capsid

the official newsletter of NoroCORE

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the goal

"...working together to reduce viral food borne illness"

NoroCORE, the USDA-NIFA Food Virology Collaborative, is a food safety initiative that focuses on outreach, research, and education in the field of food virology.

NoroCORE's ultimate goal is to reduce the burden of food borne disease associated with viruses, particularly noroviruses.

Welcome to the Capsid, official newsletter of the USDA-NIFA Food Virology Collaborative, also called NoroCORE (standing for Norovirus Collaborative for Outreach, Research and Education). NoroCORE is a food safety initiative that focuses on the field of food virology. Our ultimate goal is to reduce the burden of food borne disease associated with viruses, particularly human noroviruses. NoroCORE is a large, multi-disciplinary team of researchers, extension specialists, and educators who work together collaboratively, with extensive stakeholder involvement from members of industry, academia, and government entities.

We are working in an integrated manner to develop improved tools, skills, and capacity to understand and control food borne virus risks. NoroCORE activities belong to one of six principal functions which we call Cores: Molecular Virology; Detection; Epidemiology and Risk Analysis; Prevention and Control; Extension and Outreach; and Capacity Building. But all that's in the brochure; and, for those who are not familiar with it, our website- norocore.com.

To keep our team members abreast of current developments in the initiative and the food borne virus world, as well as to foster the collaborative spirit that is the foundation for success of the NoroCORE initiative, we will be issuing the *Capsid* on a quarterly basis. So named, because, like the capsid of a virus, our newsletter will offer the "outside world" a view of what we're doing, containing snapshots of our work and activities, both internal and external. The newsletter will be distributed electronically, and in print version at select important events.

Every issue of the *Capsid* will include certain regular elements, as well as flexible pieces as the occasion arises. The "permanent fixtures" include recent success stories from the Collaborative's efforts and updates on the progress of each of the six Cores. Also included is the "Science Spotlight," which will feature a recent publication from one or more members of the Collaborative, explained in lay terms. We will be interviewing one collaborator and one stakeholder, and providing a profile of each in "norolink," another regular column. Each issue will always conclude with important announcements, such as upcoming meeting dates, recipients of fellowships or special funding awards, and lists of key scientific presentations, workshops, and publications.

We also hope that the newsletter will remind you to check out our website on a regular basis, where we feature updates for team members, weekly blog articles about norovirus in the news, biosketches of our team members, and virus-related food safety information for all stakeholder sectors (Retail/Grocery; Fresh Produce; Sanitizers/Disinfectants; Detection; Molluscan Shellfish; and Education/Non-Profit). You can learn more about food virology, what we're doing about it, and why, at norocore.com.

We welcome questions and comments via the "contact us" form on the website. If you wish to receive the regular electronic version of the *Capsid*, please send us your email address via the "contact us" form on the website, and we will add you to the listserv. If you prefer paper copies, not a problem; just clarify that in your request. Welcome to the *Capsid*, we're glad you're interested in our work!

contents

USDA-NIFA Food Virology Collaborative Update

In this first issue of the *Capsid*, we provide a snapshot of our Research Core functions, including a list of key activities. Much of this information is available in our brochure and on our website, but this is a nice synopsis for those of you unfamiliar with our group, or who would like a refresher relative to our mission and goals. In subsequent issues of the *Capsid*, we will do the same for our Extension and Education initiatives, and also provide updates on the progress of key activities for select Cores. Keep in mind that, as a sum total of the activities of each of our Cores, our long-term goal is to **reduce the burden of food borne disease associated with viruses**, particularly noroviruses. Our approach is highly multi-disciplinary, with our team working in an integrated manner to develop improved tools, skills, and capacity to understand and control food borne virus risks.

