



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

Health Practices on Cruise Ships: Training for Employees Transcript

Gastrointestinal Illness Outbreak Prevention and Control

The Centers for Disease Control and Prevention's Vessel Sanitation Program is proud to bring to you the following session: Outbreak Investigations. While this presentation is primarily intended for cruise vessels under the jurisdiction of the Vessel Sanitation Program, it may also be used by anyone who is interested in this topic. This session should not be used as a replacement for existing interactive training, but should be used as an adjunct to a comprehensive training program.

Outbreak Investigations, Vessel Sanitation Program 2007. Our learning objectives for this session are to understand the Vessel Sanitation Program's gastrointestinal illness surveillance system, or GISS, also to describe what is involved in a gastrointestinal illness outbreak investigation, and lastly, to explain the roles and responsibilities for case reporting and outbreak investigations.

Case tracking and management. Case tracking: gastrointestinal illness log, otherwise known as GI log. This document is the foundational document for the Vessel Sanitation Program surveillance system. It is actually a line listing of cases of gastrointestinal illness reporting to the ship's medical staff. This document is used to gather information to manage and report cases of gastrointestinal illness. It is also used in all outbreak investigations. Please note this document is also required for each cruise or voyage.

Contents of the GI log. The data elements that are required to be collected in the GI log include the date the case first reported to the clinic or reported to the medical staff, the case patient name, age, and gender, the designation of whether the case is a passenger or crew, if it's a crew member, the crew member position, assigned cabin number, as well as assigned dining room meal seating. Generally, this is usually recorded as either the first or the second seating. In some instances, your ship may not have assigned seating for meals, and therefore this element could be excluded. Continuing with additional elements that are required in the GI log, the date and time of illness onset is extremely important to outbreak investigations, as well as illness symptoms including diarrhea, vomiting, and other symptoms that we'll describe later in the presentation, stool specimens, whether they were requested and/or whether the specimens were received, whether any antidiarrheal medication was dispensed to control the illness, and whether there are any underlying medical conditions that may cause the doctor not to count the individual as a case of reported GI illness. Examples include irritable bowel syndrome and other conditions that may mimic GI illness. Gastrointestinal illness reporting system.



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

Case reporting: the basics. The Vessel Sanitation Program has a surveillance system for tracking gastrointestinal illness that is based in either a Web-based system or an email-based system of reporting. There is also backup reporting methods in case the Web system or the email system is unavailable to the ship. They include faxes, telephone reporting, as well as general email reporting. This reporting system has a set of standard fields that must be reported by all ships under VSP jurisdiction. Case reporting: reporting requirements. The Vessel Sanitation Program surveillance system is divided into two types of reports. Routine reporting is required whenever a vessel is calling on a U.S. port from a foreign port and is within 24 to 36 hours of arrival at the first U.S. port. All of the cases of gastrointestinal illness that are reportable are included in the report at that time. If in the event there are additional cases that occur no later than four hours prior to arrival, an additional four-hour update report is required. The second component of the reporting system is the special report. And this notifies the Vessel Sanitation Program whenever there are greater than or equal to 2% GI illness in passenger or crew populations. And an outbreak is considered anytime there is greater than 3% gastrointestinal illness in any passenger or crew population. The special report is also required at any time during the cruise, even between two U.S. ports, when the vessel is within 15 days of arrival at the first U.S. port. This system is based on a set of symptoms. It is not based on laboratory-defined illness. For this reason, we refer to this system as a syndromic system. It's based on a set of symptoms. In addition, the data from the GI log serves as the feeder report for both the routine report as well as the special report.

This slide demonstrates the use of the Web-based system of reporting. This ship filed a 24-hour report, and this report was successfully received by the Vessel Sanitation Program. Please note at the bottom of the slide the automatic confirmation that is provided back to the ship. This confirmation report should be maintained onboard the vessel and be made available to VSP inspectors during the inspection process. This slide illustrates the email-based version of the reporting system. The fields here are listed in a template that is available by sending an email to the VSP mailbox, in which case you will receive a template that can be used for reporting purposes.

