STRATEGIES FOR NOROVIRUS INFECTION CONTROL
ROBERT E. WHEELER, MD, FACEP
VOYAGER MEDICAL SEMINARS

Strategies for Norovirus Infection Control
Robert E. Wheeler, MD, FACEP
Voyager Medical Seminars

Today’s Topics
- The Norovirus
- Norovirus Infection
- Shipboard Sanitation and the VSP
- Disinfectants for Norovirus
- Disinfection Procedures for Norovirus
- Hand Hygiene

Viruses
- Ultra-microscopic obligate parasites
- Relatively simple in structure and composition
- With or without a lipoprotein envelope

Norovirus
- Norwalk Virus, Norwalk-like virus, NLV
- SRSV (Small Round Structured Virus)
- 2002
  - Family – Caliciviridae
  - Genus – Norovirus
  - Genogroups – I, II, III, IV
  - Multiple clusters/strains

Norovirus Transmission
- "Oral-fecal" route
- Mouth → Gut (Replication) → Anus
- Hands
- Air
- Environmental surfaces
- Food
- Water

A Webber Training Teleclass
Hosted by Paul Webber  paul@webbertraining.com
www.webbertraining.com
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Norovirus Transmission

- Food (39%)
- Hands (12% “person to person”)
- Water (3%)
- Environmental surfaces (fomites)
- Air (aerosolization with vomitus)
- 46% unknown or no data available

Norovirus Food Contamination

- Source
  - Shellfish from contaminated water
  - Contaminated water used for irrigation
  - Human feces used as fertilizer
- Processing
- Preparation
- Food handlers
- Customers
- Insects

Norovirus Food Contamination

- Shellfish (oysters, clams, mussels)
- Ready to eat foods that require handling but no subsequent cooking
  - Salads
  - Peeled fruits
  - Deli-sandwiches
  - Finger foods
  - Hors d’oeuvres
  - Dips
  - Communal foods

Foods Most at Risk

- Shellfish (oysters, clams, mussels)
- Ready to eat foods that require handling but no subsequent cooking
  - Salads
  - Peeled fruits
  - Deli-sandwiches
  - Finger foods
  - Hors d’oeuvres
  - Dips
  - Communal foods

Norovirus Water Contamination

- Typically via improper sewerage treatment or overflow
- Surface water
  - Ponds, lakes, streams, rivers, reservoirs
- Well water
- Swimming pool water
- Ice

Evidence for airborne transmission of Norwalk-like virus (NLV) in a hotel restaurant; PJ Marks; Epidemiol. Infect. 2000, 124: 481-487

- 71% Hotel restaurant with 126 patrons
- 91% Patron (†) vomited at table
- 56% 52 of 83 survey responders ill
- 50% 63% overall attack rate
- 40% Attack rates higher at closer tables
- 25% Consistent with airborne transmission of NLV

Viral transmission:
Air
PTP
ES
Distance
Time
Food
Water
\[ \begin{array}{c}
71% \\
91% \\
56% \\
50% \\
40% \\
25%
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Widespread environmental contamination with NLV detected in a prolonged hotel outbreak of gastroenteritis; JS Cheeseborough; Epidemiol Infect 2000, 125: 93-98

- RT PCR environmental surface testing +
- Carpets (known vomiting) 5/8 (62%)
- Carpets (no vomiting) 9/12 (75%)
- Toilet rims/seats 8/11 (73%)
- Toilet handles, taps, basins 13/39 (37%)
- Horizontal surfaces below 1.5 m 6/12 (50%)
- Horizontal surfaces above 1.5 m 2/10 (20%)  

It's Everywhere! 13

Norovirus Infection

- "Stomach flu"
- "Lurgy"
- "Winter vomiting disease"
- 24-48 hour incubation period
- 12-60 hour duration of illness
- A "mild" and short lived illness

Norovirus Infection Symptoms

- Vomiting
- Diarrhea
- Nausea
- Abdominal cramps
- Headache, muscle aches
- Fever (minority)
- Dehydration in young and elderly victims
- Up to 30% may be asymptomatic

