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Leslie Barclay Date

ASSESSMENT OF CDC HICPAC GUIDELINES FOR PREVENTION AND CONTROL OF NOROVIRUS OUTBREAKS IN HEALTHCARE INSTITUTIONS

BY

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BY

Leslie Barclay
M.P.H., Emory University, 2014
B.S., University of California, Irvine, 2000

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An abstract of
A Thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements of the degree of
Master of Public Health in the Executive MPH program
2014

Abstract

ASSESSMENT OF CDC HICPAC GUIDELINES FOR PREVENTION AND CONTROL OF NOROVIRUS OUTBREAKS IN HEALTHCARE INSTITUTIONS

BY
Leslie Barclay

Norovirus is the leading cause of acute gastroenteritis outbreaks. Although illness is usually self-limiting, norovirus can cause severe illness and potentially death in immune compromised individuals and the elderly. Several attributes of norovirus impede prevention and control: multiple transmission routes (person-to-person, food, environment, and water), large genetic diversity, limited immunity, environmental stability, and resistance to common disinfectants. No vaccine is currently available.

Norovirus outbreaks disproportionately affect healthcare institutions more than non-healthcare institutions. Recently, the Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Centers for Disease Control and Prevention (CDC) published guidelines (CDC HICPAC guidelines), which included 61 recommendations, specifically for healthcare institutions, to prevent and control norovirus outbreaks. However, challenges and limitations can affect consistent implementation in every institution.

The purpose of this study was to gain a better understanding of commonly implemented recommendations and challenges involved in implementing infection control measures. The study analyzed data from a survey distributed to members of the Association for Professionals in Infection Control and Epidemiology (APIC). The survey focused on three areas: knowledge of norovirus and the CDC HICPAC guidelines, implementation of the CDC HICPAC guidelines, and barriers encountered during the implementation process.

The study found that most (93%) participants were aware of the CDC HICPAC guidelines, but only 50% were aware of the norovirus prevention toolkit. Of those that used the toolkit, 78% found it useful in implementing recommendations. Participants most frequently implemented active hand hygiene promotion (88%) and increased cleaning frequency (74%). The most challenging recommendations to implement were reportedly exclusion of ill staff (22%) and closure of units (19%). Poor compliance (28%) and personnel limitations (21%) were selected as the most significant barriers to implementation. Participants that recently experienced a norovirus outbreak were significantly ($P<0.01$) more likely to implement recommendations.

Implementation of the CDC HICPAC guidelines is widespread, particularly among facilities with recent outbreak experience. However, gaps in norovirus knowledge exist. Recommendations include educational training opportunities focusing on norovirus and infection control practices, in particular norovirus outbreak prevention, and promotion of the norovirus toolkit. Future studies should address reducing barriers that inhibit implementation of the CDC HICPAC guidelines.

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Acknowledgments

I would like to thank Jeff Hageman and Erin Stone for the recommendation to pursue reviewing and developing a project centered on the CDC HICPAC guidelines. Everardo Vega was an invaluable resource, utilizing his experience and knowledge of R while troubleshooting my analysis. A special thanks to Ben Lopman and Aron Hall for their continued guidance, input, and encouragement to complete this project. I greatly appreciate Kathy Miner for her feedback, support, and guidance with throughout this process.

Finally, a very special thank you to my loving parents for which without their support, both financially and emotionally, I would not have had the opportunity to obtain this degree. Moreover, I am forever grateful to my husband, Dennis, for his blunt and honest editorial commentary throughout this entire process. His support, love, and encouragement over the past few years are the reasons I made it through this program.

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Chapter 1: Introduction

Background

Norovirus is the most common cause of acute gastroenteritis in people of all ages and settings (Glass, Parashar, & Estes, 2009). Approximately 19–21 million illnesses occur each year in the United States (US) due to norovirus (Hall, Lopman, et al., 2013). Although illness is usually self-limiting, norovirus can cause severe illness and potentially death in children less than 5, adults greater than 65, and immune compromised individuals (Glass et al., 2009; Hall, Lopman, et al., 2013).

Many attributes make norovirus difficult to prevent and control. The virus has a low infectious dose and individuals shed virus in high amounts prior to illness and well after resolution of symptoms (CDC, 2011; Glass et al., 2009; Teunis et al., 2008). These factors contribute to the ease of transmissibility and secondary cases. Further, norovirus can be spread through person-to-person contact, food, water, and the environment (Dicaprio, Ma, Hughes, & Li, 2013; Glass et al., 2009). In addition, a large genetic diversity along with no long lasting immunity hinders prevention measures due to persistence of the virus in the population allowing for a continuity of transmission (CDC, 2011; Donaldson, Lindesmith, Lobue, & Baric, 2008; Glass et al., 2009). Major factors that affect the control of norovirus outbreaks are the virus' environmental stability, survivability in varying environmental conditions, and resistance to common disinfectants (CDC, 2011; Dicaprio et al., 2013; Glass et al., 2009). Finally, there is no vaccine currently available (Glass et al., 2009).

Norovirus causes more than 50% of all acute gastroenteritis outbreaks in the US (Hall, Wikswo, et al., 2013; Vega et al., 2014). Norovirus outbreaks are a burden on healthcare institutions, i.e., hospitals, long-term care facilities (LTCF), and outpatient clinics, which

disproportionately occur in these settings compared to community settings, i.e., cruise ships, restaurants, and schools (Gastanaduy, Hall, Curns, Parashar, & Lopman, 2013; Hall, Wikswo, et al., 2013; Trivedi et al., 2012; Vega et al., 2014). A study of 289 hospitals found that norovirus was the number one causative agent for all outbreaks investigated (Rhinehart, Walker, Murphy, O'Reilly, & Leeman, 2012). Norovirus outbreaks in LTCF lead to an increase in all-cause hospitalizations and deaths (Trivedi et al., 2012). Current annual hospital, emergency department, and outpatient visits are estimated at 56,000–71,000, 400,000, and 1.7–1.9 million, respectively (Hall, Lopman, et al., 2013), which contribute to the burden on healthcare institutions.

The annual US healthcare costs for hospitalizations and emergency department visits due to norovirus are approximately $493 million and $284 million, respectively (Gastanaduy et al., 2013; Lopman, Hall, Curns, & Parashar, 2011). Norovirus outbreaks impose an economic burden on healthcare institutions. Closure of units or wards, staff absenteeism due to illness, implementation of prevention and control measures, as well as overall hospital costs are a few factors when calculating economic costs (Danial et al., 2011; Gastanaduy et al., 2013; Lee et al., 2011; Lopman et al., 2011). A United Kingdom study estimated that those costs over a 2 year period were £1.2 million (~$2 million) in one regional area (Danial et al., 2011), compared to the national burden in the United Kingdom estimated at £115 million (~$200 million) (Lopman et al., 2004). A contributing factor to these costs is the length of duration and attack rates. A review of published outbreaks demonstrated that healthcare settings had longer outbreak durations and higher attack rates than non-healthcare settings (Harris, Lopman, & O'Brien, 2010).

Problem Statement

The continued burden of norovirus outbreaks in healthcare institutions demonstrates that there is a gap in infection control measures, which allows norovirus to evade them, likely due to the many attributes of norovirus previously described. Hence, many infection control measures directed at preventing and controlling norovirus outbreaks aim to suppress and limit norovirus transmission (CDC, 2011). Guidelines for infection control of norovirus outbreaks are available from several public health agencies worldwide (CDNA, 2010; HPA et al., 2012; MacCannell et al., 2011). However, there is a lingering question of which recommendations best address prevention and control of norovirus. In 2011, the Healthcare Infection Control Practices Advisory Committee (HICPAC) and the Centers for Disease Control and Prevention (CDC) published guidelines that contained 61 prevention and control recommendations for healthcare institutions based on a systematic literature review intended to evaluate the evidence of prevention and control measures (CDC HICPAC guidelines) (MacCannell et al., 2011). The CDC HICPAC guidelines provide a thorough list of recommendations and provide some level of supporting evidence. However, healthcare institutions have the difficulty in deciding which recommendations to implement, as it may not be feasible to implement them all. There is no clear understanding to which recommendations are implemented most frequently or the factors involved in the decisions to implement particular infection control measures.

Theoretical Framework

The implementation of the CDC HICPAC guidelines may require policy change in healthcare institutions. Several theoretical frameworks exist to explain policy change, and for this study diffusion of innovation was chosen to demonstrate this change (Berry & Berry, 2007).

Policy diffusion framework explains the process by which an innovation, i.e., recommendation, is passed along through a communication network of similar entities, i.e.,

infection control professionals, over time (Berry & Berry, 2007). There are four main elements to this framework: the innovation, communication network, time, and social system. Further, the framework relies on the interactions of individuals to promote an adopted policy to those that have not adopted it yet (Berry & Berry, 2007). In a positive cycle, where a healthcare institution adopts recommendations in the CDC HICPAC guidelines and yields beneficial results, i.e., decrease in norovirus outbreaks, they will share their experience with colleagues, typically through conferences, meetings, etc. If the timing and need are right, those colleagues will adopt the recommendations at their institution, and continue the process of adoption. However, the opposite is true as well. If an institution adopts recommendations and does not produce positive results, they will more than likely communicate their negative experiences to colleagues, which may slow the adoption of recommendations (Berry & Berry, 2007).

Purpose Statement

The CDC HICPAC guidelines compiled and rated recommendations into a single comprehensive guideline for healthcare institutions. Understanding the extent and practicality of the implementation of these recommendations in healthcare institutions is the overall goal of this study. In order to assess the implementation of the CDC HICPAC guidelines, there are several specific objectives:

- Determine the knowledge, attitudes, and practices of infection control professionals in healthcare institutions concerning norovirus and the CDC HICPAC guidelines
- Estimate the proportion of infection control preventionists that implemented selected recommendations from the CDC HICPAC guidelines and establish the most commonly implemented recommendations
- Identify barriers to implementing the CDC HICPAC guidelines

Significance

The CDC HICPAC guidelines include detailed recommendations developed by a robust, systematic process. However, the burden of implementing these guidelines can be quite time

consuming and costly, which may question their practicality. In understanding the implementation and practicality of the recommendations in healthcare institutions, it may be desirable, from the perspective of an infection control practitioner, to streamline the recommendations to a "top 5" or "top 10", including all recommendations that prevent and control norovirus, regardless of ease of use. Discovering barriers that affect implementation will aid investigators in studying these barriers and their role in healthcare institutions, with the intent to limit barriers and improve the implementation process.

This study will also bring another opportunity for dissemination of the CDC HICPAC guidelines, furthering awareness. By participating in the study, there is the potential to increase exposure and awareness of the CDC HICPAC guidelines.

Definition of Terms

ABHS: Alcohol-based hand sanitizers

Acute gastroenteritis: An infection of the stomach and intestines leading to rapid onset of vomiting and/or diarrhea

APIC: Association for Professionals in Infection Control and Epidemiology

CDC: Centers for Disease Control and Prevention

CDC HICPAC guidelines: Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreaks in Healthcare Settings, 2011

GRADE: Grading of Recommendations Assessment, Development and Evaluation

Healthcare institution: hospitals, long-term care facilities, outpatient clinics, urgent care facilities, and ambulatory surgical facilities

HICPAC: Healthcare Infection Control Practices Advisory Committee

Immune compromised: An individual with an impaired or weakened immune system

Infectious dose: The amount of pathogen required to cause an infection in a host

LTCF: Long-term care facility

RNA: Ribonucleic acid

Self-limiting disease: A condition that ultimately resolves itself without treatment

WHO: World Health Organization

Chapter 2: Literature Review

Introduction

Many attributes facilitate the transmission of norovirus. The low infectious dose (Teunis et al., 2008), high viral shedding (Atmar et al., 2008), environmental stability (Lopman et al., 2012), and resistance to disinfectants (Park et al., 2010) influence the range of transmission modes (person-to-person, food, water, and environment) (Green, 2013). These attributes along with the variety of transmission modes present challenges to develop effective infection control measures. Infection control practitioners utilize a range of strategies to prevent and control norovirus outbreaks (CDC, 2011; HPA et al., 2012; MacCannell et al., 2011).

Literature Review

Norovirus Characteristics

Classification and Structure

Noroviruses comprise a genus in the family *Caliciviridae*, which includes five genera: *Lagovirus*, *Nebovirus*, *Norovirus*, *Sapovirus*, and *Vesivirus*. Noroviruses and sapoviruses are the only known caliciviruses to cause disease in humans. All viruses in the family *Caliciviridae* are non-enveloped, single-stranded, positive-sense RNA viruses (Green, 2013). The norovirus genome is 7.5 – 7.7 kilobases in length and contains three open reading frames (ORFs 1, 2, and 3), with the exception of murine norovirus, which has four ORFs (Green, 2013).

Noroviruses are genetically classified into six known genogroups (G) (Green, 2013). GI, GII, and GIV are the only known genogroups to cause disease in humans. GI and GII are more commonly associated with disease than GIV noroviruses. Limitations to studying these viruses, which to date is predominately by utilization of molecular methods, are that noroviruses cannot

be grown in cell culture, except for murine norovirus (GV), and no small animal model exists (Green, 2013).

Strain Diversity

Noroviruses are a genetically diverse group of viruses, with GI and GII divided into 9 and 22 genotypes, respectively (Kroneman et al., 2013). Of the GII genotypes, GII.4 strains are the most prevalent and most commonly associated with epidemics (Vega et al., 2014; Vega et al., 2011). Since 2002, five major GII.4 strains have circulated, with each displacing the other over time due to antigenic shift (Kroneman et al., 2008; Leshem, Barclay, et al., 2013; Rosenthal et al., 2011; Vega et al., 2014; Vega et al., 2011). The genetic modification of GII.4 strains is a possible means of evading the human immune response (Saito et al., 2014).

The importance of genotyping for public health is that evidence suggests that there are potential associations with genotypes to transmission modes, settings, and severity of disease, which may assist in determining utilization of particular infection control measures (Desai et al., 2012; Huhti et al., 2011; Leshem, Barclay, et al., 2013; Leshem, Wikswo, et al., 2013; Vega et al., 2014). Person-to-person and healthcare institution outbreaks are more commonly associated with GII.4 strains (Leshem, Wikswo, et al., 2013; Vega et al., 2014). In contrast, non-GII.4 strains, in particular GI strains, are associated with foodborne and waterborne outbreaks (Bitler, Matthews, Dickey, Eisenberg, & Leon, 2013; Kroneman et al., 2008; Leshem, Barclay, et al., 2013). GII.4 strains are also associated with more severe outcomes, i.e., higher hospitalizations and mortality rates, than non-GII.4 strains (Desai et al., 2012; Huhti et al., 2011). Further, some studies suggest GII.4 strains are associated with longer duration of illness (Huhti et al., 2011; Kanerva et al., 2009).

Norovirus Epidemiology

Clinical Features

Norovirus causes acute gastroenteritis, with a rapid onset of symptoms, typically within 24–48 hours in immune competent individuals. Symptoms of acute gastroenteritis include a low-grade fever, vomiting, watery diarrhea, nausea, abdominal cramps, and general malaise (Glass et al., 2009). Symptoms typically resolve within a few days; however, in infants and children, the duration of infection can be prolonged (up to 6 weeks) and symptoms more severe (Huhti et al., 2011). The elderly are at a significantly higher risk for severe infection and even death. Recovery is usually complete with no long-term effects (Glass et al., 2009). There have also been several documented cases of immune compromised and suppressed individuals who have had symptoms lasting over 2 years (Green, 2014).

Disease Burden

Norovirus is the leading cause of acute gastroenteritis in people of all ages (Glass et al., 2009). It is responsible for more than half of all acute gastroenteritis outbreaks (Patel, Hall, Vinje, & Parashar, 2009), sporadic cases (Hall et al., 2011), and is the leading cause of foodborne outbreaks and disease (Hall et al., 2014; Scallan et al., 2011). Recent estimates in the US indicate that approximately 19–21 million illnesses of norovirus occur annually (Hall, Lopman, et al., 2013). Of these, foodborne transmission is responsible for 5.5 million illnesses (Scallan et al., 2011). There are 1.7–1.9 million outpatient visits, with more severe illness causing 400,000 emergency department visits, and 50,000–71,000 hospitalizations. Finally, norovirus illness affects the very young, very old, and immune compromised individuals more severely than immune competent individuals, which leads to 570–800 deaths, annually (Glass et al., 2009; Hall, Lopman, et al., 2013).

The annual US healthcare costs for hospitalizations and emergency department visits due to norovirus are approximately $493 million and $284 million, respectively (Gastanaduy et al., 2013; Lopman et al., 2011). Foodborne disease due to norovirus burdens the US economy with approximately $2 billion annually in healthcare expenses and lost productivity (Hoffmann, Batz, & Morris, 2012).

Although norovirus outbreaks occur year-round, most outbreaks occur during the winter season, with a peak in January/February (Vega et al., 2011; Wikswo, Hall, & CDC, 2012). GII.4 outbreaks appear to drive the seasonality (Rosenthal et al., 2011; Vega et al., 2011). Non-GII.4 outbreaks occur year-round at a relatively constant rate, with GI outbreaks predominately occurring in summer months (Kroneman et al., 2008; Rosenthal et al., 2011).

Settings

Norovirus outbreaks are ubiquitous, occurring in a wide variety of settings. More than 60% of outbreaks occur in healthcare institutions, with LTCF making up the majority of outbreaks (Hall, Wikswo, et al., 2013; Vega et al., 2014). Further, outbreaks occur in restaurants, schools, correctional facilities, and childcare facilities, but to a lesser degree (Vega et al., 2014). A recent study found that hospitals might be under-reporting outbreaks, as norovirus was the number one cause for all outbreaks, yet reporting of outbreaks occurred in only 50% of investigated outbreaks (Rhinehart et al., 2012). This may explain the low estimates in recent reports that indicate about 5% of norovirus outbreaks occur in hospitals (Vega et al., 2014; Wikswo et al., 2012).

Transmission Modes

Transmission of norovirus is directly by person-to-person contact or indirectly through foodborne, waterborne, and environmental transmission. Direct transmission between person-to-

person can occur through fecal-oral or vomit-oral routes. Person-to-person transmission is responsible for more than 80% of norovirus outbreaks (Vega et al., 2014). Further, most person-to-person outbreaks occur in healthcare institutions (Hall, Wikswo, et al., 2013; Vega et al., 2014).

Foodborne, waterborne, and environmental outbreaks are reported to a lesser degree (Vega et al., 2014). Of these types of outbreaks, foodborne are more common in restaurants and banquet facilities (Hall et al., 2014). Typically a contaminated source, i.e., food, water, or fomite, is the transmission vehicle (Bitler et al., 2013). The persistence of norovirus on these contaminated sources could affect the duration of foodborne, waterborne, and environmental outbreaks (Kotwal & Cannon, 2014; Lopman et al., 2012). The most common food vehicles related to norovirus outbreaks are ready-to-eat foods, with leafy greens, fruits, and mollusks identified most often in outbreaks with an implicated food type (Hall et al., 2014).

A risk factor that contributes to the array of transmission modes is the presentation of norovirus symptoms, namely acute, projectile vomit (O'Neill & Marks, 2005; Zelner, Lopman, Hall, Ballesteros, & Grenfell, 2013). The aerosolization of vomit, in combination with close proximity to ill individuals, may increase transmission and likelihood of infection (Harris, Lopman, Cooper, & O'Brien, 2013). Studies of illness clusters surrounding a public vomiting event demonstrate that several transmission modes are at play, initially person-to-person spread with environmental transmission occurring in later cases, which contribute to extending outbreak durations (Thornley, Emslie, Sprott, Greening, & Rapana, 2011; Wikswo et al., 2011).

Norovirus Infection Control Practices

Norovirus Evasion Mechanisms

Many factors facilitate the spread of norovirus and impede prevention control measures. Norovirus is a highly infectious virus, with estimates as low as 18 viral particles causing

infection (Teunis et al., 2008). Viral shedding, in high amounts, for prolonged periods, and asymptomatically can lead to issues of outbreak control and secondary transmission. Studies have shown that at peak shedding (2–5 days post-infection) norovirus ranges from 10^5 to 10^9 particles per gram of stool (Atmar et al., 2008; Kirby, Shi, Montes, Lichtenstein, & Moe, 2014). In addition, detection of the virus in stool can occur up to eight weeks after onset of symptoms, with a median of four weeks (Atmar et al., 2008). Further, viral shedding has been documented to be much longer in immune compromised individuals (Green, 2014) and studies report that norovirus can be detected up to 1 year (or longer), which may play a role in secondary transmission (Sukhrie, Siebenga, Beersma, & Koopmans, 2010). Studies demonstrate that asymptomatic shedding occurs at similar levels to symptomatic individuals (Atmar et al., 2008; Kirby et al., 2014). However, the role and importance of asymptomatic shedding in transmission is still not well understood (Lopman, Simmons, Gambhir, Vinje, & Parashar, 2014; Ozawa, Oka, Takeda, & Hansman, 2007; Sukhrie et al., 2012).

