The Hand is Quicker Than a Sneeze in the Spread of Disease
Prof. Chuck Gerba, University of Arizona
Teleclass broadcast sponsored by GOJO (www.gojo.com)

The Hand is Quicker Than a Sneeze in the Spread of Disease
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Learning Objectives
- How we can use risk assessment in modeling disease transmission via fomites in indoor environments
- How the nature of a fomite and pathogen effects their transfer to hands
- Survival of pathogens on the hands
- Speed and movement of microbes in indoor environments

Hand vs. Sneeze

Percentage of Disease Due to Transmission Route

Role of fomites in transmission of a disease

How do we Logically Assess the Spread and Control of Disease Transmission in Indoor Environments

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What is CAMRA?

- Established to model microbial risks from:
  - Fomites
  - Drinking water
  - Aerosols

How do we use risk analysis?

- Develop standards for toxic substances and pathogens in food and water
- Assess cost: benefits of regulations

Quantitative Microbial Risk Assessment is an approach that allows the expression of risks in a quantitative fashion in terms of infection, illness, or mortality from microbial pathogens

Risk Assessment

- Estimation of potential adverse effects associated with exposure of individuals or populations to hazards

Risk Management

- The process for controlling risks:
  - Wear gloves
  - Disinfect key fomites
  - Use hand sanitizers

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A failure in risk communication

Risk Communication

CAUTION
THIS SIGN HAS SHARP EDGES
DO NOT TOUCH THE EDGES OF THIS SIGN

Dose-Response Curve

No-effect range
Threshold
Range of increasing effect with increasing dose
Maximum effect range

Increasing Dose

A failure in risk communication

Four Basic Steps in Risk Assessment

➢ Hazard Identification - identifying the organism(s) – MRSA, C. difficile, norovirus, Salmonella
➢ Dose-Response Assessment - relationship between the concentration of harmful substance and the probability of an adverse outcome (i.e. how many does it take to make you sick or kill you)

Four Basic Steps in Risk Assessment

• Exposure Assessment - Determining the concentration that you are exposed to.
• Risk Characterization - Estimating the potential impact (illness, death)

Factors Important in Assessing Exposure

➢ Route of Exposure (hand, inhalation, ear, mouth)
➢ Duration of exposure
  • Entire work day?, a few hours
➢ Number of exposures
  • How many times in a day, month, year
➢ Degree of exposure
  • Number and types of surfaces touched
  • Numbers of pathogen on the surface

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Microbial Risks are usually defined as risk of infection from a one-time exposure or over a period of one year.

Microbial Risk Assessment

- What is an acceptable Microbial Risk?
- USEPA Guideline drinking water treatment should be treated to reduce the risk of infection to 1:10,000 per year (Surface Treatment Rule)

Quantitative Microbial Risk Assessment

- Identify pathogen of concern
- Dose-response data from humans
- Model infection probability
- Predict probability of disease from exposure
- Clinical data to estimate probability of disease and mortality
- Validate model from outbreak data

How good is QMRA? Can Compare to Outbreaks

<table>
<thead>
<tr>
<th>Food</th>
<th>Dose (CFU)</th>
<th>Amount consumed</th>
<th>Attack rate (%)</th>
<th>Predicted P (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>17</td>
<td>1 liter</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Pancretin</td>
<td>200</td>
<td>7 doses</td>
<td>100</td>
<td>77</td>
</tr>
<tr>
<td>Ice cream</td>
<td>102</td>
<td>1 portion</td>
<td>52</td>
<td>54</td>
</tr>
<tr>
<td>Cheese</td>
<td>100-500</td>
<td>28 g</td>
<td>28-36</td>
<td>53-98</td>
</tr>
<tr>
<td>Cheese</td>
<td>10⁷</td>
<td>100 g</td>
<td>100</td>
<td>&gt;99.99</td>
</tr>
<tr>
<td>Ham</td>
<td>10⁸</td>
<td>50-100 g</td>
<td>100</td>
<td>&gt;99.99</td>
</tr>
</tbody>
</table>

Modified from Rose et al. (1995)

Application of Microbial Risk Assessment

- Set Standards for pathogens on fomites/water/food
- Determine the cost/benefits of different intervention options
- Assessment strategies for control of pathogens
  - Hand hygiene
  - Type of disinfectant
  - Frequency of disinfectant use
  - Self-sanitizing surfaces or fabrics

Hand Contact in Adults

- Adults touch their face 15.5 times per hour
  - 2.5 eyes
  - 5 nose
  - 8 lip

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How Efficient is Transfer?
(Lopez et al, 2009)
- Type of suspending media
  - Greater transfer when suspended in feces than phosphate buffered saline
- Hand/object contact
  - Type of interaction with object (i.e. doorknob vs. push button)
  - Finger vs. hand

