bacteriophage
Lee 1997: Results

- E.coli and S. fecalis concentrations predict GI illness, but not after taking into account F-specific phage concentrations
- Phages concentrations increase risk
- Other predictors of illness (1-2 fold increase in risk): swallowing water, accidental swimming in course, drinking before getting changed
Fewtrell 1992: Design

- Setting: Two white water canoeing slalom channels
- Subjects: canoeists and spectators
- Health: by questionnaire at site + telephone follow-up
- Water: Indicators, enterovirus
Fewtrell 1992: Results

- Canoeists had higher rates of GI symptoms than unexposed study subjects (3-4 fold increase in risk)
- Higher rates of illness among canoeists at the site with higher indicator and enterovirus concentrations
Water quality: Lee, Fewtrell vs. CAW

Organism density /100mL

- Fewtrell Site A
- Fewtrell Site B
- Lee
- CAW: NS-Down

- E.coli
- Fecal coliforms
Characterizing rates of illness due to non-swimming recreational contact with the CAW:

Option 2: Extrapolate from studies of swimmers
Indicator density vs. risk for freshwater swimmers (Pruss 1998)
Dose-response, freshwater swimmers (Wade 2006)

- 10-fold increase in E. coli: 2.1-fold increase in risk of illness
- 10-fold increase in enterococcus: 1.4-fold increase in risk of illness

- Swimmers: After 45 minutes, adults swallow 16mL; kids: 37mL (Dufour 2006)
- Other recreators: ????
- Dermal contact: ?????
Characterizing rates of illness due to non-swimming recreational contact with an urban river:

Option 3: Empiric observation
To consider in designing an epidemiologic study: 1

Rates of illness \textit{among} CAW recreators
\neq
Rates of illness \textit{attributable} to CAW recreation
Attributing illness to CAW contact

• Background rates of acute gastrointestinal symptoms in general population are approximately 50/1,000 per month

• Exposure to water with low concentrations of microbes is associated with increased rates of skin, eye, respiratory symptoms
Three groups of subjects

- Unexposed recreators
- Lake recreators
- CAW recreators
Sources of risk, by group

Golfers/Cyclists  Lake recreators  River recreactors
To consider in designing an epidemiologic study: 2

- Detecting subtle effects requires large sample size
- Identifying with confidence a difference between a 50/1,000 rate and a 60/1,000 rate would require 8,400 subjects per group
Group sample size for background attack rate of 5/100

Number of subject needed per group

Lake rate=7/100
Lake rate=8/100
Lake rate=9/100

Attack rates (per 100) among river users
Sample Size Using Logistic Regression:
X=Log10 E Coli Concentration

Regression Coefficient

Event Rate = 5/100
Event Rate = 6/100
Event Rate = 7/100
Event Rate = 8/100
Event Rate = 9/100
Event Rate = 10/100
Objectives: Local

• To determine rates of illness attributable to recreational contact on the Chicago Area Waterways
• To characterize the relationship between measures of microbe densities and rates of illness
• To identify pathogens that cause cases of acute illness in study subjects
Objectives: Local and Beyond

• To compare pathogens and indicator organisms as predictors of illness among limited contact recreators
• To compare standard and rapid tests of microbe densities as predictors of illness
• To estimate dermal and oral dose of water for various activities
• To compare illness rates for swimmers and secondary contact recreators in the same body of water
UIC Research Team

- Environmental epidemiology
- Infectious disease epidemiology
- Medical
- Industrial Hygiene
- Water quality sampling and analysis
- Microbiology
- Molecular biology
- Biostatistics and risk assessment
Human subjects protection

• Protocol to be approved by UIC Institutional Review Board
• Written consent for adults
• Parental consent + assent for kids
Measurements

• Pre-activity assessment
• Exposure assessment
• Follow-up monitoring
• Analyses of water samples
• Analyses of biologic samples

• Use of standardized methods
• QA and QC protocols
Data collection

• Multidisciplinary Field teams
  – Recruitment
  – Medical/Nursing evaluations
  – Industrial hygiene
  – Survey questionnaires
  – Logistics
  – Data

• Telephone follow-up
• Home visits for clinical specimens
Potential Outputs

- Rates of illness among secondary contact recreators as a function of microbe density
- Analysis of the microbe density-illness relationship for threshold effects, guidelines for standard setting
- Comparison of 30-day geometric mean vs. single sample maximum
- Estimation of water exposure (dose) by recreational activity
- Recommendations for monitoring pathogens vs. indicators
- PCR vs. culture-based tests
Questions and comments