Core 1, Molecular Virology. Collaborators are developing improved methods to facilitate the study of food borne viruses and to further elucidate the significance of viral food borne disease. Ultimately, this should lead to increasing scientific capacity and the generation of new knowledge and tools upon which science-based interventions can be based. The initiative is lead by Dr. Mary Estes of Baylor College of Medicine, and Dr. Jan Vinjé of the U.S. Centers for Disease Control and Prevention (CDC). Other key collaborators include Drs. Linda Saif and Qiuhong Wang of The Ohio State University, and Dr. Jason Jiang of Cincinnati Children's Hospital. Four activities are underway:

Activity 1.1: Develop a fully permissive system to cultivate infectious human noroviruses.

Activity 1.2: Identify and validate the usefulness of alternative cultivatable human norovirus surrogates.

Activity 1.3: Improve understanding of the role of viruses as a cause of food borne disease of unknown etiology.

Activity 1.4: Develop models to predict human norovirus evolution and strain emergence.

Core 2, Detection. The activities of this Core focus on development and validation of sensitive, rapid, and practical methods to detect and genotype food borne viruses in a variety of sample matrices; such methods currently do not exist. In so doing, it is also necessary to address several difficult-to-overcome barriers preventing the ability to detect viruses in food, environmental, and clinical samples. This work is being lead by Dr. Robert Atmar (Baylor), Dr. Jennifer Cannon (University of Georgia), and Dr. Lee-Ann Jaykus (North Carolina State University). Five activities are being pursued:

Activity 2.1: Develop simple, practical, and broadly reactive methods to detect human noroviruses in clinical samples.

Activity 2.2: Develop simple, practical, and broadly reactive methods to detect human noroviruses in relevant non-clinical sample matrices (food, water, and environmental).

Activity 2.3: Compare methods that allow us to discriminate between infectious and non-infectious foodborne viruses using molecular methods.

Activity 2.4: Evaluate candidate biosensor platforms for the detection of human noroviruses in clinical samples, as a model for future application to food and environmental samples.

Activity 2.5: Develop microarray-based methods for strain typing of food borne viruses.

Core 3, Epidemiology and Risk Analysis. The activities of this Core focus on collecting and analyzing data that will support characterization of food borne viral disease burden, and providing information on epidemiological attribution, all of which can be used to characterize risk. This is critical information for characterizing public health significance, aiding regulatory agencies in their risk assessment and management efforts, as well as identifying which foods and transmission routes should be targeted for intervention strategies. The work is being lead by Dr. Christine Moe of Emory University and Dr. Aron Hall of CDC. Five activities are underway:

Activity 3.1: Develop risk assessment models for understanding food borne virus transmission and control.

Activity 3.2: Estimate economic burden of human norovirus food borne outbreaks.

Activity 3.3: Characterize the burden of endemic (non-outbreak-associated) human norovirus disease in the population at large, and in association with the consumption of foods.

Activity 3.4: Characterize the burden of epidemic (outbreak-associated) human norovirus disease in the population at large, and in association with the consumption of foods.

Activity 3.5: Develop epidemiological attribution models linking specific foods and specific virus contamination routes for those foods.

Core 4, Prevention and Control. Using the tools and information developed by activities associated with the first three Cores, this Core is gathering information about virus occurrence, persistence, and resistance in the food chain. The Core is also studying methods to prevent viral contamination of foods, and to inactivate viruses if they are present. This includes both traditional (e.g., heat, disinfectants, sanitizers) and more novel processing technologies (e.g., high pressure, ultraviolet light). Lead by Drs. Alvin Lee (Institute for Food Safety and Health at Illinois Institute of Technology) and Leonard Williams (North Carolina A&T University), there are four activities associated with this initiative:

Activity 4.1: Evaluate and monitor virus load pre- and post-harvest.

Activity 4.2: Develop and/or evaluate methods to prevent virus contamination in foods.

Activity 4.3: Test efficacy of candidate technologies to remove and/or inactivate viruses and their surrogates in foods (small scale).

Activity 4.4: Move promising processing technologies toward commercialization using stage-gate approach.