Additional attributes that hamper infection control measures and lead to continued transmissibility of norovirus are its stability in the environment (Cheesbrough, Barkess-Jones, & Brown, 1997; Kotwal & Cannon, 2014; Lopman et al., 2012) and resistance to disinfectants (Park et al., 2010; Park & Sobsey, 2011). Norovirus has been detected up to 56 days on environmental surfaces (D'Souza et al., 2006; Lamhoujeb, Fliss, Ngazoa, & Jean, 2009), and transferred from a contaminated environmental surface to lettuce (D'Souza et al., 2006). A study demonstrated that norovirus remains infectious in water for at least 61 days, and persists for more than 3 years (Seitz et al., 2011).

Norovirus is difficult to eliminate from surfaces and hands. Common disinfectants, such as quaternary ammonium compounds (QAC) and alcohols, are not effective against norovirus,

and its culturable surrogates, murine norovirus (MNV) and feline calicivirus (FCV) (Cannon et al., 2006; Girard, Ngazoa, Mattison, & Jean, 2010; Park et al., 2010; Tung, Macinga, Arbogast, & Jaykus, 2013). The Environmental Protection Agency (EPA) maintains a list (List G) of products approved for norovirus disinfection (EPA, 2009). However, the EPA list contains products based on FCV efficacy, which exhibits different physiochemical properties than norovirus and other culturable surrogates and could overestimate the efficacy of a disinfectant (Park et al., 2010; Park, Linden, & Sobsey, 2011).

CDC HICPAC Guidelines

The CDC HICPAC guidelines are a compilation of 61 prevention and control recommendations supported by varying degrees of evidence from published studies and other guidelines (MacCannell et al., 2011). Utilization of the Grading of Recommendations Assessment, Development and Evaluation (GRADE) method (http://www.gradeworkinggroup.org/index.htm), a method used to assess quality of evidence, the authors ranked the recommendations by categories, IA, IB, IC, II, and recommend further research. The IA category describes strong recommendations supported by high to moderate evidence. IB category represents strong recommendations supported by low-quality evidence. IC category describes strong recommendations based on required state or federal regulations. Category II denotes weak recommendations supported by any quality of evidence. Finally, recommendations captured within the recommend further research category have low to very low quality evidence to support those recommendations (MacCannell et al., 2011).

There were 34 strong recommendations captured in categories IA, IB, and IC, which the CDC HICPAC guidelines suggest to implement as a priority. Of these, there was only one recommendation categorized as IA, utilization of Kaplan's criteria to identify a norovirus

outbreak (MacCannell et al., 2011). This is an important recommendation, as early detection of an outbreak can shorten the duration by implementing recommendations earlier (Cheng et al., 2006; Lopman et al., 2004). The remaining 27 recommendations grouped into category II or recommend further research are not priority recommendations, but may assist in prevention and control of norovirus (MacCannell et al., 2011).

To facilitate the implementation process, the CDC HICPAC guidelines included a section that places a priority on implementing nine recommendations (MacCannell et al., 2011). Additionally, the CDC produced the norovirus prevention toolkit, which incorporates easy to use documentation to assist with the implementation of key recommendations. The purpose of the norovirus prevention toolkit was to use it in conjunction with the CDC HICPAC guidelines to assist with implementing the recommendations and outbreak investigations (CDC, 2013).

Outbreak Management

According to the World Health Organization (WHO), management and control of outbreaks begins with having clear guidance in place for preparedness, identification, response, and evaluation of outbreaks (Connolly, 2005). In addition, policies that support and implement infection control measures, in a timely manner, assist in prevention and control of outbreaks (CDC, 2011; Cheng et al., 2006; Lopman et al., 2004; MacCannell et al., 2011). Preparedness is inclusive of organizational structure, education, and communication (MacCannell et al., 2011; Sydnor & Perl, 2011). The structure that best supports a streamlined approach to initiation of infection control measures is having one department or a committee responsible for these decisions (Sydnor & Perl, 2011).

Education is an important aspect for staff, patients, and visitors, in order to become aware and recognize norovirus symptoms and transmission modes (MacCannell et al., 2011; Sydnor &

Perl, 2011). Constant and consistent reminders of proper hygiene, disinfection measures, and personal protection, can enable staff to begin these measures before enhanced infection control measures are initiated (Cheng et al., 2011). A recent study found that infection control practitioners lacked basic norovirus knowledge, in particular, symptomology and transmission modes, as well as prevention and control measures, in particular, hand hygiene and disinfection (Kosa, Cates, Hall, Brophy, & Frasier, 2014).

Communication and reporting of outbreaks to appropriate authorities, i.e., local public health departments, may assist with outbreak control (MacCannell et al., 2011). On both sides, healthcare institutions and public health departments, communication is necessary for education, surveillance, and infection control (Stachel, Bornschlegel, & Balter, 2012). A study compared notification time to outbreak duration of over 250 norovirus outbreaks. Although the average notification time was four days, outbreaks reported within one day had significantly shorter durations (Davis, Vally, & Beard, 2011). Another explanation for the shorter duration could be due to implementing infection control practices earlier in outbreaks, which are also associated with shortening the outbreak duration (Cheng et al., 2006; Harris, Adak, & O'Brien, 2014).

Identification of outbreaks includes proper monitoring and surveillance, which can lead to early response and initiation of infection control measures. The use of Kaplan's clinical and epidemiological criteria can assist in early detection of a norovirus outbreak, in particular if laboratory testing is not available (MacCannell et al., 2011). Kaplan's criteria include four conditions, which need to be true to classify an outbreak as norovirus (Kaplan, Feldman, Campbell, Lookabaugh, & Gary, 1982):

- Stool tests negative for bacteria
- Vomiting in more than 50% of cases
- Mean duration of illness of 12–60 hours
- Mean incubation period of 24–48 hours

An early response system enables the initiation of enhanced infection control measures against norovirus (Cheng et al., 2006; Lopman et al., 2004). Implementing infection control measures upon the presentation of a vomiting event effectively reduced outbreak duration (Cheng et al., 2006). Further, vomit episodes can be used as an early warning system (up to 4 weeks in advance) of norovirus outbreaks, and hence, initiate education and ensure infection control measures are in place (Loveridge et al., 2010).

Hygiene

Alone, or in conjunction with other infection control measures, studies that included enhanced hand hygiene observed fewer norovirus outbreaks (Cheng et al., 2011; Heijne et al., 2009). Enhanced hand hygiene includes washing hands with soap and warm running water for at least 20 seconds before and after patient contact, using the lavatory, and eating (CDC, 2011; MacCannell et al., 2011). To ensure proper hand hygiene, one study implemented direct observation of hand washing (along with education and testing), and found a significant decrease in the number of outbreaks compared to the previous year (Cheng et al., 2011).

Although widely used in healthcare institutions, the efficacy of alcohol-based hand sanitizers (ABHS) against norovirus is inconclusive. A study by Liu, Yuen, Hsiao, Jaykus, and Moe (2010) demonstrated that antibacterial soap was more effective than ABHS. ABHS is not recommended during norovirus outbreaks (Bolton et al., 2013; Macinga, Sattar, Jaykus, & Arbogast, 2008; Park et al., 2010; Sickbert-Bennett et al., 2005). A study found an association between the use of ABHS and norovirus outbreaks (Blaney et al., 2011). In this cross-sectional study, the association confounded by other factors, i.e., hand hygiene compliance rates, could limit the authors' conclusions (Longtin, Voss, Allegranzi, & Pittet, 2012). In contrast, a cluster randomized controlled study conducted at an elementary school found that the use of ABHS in

conjunction with QAC disinfecting wipes decreased absenteeism due to gastrointestinal illness and was detected less frequently in the intervention group (Sandora, Shih, & Goldmann, 2008).

Close proximity to an infected individual, in particular the aerosolization of vomit, increases the risk of norovirus transmission (Harris et al., 2013; O'Neill & Marks, 2005). Therefore, appropriate personal protective equipment (PPE), i.e., gloves and masks, is a useful means of prevention (Cheng et al., 2006; MacCannell et al., 2011). Guidelines suggest using disposable PPE and changing it frequently to limit the spread of norovirus to staff and visitors (MacCannell et al., 2011).

Cleaning and Disinfection

Studies demonstrate that cleaning followed by disinfecting contaminated areas can control outbreaks and prevent the spread of norovirus (Heijne et al., 2009; Park & Sobsey, 2011). Due to the high transmissibility of norovirus via contaminated environmental surfaces (Lopman et al., 2012), increasing the frequency of high-traffic and affected areas as well as paying closer attention to commonly touched surfaces, i.e., door handles, keyboards, is recommended to decrease the spread of norovirus (Heijne et al., 2009; MacCannell et al., 2011). Further, to reduce risk of spread to unaffected areas, cleaning should occur from unaffected to affected areas, following a low-contamination to high-contamination cleaning pattern (MacCannell et al., 2011).

The use of appropriate products to clean and disinfect is an important aspect to controlling and preventing norovirus outbreaks, as discussed previously, norovirus has a high resistance to common disinfection products and is environmentally stable (Cannon et al., 2006; Park et al., 2010). A bleach solution at a concentration of at least 1000 parts per million (ppm) sodium hypochlorite prepared fresh daily has been shown to be the most effective product

against norovirus (Barker, Vipond, & Bloomfield, 2004; Feliciano, Li, Lee, & Pascall, 2012; Girard et al., 2010; Tung et al., 2013). However, guidelines suggest that in circumstances where bleach is unavailable, corrosive to the particular material, or adversely affected, to utilize the EPA products on List G (EPA, 2009; MacCannell et al., 2011). Soft furnishing, i.e., carpets, chairs, rugs, typically fall into this category of using EPA List G products. Recommendations suggest that soft furnishings should be steam cleaned after appropriate cleaning of detergent and warm water. Carpet, which was improperly cleaned (vacuumed daily for 2 weeks), was determined to be the culprit in an outbreak that occurred more than 2 weeks after initial norovirus outbreak (Cheesbrough et al., 1997).

Isolation, Cohorting, and Closures

Due to person-to-person contact being the transmission route for the majority of norovirus outbreaks, healthcare institutions utilize different isolation techniques to eliminate the exposure risk and further spread of norovirus. Commonly used techniques are patient isolation, patient cohorting (grouping patients based on symptoms), exclusion of symptomatic staff and visitors, and ward closure (CDC, 2008; Cheng et al., 2006; Harris et al., 2013; Illingworth et al., 2011; Kanerva et al., 2009; Vinnard, Lee, & Linkin, 2012; Wadl et al., 2010). Evidence suggests that patient cohorting into symptomatic, exposed asymptomatic, and unexposed symptomatic decreases outbreak duration and prevents secondary transmission (Cheng et al., 2006; Harris et al., 2013; Wadl et al., 2010). A modeling study demonstrated that proximity to symptomatic individuals could increase risk of infection (Harris et al., 2013). Guidelines recommend excluding ill staff for at least 48 hours after symptom resolution (MacCannell et al., 2011). Institutions that have excluded ill staff have demonstrated reduced risk of secondary transmission (CDC, 2008; Vinnard et al., 2012; Wadl et al., 2010). A recent study demonstrated that

symptomatic staff, not asymptomatic staff, was responsible for the majority of norovirus transmission (Sukhrie et al., 2012). Although costly (Lee et al., 2011; Said, Perl, & Sears, 2008), guidelines recommend closing wards or units to new admissions, transfers, and visitors. Studies demonstrate that ward or unit closures are effective means in controlling norovirus outbreaks (Harris et al., 2014; Illingworth et al., 2011; Kanerva et al., 2009), and may prevent further spread (Harris et al., 2013). Further, Illingworth et al., (2011) found that closing a single bay ward as opposed to the entire ward was more cost-effective as well as controlled outbreaks.

Food Safety in Healthcare Settings

In addition to the above infection control measures, foodborne outbreaks require other means to control and prevent norovirus outbreaks. Guidelines recommend discarding food exposed to norovirus, i.e., public vomiting event in a cafeteria or break room, as well as closing affected dining areas (MacCannell et al., 2011). Guidelines as well as regulatory recommendations include excluding ill staff for at least 48 hours after symptom resolution and avoiding contact with ready-to-eat foods (MacCannell et al., 2011; U.S., 2013). An abundance of evidence supports that when ill staff, especially those that handle food, are excluded from work both outbreak duration is reduced and secondary transmission is prevented (Greig, Lee, & Harris, 2011; Wadl et al., 2010). In addition, ensuring proper food preparation and storage, specifically temperature monitoring, demonstrated to be key aspects in preventing foodborne outbreaks (Greig et al., 2011).

Challenges to Infection Control Practices

Challenges to infection control practices are commonly reported as compliance issues and funding. Compliance, in particular hand hygiene, is widely reported with programs promoting intervention strategies to increase compliance (Allegranzi, Conway, Larson, & Pittet,

2014; Aragon, Sole, & Brown, 2005; Stevenson et al., 2014; Tschudin-Sutter, Pargger, & Widmer, 2010). WHO launched a campaign in 2009, which has increased hand hygiene compliance (Allegranzi et al., 2014). These studies also indicate that constant reminders are necessary for complete compliance and implementation of recommendations (Aragon et al., 2005; Stevenson et al., 2014).

The expense involved with implementing the recommendations within the CDC HICPAC guidelines is another challenge for healthcare institutions, which can lead to only implementing a few key recommendations (Fretz et al., 2009; Zingg, Colombo, Jucker, Bossart, & Ruef, 2005). Lee et al. (2011) examined the cost savings of implementing particular recommendations and found that key recommendations likely outweigh the expense. The authors evaluated six recommendations and compared the cost-savings of implementing each strategy individually, combinations of strategies, or no strategy during norovirus outbreaks. Their study determined that key strategies, i.e., increased hand hygiene, increased disinfection practices, use of protective apparel, or exclusion of ill staff, as well as the combination of these, prevent norovirus cases and provide cost-savings to healthcare institutions. In addition, they found that patient isolation and unit/ward closure could increase the costs involved with prevention and control of norovirus outbreaks (Lee et al., 2011), yet if these measures are imposed early (within 3 days of first case) the outbreak duration could decrease (CDC, 2011; Cheng et al., 2006; Harris et al., 2014; Said et al., 2008).

Summary

There is a need for comprehensive infection control measures to prevent and control norovirus outbreaks (Heijne et al., 2009; Said et al., 2008). Further, the sooner the initiation of infection control measures the sooner control of an outbreak can occur (Lopman et al., 2004;

Vinnard et al., 2012). Enhanced hand hygiene, PPE, and cleaning and disinfection, alone, or in conjunction, are the most cost-effective infection control measures (Lee et al., 2011).

Several countries compiled guidelines that highlight infection control measures supporting the reduction and prevention of norovirus outbreaks in healthcare facilities (CDNA, 2010; HPA et al., 2012; MacCannell et al., 2011). Although studies demonstrate that current infection control measures work in those particular outbreaks (Cheng et al., 2011; Davis et al., 2011; Heijne et al., 2009), the true effectiveness, i.e., decrease in outbreak duration, lower attack rates, and timely implementation, of these recommendations is still not certain (Harris et al., 2010). Controversies in recommendations, i.e., proper hand hygiene to prevent and control norovirus outbreaks, or closure of wards/units, may affect hospitals' decisions to implement recommendations. Many of these controversies exist due to the lack of high quality evidence in existing studies. The need for infection control practitioners to review their infection control strategies, as well as document their successes and failures, and develop randomized controlled trials with more rigorous statistical methods, will assist in refining guidelines.

It is not well understood the level of awareness of the CDC HICPAC guidelines or which recommendations, if any, have been implemented in healthcare institutions. Implementation barriers are present and can affect the implementation process for infection control practices of norovirus, but other than hand hygiene compliance, barriers to norovirus infection control practices are unknown.

Chapter 3: Methodology

Introduction

An online survey was distributed to Association for Professionals in Infection Control and Epidemiology (APIC) members in May 2014. The survey focused on three main areas: 1) knowledge of norovirus and the CDC HICPAC guidelines, 2) implementation of recommendations to prevent and control norovirus outbreaks, and 3) barriers encountered during the implementation process. APIC collected and anonymized survey responses, which then were used for analysis in this study. Descriptive analysis was performed on survey responses regarding general participant information. Univariate analysis was conducted to demonstrate associations among occupation, participant's facility type, and reporting an outbreak in comparison to survey responses. Qualitative assessment of the two free text responses was performed to examine responses for common themes.

Population and Sample

The main goal of this study was to determine the degree of implementation of CDC HICPAC guidelines in US healthcare institutions to control and prevent norovirus outbreaks. Therefore, the study population consisted of infection control professionals working in healthcare institutions throughout the US. The professional organization, APIC, has a membership of infection control professionals throughout the US. In addition, members of APIC are employed in varying professions, i.e., nurses, physicians, epidemiologists, and at differing healthcare institutions. With a current membership estimated at 14,000, APIC members were used as a convenient sample for the infection control professional population.

Research Design and Procedure

The survey tool included three sections (Appendix A). Prior to the first section, all participants were asked whether they consented to the survey. If they selected no, the survey ended. If they selected yes, they proceeded to the survey. The first section of the survey captured descriptive information regarding participant's occupation, facility type, and experience with norovirus outbreaks. The second part detailed their knowledge of norovirus, beliefs of infection control practices, awareness of CDC HICPAC guidelines and the CDC norovirus toolkit, and their effectiveness. If participants were not aware of the CDC HICPAC guidelines or CDC norovirus toolkit, they were prompted directly to the third section. The final section, included questions about selected recommendations. Participants were asked to select which recommendations their institution implemented, barriers to the implementation, and the most challenging recommendation to implement. The survey ended with two free text comment questions, which requested elaboration on challenges with the implementation process and feedback on the CDC HICPAC guidelines. In total, the survey tool consisted of 21 questions.

APIC distributed the survey using their electronic survey program. APIC recruited study participants through their membership email list by sending them a link to the online survey. The anonymous survey was open for three weeks (May 27, 2014 – June 17, 2014). In addition, to increase response rates, APIC sent a reminder email after two weeks.

Study participants who opened the survey link had an opportunity to consent to completing the survey or opt out of the survey. The survey and responses were voluntary, as study participants were allowed to skip questions they chose not to answer or close the survey without answering any further questions. The 21-question survey asked participants about their general opinion and knowledge of norovirus and the recommendations mentioned in the CDC

HICPAC guidelines. The survey included skip logic, as not all questions were relevant to everyone taking the survey.

APIC collected the survey data and tracked the number of participants that were sent the survey. In addition, they collected the number of participants that opened the survey, consented (or not) to participate in the survey, and completed the survey. APIC removed all potential identifiers, i.e., member or institute ID, which may have been associated with the data before sharing completed survey responses for data analysis in this study.

Data Analysis Plan

Survey responses were imported into R version 3.1.1 (http://www.r-project.org/) for data formatting, statistical analyses, and graphing/charting. Responses from survey participants were presented as frequencies and percentages to summarize participants' characteristics, beliefs and knowledge of norovirus and the CDC HICPAC guidelines, and opinions of prevention versus control. Main categories used in cross tabulations to determine initial associations with other survey variables were occupation (infection preventionist versus non-infection preventionist), participant facility type (hospital, LTCF, and all others), and experiencing a norovirus outbreak. Odds ratios and 95% confidence intervals were calculated and significance of association was demonstrated based on chi-square analysis.

Qualitative survey responses, such as the free text comments for elaborating issues with implementation (Question 20) and seeking feedback on improving infection control guidelines (Question 21), had key words and 2-worded phrases extracted and frequencies analyzed to determine themes using QDA Miner 4 and WordSTAT 6 (http://provalisresearch.com/). The responses were evaluated manually to determine context of the top 10 key words and phrases.

This was a secondary data analysis study utilizing data collected from APIC. APIC's review board approved the survey, which underwent pilot testing prior to distribution. Due to the nature of the study, Emory's institutional review board (IRB) granted the study exemption from IRB review (Appendix B).

Chapter 4: Results

Introduction

The knowledge, attitude, and practices of infection control professionals towards norovirus, infection control, and the implementation of the CDC HICPAC guidelines will assist in providing a better understanding of awareness and the potential for improved educational and training materials on norovirus prevention and control. This chapter reviews the results of the survey distributed to APIC members, and presents the analyses of associations between occupation, facility type, and experiencing a norovirus outbreak compared to selected survey questions.

Findings

APIC distributed the survey to its membership, which consists of 15,178 members. Of the 1111 (7.3%) members that consented to participating in the survey, 825 (74.3%) submitted responses to the survey. Total responses for each question vary, as there was no requirement for participants to complete every question. Each table and figure denotes the total responses utilized in the analyses. Characteristics of the participants are shown in Table 1. The majority identified themselves as infection preventionists (80%), worked in hospitals (74%), and worked in facilities of greater than 100 beds (63%) (Table 1). Forty-two percent (n=347) of participants reported that their facility experienced at least one norovirus outbreak in the past 5 years (Table 1), with 256 (74%) of these participants reporting that their facility experienced an outbreak within the past 3 years (Figure 1).