Kaplan Criteria for Norovirus

- Vomiting in 50% or more of cases
- Average/median duration of illness of 12-60 hours
- Average/median incubation period of 24-48 hours
- Stool specimens negative for bacterial pathogens

Many consider absence of fever to be another indicator for Norovirus infection

Norovirus Detection

- Reverse transcriptase polymerase chain reaction (RT-PCR) of stool, vomitus and environmental surfaces
- Sequencing for genotype and cluster ID
- Direct & immune EM of stool samples
- 4-fold increase in acute and convalescent IgG serum antibodies

Norovirus Infection Treatment

- Symptomatic therapy
  - PO, IV fluids
  - Antispasmodics
  - Analgesics
  - Antipyretics

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2002: “Year of The Norovirus”
- VSP reports 23 shipboard AGE outbreaks
- 12 determined to be due to Norovirus
- 9 others of unknown etiology
- In excess of half, and probably more, of the outbreaks were due to Norovirus

2002: “Year of The Norovirus”
It really wasn’t our fault!

Similar increase in Norovirus cases shoreside:
- Hotels
- Restaurants
- Theaters
- Hospitals
- Nursing homes
- Day care centers
- Schools
- Dormitories
- Military barracks
- Trains
- Buses
- Aircraft

2002: “Year of The Norovirus”
- Accounts for 2/3 of all acute gastroenteritis (AGE) in the United States
- Causes 33% of hospitalizations and 7% of deaths due to AGE
- 23-25 million cases, 8% of population in U.S.
- Incidence of cases aboard cruise ships in 2002 was only ~ 0.025% of total cruise passengers

Norovirus Critical Characteristics
- Highly contagious
- Multiple modes of transmission
- Stabile in the environment
- Resistant to routine disinfection methods
- Asymptomatic infections
- Limited immunity

Norovirus Control
- Prevention Plan
- Surveillance Plan
- Response Plan
The Vessel Sanitation Program

- Centers for Disease Control & Prevention
- Established in 1975
- Minimize the risk of diarrheal outbreaks
- Assist the cruise industry in the development and implementation of environmental health programs

The Vessel Sanitation Program

- Environmental Health Officers (EHO)
- Twice-yearly unannounced comprehensive food safety and environmental sanitation inspections of vessels with a foreign itinerary that call on a U.S. port and carry 13 or more passengers

The Vessel Sanitation Program

- Ongoing surveillance of GI illness
- Conduction & coordination of outbreak investigations on affected vessels
- Food safety and environmental sanitation training seminars for vessel and shore operations management personnel

The Vessel Sanitation Program

- Consultative services for reviewing plans for renovations and new construction
- Construction inspections at the shipyards and when the vessel makes its initial call at a U.S. port
- Dissemination of information to the public

www.cdc.gov/nceh/vsp

VSP Inspections

- 100 point scoring system
- Score of 86 is considered satisfactory
- Storage, distribution and halogenation of water supply
- Storage, preparation and service of food
- Practices and personal hygiene of employees

VSP Inspections

- Equipment maintenance
- Dishwashing procedures
- Solid and liquid waste disposal
- Toilet and hand-washing facilities
- Pest and toxic substances control
VSP Inspections
Reportable GI Illness

- Diarrhea
  - 3 or more episodes of loose stools in a 24 hour period
  or
- Vomiting plus one additional symptom
  - One or more episodes of loose stools in a 24 hour period, or abdominal cramps, or headache, or muscle aches, or fever

VSP Inspections
Disease Surveillance & Reporting

- Gastrointestinal Illness Log
- Anti-diarrheal Medications Log
- Gastrointestinal Illness Questionnaire
- 24 hour GI Illness Report
- 2% and 3% threshold GI Illness Reports
- Passenger and crew pre-boarding questionnaire for Norovirus symptoms

Prevention & Surveillance

- NOROVIRUS AWARENESS
- Shipboard Sanitation
  - Food, water, air
  - Living quarters
  - Public areas
  - Waste disposal and pest control
- Disease surveillance and reporting by the shipboard medical staff