We hope we have provided you with a bit of an introduction to our research efforts. Ambitious, but exciting. Stay tuned to hear about our extension, outreach, and educational efforts, and more about progress against our objectives. Until next time…

Science Spotlight

Food Borne Viruses and Kitchen Utensils

Publication: Wang, Q., Erickson, M., Ortega, Y., and Cannon, J.L. 2013. The Fate of Murine Norovirus and Hepatitis A Virus During Preparation of Fresh Produce by Cutting and Grating. Food Environ. Virol. 5:52-60.

Objective & Rationale:

The objective of this study was to investigate the transfer of murine norovirus (MNV-1), a human norovirus surrogate, and hepatitis A virus between various types of produce and common kitchen utensils. The rationale for these experimental trials is based on the fact that improper food handling is the most common cause for produce contamination, particularly food handling close to consumption-which includes food preparation in kitchens. Based on epidemiological attribution, fresh produce is a particularly concerning commodity. Previous studies have shown transfer between hands and produce, and food-contact surfaces and produce, but not much is known about transfer to kitchen utensils.

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Stakeholder

Mr. Michael Roberson
Director of Corporate Quality Assurance
Publix Super Markets, Inc.

"At the end of the day, if we can prevent food borne illness, we will have accomplished a great effort, together as a team. It's nothing one person can do."

Mr. Michael Roberson is the Director of Corporate Quality Assurance and food safety programs with Publix. He graduated from Mississippi State University with a B.S. in Microbiology, where a peer mentor introduced him to food microbiology; his interest in food science and food safety was piqued. After graduation, he was hired by the Walt Disney World Company as a microbiologist. While at Disney, he gained a better understanding of the different foods coming from all over the world, as well as the myriad risks associated with food production, distribution, and service. Mr. Roberson made the difficult decision to leave Disney, where he was very happy, to "stretch his arms" and take responsibility for a manufacturing operator out West. He also completed a Masters of Science and Food Safety at Michigan State University, College of Veterinary Medicine. About ten years ago, Michael returned to Florida and accepted the position he currently holds with Publix.

Mr. Roberson's role at Publix is to set the strategy for their food safety, including brand integrity and regulatory compliance related to food safety and food labeling. Responsibilities falling under this umbrella include directing food safety for over 1,000 stores throughout the southeastern U.S., as well as Publix's own manufacturing and distribution facilities. This includes supply chain programs with suppliers to Publix as well as developing programs to help improve food safety awareness in customers' homes. Needless to say, Mr. Roberson wears many hats. His days change by the moment, with no single day being the same. What he likes best about the position is that he's exposed to the many different areas of food safety, giving his duties this great variety.

Beyond the position itself, Mr. Roberson loves working for Publix, where food safety is very well understood throughout the organization, from the executives to the newly hired fresh department associate. Publix's mission is to be the premiere food quality retailer in the world, and Mr. Roberson notes that this starts with food safety- "Quality is really bred throughout all aspects of what we do. Food safety is one of those fundamental requirements we require of ourselves as well as suppliers." He feels that his professional experience best prepared him for his current position, allowing him to "really understand how all of the science interfaces with the business needs, and that you can use science to drive those business decisions." Mr. Roberson's best advice to students and young professionals interested in a similar position is to intern. He advises them to seek out opportunities early, because exposure to real world scenarios early on is such an important experience (one he wishes he'd taken advantage of).

Mr. Roberson feels that involvement with NoroCORE is an important responsibility and an extension of Publix's commitment to ensuring food safety and quality products. He feels that food safety is a shared responsibility with the ultimate end goal of preventing food borne illness. Thus far, NoroCORE stakeholder meetings have allowed industry members to begin sharing food safety information and practices that they use in their respective workplaces to prevent food borne illness. He hopes that involvement in NoroCORE will continue to result in the identification and sharing of best practices towards achieving this goal.

Dr. Kalmia (Kali) Kniel
Associate Professor
Dpt. of Animal & Food Sciences
University of Delaware

"We can all come together and show what we've done…The extension, research, and outreach piece in such a large scope all [coming] together is amazing."

