Strategies for Norovirus Infection Control

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Today's Topics

- Cruise Ships as Destination Resorts
- The Norovirus
- Cruise Ship Norovirus Outbreaks
- Shipboard Sanitation and the VSP
- Disinfectants for Norovirus
- Disinfection Procedures for Norovirus
- Hand Hygiene

North American Cruise Market

- Accounts for 75% of world cruise market
- 8.4% annual growth rate since 1980
- 175 ships now sailing
- 20 new ships to enter service by 2006
- Median age of passengers is 51 years
- Ships typically sail at > 90% capacity

North American Cruise Market

- 8 MILLION passengers in 2004
- $10 BILLION in revenue in 2004
- 50% of cruises to Bahamas & Caribbean
- Europe, Alaska, Mexico, Trans-Panama Canal, Hawaii and South America account for another 40% of all cruises

Expectations of Cruisers

- Beautiful ship
- Comfortable stateroom
- Great food
- Fun activities
- Exciting entertainment
- Competent medical care
- Safe & sanitary environment

Viruses

- Ultra-microscopic obligate IC parasites
- Relatively simple in structure and composition
- With or without a lipoprotein envelope
- 20-300 nanometers diameter

Nucleic acid genome (DNA or RNA)
Protein shell (capsid)
Lipid-protein envelope
STRATEGIES FOR NOROVIRUS INFECTION CONTROL

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
- 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

Norovirus Transmission
- “Fecal-oral” route
- Mouth ↔ Gut (Replication) ↔ Anus
- Food
- Water
- Air
- Environmental surfaces
- Hands

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

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 Food Contamination
- Source
  - Shellfish from contaminated water
  - Contaminated water used for irrigation
  - Sewerage used as fertilizer
- Processing
- Preparation
- Food handlers
- Guests
- Insects

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STRATEGIES FOR NOROVIRUS INFECTION CONTROL

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

Viral transmission:
- Air
- PTP
- ES
- Dinnerware
- Food
- Water
- Distance Time Air flow

Transmission of Norwalk Virus During a Football Game; Becker KM, Moe CL, Southwick KL, MacCormack JN; NEJM, 2000 Oct 26; 343(17):1223-7
- Duke vs. FSU, September 19, 1998
- 36 Blue Devils with N/V/D on game day
- 11 Seminoles became ill 24 hours later with the Blue Devils Revenge
- Only association was contact on the field
- Barf Bowl final score: FSU 62, Duke 13

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%)

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

- Diarrhea
- Vomiting
- 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
- ELISA test kit (IDEIA™ NLV)
- 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

2002: “Year of The Norovirus”

- VSP reports 23 shipboard AGE outbreaks
- 12 determined to be due to Norovirus
- 9 others of unknown or pending etiology
- In excess of half of the outbreaks were definitely due to Norovirus and several others were probably due to Norovirus

2002: “Year of The Norovirus”

It really wasn’t our fault!
STRATEGIES FOR NOROVIRUS INFECTION CONTROL

2002: “Year of The Norovirus”

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

Prevention & Surveillance

- NOROVIRUS AWARENESS
- Shipboard Sanitation
  - International maritime regulations
  - Cruise industry guidelines
  - Corporate policies and procedures
  - Multi-departmental shipboard protocols
  - CDC Vessel Sanitation Program
- Disease surveillance and reporting by the shipboard medical staff

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STRATEGIES FOR NOROVIRUS INFECTION CONTROL

Shipboard Sanitation
- Cruise ships are often characterized as “floating cities”
- Sanitation needs and requirements are indeed similar to those of a small town

Shipboard Sanitation
- Food, water, air
- Living quarters (passenger and crew)
- Public areas
- Waste (trash, garbage, sewerage, HAZMAT)
- Pests (vermin, insects)

Shipboard Sanitation Department Collaboration
- Industry guidelines and standards
- Corporate policies & procedures
- Ship’s Command
- Hotel
- Food & Beverage
- Housekeeping
- Engineering
- Environmental
- Medical