Norovirus Response Plan

- Isolation
- Containment
- Disinfection
- Investigation
- Information/Education

Isolation

- Confine infected crew and passengers to quarters until 3 days after cessation of symptoms or disembark them from the ship for that period
- Consider relocating unaffected cabin mates
- Provide instruction on appropriate personal hygiene, especially handwashing

Natural History of Human Calicivirus Infection:
A Prospective Cohort Study
B Rockx; CID 2002, 35: 246-53

- 99 people infected with Norovirus
- Viral Shedding (via RT-PCR):
  - Day 1 78%
  - Day 8 45%
  - Day 15 35%
  - Day 22 26%
**Containment**

- Restrict access to soiled/contaminated areas until cleaned and disinfected
- Utilize specially trained and equipped “Hit Squads” or “SWAT Teams” for vomitus or diarrhea contamination incidents

**Norovirus Special Weapons and Tactics**

- Covered 2½-5 gallon SWAT bucket
- Gloves, mask, gown, safety glasses
- Disinfectant in 1 liter/quart spray bottle
- Absorbent powder or gel
- Paper towels / disposable rags
- Alcohol-based hand sanitizer
- RED plastic biohazard bags

- Cordon off the contaminated area
- Spray disinfectant directly onto gross contaminants (vomit or stool)
- Cover area with paper towels or rags for the disinfectant contact/dwell time of 5-10 minutes
- Clean surface of gross contaminants

**Norovirus Special Weapons and Tactics**

- Apply disinfectant to the soiled surface with a 5-10 minute dwell time or let air dry
- Dispose of vomitus/stool, contaminated rags, paper towels, gloves, gown, mask, etc. in a RED plastic biohazard bag
- Clean hands with soap & water and/or an alcohol-based hand sanitizer

**Containment**

- Provide medical evaluation for those with active vomiting or diarrhea in an area of the clinic away from non-afflicted patients or in their cabins
- Adhere to universal precaution protocols (gloves, gown, mask) when providing medical care to acutely ill patients
- Waive charges for medical services
Containment

- Promptly bag & clean soiled linens or dispose of them as hazardous waste
- Advise against the use of public restrooms
- Halt inter-ship crew transfers

Containment

- Remove any potentially contaminated food, beverages and ice from service
- Close self-serve buffet lines or frequently change the serving utensils or change to a served buffet line

Disinfectants for Norovirus

- The Norovirus cannot be grown in culture
- Efficacy testing of disinfectants for Norovirus is done using a surrogate virus, typically the feline calicivirus (FCV), a similar non enveloped ssRNA virus

<table>
<thead>
<tr>
<th>PATHOGEN</th>
<th>DISINFECTANT LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria with spores</td>
<td>Chemical Sterilant</td>
</tr>
<tr>
<td>Protozoa with cysts</td>
<td></td>
</tr>
<tr>
<td>Mycobacteria</td>
<td>High</td>
</tr>
<tr>
<td>Non-enveloped viruses</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Norovirus</td>
<td></td>
</tr>
<tr>
<td>Fungi</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Vegetative bacteria</td>
<td>Low</td>
</tr>
<tr>
<td>Enveloped viruses</td>
<td>Low</td>
</tr>
<tr>
<td>Coronavirus</td>
<td></td>
</tr>
</tbody>
</table>

Inactivation of Feline Calicivirus, a Norwalk Virus Surrogate; JC Doultree; J Hosp Infect 1999, 41:51-57

- Effective disinfection agents
  - Glutaraldehyde 0.5%
  - Iodine 0.8%
  - Hypochlorite 1000 ppm (freshly reconstituted) Household bleach required 5000 ppm
- Ineffective disinfection agents
  - QUAT 1:10
  - Ethanol 75%
  - Anionic detergent 1%

Inactivation of Feline Calicivirus, a Norwalk Virus Surrogate; JC Doultree; J Hosp Infect 1999, 41:51-57

- Heat inactivation of FCV
  - 56°C for 60 minutes, complete inactivation
  - 70°C for 3 minutes, 6.5 log₁₀ reduction
  - 70°C for 5 minutes, complete inactivation
  - 100°C for 1 minute, complete inactivation
Surface survival of dried FCV
- 4°C, > 60 days
- 20°C (RT), 21-28 days
- 37°C, less than 1 day