Table 1. Characteristics of survey participants

Participant characteristics	No. (%)
Occupation	**(n=825)**
Infection preventionist	659 (79.9)
Nurse	115 (13.9)
Other/Unknown	13 (1.6)
Quality assurance/quality control	12 (1.5)
Epidemiologist	9 (1.1)
Professional trainer on infectious disease control	7 (<1)
Laboratorian	5 (<1)
Physician	5 (<1)
Participants' facility type	**(n=825)**
Hospital	609 (73.8)
Long-term care facility	131 (15.9)
Outpatient facility	47 (5.7)
Ambulatory Surgery Center	11 (1.3)
Other/Unknown	11 (1.3)
Physician office	7 (<1)
Public Health Department	5 (<1)
Correctional Facility	2 (<1)
Urgent care facility	2 (<1)
Facility size	**(n=825)**
<10 beds	8 (1.0)
10-49 beds	161 (19.5)
50-99 beds	108 (13.1)
>100 beds	476 (57.7)
Unknown	72 (8.7)
Experienced at least 1 norovirus outbreak within the past 5 years	**(n=825)**
No	478 (58.0)
Yes	347 (42.0)

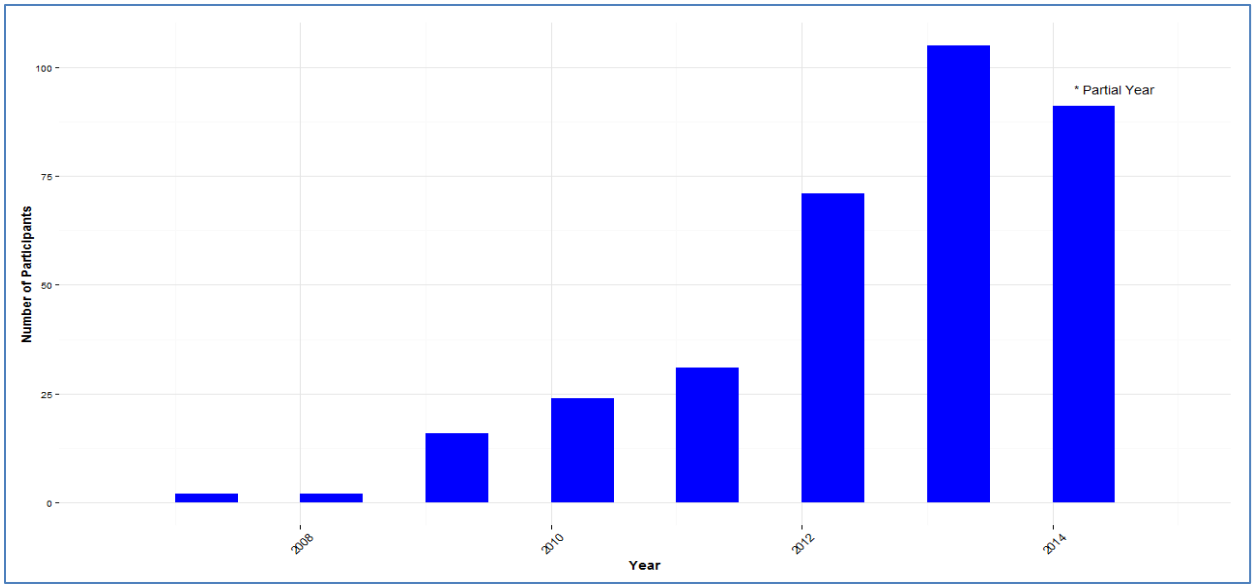

Figure 1. Number of participants reporting the most recent year a norovirus outbreak occurred (n=342)

* denotes partial year reporting for 2014 compared to previous years

Slightly more than one-third of survey participants believed healthcare facilities were the most common setting for norovirus outbreaks, while 25.8% believed cruise ships were the most common setting for norovirus outbreaks (Table 2). The majority of participants had the perception that norovirus is a moderate problem for healthcare facilities (52%), while 262 (32%) participants indicated that norovirus is a serious problem (Table 2). An almost equal proportion of participants have viewed (49.8%) versus not viewed (50.2%) the CDC norovirus prevention toolkit, whereas 768 (93.1%) participants were aware of the CDC HICPAC guidelines, with 603 (76.4%) of those participants having consulted the CDC HICPAC guidelines (Table 2). From the 411 participants that viewed the CDC norovirus prevention toolkit, 284 responded to whether the toolkit assisted them with the implementation of the CDC HICPAC guidelines. The majority (77.8%) of these participants somewhat to strongly agreed that the toolkit was useful in assisting with the implementation of the CDC HICPAC guidelines (Figure 2).

Table 2. Participants' beliefs and understanding of norovirus, the CDC norovirus prevention toolkit, and the CDC HICPAC guidelines

	No. (%)
Where do you believe most norovirus outbreaks occur?	**(n=818)**
Healthcare facilities	301 (36.8)
Cruise ships	211 (25.8)
Schools	108 (13.2)
Childcare facilities	107 (13.1)
Restaurants	64 (7.8)
Home	22 (2.7)
Correctional facilities	5 (<1)
To what extent is norovirus a problem for healthcare facilities?	**(n=819)**
Serious problem	262 (32.0)
Moderate problem	426 (52.0)
Minor problem	115 (14.0)
Not at all a problem	16 (2.0)
Have you ever seen the CDC norovirus prevention toolkit?	**(n=825)**
No	414 (50.2)
Yes	411 (49.8)
What is your level of awareness of the CDC HICPAC guidelines?	**(n=825)**
Have extensively consulted document	201 (24.4)
Have briefly consulted the document	429 (52.0)
Aware the document exists	138 (16.7)
Not aware	57 (6.9)

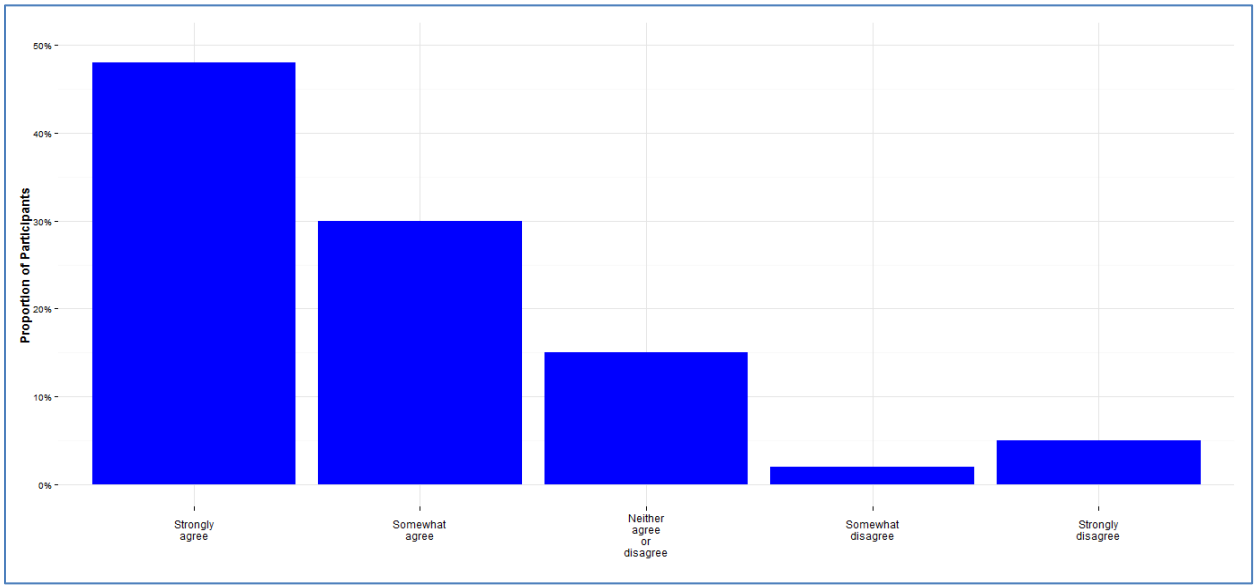

Figure 2. Proportion of participants reporting the extent that the norovirus toolkit assisted with the implementation of the CDC HICPAC guidelines (n=284)

The opinion of the participants demonstrated that infection control practices have a major impact on prevention (68.6%) and control (79.7%) of norovirus outbreaks (Table 3). Participants believed the CDC HICPAC guidelines were very effective at preventing (38%) and controlling (59.2%) norovirus outbreaks; however, the majority believed the CDC HICPAC guidelines were moderately effective at preventing (51%) norovirus outbreaks (Table 3).

Table 3. Participants' beliefs in the value of prevention and control of norovirus outbreaks

	Prevention (%)	Control (%)
Impact of norovirus infection control practices	**(n=816)**	**(n=818)**
Major impact	560 (68.6)	652 (79.7)
Moderate impact	212 (26.0)	148 (18.1)
Minor impact	43 (5.3)	17 (2.1)
No impact	1 (<1)	1 (<1)
Effectiveness of CDC HICPAC guidelines	**(n=758)**	**(n=759)**
Very effective	288 (38.0)	449 (59.2)
Moderately effective	387 (51.1)	278 (36.6)
Slightly effective	78 (10.3)	31 (4.1)
Not effective	5 (<1)	1 (<1)

Significant associations, discussed in detail below, were found between participants' facility type compared to experiencing a norovirus outbreak within the past 5 years, the extent norovirus is a problem, the impact of infection control practices on controlling norovirus, awareness of the CDC HICPAC guidelines, the effectiveness of the CDC HICPAC guidelines on controlling norovirus, and 12 selected recommendations. The extent that norovirus is a problem, the effectiveness of the CDC HICPAC guidelines on controlling norovirus, and four selected recommendations compared to occupation were significant. Associations observed among whether a facility experienced a norovirus outbreak within the past 5 years compared to the most common setting for norovirus outbreaks, extent norovirus is a problem, awareness of the CDC HICPAC guidelines, and 12 selected recommendations were significant. All other findings were found to be not significant.

The majority of LTCF-based participants (82.4%) were significantly (P<0.01) more likely to experience at least one norovirus outbreak within the past 5 years compared to 36.6% of hospital-based participants (Table 4). Participants from other facility types were significantly (P<0.01) less likely to experience a norovirus outbreak if they selected cruise ships (37.4%), childcare facilities (28%), or restaurants (28.1%) compared to participants that selected healthcare facilities (52.2%) (Table 4).

Table 4. Associations between experiencing at least one norovirus outbreak within the past 5 years and participants' facility type or belief of where the most norovirus outbreaks occur

	Experienced at least 1 norovirus outbreak within past 5 years		
	Yes (%)	**Odds Ratio (95% CI [a])**	**P-value (χ^2 test)**
Participants' facility type (n=819)			
Hospital (n=609)	223 (36.6)	1.00	
LTCF [b] (n=131)	108 (82.4)	8.06 (5.07-13.33)	<0.01*
Other [c] (n=79)	13 (16.5)	0.34 (0.18-0.62)	<0.01*
Where do you believe most norovirus outbreaks occur? (n=818)			
Healthcare facilities (n=301)	157 (52.2)	1.00	
Cruise ships (n=211)	79 (37.4)	0.55 (0.38-0.78)	<0.01*
Schools (n=108)	47 (43.5)	0.71 (0.45-1.10)	0.12
Childcare facilities (n=107)	30 (28.0)	0.36 (0.22-0.58)	<0.01*
Restaurants (n=64)	18 (28.1)	0.36 (0.20-0.64)	<0.01*
Other [d] (n=27)	13 (48.1)	0.85 (0.38-1.90)	0.69

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
[d:] Correctional facilities, Home
* Significant (<0.05)

The majority of LTCF-based participants (54.3%) were significantly (P<0.01) more likely to consider norovirus a serious problem in healthcare facilities, while 28% of participants that worked in hospitals believed that norovirus was a serious problem in healthcare facilities (Table 5). A higher proportion of non-infection preventionists (40.3%) compared to infection preventionists (30.7%) were significantly (P=0.02) more likely to believe norovirus was a serious

problem in healthcare facilities (Table 5). Participants that had experienced an outbreak within the past 5 years (36.9%) were significantly (P=0.02) more likely to feel that norovirus was a problem in healthcare facilities compared to participants that had not experienced an outbreak (29.4%) (Table 5).

Table 5. Associations between norovirus being a serious problem in healthcare facilities and participants' facility type, occupation, and experiencing at least one norovirus outbreak within the past 5 years

	Norovirus is a serious problem for healthcare facilities		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Participants' facility type (n=797)			
Hospital (n=593)	166 (28.0)	1.00	
LTCF [b] (n=127)	69 (54.3)	3.05 (2.06-4.54)	<0.01*
Other [c] (n=77)	25 (32.5)	1.24 (0.73-2.05)	0.41
Occupation (n=800)			
Infection preventionist (n=641)	197 (30.7)	1.00	
Non-infection preventionist [d] (n=159)	64 (40.3)	1.52 (1.06-2.17)	0.02*
Norovirus outbreak within past 5 years (n=803)			
Yes (n=344)	127 (36.9)	1.40 (1.04-1.89)	0.02*
No (n=459)	135 (29.4)	1.00	

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
[d] Epidemiologist, Laboratorian, Nurse, Other, Physician, Professional trainer on infectious disease control, Quality assurance/quality control
* Significant (<0.05)

Participants' opinion that infection control practices have a major impact on preventing norovirus outbreaks stratified by participants' facility type, occupation, and experiencing a norovirus outbreak within the past 5 years is shown in Table 6, whereas their opinion that infection control practices have a major impact on controlling norovirus outbreaks is shown in Table 7. There was no significance (P>0.05) among participants that believed infection control practices have a major impact on preventing norovirus outbreaks and worked in LTCF (65.1%) or other facility types (69.2%) compared to those that worked in hospitals (69.7%) (Table 6). Participants from other facility types (64.6%) were significantly (P<0.01) less likely to indicate

infection control practices have a major impact on controlling norovirus outbreaks compared to hospital-based participants (81.3%). There was no significance (P=0.66) between LTCF participants (82.9%) believing infection control practices have a major impact on controlling norovirus outbreaks compared to participants that worked in hospitals (81.3%) (Table 7). Non-infection preventionists (76.1%) were significantly (P=0.03) more likely to perceive that infection control practices have a major impact on preventing norovirus outbreaks compared to infection preventionists (67%) (Table 6). Whereas, there was no significance (P=0.1) with participants' perceptions that infection control practices have a major impact on controlling norovirus outbreaks if they were non-infection preventionists (75.2%) compared to infection preventionists (81%) (Table 7). Experiencing a norovirus outbreak (65.8%) compared to not experiencing a norovirus outbreak (70.7%) within the past 5 years was not significantly associated (P=0.14) with believing infection control practices have a major impact on preventing norovirus outbreaks (Table 6). However, believing infection control practices have a major impact on controlling norovirus outbreaks was significantly associated (P=0.02) with experiencing a norovirus outbreak (83.7%) compared to not experiencing a norovirus outbreak (76.8%) (Table 7).

Table 6. Associations between belief that infection control practices having a major impact on norovirus outbreak prevention and participants' facility type, occupation, and experiencing at least one norovirus outbreak within the past 5 years

	Infection control practices are a major impact on preventing norovirus		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Participants' facility type (n=810)			
Hospital (n=603)	420 (69.7)	1.00	
LTCF [b] (n=129)	84 (65.1)	0.81 (0.55-1.22)	0.31
Other [c] (n=78)	54 (69.2)	0.98 (0.59-1.66)	0.94

	Infection control practices are a major impact on preventing norovirus		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Occupation (n=813)			
Infection preventionist (n=654)	438 (67.0)	1.00	
Non-infection preventionist [d] (n=159)	121 (76.1)	1.57 (1.06-2.36)	0.03*
Norovirus outbreak within past 5 years (n=816)			
Yes (n=342)	225 (65.8)	0.80 (0.59-1.07)	0.14
No (n=474)	335 (70.7)	1.00	

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
[d] Epidemiologist, Laboratorian, Nurse, Other, Physician, Professional trainer on infectious disease control, Quality assurance/quality control
* Significant (<0.05)

Table 7. Associations between belief that infection control practices having a major impact on norovirus outbreak control and participants' facility type, occupation, and experiencing at least one norovirus outbreak within the past 5 years

	Infection control practices are a major impact on controlling norovirus		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Participants' facility type (n=812)			
Hospital (n=604)	491 (81.3)	1.00	
LTCF [b] (n=129)	107 (82.9)	1.11 (0.68-1.88)	0.66
Other [c] (n=79)	51 (64.6)	0.42 (0.25-0.70)	<0.01*
Occupation (n=815)			
Infection preventionist (n=654)	530 (81)	1.00	
Non-infection preventionist [d] (n=161)	121 (75.2)	0.71 (0.47-1.07)	0.10
Norovirus outbreak within past 5 years (n=818)			
Yes (n=343)	287 (83.7)	1.54 (1.08-2.22)	0.02*
No (n=475)	365 (76.8)	1.00	

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
[d] Epidemiologist, Laboratorian, Nurse, Other, Physician, Professional trainer on infectious disease control, Quality assurance/quality control
* Significant (<0.05)

Of the participants that worked in hospitals, 468 (76.8%) consulted the CDC HICPAC guidelines, while 108 (82.4%) participants from LTCF and 48 (60.8%) participants from other facility types consulted the CDC HICPAC guidelines. Participants from facilities other than hospitals and LTCF were significantly (<0.01) less likely to consult the CDC HICPAC guidelines compared to participants from hospitals (Table 8). Participants that experienced a

norovirus outbreak within the past 5 years (85.9%) were significantly (P<0.01) more likely to consult the CDC HICPAC guidelines compared to those that did not experience a norovirus outbreak (69.5%) (Table 8).

Table 8. Associations between consulting the CDC HICPAC guidelines and participants' facility type, occupation, and experiencing at least one norovirus outbreak within the past 5 years

	Consulted the CDC HICPAC Guideline		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Participants' facility type (n=819)			
Hospital (n=609)	468 (76.8)	1.00	
LTCF [b] (n=131)	108 (82.4)	1.41 (0.88-2.34)	0.16
Other [c] (n=79)	48 (60.8)	0.47 (0.29-0.77)	<0.01*
Occupation (n=822)			
Infection preventionist (n=659)	512 (77.7)	1.00	
Non-infection preventionist [d] (n=163)	117 (71.8)	0.73 (0.50-1.08)	0.11
Norovirus outbreak within past 5 years (n=825)			
Yes (n=347)	298 (85.9)	2.67 (1.87-3.85)	<0.01*
No (n=478)	332 (69.5)	1.00	

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
[d] Epidemiologist, Laboratorian, Nurse, Other, Physician, Professional trainer on infectious disease control, Quality assurance/quality control
* Significant (<0.05)

Participants' facility type, occupation, and reporting a norovirus outbreak within the past 5 years associated with their opinion on the effectiveness of the CDC HICPAC guidelines at preventing and controlling norovirus outbreaks are shown in Table 9 and Table 10, respectively. Believing the CDC HICPAC guidelines were very effective at preventing norovirus outbreaks was not significant among participants that worked in LTCF (33.3%) or other facility types (29.2%) compared to hospital-based participants (40.3%) (Table 9). However, participants in LTCF (53.4%) and other facility types (34.7%) were significantly (P=0.04 and P=<0.01) less likely to believe that the CDC HICPAC guidelines were very effective at controlling norovirus outbreaks than hospital-based participants (63.6%) (Table 10). Of the infection preventionists and non-infection preventionists, 236 (38.6%) and 52 (36.1%), respectively, believe the CDC

HICPAC guidelines were very effective at preventing norovirus outbreaks, while 382 (62.4%) infection preventionists and 67 (46.5%) non-infection preventionists consider the CDC HICPAC guidelines were very effective at controlling norovirus outbreaks. Participants' occupation was not significant (P=0.58) with believing the CDC HICPAC guidelines were very effective at preventing norovirus outbreaks (Table 9). However, non-infection preventionists were significantly (P<0.01) less likely to indicate the CDC HICPAC guidelines were very effective at controlling norovirus outbreaks (Table 10). Among participants that experienced a norovirus outbreak, 36.2% indicated that the CDC HICPAC guidelines were very effective at preventing norovirus outbreaks, while 62.2% indicated that the CDC HICPAC guidelines were very effective at controlling norovirus outbreaks. Experiencing a norovirus outbreak within the past 5 years was not significantly associated with believing the CDC HICPAC guidelines were very effective at preventing (P=0.39) or controlling (P=0.14) norovirus outbreaks compared to not experiencing a norovirus outbreak (Tables 9 and 10).