Shipboard Sanitation - Food
- HACCP Program
- Reliable suppliers
- Strict quality control
- Proper food storage
- Inventory control
- Food separation

Shipboard Sanitation - Food
- Sanitary preparation and serving areas
- Appropriate cooking and serving temps
- Clean-rinse-sanitize process for cookware and dinnerware
- Strict hygiene protocols for food handlers

Shipboard Sanitation - Water
- Bunkering of water only from safe sources
- Water desalination
  - Distillation
  - Reverse osmosis
- Filtering
- Halogenation
- Continuous monitoring of water quality
STRATEGIES FOR NOROVIRUS INFECTION CONTROL

**Shipboard Sanitation - Air**
- Filtering
- Air exchange
- Temperature control
- Humidity control
- Duct cleaning

**Passenger Living Quarters**
- Passenger staterooms are cleaned at least twice daily
- Disinfectants routinely used on bathroom and high hand-contact areas

**Crew Living Quarters**
- Daily cleaning
- Crew sanitation regulations
- Weekly inspections

**Public Areas**
- Daily cleaning
- Repeat cleaning with additional use
- Disinfection of heavy hand-contact and soiled/contaminated areas

**Waste Management**
- Adherence to international regulations
- Separation & recycling
- Incineration
- Bilge, waste water & sewerage treatment
- Off-loading of hazardous materials

**Pests**
- Rare on modern cruise ships due to the strict sanitation protocols in place
- Rats, mice, flies, ants, cockroaches, silverfish
- Continuous surveillance
- Pesticides as needed
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

www.cdc.gov/nceh/vsp
STRATEGIES FOR NOROVIRUS INFECTION 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

**VSP 1986-1993**

**JAMA 1996-Vol. 275, No. 7**
- 13,442 cruises of 3-15 days duration
- 31 outbreaks
  - 7,626 passengers
  - 601 crew
  - Bacterial - 39%
  - NLV - 29%
  - Unknown - 32%

**VSP 1986-1993**

**JAMA 1996-Vol. 275, No. 7**
- 1.4 outbreaks/1000 cruises
- 2.3 outbreaks/10 million passenger-days
- 1975-1979, 8.1 outbreaks/10 million p-days
- 1980-1985, 3.0 outbreaks/10 million p-days
- > 60% decrease in AGE outbreaks 1975-1985
- > 23% decrease 1985-1993
- 6 outbreak-related illnesses/100,000 p-days
- Hypothetical 1045 passenger 7 day cruise - 0.2% probability of an outbreak

**VSP 1990-2000**

**AJPM Dec 2002**
- Mean inspection scores increased from 89 in 1990 to 93 in 2000
- Baseline passenger diarrhea
  - 23.6/100,000 passenger days or 2/cruise
  - 29.2 in 1990, 16.3 in 2000
- Ships that received a satisfactory VSP inspection score had lower incidence of diarrheal illness, 21.7 vs. 30.1/100,000 passenger-days

**VSP 1990-2000**

**AJPM Dec 2002**
- Diarrheal disease outbreak related illness
  - 1990-1995, 4.2/100,000 passenger days
  - 1996-2000, 3.5/100,000 passenger days
- A 40% improvement between 1986-1993 and 1996-2000 in addition to the more than 60% decrease in AGE outbreaks from 1975-1979 to 1980-1985

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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

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
- Scraper, dust pan
- Paper towels / disposable rags
- Alcohol-based hand sanitizer
- RED plastic biohazard bags

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

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

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**NOROVIRUS SPECIAL WEAPONS AND TACTICS**

- Apply disinfectant to the soiled surface for 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 infirmary 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

**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

**FCV Donor Card**

- Name: DIVA
- Age: 5 years
- Breed: Persian
- Attitude: BAD
STRATEGIES FOR NOROVIRUS INFECTION CONTROL

**Diisnfectant Level for Various Pathogens**

<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>High</td>
</tr>
<tr>
<td>Mycobacteria</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Non-enveloped viruses</td>
<td>Intermediate</td>
</tr>
<tr>
<td>Norovirus</td>
<td>Low</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>Low</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%

*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

*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

*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% peroxycetic 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

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.