Dr. Kali Kniel was born and raised in Maryland, just outside of Washington D.C. She completed all of her degrees at Virginia Tech- a B.S. in Biology, M.S. in Molecular Cell Biology, and Ph.D. in Food Microbiology. Her M.S. work involved research on microtubule motor proteins, while her Ph.D. work focused on parasites. She diverted her focus to food microbiology in order to be involved in an applied field, liking the meaningful applications of food science. Following the completion of her degrees, she held a post-doctoral position with the USDA ARS, working in virus research. However, Dr. Kniel missed interacting with students and teaching, so she moved on to her current position as a professor at the University of Delaware. She can now balance research with teaching.

Dr. Kniel's passion for teaching is evident: when asked to describe her position, she mentioned her teaching appointments first and foremost. Her fall semester class is called Food for Thought and focuses on current issues in the food industry, while her spring class focuses on investigating outbreaks. She enjoys working with students from a number of majors and backgrounds. Dr. Kniel's research laboratory currently hosts nine students, undergraduate and graduate, with a research focus on the transmission of pathogens in the pre-harvest environment (bacterial, parasitic, and viral). Over the years, she has chosen to specialize in this area in order to understand how organisms persist and survive in the pre-harvest environment, so as to better identify risks. She always includes undergraduates in her laboratory, as this training is an important aspect of both her life and the mission of her institution. Dr. Kniel also works with local growers to educate them about the current science behind food safety regulations and with local companies on various projects. She is associate chair of her department and is involved in career development activities with the graduate students.

Her favorite aspect of the job is that it changes every day, providing great variety from teaching Good Agricultural Practices (GAPs) to growers, to working with the Food Science Club. She feels that the wide variety of experiences she had as a graduate student best prepared her for her position, including teaching, traveling to meetings, interactions with other scientists, and exposure to new research methods. She chose academia so she could continue to teach, enjoying the energy from her students: "Their motivation, their energy, it's my high everyday, it's just very exciting…I get a lot of reward working with students and I hope I provide them with something in return."

Dr. Kniel finds NoroCORE to be a great opportunity to be involved in a really important part of research where investigators can make an impact by working together. She is particularly pleased with the fact that the team is so highly diverse and collaborative, involving members across so many fields, disciplines, and institutions. She feels that the synergistic research system facilitated by the organization will result in more meaningful impacts for the food industry than individual publications might have. She hopes to contribute information about the attribution of produce contamination in the pre-harvest environment. She also enjoys interactions with and the sharing of knowledge with all of the NoroCORE partners- getting to know the other team members and learning about the headway everyone is making on the science of norovirus.

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Method:

- The research team investigated the extent of virus transfer from contaminated produce to clean utensils; transfer from contaminated utensils to clean produce items; and virus transfer in the presence and absence of food residues on the utensils. Produce types included cucumbers, strawberries, tomatoes, cantaloupes, carrots, and honeydew melons. Utensils included knives and graters.

- To study transfer from foods to utensils, produce items were artificially contaminated with virus, then cut or grated. Virus was then recovered from the utensils and quantified.

- To study transfer from multiple produce items to utensils, tomatoes and carrots were artificially contaminated, then cut or grated (respectively). The utensil was then used successively on 7 non-contaminated produce items. The 7 items were tested for presence/absence of virus.

- To study the effect of food residues on utensils, knives and graters were coated with produce residue and then used to cut or grate artificially contaminated produce. Virus was then recovered and quantified from the utensil surface.

Results:

- More than half of the utensils were contaminated after being used on contaminated produce.

- For MNV-1, transfer to utensils was greatest using artificially contaminated tomatoes and least for cantaloupes and honeydew melons. For HAV, transfer to utensils was greatest from contaminated tomatoes and least for cantaloupes and strawberries.