Inactivation of Feline Calicivirus, a Norwalk Virus Surrogate; JC Doultree; J Hosp Infect 1999, 41:51-57

Efficacy of Commonly Used Disinfectants for the Inactivation of Calicivirus on Strawberry, Lettuce and Food Contact Surfaces; BR Gulati; J of Food Protection 2001, 64(9):1430-1434

- Phenolic compounds at 2-4 times the recommended concentration completely inactivated FCV on contact surfaces
- Hypochlorite (liquid bleach) 5000 ppm was needed to inactivate FCV
- QUATS were ineffective
  - Effective when 2% sodium bicarbonate added

Effective sanitizers on FCV contaminated strawberries and lettuce
- 15% peroxyacetic acid + 11% hydrogen peroxide at 4X normal concentration
- Hypochlorite (liquid bleach) at 5000 ppm
- Water alone produced a 2 log₁₀ reduction

Disinfectants for Norovirus
Consider:
- Efficacy
- Spectrum
- Versatility
- Ease of use
- Safety profile
- Cost

Accelerated Hydrogen Peroxide™ (AHP™)
Chlorine dioxide + QUAT (Cryocide 20™)
Hypochlorite (bleach)
Parachlorometaxylenol (EcoTru®)
Peroxomonosulphate (Virkon®)
Phenols (Mikro-Bac II®, Mikro-Bac 3®)
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Accelerated Hydrogen Peroxide™

- 0.5% hydrogen peroxide solution
- Broad spectrum biocide
- Cleans and disinfects
- Concentrate, wet-wipes and RTU liquid

Accelerated Hydrogen Peroxide™

- Non-toxic in RTU form
- Environmentally safe
- 5 minute dwell time
- 24 month shelf life
- May leave an easily removed, non-toxic surfactant residue on some surfaces

Chlorine Dioxide/QUAT

- CRYOCIDE 20™
- Stabilized ClO₂ (0.75%) plus twin chain QUAT solution
- ClO₂ is a strong oxidizing agent
- Broad spectrum biocide
- Reportedly effective in several UK and European hotel Norovirus outbreaks

Chlorine Dioxide/QUAT

- Wet fog and spray/wipe disinfection
- Use full strength or a 1:4 dilution
- 12 month shelf life (dated at plant)

Chlorine Dioxide/QUAT

- Effective as a fogging agent with a 30 minute dwell time
- Safe with most fabrics
- Non-corrosive
- May be mildly irritating to skin & eyes
- Avoid mixing with acids or chlorine
- Can promote toxic ClO₂ gas formation

Hypochlorite (bleach)

- Broad spectrum biocide
- Inexpensive and readily available
- Use freshly prepared (daily) solution reconstituted from a dry hypochlorite compound to ensure the 1000 ppm effective concentration required for Norovirus
Hypochlorite (bleach)

- Organic debris reduces its effectiveness
- Cleaning of surface required prior to disinfection
- Used mainly on hard, non-porous surfaces
- Damaging to many textiles
- Corrosive to metals

Hypochlorite (bleach)

- May produce toxic chlorine gas if combined with certain other compounds
- Can be irritating to skin, eyes, mucous membranes and lungs (fumes)
- The gold (“plated”) standard for Norovirus disinfection

Parachlorometaxylenol (PCMX)

- EcoTru® (EnviroSystems, Inc.)
- 0.20% parachlorometaxylenol
- Broad spectrum biocide
- Cleans and disinfects
- Leaves no residue
- Non-staining
- RTU liquid and wipes
- 18 month shelf life

Parachlorometaxylenol (PCMX)

- Non-toxic (EPA Tox Category IV)
  - No cautions
  - No oral, dermal or inhalation toxicity
  - No eye or skin irritation
  - Hypoallergenic
  - Biodegradable
  - Non-corrosive
  - Approved for use on aircraft

Parachlorometaxylenol (PCMX)

- Nano-emulsion of charged spheres
- Efficacy against Norovirus
  - 30 minute dwell time
  - Spray and air dry
  - Fogging
    - Cold
    - Electrostatic