Accelerated Hydrogen Peroxide™

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

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
STRATEGIES FOR NOROVIRUS INFECTION CONTROL

**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 surface disinfectant and 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
Strategies for Norovirus Infection Control

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

Peroxymonosulphate
- 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

Peroxymonosulphate
- Proven efficacy (as a 2% solution) on carpet material against FCV, a Norovirus surrogate
- 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
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

PerfectCLEAN® Microfiber
- A non-chemical alternative for disinfection
- Fiber matrix of 8 triangular threads
- > 90,000 microfibers per square inch
- Cleaning wipes, towels, mops
- Pathogens absorbed into the fabric
- 3-4 log₁₀ reduction of surface FCV
- Essentially no transfer of FCV from fabric

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

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

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
  - Floor
  - Cabin bathrooms
- 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

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

- Increasingly 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.

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

Fogging Checklist

- Efficacy & spectrum of disinfectant
- Volume of disinfectant
  - As per manufacturer’s recommendation
  - General recommendation is 1 liter/100 m³
- Particle size
  - 10-20 micron diameter is optimal, will settle in 45-60 minutes in a non-ventilated room

- Fogger nozzle location in room/cabin
  - 1-2 meters above floor
  - Higher location improves dispersal of disinfectant
  - Less coverage at higher areas of room
  - Less coverage at areas posterior to nozzle
  - Avoid wall and ceiling contact with nozzle plume
  - Disinfectant will concentrate on these surfaces

- Active fogging period for surface disinfection
  - May be as little as the time needed to fog the required volume of disinfectant
  - Longer periods allow for better disinfectant dispersal and extended contact time
  - Handheld foggers and fans may help to increase disinfectant dispersal

- Active fogging period for air disinfection
  - Should be at least as long as the disinfectant’s recommended contact time
  - Longer periods allow for better disinfectant dispersal and extended contact time
  - Dwell/contact time
    - As required by the specific disinfectant agent
    - For NV disinfectants, typically 5-10 minutes
Fogging Checklist

- Room closure
  - Allows time for disinfectant particles to settle on surfaces after active fogging
  - May be influenced by safety profile of disinfectant
    - Higher toxicity = Longer closure time
  - 45-60 minutes is recommended to ensure adequate contact time of disinfectant settled on surfaces and the safety of workers and occupants

Surface Fogging Protocol

- Disable the room’s ventilation system
- Set fogger for a particle size of 10-20 microns
- Set appropriate fogging rate
- Have an adequate volume of an effective Norovirus disinfectant available in the fogger reservoir
- Fog the entire volume of disinfectant
- If using a handheld portable fogger, disperse fog evenly about the room

Surface Fogging Protocol

- Keep the fogger nozzle 1-2 meters above the floor
- Avoid contact of the fogger nozzle plume with the walls and ceiling of the room
- Maintain room closure for 45-60 minutes
- Enable the ventilation system/open to outside air
- Wipe off residual disinfectant from sensitive surfaces

Air + Surface Fogging Protocol

- Disable the room’s ventilation system
- Set fogger for a particle size of 10-20 microns
- Set appropriate fogging rate
- Have an adequate volume of an effective Norovirus disinfectant available in the fogger reservoir
- Actively fog the room for at least 5-10 minutes
- If using a handheld portable fogger, disperse fog evenly about the room

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
STRATEGIES FOR NOROVIRUS INFECTION CONTROL

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.”

ROBERT E. WHEELER, MD, FACEP
VOYAGER MEDICAL SEMINARS
“Handwashing causes a significant reduction in the carriage of potential pathogens on the hands.”