- For newly contaminated utensils used successively on 7 clean produce items, contamination frequently occurred across all 7 items for both viruses. The general trend was a decrease in the number of viruses transferred with each successive product. Transfer was sometimes discontinuous; for example, virus could be detected on item 7 even though item 6 was negative for virus.

- Transfer of virus from contaminated produce items to utensils coated with a food residue was variable. The general trend was that residues were actually protective (reduced transfer efficiency from produce to utensils) or else made no difference in transfer efficiency.

Significance:

The results of this investigation highlight the ease of virus cross-contamination during the cutting and grating of fresh produce items, but they also demonstrate the complex interplay of the many factors that affect virus transfer. The amount of virus transfer differed for different produce types, and also differed depending on the type of virus. For example, cantaloupes have a rough, netted surface-virus may have become entrapped in that surface, resulting in the observed trend of less transfer for both HAV and MNV-1 from contaminated cantaloupes to knives. In short, the netting would have protected against virus transfer.

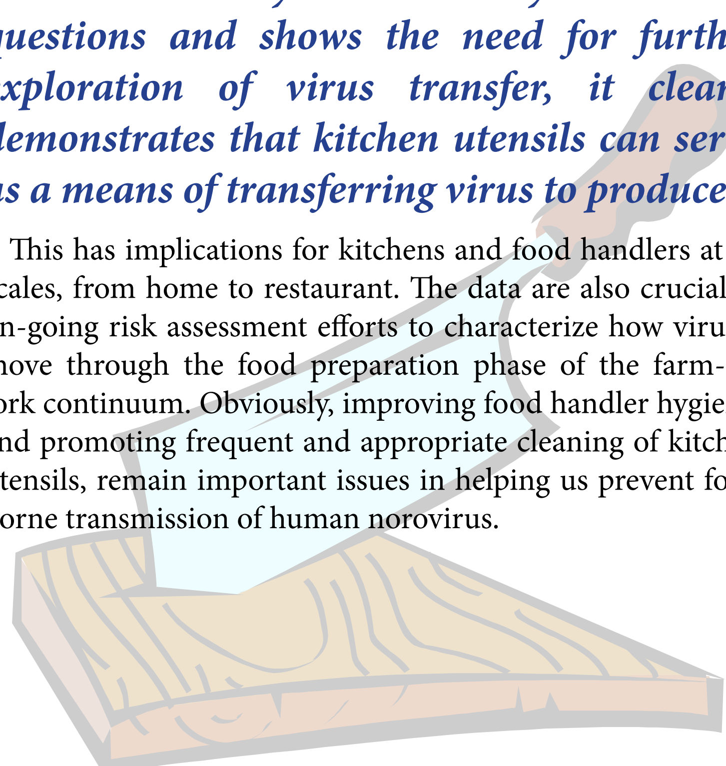
Interestingly, the presence of food residues on cutting and grating utensils made little difference, or was actually protective against virus transfer to the utensil. One possible explanation for this observation is that residue provides a "harbor" for viruses, protecting them from removal, much like the cantaloupe netting may have done.

The finding that truly stands out from this study is that a kitchen utensil used on contaminated produce could then, in turn, contaminate at least 7 additional produce items.

Since contamination was often detected on the 7th item, it may be that even more sequentially cut items could have been contaminated. The discontinuous nature of that transfer further illustrates the complexity of transfer dynamics. Clearly, unless the contaminated utensil is appropriately decontaminated, it may serve as a reservoir for food contamination through a number of different products and over a period of time.

While the study raises many additional questions and shows the need for further exploration of virus transfer, it clearly demonstrates that kitchen utensils can serve as a means of transferring virus to produce.

This has implications for kitchens and food handlers at all scales, from home to restaurant. The data are also crucial in on-going risk assessment efforts to characterize how viruses move through the food preparation phase of the farm-to-fork continuum. Obviously, improving food handler hygiene, and promoting frequent and appropriate cleaning of kitchen utensils, remain important issues in helping us prevent food borne transmission of human norovirus.



Welcome, Sydney?