Peroxomonosulphate

- Virkon® (Antec International)
- Broad spectrum disinfection
- Six synergistic biocides
- ~1000 ppm free chlorine in solution
- Powder form
- Non-toxic in prepared 1% or 2% solution
- Biodegradable
**Peroxomonosulphate**
- Proven efficacy (as a 2% solution) on carpet material against FCV
- May leave a fine film on some surfaces
- Acid sensitive surfaces require rinsing
  - Granite, marble
  - Aluminum, brass, copper
- 3 year shelf life (powder)
- 7 days mixed solution

**Phenols**
- Mikro-Bac II®, Mikro-Bac 3®
- o-phenylphenol, o-benzyl-p-chlorophenol
- Liquid concentrate
- Cleans & disinfects
- Dilute concentrate with water 1:128
  - Consistent with the concentration reported to be effective for the disinfection of FCV as a Norovirus surrogate (Gulati; JFP 2001)

**Phenols**
- Phenols should not be used in food preparation/food service areas or in areas where infants and young children might be exposed to the solution or its residue
- Phenols now have very limited use in health care facilities
  - These restrictions are due to the toxicity of phenols to various organ systems

**Disinfectants for Norovirus**
- To make an informed choice of disinfectants:
  - Request/demand company and independent testing data from the manufacturer or distributor that supports their efficacy claims against FCV/Norovirus
  - Test the disinfectant for adverse effects on your own ships’ environmental surfaces

**Fogging**
- Applies small droplets of disinfectants to the air and environmental surfaces
- Rapid environmental surface coverage
- Effective for disinfection of horizontal surfaces and air but not vertical surfaces, under surfaces, or shadowed areas
- Cold vs. thermal vs. electrostatic
**Major Uses for Fogging**
- Livestock pens/barns
- Food processing plants
  - Usually preceded by surface cleaning and spray disinfection
  - Reduces airborne microbial contamination and applies disinfectants to surfaces
  - 15-30 minutes of active fogging
  - 45-60 minutes for fog to settle and air to clear

**Fogging**
- Most health authorities do not recommend the use of fogging in healthcare facilities
- Efficacy vs. spray & wipe disinfection
- Question need for full surface disinfection
- Logistics – Where do we put the patients?
- Potential adverse reactions of already ill people to the fogging agents

**Fogging Aboard Ship**
- Should be considered an adjunct to thorough surface cleaning and disinfection
- Allows for supplemental disinfection of known and potentially contaminated surfaces
- Soft surface coverage – furniture, drapes, carpets, wall coverings
- Fog cabin for about 1 minute
- Let stand for at least 1 hour
- Open room to outside air if possible

**Disinfection**
- Institute enhanced food preparation and food service environmental surface disinfection procedures
- Apply hypochlorite (bleach) 1000 ppm and then rinse with potable water
  - The usual 200 ppm “no rinse” hypochlorite solution is not effective against Norovirus

**Disinfection**
- Restaurants
- Bars, lounges
- Showrooms
- Casinos
- Game rooms
- Library
- All passenger and crew public areas
- All passenger and crew cabins
**Disinfection**
- Consider any and all heavy hand contact surfaces to be contaminated
  - Door handles, push plates
  - Railings, elevator buttons
  - Telephones, keyboards
  - Pens, pencils
  - Tables, counters
  - Casino chips, cards, slot machines
  - Sports equipment
  - Etc., etc., etc.

**Disinfection**
- Public restrooms
  - Stall doors and latches
  - Toilet seats and handles
  - Faucets
  - Towel dispensers
  - Cabin bathrooms

**Disinfection**
- Indoor and outdoor facilities
  - Lounge chairs
  - Swimming pools
  - Hot tubs
  - Gymnasium
  - Children’s areas

**Disinfection**
- Steam cleaning
  - Soiled carpets and furniture
  - Must reach 70°C for 5 minutes at the contaminated surface to be effective against FCV/Norovirus
  - Consider chemical disinfection of soiled areas prior to steam cleaning

**Investigation**
- Food intake history (72 hrs prior to illness)
- Passive and active surveillance surveys
- Identification of potential index case(s)
- Collection of stool, vomitus and blood samples for testing
- Development of epidemic curves