What is a reportable case? A reportable case of GI illness, according to the Vessel Sanitation Program, is defined as diarrhea, three or more loose stools in a 24-hour period, or vomiting plus one other symptom, including one or more loose stool in a 24-hour period, abdominal or stomach cramps, headache, muscle aches or myalgia, and fever, defined as a temperature of greater than 38 degrees C or 100.4 degrees F. Any case meeting this description should be reported to the Vessel Sanitation Program through the surveillance system.

Why investigate gastrointestinal illness? GI illness in the United States. Gastrointestinal illness in the United States occurs on a frequent basis. Roughly 267 million episodes of diarrhea are recorded in the United States each year. Moving up the pyramid, we also



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

note that 612,000 hospitalizations for gastrointestinal illness occur in the United States each year. And unfortunately, approximately 3,000 deaths have been attributed to gastrointestinal illness in the United States. The causative agents for this gastrointestinal illness include viruses, examples being Hepatitis A and Norovirus, bacteria-- E. coli and salmonella are examples that occur in the United States each year-- and parasites, cryptosporidium being the most frequently reported parasite in the United States.

Cases of GI illness per 100,000 passenger days on cruise ships, 2001 through 2004. Data in the Vessel Sanitation Program surveillance system indicate that in 2001, roughly 18 cases per 100,000 passenger days were identified among passengers on cruise ships. This rate appears to have increased to about 31 cases per 100,000 passenger days in 2002, to approximately 32 cases per 100,000 passenger days in 2003, and to a high of approximately 33 cases per 100,000 passenger days in 2004. So we're seeing an increase in the overall rate of cases of gastrointestinal illness in the United States on passenger cruise ships.

Outbreaks of acute gastroenteritis, AGE, on cruise ships, 2001 to 2004. In 2001, we saw roughly two outbreaks of acute gastroenteritis or gastrointestinal illness for that year. That rate rapidly increased to 26 in 2002, 25 in 2003, and 26 in 2004. Therefore, it is the belief of the Vessel Sanitation Program that we are in fact seeing a true increase in the number of outbreaks of acute gastroenteritis on cruise ships sailing in U.S. waters. Outbreaks of acute gastroenteritis per 1,000 cruises, 2001 through 2004. When we look at this data with respect to the rate of outbreaks, we see that in 2001, we had less than one outbreak per 1,000 cruises for ships sailing in the United States. In 2002, the rate jumped to roughly six and a half outbreaks per 1,000 cruises in U.S. waters and, in 2003 and 2004, averaged around five and a half outbreaks per 1,000 cruises.

Who is impacted by outbreaks? Do you think the general public is impacted by outbreaks of acute gastroenteritis on cruise ships? Sure they are. The public's perception and trust of the cruise industry is adversely affected as a result of each outbreak. Whether it occurs on a specific cruise line or specific cruise ships, whether or not they're sailing on that cruise ship, the general public has a tendency to have less trust in the industry once there is an outbreak. The cruising public, also while they're on the voyage during the outbreaks are ill from acute gastroenteritis, and in some cases, unfortunately, there are deaths associated with outbreaks of acute gastroenteritis. What about the cruise ship staff? What about morale, and what about the resources? Once again, the answer is yes. Cruise ship staff is required to put in long hours, conduct duties that are not their routine duties, and also resources are adversely impacted. What about the cruise industry itself? Again, the answer is yes. The image of the cruise industry is adversely impacted as we stated earlier, and also there are some economic costs associated with outbreaks. What is the economic cost of outbreaks? In a recent study, it was estimated that \$1.3 million is the cost to the cruise industry as a result of outbreaks of acute gastroenteritis. That translates to roughly



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

\$408 for each ill passenger as well. So there is definitely an economic cost associated with each and every outbreak of acute gastroenteritis.