Table 9. Associations between the CDC HICPAC guidelines effectiveness on norovirus outbreak prevention and participants' facility type, occupation, and experiencing at least one norovirus outbreaks within the past 5 years

	CDC HICPAC guidelines are very effective for preventing norovirus		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Participants' facility type (n=752)			
Hospital (n=563)	227 (40.3)	1.00	
LTCF [b] (n=117)	39 (33.3)	0.74 (0.48-1.12)	0.16
Other [c] (n=72)	21 (29.2)	0.61 (0.35-1.03)	0.07
Occupation (n=755)			
Infection preventionist (n=611)	236 (38.6)	1.00	
Non-infection preventionist [d] (n=144)	52 (36.1)	0.90 (0.61-1.31)	0.58
Norovirus outbreak within past 5 years (n=758)			
Yes (n=323)	117 (36.2)	0.88 (0.65-1.18)	0.39
No (n=435)	171 (39.3)	1.00	

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
[d] Epidemiologist, Laboratorian, Nurse, Other, Physician, Professional trainer on infectious disease control, Quality assurance/quality control

Table 10. Associations between the CDC HICPAC guidelines effectiveness on norovirus outbreak control and participants' facility type, occupation, and experiencing at least one norovirus outbreak within the past 5 years

	CDC HICPAC guidelines are very effective for controlling norovirus		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Participants' facility type (n=753)			
Hospital (n=563)	358 (63.6)	1.00	
LTCF [b] (n=118)	63 (53.4)	0.66 (0.44-0.98)	0.04*
Other [c] (n=72)	25 (34.7)	0.31 (0.18-0.51)	<0.01*
Occupation (n=756)			
Infection preventionist (n=612)	382 (62.4)	1.00	
Non-infection preventionist [d] (n=144)	67 (46.5)	0.52 (0.36-0.76)	<0.01*
Norovirus outbreak within past 5 years (n=759)			
Yes (n=323)	201 (62.2)	1.25 (0.93-1.68)	0.14
No (n=436)	248 (56.9)	1.00	

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
[d] Epidemiologist, Laboratorian, Nurse, Other, Physician, Professional trainer on infectious disease control, Quality assurance/quality control
* Significant (<0.05)

Participants were asked to select which recommendations, from a selection of 12, were implemented in their institution. Among the 764 participants that indicated their facility implemented recommendations, 396 (51.8%) implemented at least eight recommendations. Further, 96 (12.6%) participants implemented all 12 recommendations, whereas 34 (4.5%) participants implemented one recommendation (Figure 3). The number one selected recommendation was active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks (n=670, 88%) (Figure 4). The next most frequently selected recommendations were increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks (565, 74%) and notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected (561, 73%). These were followed by exclusion of ill personnel from work for a

minimum of 48 hours after resolution of symptoms (560, 73%) and isolation of symptomatic patients for at least 48 hours after symptom resolution (556, 73%) (Figure 4).

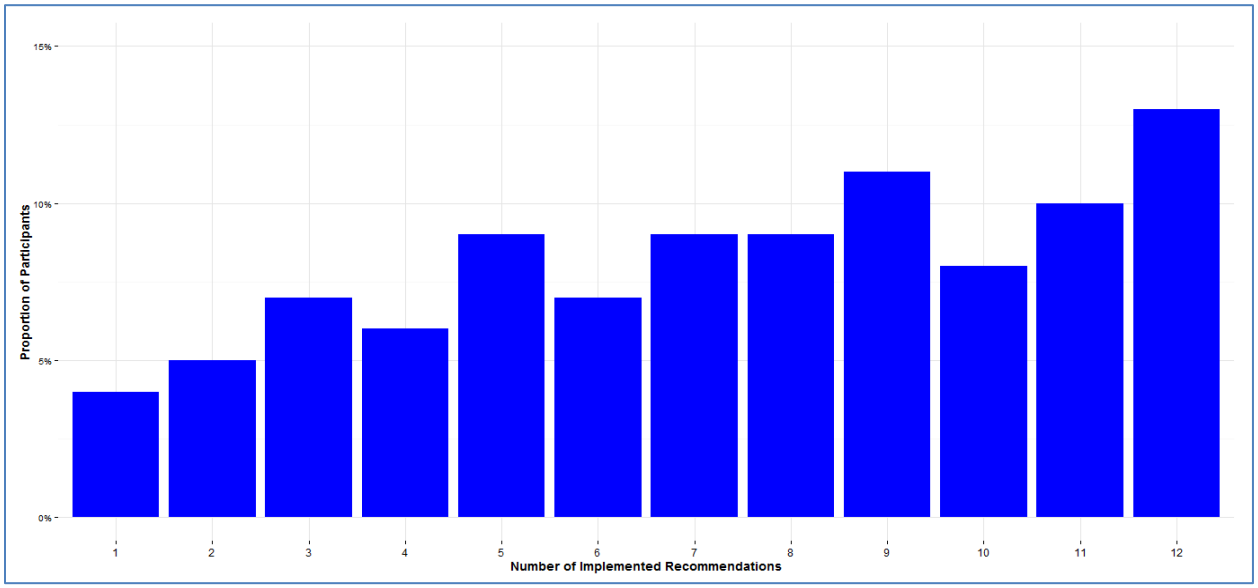

Figure 3. Proportion of participants that reported implementing only 1 through all 12 selected recommendations (n=764)

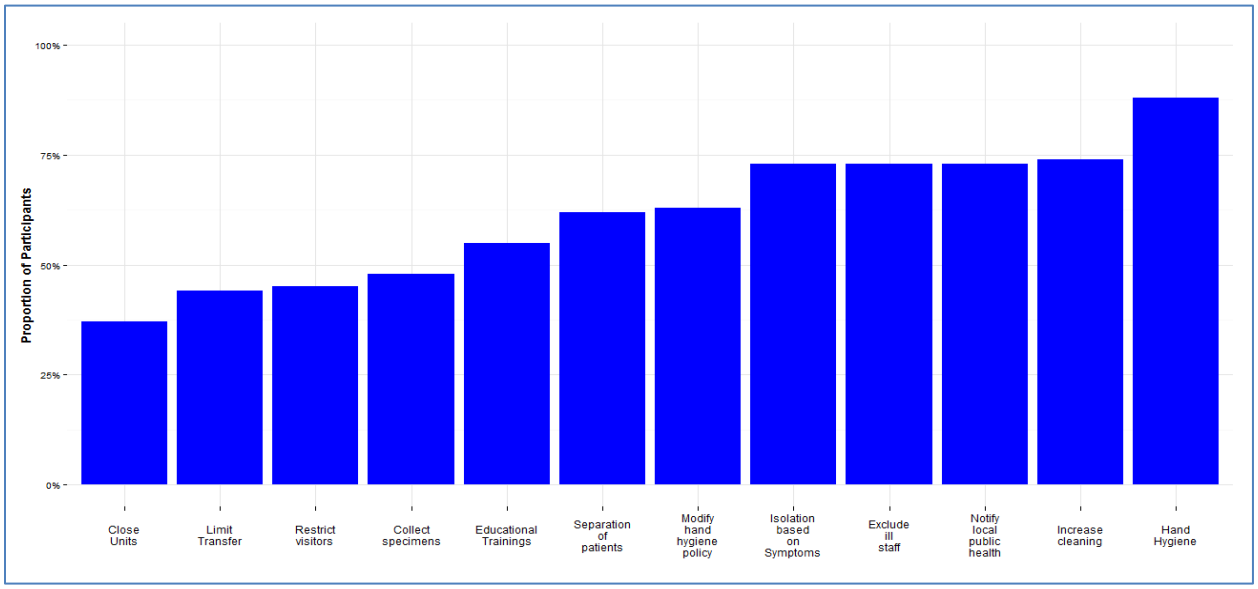

Figure 4. Proportion of participants that reported implementing selected recommendations from the CDC HICPAC guidelines (n=764).

Close Units: Closure of units or wards to new admissions or transfers during norovirus outbreaks; **Limit Transfer**: Designation of symptomatic patients prior to transferring within or between institutions; **Restrict Visitors**: Restriction of non-essential visitors from affected areas during norovirus outbreaks; **Collect Specimens**: Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing; **Educational Trainings**: Educational trainings and pamphlets for staff, patients, and visitors, during norovirus outbreaks; **Separation of Patients**: Separation of asymptomatic and symptomatic patients; **Modify Hand Hygiene Policy**: Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks; **Isolation Based on Symptoms**: Isolation of symptomatic patients for at least 48 hours after symptom resolution; **Exclude Ill Staff**: Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms; **Notify Local Public Health**: Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected; **Increase Cleaning**: Increase frequency of routine cleaning and disinfection of commonly

touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks **Hand Hygiene**: Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks

Implementation of selected recommendations was significantly associated with participants' facility type, with LTCF-based participants more likely to implement the recommendations compared to hospital-based participants (Table 11). Participants from other facility types were less likely to implement most recommendations compared to hospital-based participants (Table 11).

Table 11. Association between implementing selected recommendations and participants' facility type

	Implemented Recommendation		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks			
Participants' facility type (n=758)			
Hospital (n=559)	486 (86.9)	1.00	
LTCF [b] (n=128)	121 (94.5)	2.54 (1.22-6.26)	0.02*
Other [c] (n=71)	61 (85.9)	0.91 (0.46-1.96)	0.81
Closure of units or wards to new admissions or transfers during norovirus outbreaks			
Participants' facility type			
Hospital	170 (30.4)	1.00	
LTCF	98 (76.6)	7.43 (4.80-11.79)	<0.01*
Other	11 (15.5)	0.42 (0.21- 0.80)	<0.01*
Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing			
Participants' facility type			
Hospital	275 (49.2)	1.00	
LTCF	81 (63.3)	1.78 (1.20-2.66)	<0.01*
Other	11 (15.5)	0.19 (0.09-0.36)	<0.01*
Designation of symptomatic patients prior to transferring within or between institutions			
Participants' facility type			
Hospital	244 (43.6)	1.00	
LTCF	76 (59.4)	1.88 (1.28-2.80)	<0.01*
Other	11 (15.5)	0.24 (0.12-0.45)	<0.01*
Educational trainings and pamphlets for staff, patients, and visitors, during norovirus outbreaks			
Participants' facility type			
Hospital	281 (50.3)	1.00	
LTCF	95 (74.2)	2.84 (1.86-4.42)	<0.01*
Other	42 (59.2)	1.43 (0.87-2.38)	0.16

	Implemented Recommendation		
	Yes (%)	Odds ratio (95% CI [a])	P-value (χ^2 test)
Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms			
Participants' facility type			
Hospital	419 (75)	1.00	
LTCF	99 (77.3)	1.14 (0.73-1.82)	0.57
Other	39 (54.9)	0.41 (0.25-0.68)	<0.01*
Increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks			
Participants' facility type			
Hospital	402 (71.9)	1.00	
LTCF	115 (89.8)	3.42 (1.93-6.54)	<0.01*
Other	43 (60.6)	0.60 (0.36-1.01)	0.05
Isolation of symptomatic patients for at least 48 hours after symptom resolution			
Participants' facility type			
Hospital	429 (76.7)	1.00	
LTCF	108 (84.4)	1.63 (0.99-2.80)	0.06
Other	16 (22.5)	0.09 (0.05-0.16)	<0.01*
Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks			
Participants' facility type			
Hospital	360 (64.4)	1.00	
LTCF	90 (70.3)	1.31 (0.87-2.00)	0.20
Other	28 (39.4)	0.36 (0.22-0.60)	<0.01*
Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected			
Participants' facility type			
Hospital	408 (73)	1.00	
LTCF	111 (86.7)	2.40 (1.42-4.27)	<0.01*
Other	39 (54.9)	0.45 (0.27-0.75)	<0.01*
Restriction of non-essential visitors from affected areas during norovirus outbreaks			
Participants' facility type			
Hospital	235 (42)	1.00	
LTCF	88 (68.8)	3.02 (2.02-4.60)	<0.01*
Other	19 (26.8)	0.51 (0.28-0.87)	0.01*
Separation of asymptomatic and symptomatic patients			
Participants' facility type			
Hospital	355 (63.5)	1.00	
LTCF	89 (69.5)	1.31 (0.87-2.00)	0.20
Other	27 (38)	0.35 (0.21-0.59)	<0.01*

[a] CI: Confidence interval
[b] LTCF: Long-term care facility
[c] Ambulatory Surgery Center, Correctional Facility, Other, Outpatient facility, Physician office, Public Health Department, Urgent care facility
* Significant (<0.05)

Implementation of four recommendations was significantly associated with participants' occupation (Table 12). Non-infection preventionists were more likely to indicate that they implemented closure of units or wards (44.4%; P=0.03) compared to infection preventionists (35%). Designation of symptomatic patients (P=0.03), isolation of symptomatic patients (P<0.01), and modification of hand hygiene policy (P=0.02) were less likely to be implemented by non-infection preventionists (35.9%, 60.1%, and 54.9%, respectively) than infection preventionists (45.6%, 76.3%, and 65%, respectively) (Table 12).

Table 12. Association between implementing selected recommendations and participants' occupation

	Implemented Recommendation		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks			
Occupation (n=761)			
Infection preventionist (n=608)	534 (87.8)	1.00	
Non-infection preventionist [b] (n=153)	135 (88.2)	1.03 (0.61-1.84)	0.89
Closure of units or wards to new admissions or transfers during norovirus outbreaks			
Occupation			
Infection preventionist	213 (35)	1.00	
Non-infection preventionist	68 (44.4)	1.48 (1.03-2.13)	0.03*
Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing			
Occupation			
Infection preventionist	300 (49.3)	1.00	
Non-infection preventionist	68 (44.4)	0.82 (0.57-1.17)	0.28
Designation of symptomatic patients prior to transferring within or between institutions			
Occupation			
Infection preventionist	277 (45.6)	1.00	
Non-infection preventionist	55 (35.9)	0.67 (0.46-0.97)	0.03*
Educational trainings and pamphlets for staff, patients, and visitors, during norovirus outbreaks			
Occupation			
Infection preventionist	326 (53.6)	1.00	
Other	95 (62.1)	1.41 (0.99-2.04)	0.06

	Implemented Recommendation		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms			
Occupation			
Infection preventionist	455 (74.8)	1.00	
Non-infection preventionist	103 (67.3)	0.69 (0.47-1.02)	0.06
Increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks			
Occupation			
Infection preventionist	455 (74.8)	1.00	
Non-infection preventionist	108 (70.6)	0.81 (0.55-1.20)	0.28
Isolation of symptomatic patients for at least 48 hours after symptom resolution			
Occupation			
Infection preventionist	464 (76.3)	1.00	
Non-infection preventionist	92 (60.1)	0.47 (0.32-0.68)	<0.01*
Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks			
Occupation			
Infection preventionist	395 (65)	1.00	
Non-infection preventionist	84 (54.9)	0.66 (0.46-0.94)	0.02*
Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected			
Occupation			
Infection preventionist	450 (74)	1.00	
Non-infection preventionist	110 (71.9)	0.90 (0.61-1.34)	0.60
Restriction of non-essential visitors from affected areas during norovirus outbreaks			
Occupation			
Infection preventionist	263 (43.3)	1.00	
Non-infection preventionist	80 (52.3)	1.44 (1.00-2.05)	0.04
Separation of asymptomatic and symptomatic patients			
Occupation			
Infection preventionist	384 (63.2)	1.00	
Non-infection preventionist	89 (58.2)	0.81 (0.57-1.17)	0.26

[a] CI: Confidence interval
[b] Epidemiologist, Laboratorian, Nurse, Other, Physician, Professional trainer on infectious disease control, Quality assurance/quality control
* Significant (<0.05)

Participants that experienced a norovirus outbreak were significantly more likely to implement selected recommendations compared to those that had not experienced a norovirus outbreak (Table 13). Since the majority of these recommendations aim to control norovirus outbreaks as opposed to prevent norovirus outbreaks, a facility that has not experienced a

norovirus outbreak would not have exposure in controlling an outbreak and therefore may not have implemented or enforced the use of some of these recommendations.

Table 13. Association between implementing selected recommendations and experiencing at least one norovirus outbreak within the past 5 years

	Implemented Recommendation		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks			
Norovirus outbreak within past 5 years (n=764)			
Yes (n=345)	328 (95.1)	4.31 (2.55-7.69)	<0.01*
No (n=419)	342 (81.6)	1.00	
Closure of units or wards to new admissions or transfers during norovirus outbreaks			
Norovirus outbreak within past 5 years			
Yes	222 (64.3)	10.74 (7.60-15.37)	<0.01*
No	60 (14.3)	1.00	
Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing			
Norovirus outbreak within past 5 years			
Yes	225 (65.2)	3.57 (2.65-4.83)	<0.01*
No	144 (34.4)	1.00	
Designation of symptomatic patients prior to transferring within or between institutions			
Norovirus outbreak within past 5 years			
Yes	207 (60)	3.44 (2.55-4.66)	<0.01*
No	127 (30.3)	1.00	
Educational trainings and pamphlets for staff, patients, and visitors, during norovirus outbreaks			
Norovirus outbreak within past 5 years			
Yes	238 (69)	2.84 (2.10-3.83)	<0.01*
No	184 (43.9)	1.00	
Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms			
Norovirus outbreak within past 5 years			
Yes	297 (86.1)	3.66 (2.56-5.31)	<0.01*
No	263 (62.8)	1.00	
Increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks			
Norovirus outbreak within past 5 years			
Yes	316 (91.6)	7.39 (4.89-11.54)	<0.01*
No	249 (59.4)	1.00	

	Implemented Recommendation		
	Yes (%)	**Odds ratio (95% CI [a])**	**P-value (χ^2 test)**
Isolation of symptomatic patients for at least 48 hours after symptom resolution			
Norovirus outbreak within past 5 years			
Yes	295 (85.5)	3.56 (2.50-5.14)	<0.01*
No	261 (62.3)	1.00	
Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks			
Norovirus outbreak within past 5 years			
Yes	252 (73)	2.24 (1.66-3.06)	<0.01*
No	229 (54.7)	1.00	
Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected			
Norovirus outbreak within past 5 years			
Yes	304 (88.1)	4.65 (3.21-6.89)	<0.01*
No	257 (61.3)	1.00	
Restriction of non-essential visitors from affected areas during norovirus outbreaks			
Norovirus outbreak within past 5 years			
Yes	215 (62.3)	3.67 (2.72-4.97)	<0.01*
No	130 (31)	1.00	
Separation of asymptomatic and symptomatic patients			
Norovirus outbreak within past 5 years			
Yes	269 (78)	3.68 (2.69-5.09)	<0.01*
No	205 (48.9)	1.00	

[a] CI: Confidence interval
* Significant (<0.05)

Participants were asked to select the most common barrier to implementing the CDC HICPAC guidelines. These were determined to be poor compliance (206, 30%), personnel limitations (169, 25%), and other priorities and demands (156, 23%) (Figure 4). Participants were also asked to select the most challenging recommendation to implement. The top two most challenging recommendations were exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms (159, 22%) and closure of units or wards to new admissions or transfers during norovirus outbreaks (140, 19%) (Figure 5).

