Strategies for Norovirus Infection Control Aboard Cruise Ships

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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

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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 2008
- Median age of passengers is 51 years
- Ships typically sail at > 95% capacity

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North American Cruise Market

- 9 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

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Expectations of Cruisers

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

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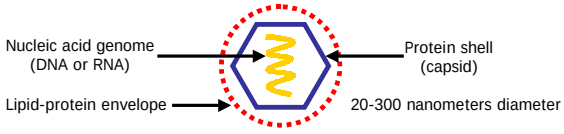
Viruses

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



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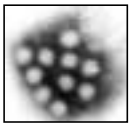
Norovirus

- Norwalk Virus, Norwalk-like virus, NLV
- SRSV (Small Round Structured Virus)
- 2002
  - Family – Caliciviridae
  - 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

Norovirus
3-D

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Norwalk virus infection and disease is associated with ABO histo-blood group type; AM Hutson; J Infect Dis 2002, 185(9):1335-7

- Individuals with an O phenotype were more likely to be infected with NV, whereas persons with a B histo-blood group antigen had decreased risk of infection and symptomatic disease

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Human susceptibility and resistance to Norwalk virus infection; L LINDESMITHE, et al; Nature Medicine, 2003, 9 (5):548-553

- NV infection requires H type-1 oligosaccharide ligand secretion for infection
- 29 % of study population were “non-secretors” and therefore not susceptible to NV infection

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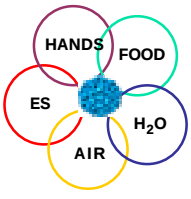
Norovirus Transmission

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



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Norovirus Transmission

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

MMWR 2001; 50: RR-9

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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 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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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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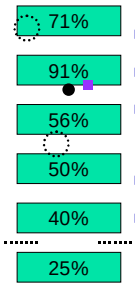
Evidence for airborne transmission of Norwalk-like virus (NLV) in a hotel restaurant;

PJ Marks; Epidemiol. Infect. 2000, 124: 481-487



- 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

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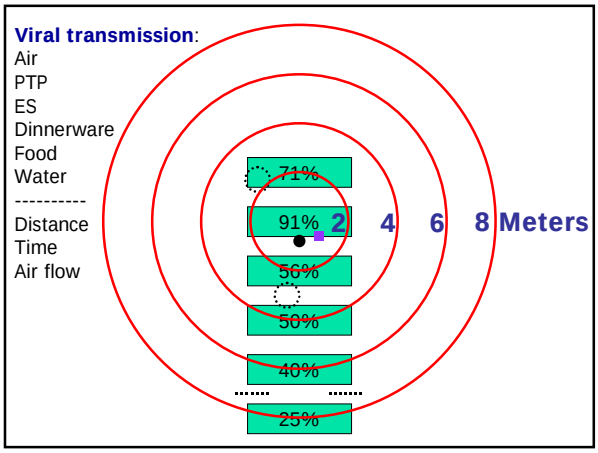

Transmission of Norwalk Virus During a Football Game;

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

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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

- **Diarrhea**
- **Vomiting**
- 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 12-60 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

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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
- ELISA test kit (IDEIA™ NLV)
- 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 or pending etiology
- In excess of half of the outbreaks were definitely due to Norovirus and several others were probably 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
- Restaurants
- Theaters
- Hospitals
- Nursing homes
- Day care centers
- Schools
- Dormitories
- Military barracks
- Trains
- Buses
- Aircraft

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Prevalence of Norovirus among Visitors from the United States to Mexico and Guatemala Who Experience Traveler's Diarrhea; Chapin AR, et al; Journal of Clinical Microbiology 2005, 43: 1112-1117

- 34 traveler's diarrhea cases
- 65% positive for NV (all genogroup I)
- 11 also positive for enterotoxigenic Escherichia coli (ETEC)
- Infection rate increased with length of stay at the destination: > 66% of cases after 7 days

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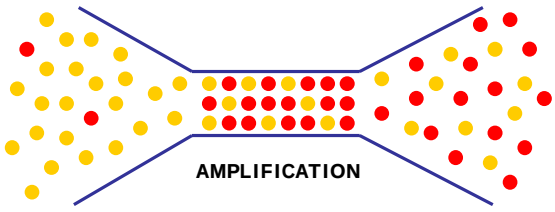
Amplification of Disease Transmission