Cruise ship outbreaks by etiologic or causative agent, calendar year 2006. Data that's recently published to our Web site indicate that the predominant pathogen that causes the outbreaks of acute gastroenteritis on board cruise ships is Norovirus. Norovirus is also the predominant pathogen for land-based outbreaks of acute gastroenteritis. In 2006, we saw approximately 32 outbreaks that were attributable to Norovirus, for roughly 86.5% of all outbreaks. But Norovirus is not the only pathogen that we see. In that same year, we also saw at least one outbreak of enterotoxigenic *E. coli*, representing 2.7%. Outbreaks of unknown etiology represented four outbreaks, or 10.8% of the total outbreaks experienced in calendar year 2006. There are roughly 37 outbreaks that occurred on cruise ships in the calendar year 2006.

Epidemiologic reasons for investigating outbreaks. The primary reasons for investigating outbreaks are twofold. One, eliminate exposure to the sources of infection. In essence, stop the spread of the outbreak. And secondly, to develop strategies for control. And this comes about in the basis of recommendations that are provided as a result of the outbreak investigations. Epidemiologic reasons for investigating outbreaks continued. Secondary reasons for investigating outbreaks include the following: to describe new diseases and learn more about existing diseases; to evaluate the existing preventive strategies; in addition, to teach and learn epidemiology for people who are new to the discipline; and lastly, to address public concern about the outbreak.

Three main activities of an outbreak investigation. At this point, we're going to look at the activities that are conducted during an actual outbreak investigation. During an outbreak investigation, we have three main components. One is referred to as the laboratory assessment. And in this case, we're looking at the agent or the causative agent of the outbreak itself. The second area that we're interested in is the environmental health assessment. And essentially, we're going to look at the environment of the ship to see if that might have contributed to the outbreak, or at least its spread.

And lastly, targeted environmental health assessment. The targeted environmental health assessment evaluates the same areas that are covered during an operational inspection, except the deficiencies that are noted are specific to those that are related to the cause of the outbreak or results in the outbreak's spread. In addition, there's no score associated with the targeted environmental health assessment, nor is there a fee or cost associated with it. The purpose must be noted that it is fact finding versus a fault finding mission. We're trying to get at the bottom of what caused the outbreak to either occur or to spread.

Laboratory assessment. During the laboratory assessment, either clinical specimens or environmental specimens are collected in an effort to identify what the causal pathogen is. Clinical specimens that are generally collected include either whole stool or swab.



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

This is the preferred method for identifying pathogens in clinical specimens. Emesis or vomit also may be used to identify pathogens. And in some cases specific to bacterial infections, blood samples may also be collected. On the environmental side, food, water, and surface swabs may also be collected. Note for Norovirus, environmental samples are generally not collected, because it is very difficult to isolate Norovirus in those media.

Example one: laboratory results, clinical specimens only. In this example, two specific pathogens were isolated from clinical specimens. This case includes *E. coli* as well as *Shigella sonnei* that were identified as the causal pathogens for this specific outbreak.

Example two: laboratory results, clinical and environmental specimens. For this particular outbreak, both whole stool specimens, approximately ten from passengers and four for crew, were collected, and about 83 food samples were collected as well. In the whole stool specimens, enterotoxigenic *E. coli* was identified as a causal pathogen, as well as salmonella. Also in the food samples, salmonella was also identified in both cooked and raw shrimp, indicating a foodborne outbreak.

New requirements for shipping specimens. In the 2005 version of the VSP operations manual, requirements were made for ships to carry certain shipping containers as well as clinical specimen collection containers. These requirements are in line with the IATA, the International Air Transport Association, and DOT, Department of Transportation, hazardous materials regulations. Cruise ships are required to comply with these regulations when shipping clinical specimens or environmental specimens.