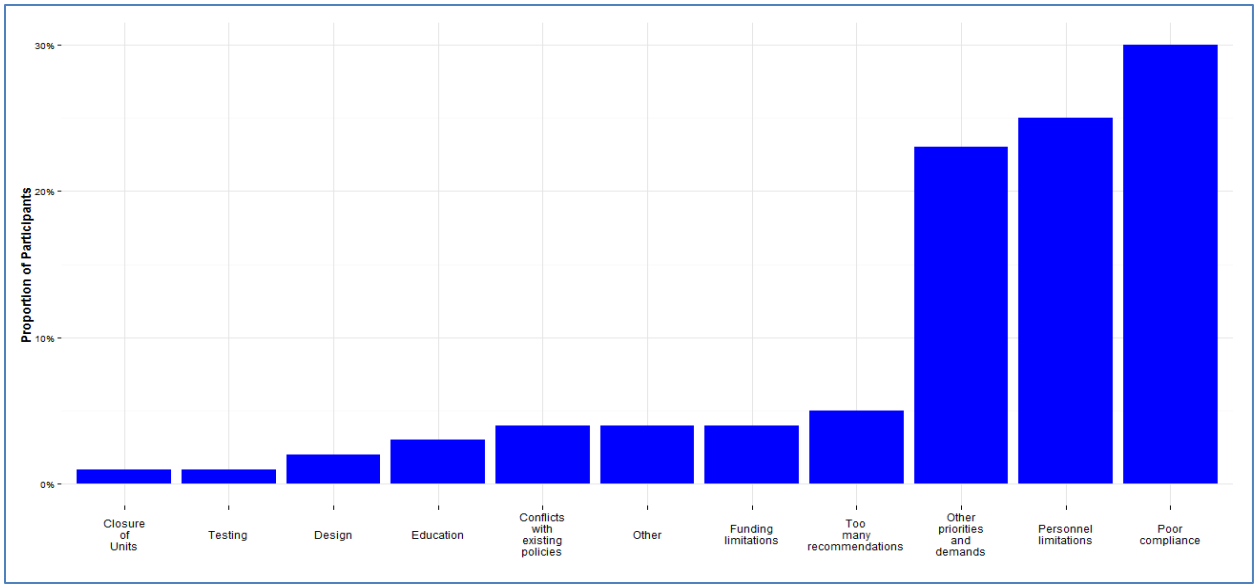

Figure 5. Proportion of participants reporting the most significant barrier to the implementation of selected recommendations (n=683)

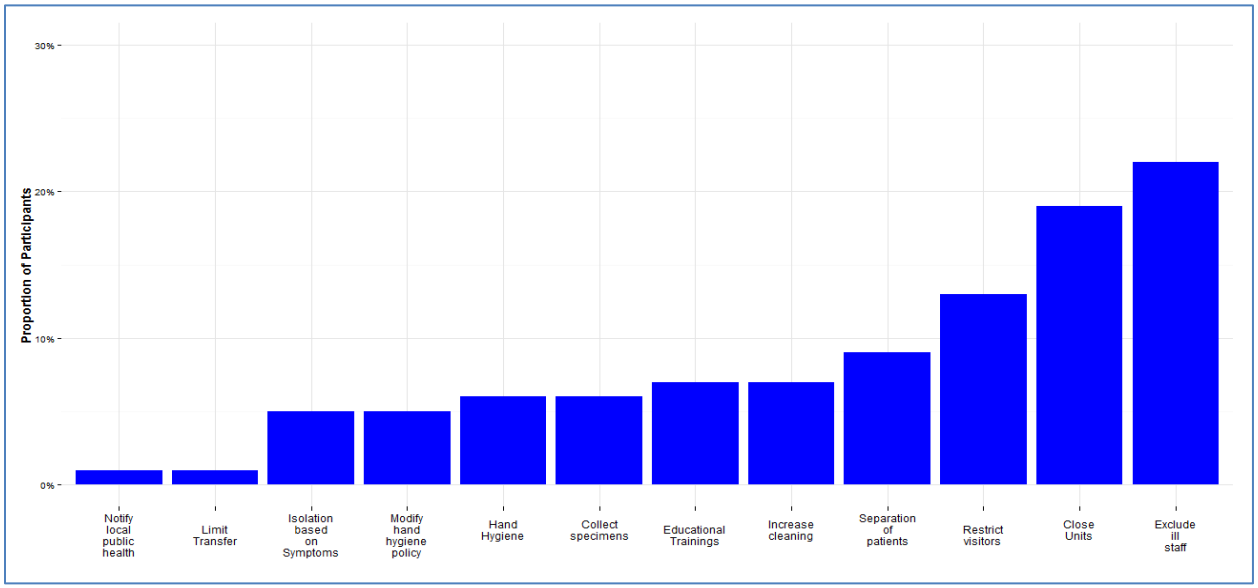

Figure 6. Proportion of participants reporting the most challenging recommendation to implement (n=726)

Notify Local Public Health: Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected; **Limit Transfer**: Designation of symptomatic patients prior to transferring within or between institutions; **Isolation Based on Symptoms**: Isolation of symptomatic patients for at least 48 hours after symptom resolution; **Modify Hand Hygiene Policy**: Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks; **Hand Hygiene**: Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks; **Collect Specimens**: Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing; **Educational Trainings**: Educational trainings and pamphlets for staff, patients, and visitors, during norovirus outbreaks; **Increase Cleaning**: Increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks; **Separation of Patients**: Separation of asymptomatic and symptomatic patients; **Restrict Visitors**: Restriction of non-essential visitors from affected areas during norovirus outbreaks; **Close Units**: Closure of units or wards to new admissions or transfers during norovirus outbreaks; **Exclude Ill Staff**: Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms;

Participants gave many reasons to why these were the most challenging recommendations. Across all reasons for selecting that a particular recommendation was the most challenging, there were several common themes. These themes included compliance to policies and/or recommendations by staff, patients, and visitors, lack of administration support, lack of resources (funds and time), floor and/or room design, space availability, and lack of education, knowledge, or awareness of norovirus.

Further breaking down the reasons by participants' chosen challenging recommendation, patterns that are more specific emerge. For example, exclusion of ill staff was the top reported challenging recommendation to implement. Common issues reported by participants that chose this recommendation were staff compliance; participants noted that employees come back to work as soon as they feel better, instead of waiting 48 hours after symptom resolution. Other participants mentioned that employees do not want to use up their time off, so they do not report symptoms and come to work. Additionally, some places have policies that do not allow employees to disclose their symptoms when they call in sick due to privacy laws. There were also mixed thoughts on time off policies. Some participants mentioned that employees do not receive any time off, whereas others mentioned that employees abuse the time off policy. Other common issues were a lack of administration support for employees to stay home while sick as well as lack of education of staff, noting that some do not understand the difference between being symptom free versus infectious free.

Participants had an opportunity to add other comments that may contribute to better understanding the implementation process of the CDC HICPAC guidelines in their institution as well as suggest improvements in the CDC HICPAC guidelines. Several mentioned that the CDC HICPAC guidelines were useful and addressed their needs, while others mentioned that they had

not read them but intend to do so now that they are aware of them. Many participants mentioned wanting a better understanding of how to implement prevention and control measures in certain patient populations, i.e., mental and behavioral health, that appear to be difficult to contain. For example, patients with limited mental capacity do not understand being confined to their room when they have symptoms, and many behavioral health institutions rely on group therapy sessions, indicating that limiting these can affect patient outcomes.

Summary

The majority of participants have consulted the CDC HICPAC guidelines and implemented at least one recommendation listed in the guidelines. The majority of participants believe infection control practices have a major impact on preventing and controlling norovirus outbreaks, whereas most of the participants believe the CDC HICPAC guidelines are moderately effective at preventing and very effective at controlling norovirus outbreaks. Prevention of norovirus outbreaks using infection control practices is significantly associated with non-infection preventionists compared to infection preventionists. Control of norovirus outbreaks using infection control practices is significantly associated with participants' from other facility types compared to hospital-based participants and experiencing a norovirus outbreak, whereas using the CDC HICPAC guidelines to control norovirus outbreaks is significantly associated with LTCF-based participants and participants from other facility types compared to hospital-based participants and non-infection preventionists compared to infection preventionists.

Among participants, 96 (13%) reportedly implemented all 12 selected recommendations. There were more implemented recommendations significantly associated with reporting an outbreak (n=12) or facility type (n= 12) than occupation (n=4). More than 80% of participants implemented active promotion of hand hygiene adherence among healthcare staff, patients, and

visitors in areas affected by norovirus outbreaks, whereas less than 40% implemented closure of units or wards to new admissions or transfers during norovirus outbreaks, which was noted as one of the most challenging to implement. Barriers, such as, poor compliance and personnel limitations, are the most common implementation issues reported by participants.

Chapter 5: Discussion

Introduction

This chapter provides a summary of the study, discusses the findings and conclusions of this project as they relate to the current understanding of norovirus infection control, and provides recommendations to help direct similar studies and guide public health education and trainings for norovirus and infection control practices.

Summary of Study

Slightly less than half of the participants (42%) reported having at least one outbreak within the past 5 years. The majority of LTCF-based participants (85.4%) reported to have experienced a norovirus outbreak with a significantly ($P<0.01$) higher likelihood than hospital-based participants (36.6%). The proportion of norovirus outbreaks from LTCF-based participants are similar to recent surveillance reports, which indicate LTCF have more than 60% of outbreaks compared to 4% in hospitals (Vega et al., 2014). A recent hospital-based investigational study indicated norovirus as the causative agent for 18% of all outbreaks and found that hospitals reported only half of all investigated outbreaks to external agencies (Rhinehart et al., 2012), indicating an under-reporting of outbreaks. As the survey in this study was anonymous, participants may be more forthcoming with reporting that their facility experienced a norovirus outbreak than officially reporting to a local public health agency, which may explain the higher proportion of norovirus outbreaks in hospitals in this study compared to previous studies (Vega et al., 2014).

Norovirus outbreaks most commonly occur in healthcare facilities (49-63%), restaurants (10-15%), and schools (5-7%) (Hall, Wikswo, et al., 2013; Vega et al., 2014). Less than half (36.8%) of the study participants accurately identified healthcare facilities as the most common

setting. Cruise ship (25.8%) was selected as the second most common setting for norovirus outbreaks, which according to Vega et al. (2014) accounts for 3% of reported outbreaks. Participants were more likely to chose healthcare facilities if their facility had experienced a norovirus outbreak. This indicates a knowledge gap in norovirus education, in particular, for facilities that have not experienced a norovirus outbreak.

Overall, 688 (84%) participants indicated that norovirus is a moderate to serious problem in healthcare facilities. Their opinion supports that norovirus is the number one cause of acute gastroenteritis outbreaks in the US and affects healthcare facilities disproportionately (Glass et al., 2009; Hall, Wikswo, et al., 2013; Vega et al., 2014). LTCF-based participants were 3 times more likely to believe norovirus is a serious problem in healthcare facilities. Since most healthcare facility outbreaks are reported from LTCF (Vega et al., 2014), participants from LTCF may have an overexposure to norovirus outbreaks, corresponding to the higher degree of seriousness.

Many recommendations that exist primarily aim to prevent norovirus outbreaks, i.e., active hand hygiene and exclusion of ill personnel, whereas other recommendations focus on controlling norovirus outbreaks, i.e., unit/ward closures, isolation and restriction of symptomatic patients. The results from the survey suggest that infection control practices and the CDC HICPAC guidelines control norovirus outbreaks more than prevent them, with the majority of participants indicating infection control practices control (80%) compared to prevent (69%) and that CDC HICPAC guidelines control (59%) compared to prevent (38%) norovirus outbreaks. Further, hospital-based participants were more likely to indicate that infection control practices had a major impact on controlling norovirus outbreaks and that controlling outbreaks was more effective with the CDC HICPAC guidelines. This finding is consistent with previous studies that

focus on implementing control measures once an outbreak occurs in order to shorten the outbreak duration (Cheng et al., 2011; Heijne et al., 2009; Illingworth et al., 2011). However, the findings contradict a study by Harris et al. (2010), which indicates control measures do not significantly affect outbreak outcomes, i.e., duration and attack rate; although they suggest there is a lack of sufficient evidence in their analyzed studies to support outcomes of infection control measures. Further, current studies appear to focus on control only or prevention and control, which may skew the perception of preventing norovirus outbreaks with appropriate actions. This distinction found between prevention and control of outbreaks suggests that trainings, education, and future studies should focus on recommendations that prevent norovirus outbreaks, such as hand hygiene and cleaning and disinfection procedures.

The study demonstrates that the majority (93%) of participants are aware of the CDC HICPAC guidelines, with 24% of participants extensively consulting the document. The CDC created the norovirus prevention toolkit to assist facilities with the implementation of the CDC HICPAC guidelines (CDC, 2013). However, this study found that only half of the participants were aware of the norovirus prevention toolkit. Since 75% of those participants that utilized the norovirus prevention toolkit agreed that the toolkit assisted them in the implementation of the CDC HICPAC guidelines, there appears to be a knowledge gap in the purpose and use of the toolkit.

A recent study focusing on hand hygiene implementation in US hospitals found that more than 90% of surveyed facilities had an appropriate and/or optimal hand hygiene program based on the World Health Organization's hand hygiene strategy (Allegranzi et al., 2014). This may explain the high proportion (~90%) of participants that implemented active promotion of hand hygiene policies as well as the 60% that implemented modified hand hygiene policies.

Participants selected closure of units (~35%) as the least implemented recommendation, which is similar to the findings of a US hospital-based study indicating that facilities reported closing units in 23% of all outbreaks (Rhinehart et al., 2012). Rhinehart et al. (2012) also found the majority (85%) of hospitals utilized enhanced environmental cleaning as a control measure when an outbreak occurred. Similarly, the implementation rate in this study found increased cleaning and disinfection policies to be ~70%.

LTCF-based participants were significantly more likely to implement selected recommendations compared to hospitals. Further, participants reporting an outbreak were significantly more likely to implement selected recommendations. Since LTCF-based participants were also significantly more likely to report a recent outbreak, a question arises as to whether the implementation of a recommendation occurs due to the proactive infection control efforts of the facility or experiencing an outbreak, which requires the use of multivariate analyses that are outside the scope of the current project.

This study found that the majority of participants indicated visitor restrictions, closure of units, and excluding ill staff were the most challenging recommendation to implement. Participants reported poor compliance and personnel limitations as the most likely barriers to implementation, which could relate to the most challenging selected recommendations to implement. These findings are consistent with current literature, which suggests poor compliance, typically adherence to recommendations, i.e., hand hygiene, affects the implementation of infection control practices (Aragon et al., 2005; Stevenson et al., 2014).

Limitations and Delimitations

This study contains several forms of sample bias. First, the study utilizes responses from APIC members, as it is comprised mainly of infection control professionals. However, the

members are a sample of convenience, and are not necessarily representative of all infection control professionals. Second, although the study included information on participants' facility, the survey collected data at an individual level. Therefore, it is possible that multiple individuals from the same institution completed the survey, causing an oversampling that could affect the analysis. The latter point is also a limitation in the study design. In order to ensure no identifiers, i.e., personal or institutional, were captured, the study design focused on an anonymous, individual level survey in lieu of a facility-based survey.

The potential for social desirability bias exists in this study as well. A majority of participants indicated that they were aware of CDC HICPAC guidelines, which could be an over-exaggeration as infection control practitioners may be embarrassed to admit they had no knowledge of the CDC HICAPC guidelines. Further, the survey contained a link to both the CDC HICPAC guidelines and the norovirus prevention toolkit, as a means to promote and improve their knowledge. This may have contributed to the large proportion of participants that were aware of the CDC HICPAC guidelines. However, if that is the case, then the awareness of the norovirus prevention toolkit may be considerably less than reported.

The survey response rate for this study was low (5.4%). The survey distribution coincided with the APIC annual conference, which may have affected the response rate. Additionally, survey fatigue could have an effect on the response rate since APIC members are utilized quite frequently for surveys. However, response rates from other surveys that utilize similar populations, i.e., APIC members, have comparable response rates (Allegranzi et al., 2014; Kosa et al., 2014; Rhinehart et al., 2012), suggesting this is a typical response rate.

Improvement of the survey tool could better elicit responses and analysis of results. For example, skip logic directed respondents that selected "Other" as a facility to question 2 to

complete the number of beds their institution contained. Some facilities, such as public health departments, should have been exempt from completing this question. To alleviate confusion in responses, a "Not Applicable" response should have been included. In addition, questions 17 and 19 make certain assumptions that a facility only implemented the listed recommendations. Including a "None" and "Other (fill in the blank)" responses for these questions could remove those assumptions.

Conclusion

A key finding in this study was that approximately 1/3 of participants believed that healthcare facilities were the most common setting for norovirus outbreaks. Additionally, 30% consider norovirus a serious problem in healthcare facilities. The majority of participants are knowledgeable of the CDC HICPAC guidelines, but only 50% are aware of the norovirus prevention toolkit. Further, the norovirus toolkit assisted 78% of the participants that used it with implementing recommendations.

This study demonstrates that implementation of the CDC HICPAC guidelines is widespread, in particular in facilities with recent outbreak experience. However, the degree of implementation varies; slightly more than 50% of participants implemented at least eight recommendations. The most frequently implemented recommendations were active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks and increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks. The most challenging recommendations to implement were exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms and closure of units or wards to new admissions or transfers during norovirus outbreaks, which could relate to the most

frequently selected barriers to implementing recommendations, poor compliance and personnel limitations.

Recommendations

This study found gaps in norovirus knowledge among participants, which indicates a need for additional education and training. An outreach program that provides training opportunities as well as promotion of the norovirus toolkit would benefit healthcare workers with the implementation process as well as improve their understanding of norovirus. As these participants belong to a national organization, working with APIC to develop training materials and/or courses focusing on norovirus and infection control practices may provide a means of dissemination to APIC members and supplemental use at local and state public health departments.

The participants' have a perception that the CDC HICPAC guidelines are more effective at controlling than preventing norovirus outbreaks. In order to provide a more directed training at participants' needs, a better understanding of the reasons that this perception exists, i.e., implementation issues, educational gaps, understanding differences between prevention and control, or a combination of reasons, is necessary. Future studies should capture distinct association(s).

Additional studies that focus on the implementation barriers and approaches to avoid and/or reduce these barriers may improve the implementation process. Future studies should evaluate whether closure of wards or exclusion of ill staff, which were shown to be implemented less frequently as well as the most challenging to implement, are effective at preventing and controlling norovirus outbreaks. Results from such studies would enhance future recommendations.

References

Allegranzi, B., Conway, L., Larson, E., & Pittet, D. (2014). Status of the implementation of the World Health Organization multimodal hand hygiene strategy in United States of America health care facilities. *Am J Infect Control, 42*(3), 224-230. doi: 10.1016/j.ajic.2013.11.015

Aragon, D., Sole, M. L., & Brown, S. (2005). Outcomes of an infection prevention project focusing on hand hygiene and isolation practices. *AACN Clin Issues, 16*(2), 121-132.

Atmar, R. L., Opekun, A. R., Gilger, M. A., Estes, M. K., Crawford, S. E., Neill, F. H., & Graham, D. Y. (2008). Norwalk virus shedding after experimental human infection. *Emerg Infect Dis, 14*(10), 1553-1557. doi: 10.3201/eid1410.080117

Barker, J., Vipond, I. B., & Bloomfield, S. F. (2004). Effects of cleaning and disinfection in reducing the spread of Norovirus contamination via environmental surfaces. *J Hosp Infect, 58*(1), 42-49. doi: 10.1016/j.jhin.2004.04.021

Berry, F. S., & Berry, W. D. (2007). Innovation and Diffusion Models in Policy Research. In P. A. Sabatier (Ed.), *Theories of the Policy Process* (2 ed., pp. 223-260). Boulder, Colorado: Westview Press.

Bitler, E. J., Matthews, J. E., Dickey, B. W., Eisenberg, J. N., & Leon, J. S. (2013). Norovirus outbreaks: a systematic review of commonly implicated transmission routes and vehicles. *Epidemiol Infect, 141*(8), 1563-1571. doi: 10.1017/S095026881300006X

Blaney, D. D., Daly, E. R., Kirkland, K. B., Tongren, J. E., Kelso, P. T., & Talbot, E. A. (2011). Use of alcohol-based hand sanitizers as a risk factor for norovirus outbreaks in long-term care facilities in northern New England: December 2006 to March 2007. *Am J Infect Control, 39*(4), 296-301. doi: 10.1016/j.ajic.2010.10.010

Bolton, S. L., Kotwal, G., Harrison, M. A., Law, S. E., Harrison, J. A., & Cannon, J. L. (2013). Sanitizer efficacy against murine norovirus, a surrogate for human norovirus, on stainless steel surfaces when using three application methods. *Appl Environ Microbiol, 79*(4), 1368-1377. doi: 10.1128/aem.02843-12

Cannon, J. L., Papafragkou, E., Park, G. W., Osborne, J., Jaykus, L. A., & Vinje, J. (2006). Surrogates for the study of norovirus stability and inactivation in the environment: A comparison of murine norovirus and feline calicivirus. *J Food Prot, 69*(11), 2761-2765.

CDC. (2008). Norovirus outbreak in an elementary school--District of Columbia, February 2007. *MMWR Morb Mortal Wkly Rep, 56*(51-52), 1340-1343.

CDC. (2011). Updated norovirus outbreak management and disease prevention guidelines. *MMWR Recomm Rep, 60*(Rr-3), 1-18.

CDC. (2013). Norovirus in Healthcare Settings. Retrieved November 7, 2014, from http://www.cdc.gov/HAI/organisms/norovirus.html#a4

CDNA. (2010). *Guidelines for the public health management of gastroenteritis outbreaks due to norovirus or suspected viral agents in Australia* Retrieved from https://www.health.gov.au/internet/main/publishing.nsf/Content/cda-cdna-norovirus.htm/$File/norovirus-guidelines.pdf

Cheesbrough, J. S., Barkess-Jones, L., & Brown, D. W. (1997). Possible prolonged environmental survival of small round structured viruses. *J Hosp Infect, 35*(4), 325-326.

Cheng, F. W., Leung, T. F., Lai, R. W., Chan, P. K., Hon, E. K., & Ng, P. C. (2006). Rapid control of norovirus gastroenteritis outbreak in an acute paediatric ward. *Acta Paediatr, 95*(5), 581-586. doi: 10.1080/08035250500449874

Cheng, V. C., Wong, L. M., Tai, J. W., Chan, J. F., To, K. K., Li, I. W., . . . Yuen, K. Y. (2011). Prevention of nosocomial transmission of norovirus by strategic infection control measures. *Infect Control Hosp Epidemiol, 32*(3), 229-237. doi: 10.1086/658330

Connolly, M. A. (Ed.). (2005). *Communicable disease control in emergencies : a field manual*. Geneva, Switzerland: World Health Organization.