~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/open door with paper towel

Efficacy of Handwashing for FCV/Norovirus
- Running water ~ 2 log_{10} (99%) reduction
- Soap & water ~ 3 log_{10} (99.9%) reduction
- Antibacterial soaps offer no significant increased benefit for FCV/Norovirus

Handwashing
- It’s a NO BRAINER
Alcohol-based Hand Sanitizers

- A product must provide at least a $2 \log_{10}$ (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.
- 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 (2 cm diameter/nickel size of gel).
- Amount for a 20-30 second contact time:
  - 2 ml (2.5 cm diameter/quarter size of gel).

Manorapid Synergy® / VIRA-GARD™

- Hand sanitizer/antiseptic.
- Active ingredients:
  - Ethanol 54.1%.
  - 1-propanol 10%.
- Other ingredients:
  - 1,2 propylene glycol 5.9%.
  - 1,3 butanediol 5.7%.
  - Gel, liquid, spray, wipes.

Manorapid Synergy® / VIRA-GARD™

- Proven efficacy against FCV.
- 2-3 $\log_{10}$ reduction on hands @ 30 seconds.
- Apply 3 ml for 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

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 handwashing

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

Summary

- Norovirus is a ubiquitous and highly contagious gastrointestinal pathogen.
- Enhanced sanitation procedures are necessary to prevent and control Norovirus outbreaks aboard cruise ships.
- Proper handwashing by passengers and crew members can have a significant impact on the spread of Norovirus in the cruise ship environment.

Updated FBI Primer

Diagnosis and Management of Foodborne Illnesses: A Primer for Physicians and Other Health Care Professionals

MMWR 2004, 53 (RR-4)

www.ama-assn.org/go/foodborne
BON VOYAGE!

…but wash your hands before you leave.

For additional info, contact:
Robert E. Wheeler, MD, FACEP
Voyager Medical Seminars
9 Corduroy Road
Amherst, NH 03031-2724
603-672-5775 Voice/Fax
vms@adelphia.net
www.vms4csm.com
### Vessel Name Inspection Report

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
</table>

#### DISEASE REPORTING

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>4</td>
<td>Disease reporting</td>
</tr>
<tr>
<td>02</td>
<td>1</td>
<td>Medical logs maintenance</td>
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</tbody>
</table>

#### POTABLE WATER

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>03</td>
<td>5</td>
<td>Bunker / production source; Halogen residual</td>
</tr>
<tr>
<td>04</td>
<td>5</td>
<td>Distribution system halogen residual</td>
</tr>
<tr>
<td>05</td>
<td>5</td>
<td>Distribution system halogen analyzer calibrated</td>
</tr>
<tr>
<td>06</td>
<td>2</td>
<td>Halogen analyzer chart recorder maintenance, operation, records; Micro sampling, records</td>
</tr>
<tr>
<td>07</td>
<td>3</td>
<td>System protection cross-connections, backflow; Disinfection</td>
</tr>
<tr>
<td>08</td>
<td>1</td>
<td>Filling hoses, caps, connections, procedures; Sample records, valves; System construction, maintenance</td>
</tr>
</tbody>
</table>

#### SWIMMING POOLS, SPAS

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>09</td>
<td>3</td>
<td>Swimming pools / spas halogen residuals</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>Swimming pools / spas maintenance, safety equipment</td>
</tr>
</tbody>
</table>

#### FOOD SAFETY

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>5</td>
<td>Food handlers infections, communicable diseases</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>Hands washed; Hygienic practices</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>Management, knowledge, monitoring</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>Outer clothing clean; Jewelry, hair, hand sanitizers</td>
</tr>
</tbody>
</table>