Required clinical specimen containers. Cruise ships are now required to carry ten each of collection containers for both bacteria and viral specimens. For bacteria, the acceptable transport media or containers are Cary-Blair and Para-Pak C&S. C&S stands for "culture and sensitivity." Examples are illustrated in the graphic to the right. Viral clinical specimens are generally collected in sterile specimen containers. The ship is also required to maintain ten of these containers on board in the event of an outbreak of acute gastroenteritis.

Required specimen shipper, diagnostic specimens. The types of specimens that are collected as a result of an outbreak of acute gastroenteritis are considered to be diagnostic specimens. There are specific types of containers that are used for shipping these types of specimens. The packaging must be insulated so that you can ship refrigerated specimens, and it must be leak-proof. There must also be an outer container, and generally this is of a cardboard construction. The shipments must also be shipped with ice packs or coolant packs, and on the exterior of the containers there must be a complete shipper's address and phone number, as well as the receiving lab's address and phone number. And lastly, there must be both the proper shipping name on the exterior of the packaging, an example being "Diagnostic specimens," and the proper shipping labels and markings, such as the 3373 hazard diamond, that must accompany all diagnostic specimen shipments.



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

Epidemiological investigation. The epidemiological investigation consists of two distinct components. The first is the descriptive epidemiology. During this phase, we investigate the who, the what, the when, and the where of the outbreak. The second component is called the analytical epidemiology, and it investigates the why and the how of the outbreak. We'll discuss these two components in detail in the next slides.

Descriptive epidemiology, person, place, and time. During this phase of the outbreak investigation, we're looking at who became a case. During different outbreaks, passengers and/or crew may be implicated as cases in the outbreak. We also look at the symptom characteristics. Are the primary symptoms diarrhea or vomiting? Is it some other symptom such as fever that may indicate a bacterial cause? In addition, we look at the age distribution of the cases-- are the cases primarily among the young, or are they primarily in the elderly? In addition, this might indicate a specific type of organism that might be causing illness in the young, such as rotavirus. Another aspect of the case distribution that we would look at is the male-female ratio, or gender ratios. Are more cases found among males or females? This might indicate a specific cause of the outbreak. In addition, job categories and positions among crewmembers are important. A food handler may be the index case or the case that first comes to the attention of the medical staff and the epidemiologist as the cause of the outbreak. Lastly, we look for the index cases, as well as any secondary cases that might occur as the result of the spread of the outbreak.

Descriptive epidemiology, person, place, and time. Where cases were exposed. Essential to investigating this aspect of the outbreak are factors such as cabin locations. Do we specifically see a distribution of cases among certain cabins? Another factor might be dining room seating. Do most of the cases occur during the first or second dining room seating, or is it dispersed uniformly throughout? Table number might also provide an indication of where the outbreak may have started, particularly if there's a public vomiting or public diarrhea incident that occurred in a dining room or a restaurant facility. Lastly, shore excursions may be important in the outbreak as well. Did the cases go on a specific shore excursion, or were they all the result of activities onboard the ship?

Descriptive epidemiology, person, place, and time. When did the cases become ill? Date of illness onset is very important, as it provides an indication of the start of the outbreak. Time of illness onset is also very important in constructing the epidemic curve, as well as understanding the dynamics of the outbreak. And also, within what time period did the cases occur? In many of the outbreaks that we see in the Vessel Sanitation Program, the cases started well before the individuals ever came to the ship, indicating that the outbreak started from something other than activities on board the ship.

Tools for gathering data. There are three distinct tools that are necessary in any epidemiologic investigation for gathering data. The first is personal interviews. During



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

many of the outbreak investigations, ill passengers and crewmembers are interviewed for risk factors associated with their contracting the illness. In addition, key management personnel may be interviewed to see if there are any problems onboard the ship in any of the specific systems, such as the F&B manager may be interviewed for food handling practices, the engineer may be interviewed to determine if there are any breaches in the potable water system. Also, selected workers may be interviewed for the very same reasons, an example being maybe the executive chef we would interview because we suspect a foodborne origin for the outbreak. The second tool that's used are questionnaires. And questionnaires are very important during the analytic phase of the epidemiologic investigation. Questionnaires are normally distributed to both passengers and crew, unless the outbreak is restricted to only one of the subpopulations. And the last element is key documents. There are many key documents that we'll look at. One, as you know, is the GI log.