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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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Cruise Ship GI Illness Outbreaks

- 2003 – 29, at least 18 due to NV
- 2004 – 36, at least 17 due to NV
- 2005* – 16, at least 11 due to NV

* As of May 16, 2005

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Norovirus Critical Characteristics

- Highly contagious
- Multiple modes of transmission
- Stabile 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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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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Shipboard Sanitation

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

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Shipboard Sanitation

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

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Shipboard Sanitation Department Collaboration

- Industry guidelines and standards
- Corporate policies & procedures
- Ship's Command
- Hotel
- Food & Beverage
- Housekeeping
- Engineering
- Environmental
- Medical

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Shipboard Sanitation - Food

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

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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

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Shipboard Sanitation - Water

- Bunkering of water only from safe sources
- Water desalination
  - Distillation
  - Reverse osmosis
- Filtering
- Halogenation
- Continuous monitoring of water quality

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Shipboard Sanitation - Air

- Filtering
- Air exchange
- Temperature control
- Humidity control
- Duct cleaning

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Passenger Living Quarters

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

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Crew Living Quarters

- Daily cleaning
- Crew sanitation regulations
- Weekly inspections

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Public Areas

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

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Waste Management

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

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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

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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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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%

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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

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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

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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

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Isolation

- Confine infected crew and passengers to quarters up to 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
- Scraper, dust pan
- 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) 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

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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 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

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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

- Norovirus is difficult to replicate in cell 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: **6 years**
Breed: **Persian**
Attitude: **BAD**

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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 $\log_{10}$ reduction
  - 70˚C for 5 minutes, complete inactivation
  - 100˚C for 1 minute, complete inactivation

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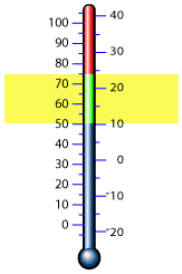
Inactivation of Feline Calicivirus, a Norwalk Virus Surrogate; JC Doultree; J Hosp Infect 1999, 41:51-57

- 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 $\log_{10}$ 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 (Selectrocide™)
- Hypochlorite (bleach)
- Peroxymonosulphate (Virkon®)
- Phenols (Mikro-Bac II®, Mikro-Bac 3®)
- Super-oxidized water (Sterilox®)

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Accelerated Hydrogen Peroxide™

AHP™ VIROX

- 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

ACCELERATED HYDROGEN PEROXIDE

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Chlorine dioxide

Selectrocide

- On site ClO2 gas/solution generation
- Broad spectrum disinfectant
- 100 ppm/10 minutes for FCV/NV

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Chlorine dioxide

- Neutral pH
- Low toxicity in RTU form
- Concentration dependent metal corrosion
- May damage textiles
- 15 day prepared solution shelf life

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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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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

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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

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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)

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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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Super-oxidized water

EO (electrolyzed oxidizing) water

$$HOCl \leftrightarrow OCl^- + H^+$$

hypochlorous acid — hypochlorite

0 — pH — 14

STERILOX

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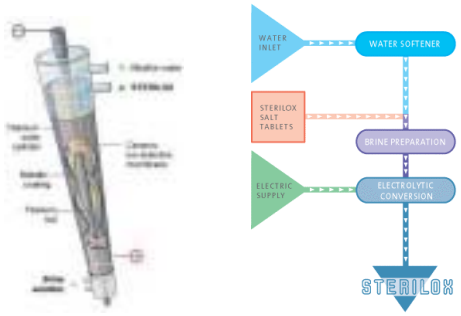

The Sterilox generator produces a pH neutral solution of hypochlorous acid and other oxy-chloro compounds via electrolytic conversion of brine solution

Super-oxidized water

- Broad spectrum biocide
- 300-400 ppm/2 minutes for Polio 2
- Low toxicity in RTU form
- Concentration dependent metal corrosion
- May damage textiles

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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 $\log_{10}$ reduction of surface FCV
- Essentially no transfer of FCV from fabric

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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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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
  - Floor
- Cabin bathrooms

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Disinfection

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

101

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

102

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

103

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

104

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

105

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.

