Recreational Water Quality Criteria
Case Definition

- Current Case Definition of GI illness from the EPA NEEAR Study (NGI)
  - Diarrhea (3 or more loose stools in 24 hours) OR
  - Vomiting OR
  - Nausea and stomachache OR
  - Nausea or stomachache with an impact on daily activities
Current Water Quality Criteria-2012

36 cases of GI illness/1,000

* Corresponds to a 30 day Geometric Mean (GM):
  * 35 cfu/100 ml Enterococci in marine and fresh water
  * 126 cfu/100 ml *E. coli* in fresh water

32 cases of GI illness/1,000

* Corresponds to a 30 day Geometric Mean (GM):
  * 30 cfu/100 ml Enterococci in marine and fresh water
  * 100 cfu/100 ml *E. coli* in fresh water
But, are all cases of GI illness the same?

* Symptoms vary in duration and intensity
  * But still technically all meet the same case definition
* Result in several responses to illness:
  * Stay home from work or school
  * Take OTC medication
  * Contact a health care provider
  * Take prescription medication
  * Go to an Emergency Room
  * Be admitted to a hospital
2 Scenarios

Beach A
- 1 million annual recreators
- Rate of Illness: 100/1,000 recreation events
- Responses to illness:
  - 40% take OTC medication
  - 1% see their doctor

Beach B
- 1 million annual recreators
- Rate of Illness: 10/1,000 recreation events
- Response to illness
  - 75% take prescription medication
  - 50% go to Emergency Room
  - 25% hospitalized
Why might severity vary across beaches?

* Demographics
  * Are there more children/elderly persons at the beach?

* Underlying medical condition
  * Pre-existing GI condition?
  * Diabetes?
  * Immune compromised?
How can illness severity be quantified?

* Several different methods
  * No single metric which can completely summarize illness severity
  * Common methods:
    * Examining responses to illness
    * Calculating the duration of GI illness
      * Calculate “symptom-days”
    * Use of a GI severity scoring tool
Two approaches:
Symptom-Days, Duration of GI Illness

- Stomachache/stomach cramps: 3 days
- Diarrhea: 2 days
- Nausea: 1 day
- Vomiting: 1 day

Duration of GI Illness: 3 Days
Symptom-Days: 7 Symptom-Days
GI Severity Score
(Modified based on Freedman 2010)

<table>
<thead>
<tr>
<th></th>
<th>0 Points</th>
<th>1 Point</th>
<th>2 Points</th>
<th>3 Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration of diarrhea (days)</strong></td>
<td>0</td>
<td>1-4</td>
<td>5</td>
<td>≥6</td>
</tr>
<tr>
<td><strong>Maximum number of loose stools in 24 hours</strong></td>
<td>0</td>
<td>1-3</td>
<td>4-5</td>
<td>≥6</td>
</tr>
<tr>
<td><strong>Duration of vomiting (days)</strong></td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>≥3</td>
</tr>
<tr>
<td><strong>Body Temperature (°F)</strong></td>
<td>≤98.6</td>
<td>98.7-101.1</td>
<td>101.2-102.0</td>
<td>≥102.1</td>
</tr>
<tr>
<td><strong>Health Care Provider</strong></td>
<td>None</td>
<td>Contact with health care provider</td>
<td></td>
<td>Emergency Room</td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td>None</td>
<td>OTC Medication</td>
<td>Prescription medication</td>
<td>Hospitalization</td>
</tr>
</tbody>
</table>
Chicago Health, Environmental Exposure, and Recreation Study (CHEERS)

- Assessed non-primary contact water recreators on
  - The Chicago River
    - Over 90% of the flow during dry weather is non-disinfected waste water
  - Lake Michigan
  - Other local water ways
- Interviewed over 11,000 participants at baseline and for up to 28 days of follow up
~9% of CHEERS participants developed GI Illness

- Rate attributable to water recreation: ~14/1,000
- Of those with GI Illness:
  - 47% stayed home from work or school
  - 56% took OTC medication
  - 17% sought medical care
  - 8% took prescription medications
  - 2% seen in an emergency room or were hospitalized
  - 27%: none of the above
Duration of GI Illness among CHEERS participants with ~NGI (n=789)
Symptom-Days among CHEERS participants with ~NGI (n=789)
GI Severity Score among CHEERS participants with ~NGI (n=789)
Predicting Severity

- Conducted several logistic regression models
  - Using dichotomous severity outcome
- Evaluated water exposure and severity
  - Can water exposure can predict severity?
Swallowing Water as a Predictor of Severity: Preliminary Findings

- Assessing severity among those who swallowed water, compared to those not swallowing water

<table>
<thead>
<tr>
<th>Severity Metric</th>
<th>Adjusted Odds Ratio (Water rec. with NGI)</th>
<th>Adjusted Odds Ratio (All water recreators*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Responses to Illness †</td>
<td>2.16 (1.02-4.57)</td>
<td>--</td>
</tr>
<tr>
<td>≥2 days of Illness</td>
<td>1.05 (0.44-1.18)</td>
<td>--</td>
</tr>
<tr>
<td>≥ 4 Symptom-Days</td>
<td>1.17 (0.49-2.81)</td>
<td>2.02 (1.22-3.34)</td>
</tr>
<tr>
<td>GI Severity Score ≥ 6</td>
<td>1.27 (0.43-3.37)</td>
<td>2.57 (1.03-6.44)</td>
</tr>
</tbody>
</table>

† Staying home from work or school, taking prescription medication, or visiting an Emergency Room or being admitted to a hospital

*Water recreators with out symptoms, recorded as 0
Upcoming analyses....

- Identify other predictors of severity
  - Degree of body wetness?
    - Swallowing water
  - Can we observe a dose response between increased water exposure and severe illness?
Conclusions

* Only looking at occurrence of illness misses a continuum of severity that may matter for determining ‘acceptable’ rates of illness for standards
* Swallowing water appears to be a predictor
* The severity of illness, not just the rate of illness may be useful for prioritizing locations for mitigations
Acknowledgements

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