Key documents in outbreak investigations. Some of the documents that we'll look at and evaluate during the outbreak investigation include the GI log, as previously mentioned, the ship's itinerary. Where was the ship when the outbreak occurred? Activity history amongst the cases-- were there specific activities or hotels or other activities that they participated in prior to becoming ill? Food histories-- generally, this is a 72-hour food history that evaluates food consumption 72 hours prior to becoming a case. If the level of illness or the numbers of cases indicates a potable water source, we may review the potable water logs, including system maintenance as well as microbiological testing. Pools and spa logs-- again, if recreational water systems are implicated, the environmental health officer may evaluate the pool and spa logs as well. Provision logs-- if a foodborne etiology is suspected, and it is suspected that the ship brought on food items that may have been contaminated, provisions logs may also be evaluated. In a few cases, outbreaks have been associated with crewmembers who are transferred from one vessel to another, and the crewmember was ill, resulting in an outbreak on the receiving vessel. Therefore, crew transfer records are also evaluated. Housekeeping procedures are instrumental in containing the outbreak, and in virtually all outbreaks, housekeeping procedures will be evaluated for its completeness, and any breaches in the housekeeping procedures, recommendations will be made and corrective action taken immediately. Also, any other standard operating procedure that the ship may have for controlling outbreaks is also evaluated.

Outbreak investigation: GI logs. The GI log once again is a critical document during outbreak investigations. Some of the things that can be evaluated is the plotting of the epidemic curve, the calculating of passenger and crew case ratios, diarrhea to vomiting ratios, are all important to determining etiology, symptom type and duration, again, what the causative agent may be. Estimated percentage on board of truly ill can also be identified through the GI logs, as well the identification of additional cases that are not reported. Also, the GI log can be used to identify additional cases that do not meet the standard operational case definition. T



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

he epidemic or "epi" curve. What is the epi curve? The epi curve is actually a bar chart without spaces, otherwise known as a histogram, that plots the number of cases per day or by instance of time. The height of the bars for any particular day or time period represents the number of cases that are infected in any period of time. Why do we plot it? The epidemic curve is instrumental in determining the size or magnitude of the outbreak. In addition, the shape of the epidemic curve may give us clues to the mode of transmission. Also, by plotting the epidemic curve, we can determine the duration of the disease through incubation period calculations. Lastly, the possible causes and the possible vehicles can be determined by the shape and the spread of the epidemic curve. Please note that all the data elements that are required to construct the epidemic curve are found in the GI log.

Types of epidemic curves. There are three specific types of epidemic curves that are common to most outbreaks of acute gastroenteritis. The first and probably the most common is referred to as the common source outbreak. It is also sometimes referred to as a point source or continuing common source outbreak. We will discuss this in detail in the next slide. In addition, a second group is referred to as a propagating outbreak. And the last one is referred to as a mixed outbreak. The type of curve gives us clues as to the mode of transmission of the pathogen.

The graphic on the right is a classic common source outbreak epidemic curve. Please note that there is a rapid rise of cases initially with a slower decline on the back side of the epidemic curve. There generally is only a single peak, and the outbreak is usually of a very short duration. This type of outbreak is generally associated with either a food- or waterborne outbreak.

Epi curve: propagated outbreak. The graphic to the right is an example of a propagated outbreak. In this case, the case presentations in this type of outbreak generally result in a slow rise in the number of cases, and also a slow decline. In addition, there are generally multiple peaks throughout the epidemic period. Also, the outbreaks tend to be spread out over a much longer period of time, and these types of outbreaks are generally associated with person-to-person or environmental spread. These are the types of outbreaks that we commonly see on cruise ship-associated outbreaks.