#### EQUIPMENT

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>2</td>
<td>PHF temperature maintenance facilities; Food-contact surfaces; Food TMD’s</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>Nonfood-contact surfaces; Ambient TMD’s</td>
</tr>
<tr>
<td>22</td>
<td>2</td>
<td>Warewashing facilities; TMD’s; Test kits</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>Pre-wash; Wash and rinse solutions</td>
</tr>
<tr>
<td>24</td>
<td>3</td>
<td>Sanitizing rinse</td>
</tr>
<tr>
<td>25</td>
<td>1</td>
<td>Wiping cloths / chef’s towels</td>
</tr>
<tr>
<td>26</td>
<td>3</td>
<td>Food-contact surfaces equipment / utensils; Safe materials</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>Non-food contact surfaces equipment / utensils clean</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>Equipment / utensil / linen / single / service storage handling dispensing; Cleaning frequency</td>
</tr>
</tbody>
</table>

#### TOILET AND HANDWASHING FACILITIES

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>3</td>
<td>Facilities convenient, accessible, design, installation</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>Hand cleanser, sanitary towels, waste receptacles, handwash signs; Maintenance</td>
</tr>
</tbody>
</table>

#### TOXIC SUBSTANCES

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Point Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>5</td>
<td>Toxic items</td>
</tr>
</tbody>
</table>

#### MEDICAL LOG REVIEW

<table>
<thead>
<tr>
<th>Cruise - Start / End / Port / PAX / ILL / CREW / ILL</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
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<td>5.</td>
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</table>

Comments:
### Gastrointestinal Illness Surveillance System Log

**Vessel____________________  Voyage Number _______  Dates: From: _____/_____/_______ To: _____/_____/_______  Page ___ of ___ for voyage**

<table>
<thead>
<tr>
<th>Date (mm/dd/yyyy)</th>
<th>Name Last, First</th>
<th>Age</th>
<th>M / F</th>
<th>Pax / Crew</th>
<th>Crew Position</th>
<th>Cabin No.</th>
<th>Meal Seat</th>
<th>Illness Onset</th>
<th>Date (mm/dd/yyyy)</th>
<th>Time (hr:min AM / PM)</th>
<th>Y/ N</th>
<th>Blood</th>
<th>Y/N</th>
<th>#</th>
<th>Y/ N</th>
<th>Y/N</th>
<th>°F</th>
<th>Req</th>
<th>Rec</th>
<th>Antidiarrheal Medication (Y/N)</th>
<th>Underlying Illness (Specify)</th>
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# = Episodes / 24 Hours
# Gastrointestinal Illness Surveillance System
## Antidiarrheal Medications Total Daily Sales / Dispensed Log

Vessel __________ Voyage Number _______ Dates: From: _____/____/____ To: _____/____/____

Page ____ of ____ for voyage

<table>
<thead>
<tr>
<th>Date (mm/dd/yyyy)</th>
<th>Drug Name</th>
<th># Tablets or ml</th>
<th>Dose</th>
<th>Date (mm/dd/yyyy)</th>
<th>Drug Name</th>
<th># Tablets or ml</th>
<th>Dose</th>
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</table>
Gastrointestinal Illness Surveillance System Questionnaire
(To be completed if you have experienced gastrointestinal illness)

Vessel Name (1) ______________ Date (2) ______________

Last Name (3) ________________ First Name (4) ________________

Date of Birth (5) ______________ Age (6) ______ Sex (7) Male / Female

(8) ______ Cabin Number Total Number People in Cabin (10) ______

(9) ______ Dining Seating Dining Table Number (11) ______

Symptoms Started Date: (12) ______________ Time: (13) ______________ AM / PM

Do you know other people with the same symptoms? (14) Yes / No

If Yes, Please, List Names: (15)_____________________________________________________

Did you stay overnight or longer in the boarding port before you joined the vessel?
(16) Yes / No Where? (17) _____________________ How many days? (18) ______

What do you think is the cause of your illness? (19) ___________________________________

PLEASE TURN THIS FORM OVER TO PROVIDE FOOD AND ACTIVITIES HISTORY

Confidentiality: All personal medical information received by CDC personnel shall be protected in accordance with applicable federal law, including 5 U.S.C. Section 552a. Privacy Act - Records maintained on individuals and the Freedom of Information Act. 5 U.S.C. Section 552. Administrative Procedure - Public information; agency rules, opinions, orders, records, and proceedings.