106

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

107

Fogging Checklist

- Efficacy & spectrum of disinfectant
- Volume of disinfectant
  - As per manufacturer's recommendation
  - General recommendation is 1 liter/100 m^3
- Particle size
  - 10-20 micron diameter is optimal, will settle in 45-60 minutes in a non-ventilated room

108

Fogging Checklist

- 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

109

Fogging Checklist

- 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

110

Fogging Checklist

- 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

111

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

112

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

113

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

114

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

115

Air + 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

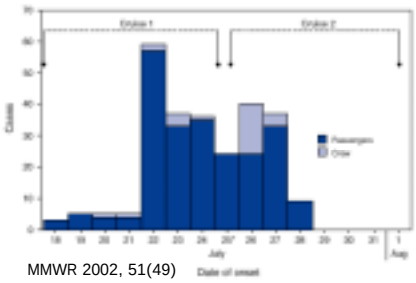
116

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

117

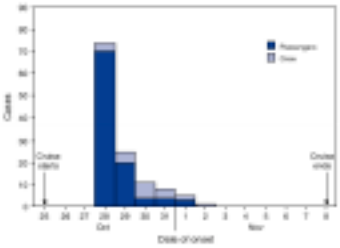
Norovirus Epidemic Curve



MMWR 2002, 51(49)

118

Norovirus Epidemic Curve



MMWR 2002, 51(49)

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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

120

Hand Hygiene

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

Stay Healthy–Wash Your Hands

121

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

122

CDC

U.S. Centers for Disease Control and Prevention

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

123

APIC

Association for Professionals in Infection Control and Epidemiology

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

124

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%

125

Hand Hygiene

- Can help to break the "recontamination cycle"

CONTAMINATION

DISINFECTION

RECONTAMINATION

126

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

127

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

FRICTION & FLOW

128

Handwashing

It's a NO BRAINER

129

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

130

Efficacy of Alcohol-based Hand Sanitizers

- Dependent upon the specific agent, concentration and contact time
- propanol > ethanol > isopropanol
- Liquid > Gel > Foam
- 60-95% concentration

131

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)

132

Efficacy of Alcohol-based Hand Sanitizers

- Generally 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 typically reduced by only 1-2 $\log_{10}$ (90-99%) with a 30 second contact time

133

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

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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

VIRA-GARD™

135

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

136

Handwashing vs. Sanitizers

Handwashing	Sanitizers
Hands visibly soiled	No visible soiling
After contact with bodily fluids	When soap & water are not available
Before eating	Between handwashings
After using the restroom	To supplement hand-washing

137

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

138

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

140

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

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BON VOYAGE!

...but wash your hands before you leave.

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For additional info, contact:

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www.vms4csm.com

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Some Disinfectants Effective Against Feline Calicivirus (as a surrogate for Norovirus)

Product Name	Manufacturer	Main Active Ingredient(s)	Application(s)	Contact Time (minutes)	Log_{10} Reduction	Safety Profile (as used)	Cost/Liter (as used)
Accelerated Hydrogen Peroxide™	Virox Technologies	0.5% hydrogen peroxide (RTU)	RTU liquid, wipes, concentrate (mix 1: 16)	2	> 4.7	Non-toxic	$0.12
Big Spray®	Antiseptica	25.92% ethanol, 11.5% 2-propanol, 0.054% polyhexanide	RTU liquid	1	> 4.7	Eye, lung , skin irritation; flammable	$9.00
Bleach	(generic)	0.1% (1000 ppm) Sodium hypochlorite	Powder, liquid	1	> 4.7	Eye, lung, mucous membrane and skin irritation	$0.01
Coverage 256®	ConvaTec	4 QUATS, 2470 ppm @ 1: 62	Concentrate, mix 1: 62	10	4	Eye, lung, mucous membrane and skin irritation	$0.08
EcoTru®	EnviroSystems	0.2% parachlorometaxylenol	RTU liquid, wipes	30	4.12	Non-toxic	$2.75
Ethanol	(generic)	75% ethanol	RTU @ 75%	10	4.7	Eye, lung, skin irritation; flammable	$1.50
Lysol® Disinfectant (Aerosol) Spray	Rickitt Benckiser	79% ethanol, 0.1% QUAT	RTU spray	3	3.4	Eye, lung , skin irritation; flammable	$16.00
Mikro-Bac® II	Ecolab	4.75% o-phenylphenol, 4.75% o-benzyl-p-chlorophenol	Concentrate, mix 1:128	10	6.2	Toxicity to brain (ethylene glycol), kidneys, liver, lungs, skin; carcinogen (OPP); teratogen (ethylene glycol)	$0.04
Virkon®	Antec International	21.45% Peroxomonosulphate	Powder, mix as a 1% or 2% solution	10	> 4.0 @ 1% solution	Non-toxic	$0.35
Cryocide 20™	R.P. Adam	0.75% Stabilized chlorine dioxide + twin chain QUAT	RTU liquid, used a surface disinfectant and fogging agent	30	> 4.68	Eye, lung (ClO_2 gas), skin irritation	$22.50

