

Strategies for Norovirus Infection Control

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Today's Topics

- The Norovirus
- Norovirus Infection
- Shipboard Sanitation and the VSP
- Disinfectants for Norovirus
- Disinfection Procedures for Norovirus
- Hand Hygiene

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Viruses

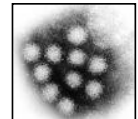
- Ultra-microscopic obligate parasites
- Relatively simple in structure and composition
- With or without a lipoprotein envelope



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Norovirus

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

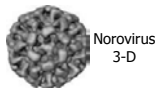


Norovirus
Electron Micrograph

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Norovirus

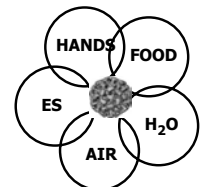
- Non-enveloped ssRNA virus
- 27-35 nm in size (SRSV)
- Infectious dose of 10-100 virus particles
- Viral shedding of 3 weeks or more
- Survives 0°C, 60°C, chlorine 10 ppm
- Limited (few months) immunity



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Norovirus Transmission

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



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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

MMWR 2001; 50: RR-9

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Norovirus Food Contamination

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



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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



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Norovirus Water Contamination

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

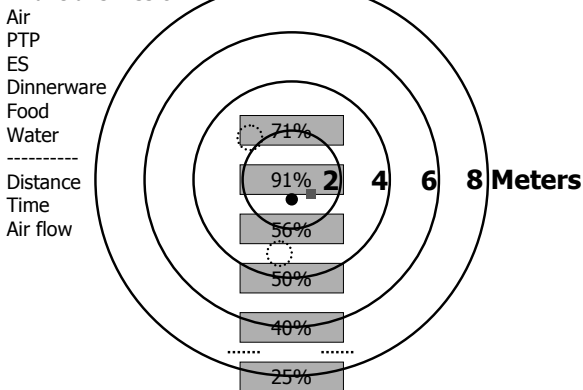
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Evidence for airborne transmission of Norwalk-like virus (NLV) in a hotel restaurant;
 PJ Marks; Epidemiol. Infect. 2000, 124: 481-487

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

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Viral transmission:



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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 (39%)
 - Horizontal surfaces below 1.5 m 11/29 (37%)
 - Horizontal surfaces above 1.5 m 6/12 (50%)
 - Phones, door handles, etc. 7/29 (24%)
 - Soft furnishings 2/10 (20%)
 - Total 61/144 (42%)

It's Everywhere!

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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

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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



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Kaplan Criteria for Norovirus

- Vomiting in 50% or more of cases
- Average/median duration of illness of 12-16 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

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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

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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

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2002: "Year of The Norovirus"

It really wasn't our fault!



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2002: "Year of The Norovirus"

Similar increase in Norovirus cases shoreside:

- | | |
|--------------------|---------------------|
| ■ Hotels | ■ Schools |
| ■ Restaurants | ■ Dormitories |
| ■ Theaters | ■ Military barracks |
| ■ Hospitals | ■ Trains |
| ■ Nursing homes | ■ Buses |
| ■ Day care centers | ■ Aircraft |

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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

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Norovirus Critical Characteristics

- Highly contagious
- Multiple modes of transmission
- Stable in the environment
- Resistant to routine disinfection methods
- Asymptomatic infections
- Limited immunity

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Norovirus Control



- Prevention Plan
- Surveillance Plan
- Response Plan

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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

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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

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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

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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

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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

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VSP Inspections

- Equipment maintenance
- Dishwashing procedures
- Solid and liquid waste disposal
- Toilet and hand-washing facilities
- Pest and toxic substances control

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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

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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

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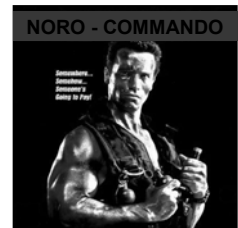
Prevention & Surveillance

- **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

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Norovirus Response Plan

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



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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

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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%



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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

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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

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Norovirus Special Weapons and Tactics

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

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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

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Norovirus Special Weapons and Tactics

- Open the room to outside air
- Soiled carpets and upholstery can be steam cleaned after the chemical disinfection
- Air dry rugs and furniture in the sunlight

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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

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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

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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

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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



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DISINFECTANT LEVEL FOR VARIOUS PATHOGENS

PATHOGEN	DISINFECTANT LEVEL
Bacteria with spores	Chemical Sterilant
Protozoa with cysts	
Mycobacteria	High
Non-enveloped viruses	Intermediate
Norovirus	
Fungi	Intermediate
Vegetative bacteria	Low
Enveloped viruses	Low
Coronavirus	

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%

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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

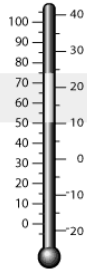


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Inactivation of Feline Calicivirus, a Norwalk Virus Surrogate; JC Doultree; J Hosp Infect 1999, 41:51-57

- Surface survival of dried FCV
 - 4°C, > 60 days
 - **20°C (RT), 21-28 days**
 - 37°C, less than 1 day



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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

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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

- 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

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Disinfectants for Norovirus

Consider:

- Efficacy
- Spectrum
- Versatility
- Ease of use
- Safety profile
- Cost



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Disinfectants for Norovirus

- When selecting a disinfectant, it's important to consider the product's entire formulation since there may be significant disinfectant action synergism produced by the specific combination of ingredients.