GII.4 Sydney…it's the newly emerged epidemic strain of human norovirus. If you've watched the news in the first half of 2013, there's a really good chance you have already heard about it. Norovirus has been in the media spotlight, with widespread outbreaks in hospitals, schools, restaurants, long-term care facilities, cruise ships, and more. In late January, the CDC released its Morbidity and Mortality Weekly Report (MMWR), available at www.cdc.gov, featuring an official report of the new strain. Since that bulletin, major news networks such as ABC and CBS have featured pieces on the bug. The hallmark symptoms of norovirus are vomiting and diarrhea, with the illness lasting a few days (but infected individuals can remain contagious for much longer). Infections can be severe for the elderly, children, and immuno-compromised persons. This year, it really seems to be getting around- both in the population and in the press.

To understand what the emergence of a new strain means, you need to understand how noroviruses are related to each other. Basically, noroviruses are categorized into five distinct groups, called genogroups I-V (abbreviated GI, GII, GIII, GIV, and GV); members of GI and GII are most often associated with human disease, with GII predominating. Each of these genogroups is further subdivided into genetically related genotypes that consist of various virus strains. Each strain is slightly different from any other strain in both its capsid (outer protein coat) and genetic make-up (sequence of viral RNA). For example, GII.4 Sydney means this strain belongs to genogroup GII, genotype 4, strain Sydney. This is much like influenza- every year the flu is the flu, but a slightly different version of the virus may be causing it (and that's why you need a new flu vaccine each year). The GII.4 strains are responsible for most norovirus outbreaks, and according to the CDC, GII.4 strains are also associated with higher rates of hospitalization and death during outbreaks. New strains of the GII.4 viruses emerge every few years, sometimes resulting in an increase in outbreak activity. GII.4 Sydney is the most recent flavor, emerging in March 2012, in Australia, and replacing GII.4 New Orleans as the major cause of outbreaks around the world over the last year.

So why do new GII.4 norovirus strains periodically emerge? It depends not only on changes (mutations) in the virus itself, but also on the immune system of the host population (humans). Specifically, whether the host population is still susceptible to infection or not. Host susceptibility to infection by the virus serves as evolutionary pressure for the emergence of a new strain. In other words, whether or not the virus can make a population sick influences the success of virus strains and whether changes in the virus will persist or be lost. When first exposed to a new strain of virus, most of the population will be susceptible. Our immune systems cannot tackle the virus right away because they've never been exposed to it (except for those lucky enough to have natural genetic immunity to infection by a given strain). That means most of the population will be susceptible to illness, so

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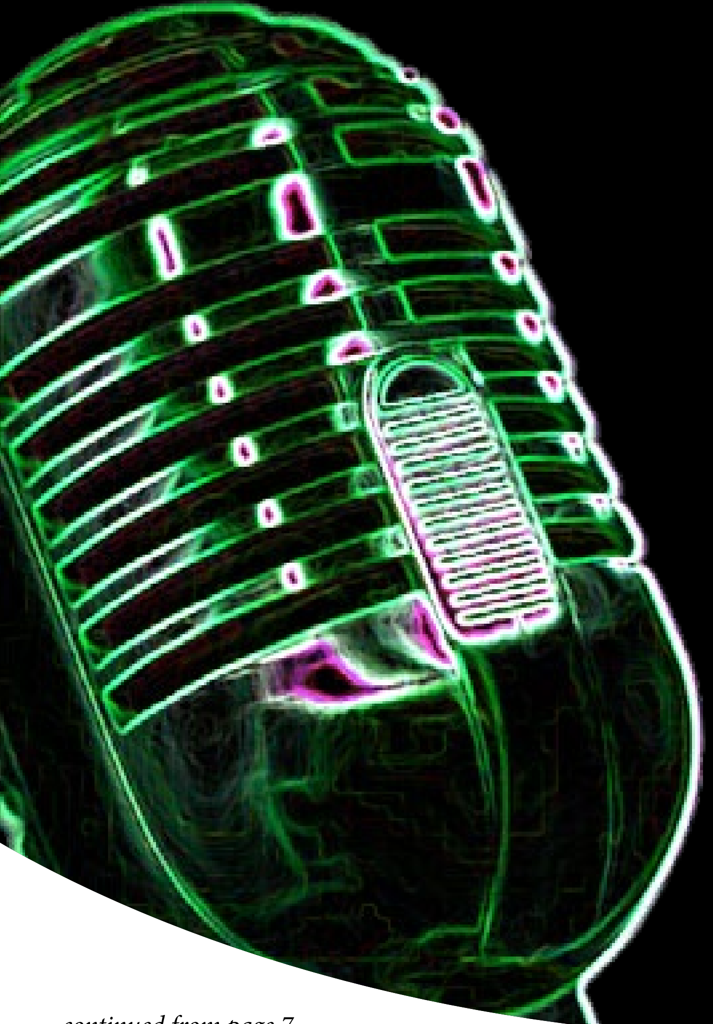
Profile: GII.4 Sydney