From Sattar and Wheeler, Seatrade Cruise Shipping Convention, Miami, March 4, 2003.

Comments:

A Log10 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.

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

VESSEL SANITATION INSPECTION REPORT

Vessel Name	Inspection Date		Port	Results Presented To	Score:
Cruise Line	**No. Pax**	**No. Crew**	**Inspection Type**	**Inspected by**	

Item No.	Point Value	Description — **Bold** = Critical Item
DISEASE REPORTING		
01	**4**	**Disease reporting**
02	1	Medical logs maintenance
POTABLE WATER		
03	**5**	**Bunker / production source; Halogen residual**
04	**5**	**Distribution system halogen residual**
05	**5**	**Distibution system halogen analyzer calibrated**
06	2	Halogen analyzer chart recorder maintenance, operation, records; Micro sampling, records
07	**3**	**System protection cross-connections, backflow; Disinfection**
08	1	Filling hoses, caps, connections, procedures; Sample records, valves; System construction, maintenance
SWIMMING POOLS, SPAS		
09	**3**	**Swimming pools / spas halogen residuals**
10	1	Swimming pools / spas maintenance, safety equipment
FOOD SAFETY		
PERSONNEL		
11	**5**	**Food handlers infections, communicable diseases**
12	**4**	**Hands washed; Hygienic practices**
13	**3**	**Management, knowledge, monitoring**
14	1	Outer clothing clean; Jewelry, hair, hand sanitizers
FOOD		
15	**5**	**Food source, sound condition; Food re-service**
16	**5**	**Potentially hazardous food temperatures**
17	2	Temperature practices; Thawing
18	**3**	**Cross-contamination**
19	2	Food protection; Original containers; labeling; In-use food dispensing, preparation utensils
MEDICAL LOG REVIEW		

Cruise - Start / End / Port / PAX / ILL / CREW / ILL

1.
2.
3.
4.
5.

Item No.	Point Value	Description — **Bold** = Critical Item
EQUIPMENT		
20	2	PHF temperature maintenance facilities; Food-contact surfaces; Food TMD's
21	1	Nonfood-contact surfaces; Ambient TMD's
22	2	Warewashing facilities; TMD's; Test kits
23	2	Pre-wash; Wash and rinse **solutions**
24	**3**	**Sanitizing rinse**
25	1	Wiping cloths / chef's towels
26	**3**	**Food-contact surfaces equipment / utensils clean; Safe materials**
27	1	Non-food contact surfaces equipment / utensils clean
28	2	Equipment / utensil / linen / single / service storage handling dispensing; Cleaning frequency
TOILET AND HANDWASHING FACILITIES		
29	**3**	**Facilities convenient, accessible, design, installation**
30	1	Hand cleanser, sanitary towels, waste receptacles, handwash signs; Maintenance
TOXIC SUBSTANCES		
31	**5**	**Toxic items**
FACILITIES		
32	1	Solid waste containers
33	1	Decks / bulkheads / deckheads
34	1	Plumbing fixtures / supply lines / drain lines / drains
35	2	Liquid waste disposal
36	1	Lighting
37	1	Rooms / equipment venting
38	1	Unnecessary articles, cleaning equipment; Unauthorized personnel
ENVIRONMENTAL HEALTH		
39	**3**	**IPM program effective; Approved pesticide application**
40	1	IPM procedures; Outer openings protection
41	2	Housekeeping; Child-Activity Centers