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Disinfectants for Norovirus

- Accelerated Hydrogen Peroxide™ (AHP™)
- Chlorine dioxide + QUAT (Cryocide 20™)
- Hypochlorite (bleach)
- Parachlorometaxlenol (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

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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



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Chlorine Dioxide/QUAT

- **CRYOCIDE 20™**
- Stabilized ClO_2 (0.75%) plus twin chain QUAT solution
- ClO_2 is a strong oxidizing agent
- Broad spectrum biocide
- Reportedly effective in several UK and European hotel Norovirus outbreaks



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Chlorine Dioxide/QUAT

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



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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 ClO_2 gas formation

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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

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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

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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

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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



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Parachlorometaxylenol (PCMX)

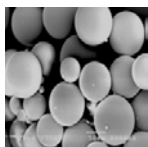
- Non-toxic (EPA Tox Category IV)
 - No cautions
 - No oral, dermal or inhalation toxicity
 - No eye or skin irritation
- Hypoallergenic
- Biodegradable
- Non-corrosive
 - Approved for use on aircraft



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Parachlorometaxylenol (PCMX)

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



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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



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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



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Phenols

- Mikro-Bac II[®], Mikro-Bac 3[®]
- o-phenylphenol, o-benzyl-p-chlorophenol
- Liquid concentrate
- Cleans & disinfects **ECOLAB[®]**
- 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)

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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

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Phenols

- Potential toxicity from o-phenylphenol, o-benzyl-p-chlorophenol and ethylene glycol (anti-freeze)
 - Skin, brain, kidneys, liver, lungs
 - O phenylphenol is listed as a carcinogen
 - Ethylene glycol is listed as a teratogen
 - Hazardous to the aquatic environment

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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

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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

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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

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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

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Fogging

- Infrequently used in hotels, cruise ships, trains, tour buses, airliners
 - Anecdotal reports indicate that fogging may be a useful mode of disinfection for Norovirus outbreaks aboard ship as well as in shoreside hotels.

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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

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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

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Disinfection

- Restaurants
- Bars, lounges
- Showrooms
- Casinos
- Game rooms
- Library
- All passenger and crew public areas
- All passenger and crew cabins



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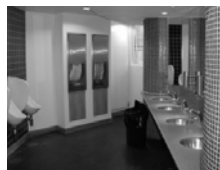
Disinfection

- 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.



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Disinfection



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

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Disinfection

- Indoor and outdoor facilities
 - Lounge chairs
 - Swimming pools
 - Hot tubs
 - Gymnasium
- Children's areas



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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

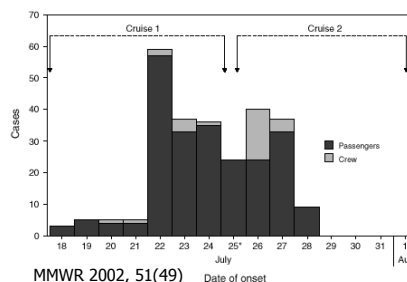
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Investigation

- 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

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Norovirus Epidemic Curve



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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

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Hand Hygiene

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



Stay Healthy—Wash Your Hands

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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

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CDC

U.S. Centers for Disease Control and Prevention

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

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APIC

Association for Professionals in Infection Control and Epidemiology

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

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Handwashing and Respiratory Illness Among Young Adults in Military Training
MA Ryan; AJPM 2001, 21(2): 79-83

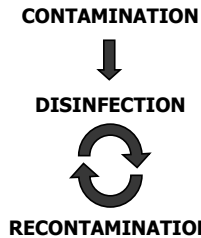
- ~90% attack rate for URI in 1996
- Operation Stop Cough 1997 through 1998
- Ordered to wash hands 5 times/day
- Incidence of URI decreased by 45%



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Hand Hygiene

- Can help to break the "recontamination cycle"



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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



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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

FRICITION & FLOW

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Alcohol-based Hand Sanitizers

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



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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

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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)

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Efficacy of Alcohol-based Hand Sanitizers

- Provide an overall 3-4 log₁₀ (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 log₁₀ (90-99%) with a 30 second contact time

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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

Clean Hands in Just a Minute

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Handwashing vs. Sanitizers

Handwashing

- Hands visibly soiled
- After contact with bodily fluids
- Before eating
- After using the restroom

Sanitizers

- No visible soiling
- When soap & water are not available
- Between handwashings
- To supplement hand washing

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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

Don't Get Caught DIRTY HANDED!

www.washup.org

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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

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