As the norovirus outbreak period generally peaks in January, and statistical analysis of the 2013 data has not yet been done, it is too early to tell if we have actually observed more outbreaks than usual.

GII.4 Sydney has, however, been predominantly responsible for the early onset of the norovirus season in the United Kingdom (think of all those hospital wards we've been blogging about), as well as illnesses in Japan and the U.S.

The CDC provides some interesting numbers from data reported in the U.S. during September-December of 2012:

- GII.4 Sydney caused more than half of the norovirus outbreaks reported during this period.
- The percent of outbreaks caused each month by GII.4 Sydney has increased from approximately 20% to 60% (in other words, it is becoming responsible for more outbreaks each month).
- More than half of these outbreaks were caused by person-to-person transmission; food borne transmission placed second for known causes, resulting in 20% of these outbreaks (a large chunk of outbreaks are of unknown transmission).
- Long-term care facilities and restaurant settings accounted together for almost 80% of the outbreaks.



announcements

meet the NoroCORE team...

North Carolina State University
Baylor College of Medicine
CDC
Clemson University
Emory University
Illinois Institute of Technology
North Carolina A&T University
North Carolina Central University
RTI International
University of Georgia
Arizona State University
Cincinnati Children's Hospital
FDA CFSAN
Louisiana State University
New Mexico State University
Ohio State University
Rutgers University
University of Delaware
USDA ARS

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there are plenty of hosts in which the virus can multiply. These infected hosts serve as vectors that "move" the virus to other hosts. But over time, as more people become sick from that strain (and sometimes from similar strains), their immune systems are better able to combat infection, gaining short-term immunity, and there are fewer available hosts. Not only does this mean fewer people for the virus to infect, but also that it's less likely for the smaller remaining susceptible population to become infected because there are fewer people to serve as contagious vectors. The virus becomes less prevalent because it has fewer hosts, and is therefore considered less successful. This concept is called herd immunity.

But all the virus wants to do is survive! When a strain no longer has as many hosts available, there is a survival advantage for strains that have mutated so that they can now infect previously immune hosts. So if a strain undergoes a mutation that makes it different enough to circumvent the immune system of a high proportion of the population, and cause infection, it has many more potential hosts available and gains a competitive advantage over the old strain. This strain will now rise in prevalence until herd immunity develops and the cycle repeats. Sometimes this shift in predominant strains results in a larger number of cases or outbreaks, sometimes not. Because of this phenomenon, the newly emerged GII.4 Sydney strain has replaced the older GII.4 New Orleans strain as the predominant human norovirus strain, at least for now. With norovirus, these shifts tend to happen approximately every four years. This whole concept of herd immunity and virus emergence is one reason why some people continue to be susceptible to norovirus infection for their entire lives.

Interesting stuff! If you want to read more, visit the CDC website (www.cdc.gov) for information about Sydney, and the NoroCORE blog for links to Sydney news stories (norocore.com).