The information requested on this form is collected under authority of Section 301 of the Public Health Service Act (42 USC 269). Response in this case is voluntary. The individually identified data may be shared with health departments and other public health or cooperating medical authorities. It will be used to investigate the causes of gastrointestinal illness and to make recommendations to resolve and prevent the recurrence of such health problems. An accounting of such disclosure will be made to the subject individual upon request.
# Meal and Activities - Aboard Vessel and On Shore Prior to Illness

Please list the specific vessel or shore locations of the meals you consumed and the vessel and shore activities you participated in before you became ill:

<table>
<thead>
<tr>
<th>Day of Illness Onset</th>
<th>Day Before</th>
<th>Two Days Before</th>
<th>Three Days Before</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meal / Activity</strong></td>
<td><strong>Location &amp; Name of Event</strong></td>
<td><strong>Meal / Activity</strong></td>
<td><strong>Location &amp; Name of Event</strong></td>
</tr>
<tr>
<td>Breakfast (20)</td>
<td>Breakfast (27)</td>
<td>Breakfast (34)</td>
<td>Breakfast (41)</td>
</tr>
<tr>
<td>AM Activity (21)</td>
<td>AM Activity (28)</td>
<td>AM Activity (35)</td>
<td>AM Activity (42)</td>
</tr>
<tr>
<td>Lunch (22)</td>
<td>Lunch (29)</td>
<td>Lunch (36)</td>
<td>Lunch (43)</td>
</tr>
<tr>
<td>PM Activity (23)</td>
<td>PM Activity (30)</td>
<td>PM Activity (37)</td>
<td>PM Activity (44)</td>
</tr>
<tr>
<td>Dinner (24)</td>
<td>Dinner (31)</td>
<td>Dinner (38)</td>
<td>Dinner (45)</td>
</tr>
<tr>
<td>Other Meals / Activities During Day (26)</td>
<td>Other Meals / Activities During Day (33)</td>
<td>Other Meals / Activities During Day (40)</td>
<td>Other Meals / Activities During Day (47)</td>
</tr>
</tbody>
</table>
### Some Disinfectants Effective Against Feline Calicivirus (as a surrogate for Norovirus)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Manufacturer</th>
<th>Main Active Ingredient(s)</th>
<th>Application(s)</th>
<th>Contact Time (minutes)</th>
<th>Log_{10} Reduction</th>
<th>Safety Profile (as used)</th>
<th>Cost/Liter (as used)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerated Hydrogen Peroxide®</td>
<td>Virox Technologies</td>
<td>0.5% hydrogen peroxide (RTU)</td>
<td>RTU liquid, wipes, concentrate (mix 1:16)</td>
<td>2</td>
<td>&gt; 4.7</td>
<td>Non-toxic</td>
<td>$0.12</td>
</tr>
<tr>
<td>Big Spray®</td>
<td>Antiseptica</td>
<td>25.92% ethanol, 11.5% 2-propanol, 0.054% polyhexanide</td>
<td>RTU liquid</td>
<td>1</td>
<td>&gt; 4.7</td>
<td>Eye, lung, skin irritation; flammable</td>
<td>$9.00</td>
</tr>
<tr>
<td>Bleach</td>
<td>(generic)</td>
<td>0.1% (1000 ppm) Sodium hypochlorite</td>
<td>Powder, liquid</td>
<td>1</td>
<td>&gt; 4.7</td>
<td>Eye, lung, mucous membrane and skin irritation</td>
<td>$0.01</td>
</tr>
<tr>
<td>Coverage 256®</td>
<td>ConvaTec</td>
<td>4 QUATS, 2470 ppm @ 1:62</td>
<td>Concentrate, mix 1:62</td>
<td>10</td>
<td>4</td>
<td>Eye, lung, mucous membrane and skin irritation</td>
<td>$0.08</td>
</tr>
<tr>
<td>EcoTru®</td>
<td>EnviroSystems</td>
<td>0.2% parachlorometaxylenol</td>
<td>RTU liquid, wipes</td>
<td>30</td>
<td>4.12</td>
<td>Non-toxic</td>
<td>$2.75</td>
</tr>
<tr>
<td>Ethanol (generic)</td>
<td></td>
<td>75% ethanol</td>
<td>RTU @ 75%</td>
<td>10</td>
<td>4.7</td>
<td>Eye, lung, skin irritation; flammable</td>
<td>$1.50</td>
</tr>
<tr>
<td>Lysol® Disinfectant (Aerosol) Spray</td>
<td>Rickitt Benckiser</td>
<td>79% ethanol, 0.1% QUAT</td>
<td>RTU spray</td>
<td>3</td>
<td>3.4</td>
<td>Eye, lung, skin irritation; flammable</td>
<td>$16.00</td>
</tr>
<tr>
<td>Mikro-Bac® II</td>
<td>Ecolab</td>
<td>4.75% o-phenylphenol, 4.75% o-benzyl-p-chlorophenol</td>
<td>Concentrate, mix 1:128</td>
<td>10</td>
<td>6.2</td>
<td>Toxicity to brain (ethylene glycol), kidneys, liver, lungs, skin; carcinogen (OPP); teratogen (ethylene glycol)</td>
<td>$0.04</td>
</tr>
<tr>
<td>Virkon®</td>
<td>Antec International</td>
<td>21.45% Peroxomonosulphate</td>
<td>Powder, mix as a 1% or 2% solution</td>
<td>10</td>
<td>&gt; 4.0</td>
<td>Non-toxic</td>
<td>$0.35</td>
</tr>
<tr>
<td>Cryocide 20®</td>
<td>R.P. Adam</td>
<td>0.75% Stabilized chlorine dioxide + twin chain QUAT</td>
<td>RTU liquid, used a surface disinfectant and fogging agent</td>
<td>30</td>
<td>&gt; 4.68</td>
<td>Eye, lung (ClO₂ gas), skin irritation</td>
<td>$22.50</td>
</tr>
</tbody>
</table>