Fomites - not all the same
- Acrylic
- Ceramic tile
- Glass
- Stainless steel
- Formica

Risk Assessment for Fomites
- Determine or estimate occurrence of concentrations
- Number of times fomite touched
- % of organisms transferred to hand
- Predict probability of disease from exposure
- % of organisms transferred to patient or other fomite

Transfer of MS2 Bacteriophage from Fomites to Fingers

Blue high relative humidity = 40 to 65%; Red = 20 to 30%

Model to assess transmission of a viral pathogen in a health care setting – WOW!!!
- Nicas and Sun 2006 - Risk Analysis

Another Approach – use tracers to model fate and risk from fomites/hands
- Bacteriophages have been used in day care and home studies to assess fomite contamination
- MS-2 and phiX-174 used in tracer studies

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How fast does a virus move in an office Building?

- Add a bacterial virus to the entrance door handle to an office building with 80 persons
- Collect samples after 2, 4 and 7 hours of fomites and hands

Repeat, but add bacteriophage to one persons hand?*

*Person did not know hand was contaminated

Virus detection on office workers hands/fomites after times indicated. (MS-2 virus was added to one of the push plate door entrances at beginning of day – 3 entrances to building)

Virus detection on office workers hands/fomites after times indicated. (MS-2 virus was added to one person’s hand at the beginning of the work day)
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Intervention
➢ Talk about the importance of hand hygiene in disease transmission
➢ Supply hand sanitizers and disinfecting wipes at desk
➢ Supply hand sanitizer in break room
➢ 52% of the persons in the office agreed to participate

Effectiveness of Intervention Products Against MS-2 Virus
➢ Hand Sanitizer = 74.5% reduction of virus on the hands
➢ Disinfecting wipe = 50% reduction of virus on fomites

Impact of intervention on Occurrence of Virus on Employee’s Hands

<table>
<thead>
<tr>
<th>Percentage</th>
<th>T=0hrs</th>
<th>T=7hrs</th>
<th>T=4hrs</th>
<th>T=7hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS-2</td>
<td>52%</td>
<td>50%</td>
<td>10%</td>
<td>9%</td>
</tr>
</tbody>
</table>

IS THERE A SIGNIFICANT DIFFERENCE BETWEEN VIRUS NUMBERS on Fomites BEFORE AND AFTER INTERVENTION AT T=4HOURS?

<table>
<thead>
<tr>
<th>Coliphage</th>
<th>Answer to the question</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS-2</td>
<td>Yes</td>
<td>0.000067</td>
</tr>
</tbody>
</table>

Results
➢ The number of people with viruses on their hands was reduced in half (50%). The occurrence of viruses in communal work areas was reduced by more than 80% after four hours and by 70%-100% after seven hours

Probability of Infection

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Occurrence of Salmonella on kitchen cleaning clothes
*Average of both positive and negative measurements

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average Salmonella Concentration (MPN)</th>
<th>Standard Deviation</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Number of Negative Observations</th>
<th>Number of Positive Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Bleach Intervention (Control)</td>
<td>661.28</td>
<td>8,108</td>
<td>110,000</td>
<td>0</td>
<td>173</td>
<td>7</td>
</tr>
<tr>
<td>With Bleach Intervention</td>
<td>8.44</td>
<td>88</td>
<td>1,200</td>
<td>0</td>
<td>178</td>
<td>2</td>
</tr>
</tbody>
</table>

What we have learned
➤ We can model probabilities of infection from different exposure scenarios in indoor environments
➤ Can validate models from outbreak data
➤ Can quantify the impact of interventions on disease reduction
➤ Models suggest that a 50% reduction of a virus on fomites/hands can result in an 80% reduction in illness with 50% of population participating in the intervention

Average 6-Week Probability of Infection from Handling Cleaning Clothes with and without Disinfectant Interventions

Coming Soon
20 September Inspiring Mature Minds – Adult Education in Infection Prevention and Control
Speaker: Barbara Catt, Sunnybrook Health Sciences Centre, Toronto

27 September Emerging Carbapenem Resistance: What Do We Do Now?
Speaker: Prof. Andrew Simor, University of Toronto

02 October (FREE – WHO Teleclass – Europe) The Role of Education in Low and Middle Income Countries
Speaker: Prof. Shaheen Mehtar, Stellenbosch University, South Africa
Sponsored by WHO First Global Patient Safety Challenge – Clean Care is Safer Care

11 October Evaluating Chlorhexidine Baths for the Prevention of Central Line Associated Bloodstream Infections (CLABSI)
Speaker: Prof. Silvia Munoz-Price, University of Miami Miller School of Medicine
Sponsored by Sage Products Inc (www.sageproducts.com)

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