**Norovirus Epidemic Curve**  
MMWR 2002, 51(49)
Information/Education
- Alert passengers and crew of any outbreak
- Tell them what Norovirus is and how it is transmitted
- Advise them to seek medical evaluation for symptoms of vomiting and/or diarrhea
- If ill, strictly follow the isolation procedures
- Provide instructions for proper hand hygiene

Hand Hygiene
- Contaminated hands are probably the single most common vector for the spread of Norovirus

Stay Healthy—Wash Your Hands

Hand Hygiene
- Proper hand hygiene practiced by a majority of passengers and crew members could significantly decrease the incidence and extent of Norovirus outbreaks aboard cruise ships

Clean Hands are Healthy Hands

CDC
U.S. Centers for Disease Control and Prevention

“Handwashing is the single most important procedure for preventing the spread of infection.”

APIC
Association for Professionals in Infection Control and Epidemiology

“Handwashing causes a significant reduction in the carriage of potential pathogens on the hands.”

Handwashing and Respiratory Illness Among Young Adults in Military Training
MA Ryan; AJPM 2001, 21(2): 79-83
- ~90% attack rate for URI in 1996
- Operation Stop Cough 1997 through 1998
- Ordered to wash hands 5 times/day
- Incidence of URI decreased by 45%
Hand Hygiene
- Can help to break the “recontamination cycle”

Basic Handwashing Procedure
- Wet hands with water
- Apply soap
- Scrub hands together vigorously for at least 15 seconds
- Rinse with running water
- Dry (paper towel or blow dryer)
- Turn off faucet with paper towel

Efficacy of Handwashing for FCV/Norovirus
- Running water ~ 2 log₁₀ (99%) reduction
- Soap & water ~ 3 log₁₀ (99.9%) reduction
- Antibacterial soaps offer no significant increased benefit for FCV/Norovirus

Efficacy of Alcohol-based Hand Sanitizers
- A product must provide at least a 2 log₁₀ (99%) reduction in pathogens to be considered an effective hand sanitizer

Efficacy of Alcohol-based Hand Sanitizers
- Dependent upon the specific agent, concentration and contact time
- n-propanol > ethanol > isopropanol
- Liquid > Gel > Foam
- 60-95% concentration

Efficacy of Alcohol-based Hand Sanitizers
- Amount for a 10-15 second contact time
  - 1 ml (¾ inch diameter/nickel size of gel)
- Amount for a 20-30 second contact time
  - 2 ml (1 inch diameter/quarter size of gel)
**Efficacy of Alcohol-based Hand Sanitizers**

- Provide an overall 3-4 log\(_{10}\) (99.9-99.99%) reduction in bacterial and viral pathogens with a contact time of 15 seconds
- Non-enveloped viruses are more resistant and require an extended contact time
- FCV/Norovirus are reduced by only 1-2 log\(_{10}\) (90-99%) with a 30 second contact time

**Hand Hygiene**

- Handwashing is especially important before eating and after using the restroom
- In Norovirus outbreaks, alcohol-based hand sanitizers should be considered an adjunct to handwashing and not a replacement

**Handwashing vs. Sanitizers**

<table>
<thead>
<tr>
<th>Handwashing</th>
<th>Sanitizers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands visibly soiled</td>
<td>No visible soiling</td>
</tr>
<tr>
<td>After contact with bodily fluids</td>
<td>When soap &amp; water are not available</td>
</tr>
<tr>
<td>Before eating</td>
<td>Between handwashes</td>
</tr>
<tr>
<td>After using the restroom</td>
<td>To supplement handwashing</td>
</tr>
</tbody>
</table>

**Promotion of Proper Hand Hygiene**

- Formal education to all crew during their sign-on orientation and via crew TV
- Notices to all passengers in their stateroom information folders
- Instructional signs in all public restrooms and private bathrooms

**Summary**

- Norovirus is a ubiquitous and highly contagious gastrointestinal pathogen
- Enhanced sanitation procedures are necessary to prevent and control Norovirus outbreaks
- Proper handwashing techniques can have a significant impact on the spread of Norovirus infection

**For additional info, contact:**

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