D'Souza, D. H., Sair, A., Williams, K., Papafragkou, E., Jean, J., Moore, C., & Jaykus, L. (2006). Persistence of caliciviruses on environmental surfaces and their transfer to food. *Int J Food Microbiol, 108*(1), 84-91. doi: 10.1016/j.ijfoodmicro.2005.10.024

Danial, J., Cepeda, J. A., Cameron, F., Cloy, K., Wishart, D., & Templeton, K. E. (2011). Epidemiology and costs associated with norovirus outbreaks in NHS Lothian, Scotland 2007-2009. *J Hosp Infect, 79*(4), 354-358. doi: 10.1016/j.jhin.2011.06.018

Davis, C. A., Vally, H., & Beard, F. H. (2011). Norovirus in residential care facilities: does prompt notification of outbreaks help? *Commun Dis Intell Q Rep, 35*(2), 162-167.

Desai, R., Hembree, C. D., Handel, A., Matthews, J. E., Dickey, B. W., McDonald, S., . . . Lopman, B. (2012). Severe outcomes are associated with genogroup 2 genotype 4 norovirus outbreaks: a systematic literature review. *Clin Infect Dis, 55*(2), 189-193. doi: 10.1093/cid/cis372

Dicaprio, E., Ma, Y., Hughes, J., & Li, J. (2013). Epidemiology, prevention, and control of the number one foodborne illness: human norovirus. *Infect Dis Clin North Am, 27*(3), 651-674. doi: 10.1016/j.idc.2013.05.009

Donaldson, E. F., Lindesmith, L. C., Lobue, A. D., & Baric, R. S. (2008). Norovirus pathogenesis: mechanisms of persistence and immune evasion in human populations. *Immunol Rev, 225*, 190-211. doi: 10.1111/j.1600-065X.2008.00680.x

EPA. (2009). List G: EPA's Registered Antimicrobial Products Effective Against Norovirus (Norwalk-like virus). 2013, from http://www.epa.gov/oppad001/list_g_norovirus.pdf

Feliciano, L., Li, J., Lee, J., & Pascall, M. A. (2012). Efficacies of sodium hypochlorite and quaternary ammonium sanitizers for reduction of norovirus and selected bacteria during ware-washing operations. *PLoS One, 7*(12), e50273. doi: 10.1371/journal.pone.0050273

Fretz, R., Schmid, D., Jelovcan, S., Tschertou, R., Krassnitzer, E., Schirmer, M., . . . Allerberger, F. (2009). An outbreak of norovirus gastroenteritis in an Austrian hospital, winter 2006-2007. *Wien Klin Wochenschr, 121*(3-4), 137-143. doi: 10.1007/s00508-008-1135-x

Gastanaduy, P. A., Hall, A. J., Curns, A. T., Parashar, U. D., & Lopman, B. A. (2013). Burden of norovirus gastroenteritis in the ambulatory setting--United States, 2001-2009. *J Infect Dis, 207*(7), 1058-1065. doi: 10.1093/infdis/jis942

Girard, M., Ngazoa, S., Mattison, K., & Jean, J. (2010). Attachment of noroviruses to stainless steel and their inactivation, using household disinfectants. *J Food Prot, 73*(2), 400-404.

Glass, R. I., Parashar, U. D., & Estes, M. K. (2009). Norovirus gastroenteritis. *N Engl J Med, 361*(18), 1776-1785. doi: 10.1056/NEJMra0804575

Green, K. (2013). Caliciviridae: The Noroviruses. In D. M. Knipe & P. M. Howley (Eds.), *Fields Virology* (6 ed., Vol. 1). Philadelphia, PA: Lippincott Williams & Wilkins.

Green, K. Y. (2014). Norovirus infection in immunocompromised hosts. *Clin Microbiol Infect, 20*(8), 717-723. doi: 10.1111/1469-0691.12761

Greig, J. D., Lee, M. B., & Harris, J. E. (2011). Review of enteric outbreaks in prisons: effective infection control interventions. *Public Health, 125*(4), 222-228. doi: 10.1016/j.puhe.2010.12.006

Hall, A. J., Lopman, B. A., Payne, D. C., Patel, M. M., Gastanaduy, P. A., Vinje, J., & Parashar, U. D. (2013). Norovirus disease in the United States. *Emerg Infect Dis, 19*(8), 1198-1205. doi: 10.3201/eid1908.130465

Hall, A. J., Rosenthal, M., Gregoricus, N., Greene, S. A., Ferguson, J., Henao, O. L., . . . Widdowson, M. A. (2011). Incidence of acute gastroenteritis and role of norovirus, Georgia, USA, 2004-2005. *Emerg Infect Dis, 17*(8), 1381-1388. doi: 10.3201/eid1708.101533

Hall, A. J., Wikswo, M. E., Manikonda, K., Roberts, V. A., Yoder, J. S., & Gould, L. H. (2013). Acute gastroenteritis surveillance through the National Outbreak Reporting System, United States. *Emerg Infect Dis, 19*(8), 1305-1309. doi: 10.3201/eid1908.130482

Hall, A. J., Wikswo, M. E., Pringle, K., Gould, L. H., Parashar, U. D., Division of Viral Diseases, N. C. f. I., & Respiratory Diseases, C. D. C. (2014). Vital signs: foodborne norovirus outbreaks - United States, 2009-2012. *MMWR Morb Mortal Wkly Rep, 63*(22), 491-495.

Harris, J. P., Adak, G. K., & O'Brien, S. J. (2014). To close or not to close? Analysis of 4 year's data from national surveillance of norovirus outbreaks in hospitals in England. *BMJ Open, 4*(1), e003919. doi: 10.1136/bmjopen-2013-003919

Harris, J. P., Lopman, B. A., Cooper, B. S., & O'Brien, S. J. (2013). Does spatial proximity drive norovirus transmission during outbreaks in hospitals? *BMJ Open, 3*(7). doi: 10.1136/bmjopen-2013-003060

Harris, J. P., Lopman, B. A., & O'Brien, S. J. (2010). Infection control measures for norovirus: a systematic review of outbreaks in semi-enclosed settings. *J Hosp Infect, 74*(1), 1-9. doi: 10.1016/j.jhin.2009.07.025

Heijne, J. C., Teunis, P., Morroy, G., Wijkmans, C., Oostveen, S., Duizer, E., . . . Wallinga, J. (2009). Enhanced hygiene measures and norovirus transmission during an outbreak. *Emerg Infect Dis, 15*(1), 24-30. doi: 10.3201/eid1501.080299

Hoffmann, S., Batz, M. B., & Morris, J. G., Jr. (2012). Annual cost of illness and quality-adjusted life year losses in the United States due to 14 foodborne pathogens. *J Food Prot, 75*(7), 1292-1302. doi: 10.4315/0362-028x.jfp-11-417

HPA, British, I. A., Healthcare, I. S., Infection, P. S., National, C. f. H. I., & National, H. S. C. (2012). *Guidelines for the management of norovirus outbreaks in acute and community health and social care settings* Retrieved from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317131639453

Huhti, L., Szakal, E. D., Puustinen, L., Salminen, M., Huhtala, H., Valve, O., . . . Vesikari, T. (2011). Norovirus GII-4 causes a more severe gastroenteritis than other noroviruses in young children. *J Infect Dis, 203*(10), 1442-1444. doi: 10.1093/infdis/jir039

Illingworth, E., Taborn, E., Fielding, D., Cheesbrough, J., Diggle, P. J., & Orr, D. (2011). Is closure of entire wards necessary to control norovirus outbreaks in hospital? Comparing the effectiveness of two infection control strategies. *J Hosp Infect, 79*(1), 32-37. doi: 10.1016/j.jhin.2011.04.024

Kanerva, M., Maunula, L., Lappalainen, M., Mannonen, L., von Bonsdorff, C. H., & Anttila, V. J. (2009). Prolonged norovirus outbreak in a Finnish tertiary care hospital caused by GII.4-2006b subvariants. *J Hosp Infect, 71*(3), 206-213. doi: 10.1016/j.jhin.2008.11.016

Kaplan, J. E., Feldman, R., Campbell, D. S., Lookabaugh, C., & Gary, G. W. (1982). The frequency of a Norwalk-like pattern of illness in outbreaks of acute gastroenteritis. *Am J Public Health, 72*(12), 1329-1332.

Kirby, A. E., Shi, J., Montes, J., Lichtenstein, M., & Moe, C. L. (2014). Disease course and viral shedding in experimental Norwalk virus and Snow Mountain virus infection. *J Med Virol*. doi: 10.1002/jmv.23905

Kosa, K. M., Cates, S. C., Hall, A. J., Brophy, J. E., & Frasier, A. (2014). Knowledge of norovirus prevention and control among infection preventionists. *Am J Infect Control, 42*(6), 676-678. doi: 10.1016/j.ajic.2014.02.004

Kotwal, G., & Cannon, J. L. (2014). Environmental persistence and transfer of enteric viruses. *Curr Opin Virol, 4C*, 37-43. doi: 10.1016/j.coviro.2013.12.003

Kroneman, A., Vega, E., Vennema, H., Vinje, J., White, P. A., Hansman, G., . . . Koopmans, M. (2013). Proposal for a unified norovirus nomenclature and genotyping. *Arch Virol, 158*(10), 2059-2068. doi: 10.1007/s00705-013-1708-5

Kroneman, A., Verhoef, L., Harris, J., Vennema, H., Duizer, E., van Duynhoven, Y., . . . Koopmans, M. (2008). Analysis of integrated virological and epidemiological reports of norovirus outbreaks collected within the Foodborne Viruses in Europe network from 1 July 2001 to 30 June 2006. *J Clin Microbiol, 46*(9), 2959-2965. doi: 10.1128/JCM.00499-08

Lamhoujeb, S., Fliss, I., Ngazoa, S. E., & Jean, J. (2009). Molecular Study of the Persistence of Infectious Human Norovirus on Food-Contact Surfaces. *Food Environ Virol, 1*(2), 51-56. doi: 10.1007/s12560-009-9010-0

Lee, B. Y., Wettstein, Z. S., McGlone, S. M., Bailey, R. R., Umscheid, C. A., Smith, K. J., & Muder, R. R. (2011). Economic value of norovirus outbreak control measures in healthcare settings. *Clin Microbiol Infect, 17*(4), 640-646. doi: 10.1111/j.1469-0691.2010.03345.x

Leshem, E., Barclay, L., Wikswo, M., Vega, E., Gregoricus, N., Parashar, U. D., . . . Hall, A. J. (2013). Genotype GI.6 norovirus, United States, 2010-2012. *Emerg Infect Dis, 19*(8), 1317-1320. doi: 10.3201/eid1908.130445

Leshem, E., Wikswo, M., Barclay, L., Brandt, E., Storm, W., Salehi, E., . . . Hall, A. J. (2013). Effects and clinical significance of GII.4 Sydney norovirus, United States, 2012-2013. *Emerg Infect Dis, 19*(8), 1231-1238. doi: 10.3201/eid1908.130458

Liu, P., Yuen, Y., Hsiao, H. M., Jaykus, L. A., & Moe, C. (2010). Effectiveness of liquid soap and hand sanitizer against Norwalk virus on contaminated hands. *Appl Environ Microbiol, 76*(2), 394-399. doi: 10.1128/aem.01729-09

Longtin, Y., Voss, A., Allegranzi, B., & Pittet, D. (2012). Norovirus outbreaks and alcohol-based handrub solutions: association does not prove causation. *Am J Infect Control, 40*(2), 191; author reply 192. doi: 10.1016/j.ajic.2011.05.002

Lopman, B., Gastanaduy, P., Park, G. W., Hall, A. J., Parashar, U. D., & Vinje, J. (2012). Environmental transmission of norovirus gastroenteritis. *Curr Opin Virol, 2*(1), 96-102. doi: 10.1016/j.coviro.2011.11.005

Lopman, B., Simmons, K., Gambhir, M., Vinje, J., & Parashar, U. (2014). Epidemiologic implications of asymptomatic reinfection: a mathematical modeling study of norovirus. *Am J Epidemiol, 179*(4), 507-512. doi: 10.1093/aje/kwt287

Lopman, B. A., Hall, A. J., Curns, A. T., & Parashar, U. D. (2011). Increasing rates of gastroenteritis hospital discharges in US adults and the contribution of norovirus, 1996-2007. *Clin Infect Dis, 52*(4), 466-474. doi: 10.1093/cid/ciq163

Lopman, B. A., Reacher, M. H., Vipond, I. B., Hill, D., Perry, C., Halladay, T., . . . Sarangi, J. (2004). Epidemiology and cost of nosocomial gastroenteritis, Avon, England, 2002-2003. *Emerg Infect Dis, 10*(10), 1827-1834. doi: 10.3201/eid1010.030941

Loveridge, P., Cooper, D., Elliot, A. J., Harris, J., Gray, J., Large, S., . . . Lopman, B. (2010). Vomiting calls to NHS Direct provide an early warning of norovirus outbreaks in hospitals. *J Hosp Infect, 74*(4), 385-393. doi: 10.1016/j.jhin.2009.10.007

MacCannell, T., Umscheid, C. A., Agarwal, R. K., Lee, I., Kuntz, G., Stevenson, K. B., & Healthcare Infection Control Practices Advisory Committee, H. (2011). Guideline for the prevention and control of norovirus gastroenteritis outbreaks in healthcare settings. *Infect Control Hosp Epidemiol, 32*(10), 939-969. doi: 10.1086/662025

Macinga, D. R., Sattar, S. A., Jaykus, L. A., & Arbogast, J. W. (2008). Improved inactivation of nonenveloped enteric viruses and their surrogates by a novel alcohol-based hand sanitizer. *Appl Environ Microbiol, 74*(16), 5047-5052. doi: 10.1128/aem.00487-08

O'Neill, P. D., & Marks, P. J. (2005). Bayesian model choice and infection route modelling in an outbreak of Norovirus. *Stat Med, 24*(13), 2011-2024. doi: 10.1002/sim.2090

Ozawa, K., Oka, T., Takeda, N., & Hansman, G. S. (2007). Norovirus infections in symptomatic and asymptomatic food handlers in Japan. *J Clin Microbiol, 45*(12), 3996-4005. doi: 10.1128/JCM.01516-07

Park, G. W., Barclay, L., Macinga, D., Charbonneau, D., Pettigrew, C. A., & Vinje, J. (2010). Comparative efficacy of seven hand sanitizers against murine norovirus, feline calicivirus, and GII.4 norovirus. *J Food Prot, 73*(12), 2232-2238.

Park, G. W., Linden, K. G., & Sobsey, M. D. (2011). Inactivation of murine norovirus, feline calicivirus and echovirus 12 as surrogates for human norovirus (NoV) and coliphage (F+) MS2 by ultraviolet light (254 nm) and the effect of cell association on UV inactivation. *Lett Appl Microbiol, 52*(2), 162-167. doi: 10.1111/j.1472-765X.2010.02982.x

Park, G. W., & Sobsey, M. D. (2011). Simultaneous comparison of murine norovirus, feline calicivirus, coliphage MS2, and GII.4 norovirus to evaluate the efficacy of sodium hypochlorite against human norovirus on a fecally soiled stainless steel surface. *Foodborne Pathog Dis, 8*(9), 1005-1010. doi: 10.1089/fpd.2010.0782

Patel, M. M., Hall, A. J., Vinje, J., & Parashar, U. D. (2009). Noroviruses: a comprehensive review. *J Clin Virol, 44*(1), 1-8. doi: 10.1016/j.jcv.2008.10.009

Rhinehart, E., Walker, S., Murphy, D., O'Reilly, K., & Leeman, P. (2012). Frequency of outbreak investigations in US hospitals: results of a national survey of infection preventionists. *Am J Infect Control, 40*(1), 2-8. doi: 10.1016/j.ajic.2011.10.003

Rosenthal, N. A., Lee, L. E., Vermeulen, B. A., Hedberg, K., Keene, W. E., Widdowson, M. A., . . . Vinje, J. (2011). Epidemiological and genetic characteristics of norovirus outbreaks in long-term care facilities, 2003-2006. *Epidemiol Infect, 139*(2), 286-294. doi: 10.1017/S095026881000083X

Said, M. A., Perl, T. M., & Sears, C. L. (2008). Healthcare epidemiology: gastrointestinal flu: norovirus in health care and long-term care facilities. *Clin Infect Dis, 47*(9), 1202-1208. doi: 10.1086/592299

Saito, M., Goel-Apaza, S., Espetia, S., Velasquez, D., Cabrera, L., Loli, S., . . . Norovirus Working Group in, P. (2014). Multiple norovirus infections in a birth cohort in a peruvian periurban community. *Clin Infect Dis, 58*(4), 483-491. doi: 10.1093/cid/cit763

Sandora, T. J., Shih, M. C., & Goldmann, D. A. (2008). Reducing absenteeism from gastrointestinal and respiratory illness in elementary school students: a randomized, controlled trial of an infection-control intervention. *Pediatrics, 121*(6), e1555-1562. doi: 10.1542/peds.2007-2597

Scallan, E., Hoekstra, R. M., Angulo, F. J., Tauxe, R. V., Widdowson, M. A., Roy, S. L., . . . Griffin, P. M. (2011). Foodborne illness acquired in the United States--major pathogens. *Emerg Infect Dis, 17*(1), 7-15. doi: 10.3201/eid1701.091101p1

Seitz, S. R., Leon, J. S., Schwab, K. J., Lyon, G. M., Dowd, M., McDaniels, M., . . . Moe, C. L. (2011). Norovirus infectivity in humans and persistence in water. *Appl Environ Microbiol, 77*(19), 6884-6888. doi: 10.1128/AEM.05806-11

Sickbert-Bennett, E. E., Weber, D. J., Gergen-Teague, M. F., Sobsey, M. D., Samsa, G. P., & Rutala, W. A. (2005). Comparative efficacy of hand hygiene agents in the reduction of bacteria and viruses. *Am J Infect Control, 33*(2), 67-77. doi: 10.1016/j.ajic.2004.08.005

Stachel, A. G., Bornschlegel, K., & Balter, S. (2012). Characteristics, services, and infection control practices of New York City assisted living facilities, 2010. *J Am Geriatr Soc, 60*(2), 284-289. doi: 10.1111/j.1532-5415.2011.03817.x

Stevenson, K. B., Searle, K., Curry, G., Boyce, J. M., Harbarth, S., Stoddard, G. J., & Samore, M. H. (2014). Infection control interventions in small rural hospitals with limited resources: results of a cluster-randomized feasibility trial. *Antimicrob Resist Infect Control, 3*(1), 10. doi: 10.1186/2047-2994-3-10

Sukhrie, F. H., Siebenga, J. J., Beersma, M. F., & Koopmans, M. (2010). Chronic shedders as reservoir for nosocomial transmission of norovirus. *J Clin Microbiol, 48*(11), 4303-4305. doi: 10.1128/JCM.01308-10

Sukhrie, F. H., Teunis, P., Vennema, H., Copra, C., Thijs Beersma, M. F., Bogerman, J., & Koopmans, M. (2012). Nosocomial transmission of norovirus is mainly caused by symptomatic cases. *Clin Infect Dis, 54*(7), 931-937. doi: 10.1093/cid/cir971

Sydnor, E. R., & Perl, T. M. (2011). Hospital epidemiology and infection control in acute-care settings. *Clin Microbiol Rev, 24*(1), 141-173. doi: 10.1128/cmr.00027-10

Teunis, P. F., Moe, C. L., Liu, P., Miller, S. E., Lindesmith, L., Baric, R. S., . . . Calderon, R. L. (2008). Norwalk virus: how infectious is it? *J Med Virol, 80*(8), 1468-1476. doi: 10.1002/jmv.21237

Thornley, C. N., Emslie, N. A., Sprott, T. W., Greening, G. E., & Rapana, J. P. (2011). Recurring norovirus transmission on an airplane. *Clin Infect Dis, 53*(6), 515-520. doi: 10.1093/cid/cir465

Trivedi, T. K., DeSalvo, T., Lee, L., Palumbo, A., Moll, M., Curns, A., . . . Lopman, B. A. (2012). Hospitalizations and mortality associated with norovirus outbreaks in nursing homes, 2009-2010. *JAMA, 308*(16), 1668-1675. doi: 10.1001/jama.2012.14023

Tschudin-Sutter, S., Pargger, H., & Widmer, A. F. (2010). Hand hygiene in the intensive care unit. *Crit Care Med, 38*(8 Suppl), S299-305. doi: 10.1097/CCM.0b013e3181e6a23f

Tung, G., Macinga, D., Arbogast, J., & Jaykus, L. A. (2013). Efficacy of commonly used disinfectants for inactivation of human noroviruses and their surrogates. *J Food Prot, 76*(7), 1210-1217. doi: 10.4315/0362-028x.jfp-12-532

U.S., F. a. D. A. (2013). *Food Code 2013*. College Park, MD: US Health and Human Services Retrieved from http://www.fda.gov/downloads/Food/GuidanceRegulation/RetailFoodProtection/FoodCode/UCM374510.pdf.