Comments:

Gastrointestinal Illness Surveillance System Log

Vessel _____ Voyage Number _____ Dates: From: _____/____/_____ To: _____/_____/_____ Page ____ of ____ for voyage

Total Number of Passengers Aboard _____ Total Number of Passengers Ill _____ Total Number of Crew Aboard _____ Total Number of Crew Ill _____

Date (mm/dd/yyyy)	Name Last, First	Age	M / F	Pax / Crew	Crew Position	Cabin No.	Meal Seat	Illness Onset		Diarrhea			Vomiting		Fever		Stool Specimen		Antidiarrheal Medication Y/N	Underlying Illness (Specify)
								Date (mm/dd/yyyy)	Time (hr:min AM / PM)	Y/N	#	Blood Y/N	Y/N	#	Y/N	°F	Req Y/N	Rec Y/N		

 # = Episodes / 24 Hours

Gastrointestinal Illness Surveillance System
Antidiarrheal Medications Total Daily Sales / Dispensed Log

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

Page ____ of ____ for voyage

Date (mm/dd/yyyy)	Drug Name	# Tablets or ml	Dose	Date (mm/dd/yyyy)	Drug Name	# Tablets or ml	Dose

CDC 80.15C 11/2000

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
(mm/dd/yyyy)

Cabin Number (8) _____ **Total Number People in Cabin** (10) _____

Dining Seating (9) _____ **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.

Last Name _____ **First Name** _____

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:

Day of Illness Onset		Day Before		Two Days Before		Three Days Before	
Meal / Activity	**Location & Name of Event**	**Meal / Activity**	**Location & Name of Event**	**Meal / Activity**	**Location & Name of Event**	**Meal / Activity**	**Location & Name of Event**
Breakfast (20)		Breakfast (27)		Breakfast (34)		Breakfast (41)	
AM Activity (21)		AM Activity (28)		AM Activity (35)		AM Activity (42)	
Lunch (22)		Lunch (29)		Lunch (36)		Lunch (43)	
PM Activity (23)		PM Activity (30)		PM Activity (37)		PM Activity (44)	
Dinner (24)		Dinner (31)		Dinner (38)		Dinner (45)	
Evening Activity (25)		Evening Activity (32)		Evening Activity (39)		Evening Activity (46)	
Other Meals / Activities During Day (26)		Other Meals / Activities During Day (33)		Other Meals / Activities During Day (40)		Other Meals / Activities During Day (47)	

Strategies for Norovirus Infection Control

References

APIC; Guideline for Selection and Use of Disinfectants; AJIC 1996, 24(4): 313-342

Becker AM; Transmission of Norwalk Virus During a Football Game; NEJM, 2000, 343(17): 1223-1227

Burfoot D; Fogging for disinfection of food processing factories and equipment; Trends in Food Science & Technlogy, 1999, 10: 205-210

Cartwright R; Gastric Flu Outbreaks in Hotels Pilot Guidelines for FTO Members; 2002, cartwright@dial.pipex.com

CCDR; Hand Washing, Cleaning, Disinfection and Sterilization in Health Care; 1998, 24S8

CDC/HICPAC; Draft Guideline for Disinfection and Sterilization in Healthcare Facilities; 2001, online at www.cdc.gov

CDC/HICPAC; Draft Guideline for Environmental Infection Control in Healthcare Facilities, 2001; online at www.cdc.gov

CDC Vessel Sanitation Program Operations Manual 2000; online at www.cdc.gov/nceh/vsp

CDC Vessel Sanitation Program Recommended Shipbuilding Construction Guidelines for Cruise Vessels Destined to Call on U. S. Ports; online at www.cdc.gov/nceh/vsp

Chadwick PR; Transmission of SRSV by vomiting during a hospital outbreak of gastroenteritis; J Hosp Infect 1994, 26: 251-9

Chadwick PR; Management of hospital outbreaks of gastroenteritis due to SRSV; J Hosp Infect 2000, 45: 1-10