**Comments:**

A $\log_{10}$ reduction of 4 (99.99%) or greater is considered adequate for FCV/Norovirus disinfection. Products listed as non-toxic may still cause mild eye and/or skin irritation in some people. Some compounds may leave a surfactant residue on various surfaces. 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. It is recommended that you test any specific disinfectant for adverse effects on your own ships’ environmental surfaces prior to it’s general use.
Strategies for Norovirus Infection Control

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Web Sites

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AntisepticaUSA (VIRA-GARD/Manorapid Synergy) www.antisepticausa.com
Association for Professionals in Infection Control www.apic.org
Center for Research on Environmental Microbiology www.environmental-microbiology.ca
Centers for Disease Control and Prevention www.cdc.gov
CDC Vessel Sanitation Program www.cdc.gov/nceh/vsp
Community and Hospital Infection Control Association www.chica.org
DakoCytomation (NV ELISA test kit) www.dakocytomation.co.uk
EcoLab (Mikro-Bac) www.ecolab.com
EnviroSystems (EcoTru) www.envirosi.com
Hand Hygiene Research Center www.handhygiene.org
Health Canada www.he-sc.gc.ca
International Council of Cruise Lines www.iccl.org
Mortality & Morbidity Weekly Review www.cdc.gov/mmwr/mmwr.html
Royal Institute of Public Health www.riph.org
RP Adam (Cryocide 20) www.arpal.co.uk
Silsoe Research Institute (fogging research) www.sri.bbsrc.ac.uk
Sterilox (hypochlorous acid generator) www.sterilox.com
UK Health Protection Agency www.hpa.org.uk
Virox (AHP) www.virox.com
World Health Organization www.who.int

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