Vega, E., Barclay, L., Gregoricus, N., Shirley, S. H., Lee, D., & Vinje, J. (2014). Genotypic and epidemiologic trends of norovirus outbreaks in the United States, 2009 to 2013. *J Clin Microbiol, 52*(1), 147-155. doi: 10.1128/JCM.02680-13

Vega, E., Barclay, L., Gregoricus, N., Williams, K., Lee, D., & Vinje, J. (2011). Novel surveillance network for norovirus gastroenteritis outbreaks, United States. *Emerg Infect Dis, 17*(8), 1389-1395. doi: 10.3201/eid1708.101837

Vinnard, C., Lee, I., & Linkin, D. (2012). Successful control of a norovirus outbreak among attendees of a hospital teaching conference. *Am J Infect Control, 40*(1), 73-74. doi: 10.1016/j.ajic.2011.03.033

Wadl, M., Scherer, K., Nielsen, S., Diedrich, S., Ellerbroek, L., Frank, C., . . . Bernard, H. (2010). Food-borne norovirus-outbreak at a military base, Germany, 2009. *BMC Infect Dis, 10*, 30. doi: 10.1186/1471-2334-10-30

Wikswo, M. E., Cortes, J., Hall, A. J., Vaughan, G., Howard, C., Gregoricus, N., & Cramer, E. H. (2011). Disease transmission and passenger behaviors during a high morbidity Norovirus outbreak on a cruise ship, January 2009. *Clin Infect Dis, 52*(9), 1116-1122. doi: 10.1093/cid/cir144

Wikswo, M. E., Hall, A. J., & CDC. (2012). Outbreaks of acute gastroenteritis transmitted by person-to-person contact--United States, 2009-2010. *MMWR Surveill Summ, 61*(9), 1-12.

Zelner, J. L., Lopman, B. A., Hall, A. J., Ballesteros, S., & Grenfell, B. T. (2013). Linking time-varying symptomatology and intensity of infectiousness to patterns of norovirus transmission. *PLoS One, 8*(7), e68413. doi: 10.1371/journal.pone.0068413

Zingg, W., Colombo, C., Jucker, T., Bossart, W., & Ruef, C. (2005). Impact of an outbreak of norovirus infection on hospital resources. *Infect Control Hosp Epidemiol, 26*(3), 263-267. doi: 10.1086/502537

Appendix A: Survey Instrument

Assessment of CDC HICPAC Guidelines for Prevention and Control of Norovirus Outbreaks in Healthcare Institutions

The Association for Professionals in Infection Control and Epidemiology (APIC) is collecting information about norovirus prevention and control practices in healthcare institutions. Information from the survey will allow for a better understanding of the knowledge, utility, and impacts of the CDC HICPAC "Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreaks in Healthcare Settings" (CDC HICPAC guidelines). The survey contains three sections: 1) general questions about your facility, 2) questions about your knowledge of norovirus and the CDC HICPAC guidelines, 3) questions about the implementation of recommendations to prevent and control norovirus outbreaks and barriers encountered in their implementation.

Your participation in this research study is voluntary. The survey should take no more than 20 minutes to complete. You may skip any questions you do not want to answer. Your participation involves no risk. All responses will be kept confidential. Thank you for taking the time to complete this survey.

If you have any questions about the study, you may e-mail APIC (email address). If you have any questions about your rights as a study participant, you may call Emory IRB (phone number).

Please choose the appropriate box below to participate in the survey.

- ☐ I consent to participating in the survey, Assessment of CDC HICPAC Guidelines for Prevention and Control of Norovirus Outbreaks in Healthcare Institutions. (Go to #1)
- ☐ I do not consent to participating in the survey, Assessment of CDC HICPAC Guidelines for Prevention and Control of Norovirus Outbreaks in Healthcare Institutions. (Go to "Thank you for your time" screen)

The following section will ask you general questions about your institution.

1. Which of the following best describes your healthcare institution? (Select one)
   - ☐ Hospital
   - ☐ Long term care facility
   - ☐ Out-patient facility (Go to #4)
   - ☐ Physician office (Go to #4)
   - ☐ Urgent care facility (Go to #4)
   - ☐ Other, please specify (Comment box, 125 character limit)
2. What is the size of your healthcare institution?
   - ☐ <10 beds
   - ☐ 10-49 beds
   - ☐ 50-99 beds
   - ☐ >100 beds
3. Which of the following best describes your primary occupation or profession? (Select one)
   - ☐ Dietician/nutritionist
   - ☐ Epidemiologist
   - ☐ Infection control practitioner
   - ☐ Laboratorian
   - ☐ Nurse
   - ☐ Physician
   - ☐ Professional trainer on infectious disease control

- ☐ Quality assurance/quality control
- ☐ Sanitarian or Environmental Health Specialist
- ☐ Other, please specify (Comment box, 125 character limit)

4. In the last 5 years, has your institution experienced a norovirus outbreak (defined as 2 or more patients within a single unit with gastroenteritis onset within 72 hours of each other and suspected or laboratory-confirmed to be due to norovirus)?
   - ☐ Yes
   - ☐ No (Go to #6)
5. In which year did the last norovirus outbreak occur?
   - ☐ _____ (specify year)

The following section will ask you general questions about your knowledge of norovirus and the CDC HICPAC guidelines for norovirus prevention and control.

6. Where do you believe most norovirus outbreaks occur? (Select one)
   - ☐ Child care facilities
   - ☐ Correctional facilities
   - ☐ Cruise ships
   - ☐ Healthcare facilities
   - ☐ Home
   - ☐ Restaurants
   - ☐ Schools
7. To what extent is norovirus a problem for healthcare facilities?
   - ☐ Serious problem
   - ☐ Moderate problem
   - ☐ Minor problem
   - ☐ Not at all a problem
8. How much of an impact do you believe infection control practices have on preventing norovirus outbreaks from occurring?
   - ☐ No impact
   - ☐ Minor impact
   - ☐ Moderate impact
   - ☐ Major impact
9. How much of an impact do you believe infection control practices have on controlling norovirus outbreaks once they have begun?
   - ☐ No impact
   - ☐ Minor impact
   - ☐ Moderate impact
   - ☐ Major impact
10. What is your level of awareness of the CDC HICPAC Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreaks in Healthcare Settings?
    - ☐ Not aware (Go to #14)
    - ☐ Aware the document exists
    - ☐ Have briefly consulted the document
    - ☐ Have extensively consulted document

11. How did you first hear of the CDC HICPAC Guideline for the Prevention and Control of Norovirus Gastroenteritis Outbreak in Healthcare Settings? (Select one)
    - ☐ CDC website
    - ☐ Colleague
    - ☐ Email announcement
    - ☐ Supervisor
    - ☐ Other, please specify (Comment box, 125 character limit)
12. Do you believe implementation of the CDC HICPAC guidelines is effective at preventing norovirus outbreaks from occurring?
    - ☐ Not effective
    - ☐ Slightly effective
    - ☐ Moderately effective
    - ☐ Very effective
13. Do you believe implementation of the CDC HICPAC guidelines is effective at controlling norovirus outbreaks once they have begun?
    - ☐ Not effective
    - ☐ Slightly effective
    - ☐ Moderately effective
    - ☐ Very effective
14. Have you ever seen the CDC Norovirus Outbreak Control Resource Toolkit for Healthcare Settings (also known as the CDC norovirus prevention toolkit)?
    - ☐ Yes
    - ☐ No (Go to #17)
15. Have you used material from the CDC norovirus prevention toolkit to help implement recommendations from the CDC HICPAC guidelines for prevention and control of norovirus outbreaks?
    - ☐ Yes
    - ☐ No (Go to #17)
16. The CDC norovirus prevention toolkit assisted in implementation of the CDC HICPAC guidelines?
    - ☐ Strongly disagree
    - ☐ Somewhat disagree
    - ☐ Neither agree or disagree
    - ☐ Somewhat agree
    - ☐ Strongly agree

The following section will ask you questions about the implementation and potential barriers related to specific recommendations from the CDC HICPAC norovirus prevention and control guidelines in your institution.

17. From the following, select which recommendations your institution has implemented from the CDC HICPAC guidelines (Select all that apply).
    - ☐ Educational trainings and pamphlets for staff, patients, and visitors, which includes recognition of norovirus symptoms, prevention of norovirus infection, and transmission modes, during norovirus outbreaks
    - ☐ Separation of asymptomatic and symptomatic patients
    - ☐ Isolation of symptomatic patients for at least 48 hours after symptom resolution

- ☐ Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks
- ☐ Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks
- ☐ Closure of units or wards to new admissions or transfers during norovirus outbreaks
- ☐ Designation of symptomatic patients prior to transferring within or between institutions (and notify recipient unit/institution)
- ☐ Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing
- ☐ Increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks
- ☐ Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms
- ☐ Restriction of non-essential visitors from affected areas during norovirus outbreaks
- ☐ Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected

18. Based on the selected recommendations from the previous question, what was the <u>most significant</u> barrier to implementation of these recommendations? (Select one)
    - ☐ Conflicts with existing policies
    - ☐ Funding limitations
    - ☐ Other priorities and demands
    - ☐ Personnel limitations
    - ☐ Poor compliance
    - ☐ Too many recommendations (recommendations too complex)
    - ☐ Other, please specify (Comment box, 250 character limit)
19. Which recommendation was <u>the most challenging</u> to implement? (Select one)
    - ☐ Educational trainings and pamphlets for staff, patients, and visitors, which includes recognition of norovirus symptoms, prevention of norovirus infection, and transmission modes, during norovirus outbreaks
    - ☐ Separation of asymptomatic and symptomatic patients
    - ☐ Isolation of symptomatic patients for at least 48 hours after symptom resolution
    - ☐ Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks
    - ☐ Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks
    - ☐ Closure of units or wards to new admissions or transfers during norovirus outbreaks
    - ☐ Designation of symptomatic patients prior to transferring within or between institutions (and notify recipient unit/institution)
    - ☐ Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing
    - ☐ Increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks
    - ☐ Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms

- ☐ Restriction of non-essential visitors from affected areas during norovirus outbreaks
- ☐ Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected

20. Why was this recommendation the most challenging?
    - ☐ (Comment box)
21. Please provide additional feedback on your institution's implementation process of the CDC HICPAC guidelines. For example, what do you see as the main infection control issue relating to norovirus outbreaks that is not adequately addressed by existing guidance.
    - ☐ (Comment box)

Thank you for completing this survey.

Your time and expertise are greatly appreciated.

Appendix B: Emory IRB Determination Letter

EMORY UNIVERSITY | Institutional Review Board

April 8, 2014

Leslie Barclay
Rollins School of Public Health
Atlanta, GA 30322

RE: Determination: No IRB Review Required
IRB00073950
Assessment of CDC HICPAC Guidelines for Prevention and Control of Norovirus Outbreaks in Healthcare Institutions
Investigator: Leslie Barclay

Dear Investigator:

Thank you for requesting a determination from our office about the above-referenced project. Based on our review of the materials you provided, we have determined that it does not require IRB review because it does not meet the definition of "research" as set forth in Emory policies and procedures and federal rules, if applicable. Specifically, in this project, you will analyze data from surveys distributed and collected by the Association for Professionals in Infection Control and Epidemiology (APIC). These data deal with opinions and knowledge of CDC Healthcare Infection Control Practices Advisory Committee (HICPAC) prevention and control recommendations released in 2011. Your study will examine these data to achieve the following four objectives:

1. Assess APIC member respondents' general knowledge, attitudes, and practices towards norovirus and HICPAC guidelines.
2. Determine the proportion of APIC members that implemented HICPAC guidelines for norovirus prevention and control.
3. Determine whether different clinical settings produced differential implementation of particular recommendations among APIC members.
4. Determine what barriers APIC members encountered while implementing the recommendations.

HHS regulations define *research* at 45 CFR 46.102(d) defines as follows:

> Research means a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge. Activities which meet this definition constitute research for purposes of this policy, whether or not they are conducted or supported under a program which is considered research for other purposes.

This determination could be affected by substantive changes in the study design, subject populations, or identifiability of data. If the project changes in any substantive way, please contact our office for clarification.

Thank you for consulting the IRB.

Emory University
1599 Clifton Road, 5th Floor - Atlanta, Georgia 30322
Tel: 404.712.0720 - Fax: 404.727.1358 - Email: irb@emory.edu - Web: http://www.irb.emory.edu