Epi curve: mixed outbreak. This types of outbreak as depicted on the right have elements of both common source and propagating outbreaks. Generally, the cases rise fairly rapidly and drop off fairly slowly, and the outbreak is also extended for a larger period of time. In addition, secondary spread is primarily associated with mixed outbreaks.

Analytical epidemiology, questionnaires. The purpose of the analytical epidemiology is to assess hypotheses or theories about the cause of the outbreak. The method used here is a comparison of the exposure experience of both the ill and the well with regard to food



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

and beverage consumption either on land or on board the ship, shipboard activities, an example being large gatherings, and shoreside activities, an example being specific shore excursions. The questionnaire is the key tool for gathering this data on board cruise ship outbreaks.

Example one, symptom profile. This example illustrates the results of a questionnaire that was passed out to both passengers and crew, completed, and an analysis done of the data. Note here the symptoms indicate abdominal cramps in both passenger and crew, diarrhea being the predominant symptom, equal across both passenger and crew respondents, as well as fever. This particular outbreak appears to be associated with a bacterial cause.

Example one, outbreak survey results. After the data is analyzed, an attack rate table is usually constructed that compares the exposed persons to the unexposed persons with respect to exposure, in this case suspect food. This outbreak, the vehicle or the food item was ham, and we are strongly convinced that it is ham by the statistics seen at the bottom. Please don't get buried in the statistics. This simply means that we are strongly convinced that ham was the vehicle in this outbreak. Example two: symptom profile. In this outbreak, the primary symptoms are abdominal cramps and diarrhea. There is some fever also associated with this outbreak, but please note that only one population is affected. Only passengers were ill in this particular outbreak. Example two: outbreak survey results. In this outbreak, consuming ice was the vehicle that caused the outbreak.

Example two: attack rate table. Also during this particular outbreak, it was noted that the embarkation lunch was implicated as the meal period in which the outbreak occurred, as well as shrimp being the vehicle that caused the outbreak.

Outbreak management and prevention, crew roles and responsibilities. Should you become a case of gastrointestinal illness, you are required to promptly report your illness to the medical staff. In addition, you may be required to follow isolation procedures. These isolation procedures are designed to minimize the spread of the infection. Also, during an outbreak investigation, you may be required to participate in interviews and complete questionnaires. These are essential to us finding the information regarding the cause of the outbreak. Practice good personal hygiene. Hand washing is the key to preventing most enteric pathogens from resulting in outbreaks. And understand your role in outbreak investigations. That's the purpose of this session.

Outbreak management and prevention, ship roles and responsibilities. The 2005 VSP operations manual required all ships to have a written outbreak prevention and response protocol. These protocols are designed to minimize the spread during outbreaks and, if possible, prevent outbreaks from occurring. There are also some strict procedures in these OPRPs, and it is the ship's responsibility for implementing the outbreak prevention and response procedures before, during, and after an outbreak.



Centers for Disease Control and Prevention
National Center for Environmental Health
Vessel Sanitation Program

Summary. In summary, we've discussed three key areas to outbreak investigations. The first was case reporting requirements, the reporting in the GI log as well as the 24, four hour, and special reports. We also talked about outbreak investigation procedures, both the descriptive and analytical epidemiology, as well as the environmental health and laboratory components of an outbreak investigation. And lastly, we discussed the roles and responsibilities of both the crewmembers individually as well as the ship collectively.

Conclusion. Everything you learn for the rest of the course is to prevent gastrointestinal illness outbreaks from occurring onboard your vessel.

Resources and references. For further information, visit www.cdc.gov or www.cdc.gov/nceh/vsp. For information on shipping requirements, visit www.dot.gov or www.iata.org.