Chapin AR, et al; Prevalence of Norovirus among Visitors from the United States to Mexico and Guatemala Who Experience Traveler's Diarrhea; J. Clin. Microbiology 2005, 43: 1112-1117

Cheeseborough JS; Possible prolonged environmental survival of SRSV; J Hosp Infect 1997, 35: 325-6

Cheeseborough JS; Widespread environmental contamination with NLV in a prolonged hotel outbreak of gastroenteritis; Epidemiol Infect 2000, 125: 9308

Cramer EH; Diarrheal Disease on Cruise Ships, 1990-2000; AJPM , released online Dec 2002, www.ajpm-online.net

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

Green J; The role of environmental contamination with SRSV in a hospital outbreak investigated by RT-PCR; J Hosp Infect 1998, 39: 39-45

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

Ho MS; Viral gastroenteritis aboard a cruise ship; Lancet 1989, ii: 961-965

Hutson AM; Norwalk virus infection and disease is associated with ABO histo-blood group type; J Infect Dis 2002, 185(9):1335-7

Keswick BH; Inactivation of Norwalk virus in drinking water by chlorine; Appl Environ Microbiol 1985, 50(2):261-4

Koo D; Epidemiology of Diarrheal Disease Outbreaks on Cruise Ships, 1986-1993; JAMA 1996, 275(7): 545-547

Koopmans M, Duizer E; Foodborne Viruses: An Emerging Problem; International Life Sciences Institute, September 2002

Kramer A, et al; Limited efficacy of alcohol-based hand gels; Lancet 2002; 359: 1489–90

Lindesmith L, et al; Human susceptibility and resistance to Norwalk virus infection; Nature Medicine, May 2003, 9(5): 548-553

Lopman BA; Viral gastroenteritis outbreaks in Europe, 1995-2000; Emerg Infect Dis 2003, 8

Lopman BA; Two epidemiologic patterns of Norovirus outbreaks: surveillance in England and Wales, 1992-2000; Emerg Infect Dis 2003; 8

Lopman BA, et al; Increase in viral gastroenteritis outbreaks in Europe and epidemic spread of new norovirus variant; Lancet 2004; 363: 682-88

MAFF Advanced and Hygiene Food Manufacturing LINK Programme; A Practical Guide to the Disinfection of Food Processing Factories and Equipment Using Fogging; October 1998; (available from the Silsoe Research Institute, Wrest Park, Silsoe, Bedford MK45 4HS UK, www.sri.bbsrc.ac.uk)

Marks PJ; Evidence for airborne transmission of NLV in a hotel restaurant; Epidemiol Infect 2000, 124: 481-7

Mead PS; Food Related Illness and Death in the United States; EID 1999, 5(5) 607- 625

MMWR; Diagnosis and Management of Foodborne Illnesses - A Primer for Physicians and Other Health Care Professionals, 2004, 53 (RR-4)

MMWR; “Norwalk-Like Viruses” Public Health Consequences and Outbreak Management, 2001, 50 (RR-9)

MMWR; Outbreaks of Gastroenteritis Associated with Noroviruses on Cruise Ships-United States, 2002, 51(49): 1112-1115

MMWR; Norovirus Activity-United States, 2003, 52(3): 41-45

MMWR; Guideline for Hand Hygiene in Health-Care Settings, 2002, 51 (RR-16)

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

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

Sobsey MD; Health Risks from Enteric Microbes in Water and their Control by Disinfection; ESE NOTES 1995, 30(2)

Vipond IB, et al; National epidemic of Lordsdale Norovirus in the UK; Journal of Clinical Virology, 2004, 30: 243-247

Viral Gastroenteritis Subcommittee of the Scientific Advisory Committee of the (Ireland) National Disease Surveillance Centre; National Guidelines on the Management of Outbreaks of Norovirus Infection in Healthcare Settings, 2003

Wobus CE, et al; Replication of Norovirus in Cell Culture Reveals a Tropism for Dendritic Cells and Macrophages; PLoS Biology, www.plosbiology.org; December 2004, 2 (12)

Web Sites

Antec International (Virkon)	www.antecint.co.uk
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
Hand Hygiene Research Center	www.handhygiene.org
Health Canada	www.hc-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
Selective Micro Technologies (chlorine dioxide)	www.selectivemicro.com
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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