Appendix C: R Programming Code

```
################################################################################
##Thesis Data
##2014-11-01
##Leslie Barclay
################################################################################

## Set Working directory
setwd("C:/Users/Leslie/Documents/Qsync/School/Practicum-Thesis Work/Thesis Results")

## Bring in data
Survey <- read.csv("C:/Users/Leslie/Documents/Qsync/School/Practicum-Thesis Work/Thesis
    Results/SurveyData_105114.csv")

## Libraries
install.packages(c("plyr", "ggplot2", "Hmisc", "gmodels", "epitools"))
library(ggplot2)
library(plyr)
library(Hmisc)
library(gmodels)
library(epitools)
library(scales)

## Review data
str(Survey)
names(Survey)
row.names(x = Survey) <- Survey$ID
describe(Survey)

## Correct data
Survey[Survey == " "] <- NA
Survey[Survey == ""] <- NA

Survey$Institution_Type_EDITED <- factor(Survey$Institution_Type_EDITED, order = TRUE,
    levels = c("Ambulatory Surgery Center", "Correctional Facility", "Hospital", "Long term care
    facility", "OTHER", "Out-patient facility", "Physician office", "Public Health Department",
    "Urgent care facility"))
Survey$Size_Institution_EDITED <- factor(Survey$Size_Institution_EDITED, order = TRUE,
    levels = c("<10 beds", "10-49 beds", "50-99 beds", ">100 beds"))
Survey$Occupation_EDITED <- factor(Survey$Occupation_EDITED, order = TRUE, levels =
    c("Epidemiologist", "infection control practitioner", "Laboratorian", "Nurse", "Other",
    "Physician", "Professional trainer on infectious disease control", "Quality assurance/quality
    control"))
```

```
Survey$NoV_Settings <- factor(Survey$NoV_Settings, order = TRUE, levels = c("Child care facilities", "Correctional facilities", "Cruise ships", "Healthcare facilities", "Home", "Restaurants", "Schools"))
Survey$NoV_Problem <- factor(Survey$NoV_Problem, order = TRUE, levels = c("Serious problem", "Moderate problem", "Minor problem", "Not at all a problem"))
Survey$ICP_Impact_Prevention <- factor(Survey$ICP_Impact_Prevention, order = TRUE, levels = c("Major impact", "Moderate impact", "Minor impact", "No impact"))
Survey$ICP_Impact_Controlling <- factor(Survey$ICP_Impact_Controlling, order = TRUE, levels = c("Major impact", "Moderate impact", "Minor impact", "No impact"))
Survey$HICPAC_Aware <- factor(Survey$HICPAC_Aware, order = TRUE, levels = c("Have extensively consulted document", "Have briefly consulted the document", "Aware the document exists", "Not aware"))
Survey$HICPAC_Effective_Prevention <- factor(Survey$HICPAC_Effective_Prevention, order = TRUE, levels = c("Very effective", "Moderately effective", "Slightly effective", "Not effective"))
Survey$HICPAC_Effective_Controlling <- factor(Survey$HICPAC_Effective_Controlling, order = TRUE, levels = c("Very effective", "Moderately effective", "Slightly effective", "Not effective"))
Survey$NoV_Toolkit_Useful <- factor(Survey$NoV_Toolkit_Useful, order = TRUE, levels = c("Strongly agree", "Somewhat agree", "Neither agree or disagree", "Somewhat disagree", "Strongly disagree"))

## Condense Data for Statistics
Survey$Q1[Survey$Institution_Type_EDITED %in% c("Ambulatory Surgery Center", "Correctional Facility", "OTHER", "Out-patient facility", "Physician office", "Public Health Department", "Urgent care facility")] <- "Other"
Survey$Q1[Survey$Institution_Type_EDITED == "Hospital"] <- "Hospital"
Survey$Q1[Survey$Institution_Type_EDITED == "Long term care facility"] <- "Long term care facility"
Survey$Q1 <- factor(Survey$Q1)

IP <- Survey$Occupation_EDITED == "infection control practitioner"

Survey$Q5[Survey$OB_Year %in% c("2007", "2008", "2009")] <- "2007-2009"
Survey$Q5[Survey$OB_Year == "2010"] <- "2010"
Survey$Q5[Survey$OB_Year == "2011"] <- "2011"
Survey$Q5[Survey$OB_Year == "2012"] <- "2012"
Survey$Q5[Survey$OB_Year == "2013"] <- "2013"
Survey$Q5[Survey$OB_Year == "2014"] <- "2014"
Survey$Q5 <- factor(Survey$Q5)

Survey$NoV_Problem_EDITED <- Survey$NoV_Problem
levels(Survey$NoV_Problem_EDITED)<- c("Serious problem", "Moderate problem", "Minor to Not a problem", "Minor to Not a problem")

Survey$ICP_Impact_Prevention_EDITED <- Survey$ICP_Impact_Prevention
```

```
levels(Survey$ICP_Impact_Prevention_EDITED) <- c("Major impact", "Moderate impact",
    "Minor or No impact", "Minor or No impact")

Survey$ICP_Impact_Controlling_EDITED <- Survey$ICP_Impact_Controlling
levels(Survey$ICP_Impact_Controlling_EDITED) <- c("Major impact", "Moderate impact",
    "Minor or No impact", "Minor or No impact")

Survey$HICPAC_Effective_Prevention_EDITED <- Survey$HICPAC_Effective_Prevention
levels(Survey$HICPAC_Effective_Prevention_EDITED) <- c("Very effective", "Moderately
    effective", "Slightly or Not effective", "Slightly or Not effective")

Survey$HICPAC_Effective_Controlling_EDITED <- Survey$HICPAC_Effective_Controlling
levels(Survey$HICPAC_Effective_Controlling_EDITED) <- c("Very effective", "Moderately
    effective", "Slightly or Not effective", "Slightly or Not effective")

Q17A <-
    factor(Survey$Active.promotion.of.hand.hygiene.adherence.among.healthcare.staff..patients.
    .and.visitors.in.areas.affected.by.norovirus.outbreaks, order = TRUE, levels = c("NO",
    "YES"))
Q17B <-
    factor(Survey$Closure.of.units.or.wards.to.new.admissions.or.transfers.during.norovirus.outb
    reaks, order = TRUE, levels = c("NO", "YES"))
Q17C <-
    factor(Survey$Collection.of.stool.specimens.from.symptomatic.patients.within.2.3.days.of.sy
    mptom.onset.for.norovirus.testing, order = TRUE, levels = c("NO", "YES"))
Q17D <-
    factor(Survey$Designation.of.symptomatic.patients.prior.to.transferring.within.or.between.in
    stitutions..and.notify.recipient.unit.institution., order = TRUE, levels = c("NO", "YES"))
Q17E <-
    factor(Survey$Educational.trainings.and.pamphlets.for.staff..patients..and.visitors..which.incl
    udes.recognition.of.norovirus.symptoms..prevention.of.norovirus.infection..and.transmission.
    modes..during.norovirus.outbreaks, order = TRUE, levels = c("NO", "YES"))
Q17F <-
    factor(Survey$Exclusion.of.ill.personnel.from.work.for.a.minimum.of.48.hours.after.resoluti
    on.of.symptoms, order = TRUE, levels = c("NO", "YES"))
Q17G <-
    factor(Survey$Increase.frequency.of.routine.cleaning.and.disinfection.of.commonly.touched.
    environmental.surfaces..equipment..and.high.traffic.clinical.areas.during.norovirus.outbreaks
    , order = TRUE, levels = c("NO", "YES"))
Q17H <-
    factor(Survey$Isolation.of.symptomatic.patients.for.at.least.48.hours.after.symptom.resolutio
    n, order = TRUE, levels = c("NO", "YES"))
Q17I <-
    factor(Survey$Modification.of.hand.hygiene.policy.to.the.use.of.soap.and.water.during.noro
    virus.outbreaks, order = TRUE, levels = c("NO", "YES"))
```

```
Q17J <-
    factor(Survey$Notification.to.appropriate.local.and.state.health.departments..as.required.by.state.and.local.public.health.regulations..if.a.norovirus.outbreak.is.suspected, order = TRUE, levels = c("NO", "YES"))
Q17K <-
    factor(Survey$Restriction.of.non.essential.visitors.from.affected.areas.during.norovirus.outbreaks, order = TRUE, levels = c("NO", "YES"))
Q17L <- factor(Survey$Separation.of.asymptomatic.and.symptomatic.patients, order = TRUE, levels = c("NO", "YES"))
Q18 <- factor(Survey$Implemention_Barrier_EDITED, order = TRUE, levels = c("Closure of Units", "Communication", "Conflicts with existing policies", "Design", "Education", "Funding limitations", "No outbreak", "OTHER", "Other priorities and demands", "Personnel limitations", "Poor compliance", "Testing", "Too many recommendations (recommendations too complex)"))
Q19 <- factor(Survey$Challenging_Recommendation, order = TRUE, levels = c("Educational trainings and pamphlets for staff, patients, and visitors, which includes recognition of norovirus symptoms, prevention of norovirus infection, and transmission modes, during norovirus outbreaks", "Separation of asymptomatic and symptomatic patients", "Isolation of symptomatic patients for at least 48 hours after symptom resolution", "Active promotion of hand hygiene adherence among healthcare staff, patients, and visitors in areas affected by norovirus outbreaks", "Modification of hand hygiene policy to the use of soap and water during norovirus outbreaks", "Closure of units or wards to new admissions or transfers during norovirus outbreaks", "Designation of symptomatic patients prior to transferring within or between institutions (and notify recipient unit/institution)", "Collection of stool specimens from symptomatic patients within 2-3 days of symptom onset for norovirus testing", "Increase frequency of routine cleaning and disinfection of commonly touched environmental surfaces, equipment, and high-traffic clinical areas during norovirus outbreaks", "Exclusion of ill personnel from work for a minimum of 48 hours after resolution of symptoms", "Restriction of non-essential visitors from affected areas during norovirus outbreaks", "Notification to appropriate local and state health departments, as required by state and local public health regulations, if a norovirus outbreak is suspected"))

## Analyze Data (Cross-tabulations)
CrossTable(Survey$Q1, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

Survey$Q1_EDITED[Survey$Institution_Type_EDITED == "Hospital"] <- "Hospital"
Survey$Q1_EDITED[Survey$Institution_Type_EDITED == "Long term care facility"] <- "Long term care facility"
CrossTable(Survey$Q1_EDITED, Survey$Q5, chisq = TRUE, format = "SPSS", sresid = TRUE)

Survey$NoV_Settings_EDITED[Survey$NoV_Settings %in% c("Correctional facilities", "Home")] <- "OTHER"
Survey$NoV_Settings_EDITED[Survey$NoV_Settings == "Child care facilities"] <- "Child care facilities"
Survey$NoV_Settings_EDITED[Survey$NoV_Settings == "Cruise ships"] <- "Cruise ships"
```

```
Survey$NoV_Settings_EDITED[Survey$NoV_Settings == "Healthcare facilities"] <-
    "Healthcare facilities"
Survey$NoV_Settings_EDITED[Survey$NoV_Settings == "Restaurants"] <- "Restaurants"
Survey$NoV_Settings_EDITED[Survey$NoV_Settings == "Schools"] <- "Schools"
CrossTable(Survey$NoV_Settings_EDITED, IP, chisq = TRUE, format = "SPSS", sresid =
    TRUE)
CrossTable(Survey$NoV_Settings_EDITED, Survey$NoV_OB, chisq = TRUE, format =
    "SPSS", sresid = TRUE)

CrossTable(Survey$NoV_Problem_EDITED, Survey$Q1, chisq = TRUE, format = "SPSS",
    sresid = TRUE)
CrossTable(Survey$NoV_Problem_EDITED, IP, chisq = TRUE, format = "SPSS", sresid =
    TRUE)
CrossTable(Survey$NoV_Problem_EDITED, Survey$NoV_OB, chisq = TRUE, format =
    "SPSS", sresid = TRUE)

CrossTable(Survey$ICP_Impact_Prevention_EDITED, Survey$Q1, chisq = TRUE, format =
    "SPSS", sresid = TRUE)
CrossTable(Survey$ICP_Impact_Prevention_EDITED, IP, chisq = TRUE, format = "SPSS",
    sresid = TRUE)
CrossTable(Survey$ICP_Impact_Prevention_EDITED, Survey$NoV_OB, chisq = TRUE,
    format = "SPSS", sresid = TRUE)

CrossTable(Survey$ICP_Impact_Controlling_EDITED, Survey$Q1, chisq = TRUE, format =
    "SPSS", sresid = TRUE)
CrossTable(Survey$ICP_Impact_Controlling_EDITED, IP, chisq = TRUE, format = "SPSS",
    sresid = TRUE)
CrossTable(Survey$ICP_Impact_Controlling_EDITED, Survey$NoV_OB, chisq = TRUE,
    format = "SPSS", sresid = TRUE)

CrossTable(Survey$HICPAC_Aware, Survey$Q1, chisq = TRUE, format = "SPSS", sresid =
    TRUE)
CrossTable(Survey$HICPAC_Aware, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Survey$HICPAC_Aware, Survey$NoV_OB, chisq = TRUE, format = "SPSS",
    sresid = TRUE)

CrossTable(Survey$HICPAC_Effective_Prevention_EDITED, Survey$Q1, chisq = TRUE,
    format = "SPSS", sresid = TRUE)
CrossTable(Survey$HICPAC_Effective_Prevention_EDITED, IP, chisq = TRUE, format =
    "SPSS", sresid = TRUE)
CrossTable(Survey$HICPAC_Effective_Prevention_EDITED, Survey$NoV_OB, chisq =
    TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Survey$HICPAC_Effective_Controlling_EDITED, Survey$Q1, chisq = TRUE,
    format = "SPSS", sresid = TRUE)
```

```
CrossTable(Survey$HICPAC_Effective_Controlling_EDITED, IP, chisq = TRUE, format =
    "SPSS", sresid = TRUE)
CrossTable(Survey$HICPAC_Effective_Controlling_EDITED, Survey$NoV_OB, chisq =
    TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Survey$NoV_Toolkit_Useful, Survey$Q1, chisq = TRUE, format = "SPSS", sresid
    = TRUE)
CrossTable(Survey$NoV_Toolkit_Useful, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Survey$NoV_Toolkit_Useful, Survey$NoV_OB, chisq = TRUE, format = "SPSS",
    sresid = TRUE)

CrossTable(Q17A, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17A, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17A, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17B, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17B, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17B, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17C, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17C, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17C, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17D, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17D, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17D, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17E, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17E, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17E, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17F, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17F, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17F, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17G, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17G, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17G, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17H, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17H, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17H, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17I, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17I, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17I, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)
```

```
CrossTable(Q17J, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17J, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17J, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17K, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17K, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17K, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q17L, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17L, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q17L, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

Q18_EDITED <- Q18
Q18_EDITED[Q18 %in% c("Closure of Units", "Communication", "OTHER", "Testing")] <-
    "OTHER"
Q18_EDITED[Q18 == "Conflicts with existing policies"] <- "Conflicts with existing policies"
Q18_EDITED[Q18 == "Design"] <- "Design"
Q18_EDITED[Q18 == "Education"] <- "Education"
Q18_EDITED[Q18 == "Funding limitations"] <- "Funding limitations"
Q18_EDITED[Q18 == "No outbreak"] <- "No outbreak"
Q18_EDITED[Q18 == "Other priorities and demands"] <- "Other priorities and demands"
Q18_EDITED[Q18 == "Personnel limitations"] <- "Personnel limitations"
Q18_EDITED[Q18 == "Poor compliance"] <- "Poor compliance"
Q18_EDITED[Q18 == "Too many recommendations (recommendations too complex)"] <- "Too
    many recommendations (recommendations too complex)"
CrossTable(Q18_EDITED, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q18_EDITED, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q18_EDITED, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

CrossTable(Q19, Survey$Q1, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q19, IP, chisq = TRUE, format = "SPSS", sresid = TRUE)
CrossTable(Q19, Survey$NoV_OB, chisq = TRUE, format = "SPSS", sresid = TRUE)

# Odds Ratio and Significance
oddsratio(Survey$Q1, Survey$NoV_OB)

Survey$NoV_Settings_EDITED <- factor(Survey$NoV_Settings_EDITED)
Survey$NoV_Settings_EDITED <- relevel(Survey$NoV_Settings_EDITED, ref = "Healthcare
    facilities")
oddsratio(Survey$NoV_Settings_EDITED, Survey$NoV_OB)

Survey$NoV_Problem_EDITED <- factor(Survey$NoV_Problem_EDITED)
Survey$NoV_Problem_EDITED1[Survey$NoV_Problem %in% c("Moderate problem", "Minor
    problem", "Not a problem")] <- "Problem"
```

```
Survey$NoV_Problem_EDITED1[Survey$NoV_Problem %in% c("Serious problem")] <-
    "Serious problem"
oddsratio(Survey$Q1, Survey$NoV_Problem_EDITED1)

IP <- factor(IP)
IP <- relevel(IP, ref = "TRUE")
oddsratio(IP, Survey$NoV_Problem_EDITED1)

Survey$NoV_OB <- factor(Survey$NoV_OB)
Survey$NoV_OB <- relevel(Survey$NoV_OB, ref = "Yes")
oddsratio(Survey$NoV_OB, Survey$NoV_Problem_EDITED1)

Survey$ICP_Impact_Prevention_EDITED <- factor(Survey$ICP_Impact_Prevention_EDITED,
    levels = c("Minor or No impact", "Moderate impact", "Major impact"))
Survey$ICP_Impact_Prevention_EDITED1[Survey$ICP_Impact_Prevention_EDITED %in%
    c("Moderate impact", "Minor or No impact")] <- "Moderate to No impact"
Survey$ICP_Impact_Prevention_EDITED1[Survey$ICP_Impact_Prevention_EDITED ==
    "Major impact"] <- "Major impact"
Survey$ICP_Impact_Prevention_EDITED1 <-
    factor(Survey$ICP_Impact_Prevention_EDITED1)
Survey$ICP_Impact_Prevention_EDITED1 <-
    relevel(Survey$ICP_Impact_Prevention_EDITED1, ref = "Moderate to No impact")
oddsratio(Survey$Q1, Survey$ICP_Impact_Prevention_EDITED1)

oddsratio(IP, Survey$ICP_Impact_Prevention_EDITED1)

oddsratio(Survey$NoV_OB, Survey$ICP_Impact_Prevention_EDITED1)

Survey$ICP_Impact_Controlling_EDITED <-
    factor(Survey$ICP_Impact_Controlling_EDITED, levels = c("Minor or No impact",
    "Moderate impact", "Major impact"))
Survey$ICP_Impact_Controlling_EDITED1[Survey$ICP_Impact_Controlling_EDITED %in%
    c("Moderate impact", "Minor or No impact")] <- "Moderate to No impact"
Survey$ICP_Impact_Controlling_EDITED1[Survey$ICP_Impact_Controlling_EDITED ==
    "Major impact"] <- "Major impact"
Survey$ICP_Impact_Controlling_EDITED1 <-
    factor(Survey$ICP_Impact_Controlling_EDITED1)
Survey$ICP_Impact_Controlling_EDITED1 <-
    relevel(Survey$ICP_Impact_Controlling_EDITED1, ref = "Moderate to No impact")
oddsratio(Survey$Q1, Survey$ICP_Impact_Controlling_EDITED1)

oddsratio(IP, Survey$ICP_Impact_Controlling_EDITED1)

oddsratio(Survey$NoV_OB, Survey$ICP_Impact_Controlling_EDITED1)
```

```
Survey$HICPAC_Aware <- factor(Survey$HICPAC_Aware, levels = c("Not aware", "Aware
    the document exists", "Have briefly consulted the document", "Have extensively consulted
    document"))
Survey$HICPAC_Aware_EDITED[Survey$HICPAC_Aware %in% c("Not aware", "Aware the
    document exists")] <- "Not consulted document"
Survey$HICPAC_Aware_EDITED[Survey$HICPAC_Aware %in% c("Have briefly consulted
    the document", "Have extensively consulted document")] <- "Consulted document"
Survey$HICPAC_Aware_EDITED <- factor(Survey$HICPAC_Aware_EDITED)
Survey$HICPAC_Aware_EDITED <- relevel(Survey$HICPAC_Aware_EDITED, ref = "Not
    consulted document")
oddsratio(Survey$Q1, Survey$HICPAC_Aware_EDITED)

oddsratio(IP, Survey$HICPAC_Aware_EDITED)

oddsratio(Survey$NoV_OB, Survey$HICPAC_Aware_EDITED)

Survey$HICPAC_Effective_Prevention_EDITED <-
    factor(Survey$HICPAC_Effective_Prevention_EDITED, levels = c("Slightly or Not
    effective", "Moderately effective", "Very effective"))
Survey$HICPAC_Effective_Prevention_EDITED1[Survey$HICPAC_Effective_Prevention_ED
    ITED %in% c("Slightly or Not effective", "Moderately effective")] <- "Not very effective"
Survey$HICPAC_Effective_Prevention_EDITED1[Survey$HICPAC_Effective_Prevention_ED
    ITED == "Very effective"] <- "Very effective"
Survey$HICPAC_Effective_Prevention_EDITED1 <-
    factor(Survey$HICPAC_Effective_Prevention_EDITED1)
Survey$HICPAC_Effective_Prevention_EDITED1 <-
    relevel(Survey$HICPAC_Effective_Prevention_EDITED1, ref = "Not very effective")
oddsratio(Survey$Q1, Survey$HICPAC_Effective_Prevention_EDITED1)

oddsratio(IP, Survey$HICPAC_Effective_Prevention_EDITED1)

oddsratio(Survey$NoV_OB, Survey$HICPAC_Effective_Prevention_EDITED1)

Survey$HICPAC_Effective_Controlling_EDITED <-
    factor(Survey$HICPAC_Effective_Controlling_EDITED, levels = c("Slightly or Not
    effective", "Moderately effective", "Very effective"))
Survey$HICPAC_Effective_Controlling_EDITED1[Survey$HICPAC_Effective_Controlling_E
    DITED %in% c("Slightly or Not effective", "Moderately effective")] <- "Not very effective"
Survey$HICPAC_Effective_Controlling_EDITED1[Survey$HICPAC_Effective_Controlling_E
    DITED == "Very effective"] <- "Very effective"
Survey$HICPAC_Effective_Controlling_EDITED1 <-
    factor(Survey$HICPAC_Effective_Controlling_EDITED1)
Survey$HICPAC_Effective_Controlling_EDITED1 <-
    relevel(Survey$HICPAC_Effective_Controlling_EDITED1, ref = "Not very effective")
oddsratio(Survey$Q1, Survey$HICPAC_Effective_Controlling_EDITED1)
```

```
oddsratio(IP, Survey$HICPAC_Effective_Controlling_EDITED1)

oddsratio(Survey$NoV_OB, Survey$HICPAC_Effective_Controlling_EDITED1)

oddsratio(Survey$Q1, Q17A)
oddsratio(IP, Q17A)
Survey$NoV_OB <- relevel(Survey$NoV_OB, ref = "No")
oddsratio(Survey$NoV_OB, Q17A)

oddsratio(Survey$Q1, Q17B)
oddsratio(IP, Q17B)
oddsratio(Survey$NoV_OB, Q17B)

oddsratio(Survey$Q1, Q17C)
oddsratio(IP, Q17C)
oddsratio(Survey$NoV_OB, Q17C)

oddsratio(Survey$Q1, Q17D)
oddsratio(IP, Q17D)
oddsratio(Survey$NoV_OB, Q17D)

oddsratio(Survey$Q1, Q17E)
oddsratio(IP, Q17E)
oddsratio(Survey$NoV_OB, Q17E)

oddsratio(Survey$Q1, Q17F)
oddsratio(IP, Q17F)
oddsratio(Survey$NoV_OB, Q17F)

oddsratio(Survey$Q1, Q17G)
oddsratio(IP, Q17G)
oddsratio(Survey$NoV_OB, Q17G)

oddsratio(Survey$Q1, Q17H)
oddsratio(IP, Q17H)
oddsratio(Survey$NoV_OB, Q17H)

oddsratio(Survey$Q1, Q17I)
oddsratio(IP, Q17I)
oddsratio(Survey$NoV_OB, Q17I)

oddsratio(Survey$Q1, Q17J)
oddsratio(IP, Q17J)
oddsratio(Survey$NoV_OB, Q17J)

oddsratio(Survey$Q1, Q17K)
```

```
oddsratio(IP, Q17K)
oddsratio(Survey$NoV_OB, Q17K)

oddsratio(Survey$Q1, Q17L)
oddsratio(IP, Q17L)
oddsratio(Survey$NoV_OB, Q17L)

## Figures
a <- ggplot(Survey, aes(x=OB_Year)) + geom_bar(fill = "blue", binwidth=0.5) +
  theme_minimal() + theme(axis.text.x = element_text(angle=45, vjust=0.5, size=12),
      axis.title=element_text(size=14,face="bold"),
                    plot.title = element_text(size=20, face="bold"))
a + labs(list(x = "Year", y = "Number of Participants")) + annotate("text", x = 2014.5, y = 95,
      label = "* Partial Year")

Figure2 <- read.csv("C:/Users/Leslie/Documents/Qsync/School/Practicum-Thesis Work/Thesis
      Results/Figure2_112514.csv")
Figure2$NoV_Toolkit_Useful <- factor(Figure2$NoV_Toolkit_Useful, order = TRUE, levels =
      c("Strongly agree", "Somewhat agree", "Neither agree or disagree", "Somewhat disagree",
      "Strongly disagree"))
levels(Figure2$NoV_Toolkit_Useful)
levels(Figure2$NoV_Toolkit_Useful) <- gsub(" ", "\n", levels(Figure2$NoV_Toolkit_Useful))
b <- ggplot(Figure2, aes(x = NoV_Toolkit_Useful, y = NoV_Percent)) + geom_bar(fill = "blue",
      binwidth=0.5, stat = "identity") + theme_minimal() +
  theme(axis.text.x = element_text(vjust=0.75, size=12), axis.title =
      element_text(size=14,face="bold"))
b + scale_y_continuous(limits=c(0, 0.5), label = percent_format()) + labs(list(x = "", y =
      "Proportion of Participants"))

Figure3 <- read.csv("C:/Users/Leslie/Documents/Qsync/School/Practicum-Thesis Work/Thesis
      Results/Figure3_112514.csv")
Figure3$No_Rec_Implemented <- factor(Figure3$No_Rec_Implemented)
levels(Figure3$No_Rec_Implemented)
c <- ggplot(Figure3, aes(x = No_Rec_Implemented, y = Rec_Imp_Percent)) + geom_bar(fill =
      "blue", binwidth=0.5, stat = "identity") + theme_minimal() +
  theme(axis.text.x = element_text(vjust=0.5, size=12), axis.title =
      element_text(size=14,face="bold"))
c + scale_y_continuous(limits=c(0, 0.15),label = percent_format()) + labs(list(x = "Number of
      Implemented Recommendations", y = "Proportion of Participants"))

Figure4 <- read.csv("C:/Users/Leslie/Documents/Qsync/School/Practicum-Thesis Work/Thesis
      Results/Figure4_112514.csv")
Figure4$Recommendation <- factor(Figure4$Recommendation, levels =
      Figure4$Recommendation[order(Figure4$Rec_Percent_Yes)])
levels(Figure4$Recommendation) <- gsub(" ", "\n", levels(Figure4$Recommendation))
```

```
d <- ggplot(Figure4, aes(x = Recommendation, y = Rec_Percent_Yes)) + geom_bar(fill = "blue",
    binwidth=0.5, stat = "identity") + theme_minimal() +
  theme(axis.text.x = element_text(vjust=0.5, size=12),
    axis.title=element_text(size=14,face="bold"))
d + scale_y_continuous(limits=c(0, 1),label = percent_format()) + labs(list(x = "", y =
    "Proportion of Participants"))

Figure5 <- read.csv("C:/Users/Leslie/Documents/Qsync/School/Practicum-Thesis Work/Thesis
    Results/Figure5_112514.csv")
Figure5$Implemention_Barrier_EDITED <- factor(Figure5$Implemention_Barrier_EDITED,
    levels = Figure5$Implemention_Barrier_EDITED[order(Figure5$Barrier_Percent)])
levels(Figure5$Implemention_Barrier_EDITED) <- gsub(" ", "\n",
    levels(Figure5$Implemention_Barrier_EDITED))
e <- ggplot(Figure5, aes(x = Implemention_Barrier_EDITED, y = Barrier_Percent)) +
    geom_bar(fill = "blue", binwidth=0.5, stat = "identity") + theme_minimal() +
  theme(axis.text.x = element_text(vjust=0.5, size=12),
    axis.title=element_text(size=14,face="bold"))
e + scale_y_continuous(limits=c(0, 0.3),label = percent_format()) + labs(list(x = "", y =
    "Proportion of Participants"))

Figure6 <- read.csv("C:/Users/Leslie/Documents/Qsync/School/Practicum-Thesis Work/Thesis
    Results/Figure6_112514.csv")
Figure6$Challenging_Recommendation <- factor(Figure6$Challenging_Recommendation, levels
    = Figure6$Challenging_Recommendation[order(Figure6$Chal_Percent )])
levels(Figure6$Challenging_Recommendation) <- gsub(" ", "\n",
    levels(Figure6$Challenging_Recommendation))
f <- ggplot(Figure6, aes(x = Challenging_Recommendation, y = Chal_Percent)) + geom_bar(fill
    = "blue", binwidth=0.5, stat = "identity") + theme_minimal() +
  theme(axis.text.x = element_text(vjust=0.5, size=12),
    axis.title=element_text(size=14,face="bold"))
f + scale_y_continuous(limits=c(0, 0.3),label = percent_format()) + labs(list(x = "", y =
    "Proportion of Particip isitors", "Exclude\nill\nstaff", "Close\nUnits"))
```