New York City Department of Health & Mental Hygiene
Bureau of Communicable Disease
&

New York City Department of Environmental Protection
Bureau of Water Supply

Waterborne Disease Risk Assessment Program
2018 Annual Report

March 2019

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2017 NYC Filtration Avoidance Determination

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LIST OF ACRONYMS

Acronym	Description
ADM	Anti-diarrheal medication
BCD	Bureau of Communicable Disease
CGAP	*Cryptosporidium* and *Giardia* Action Plan
CIDT	Culture independent diagnostic test
CUSUM	Cumulative sums
DEP	Department of Environmental Protection
DOHMH	Department of Health and Mental Hygiene
ED	Emergency Department
GI	Gastrointestinal
NYC	New York City
NYSDOH	New York State Department of Health
O&P	Ova and parasite test
OTC	Over the counter medication
PCR	Polymerase chain reaction
UHF	United Hospital Fund
WDRAP	Waterborne Disease Risk Assessment Program

ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

The primary objectives of New York City (NYC)'s Waterborne Disease Risk Assessment Program are to: (a) obtain data on the rates of giardiasis and cryptosporidiosis, along with demographic and risk factor information on patients; and (b) provide a system to track gastrointestinal illness (diarrhea or vomiting) to ensure rapid detection of any outbreaks. The program began in 1993, and is jointly administered by two NYC agencies, the Department of Health and Mental Hygiene (DOHMH) and the Department of Environmental Protection (DEP). This report provides an overview of program activities and data collected during 2018.

DISEASE SURVEILLANCE

Active disease surveillance for giardiasis and cryptosporidiosis began in July 1993 and November 1994, respectively, and continued through 2010 when it was replaced by an electronic reporting system. This report presents the number of cases and case rates for giardiasis and cryptosporidiosis in 2018 (and includes data from past years for comparison). Demographic information for cases of giardiasis and cryptosporidiosis diagnosed in 2018 is also summarized in this report. Telephone interviews of cryptosporidiosis patients were conducted to gather potential risk exposure information, and selected results are presented.

Giardiasis and cryptosporidiosis rates declined over the first twenty years of this surveillance program. However the introduction of new and more sensitive diagnostic assays has led to an increase in parasitic disease rates, particularly cryptosporidiosis, since 2015. In 2018, there were 1,112 reported cases of giardiasis, compared to 975 in 2017. The rate of giardiasis per 100,000 population increased from 11.4 in 2017 to 12.9 in 2018, which exceeded the range of observed rates over the last decade (rate range 2008–2017: 9.2–11.4, median: 10.5). In 2018, there were 250 reported cases of cryptosporidiosis, compared to 163 in 2017. The rate of cryptosporidiosis per 100,000 population increased from 1.9 in 2017 to 2.9 in 2018, which again exceeded the range of observed rates over the last decade (rate range 2008–2017: 1.0–2.2, median: 1.3).

In 2015, the introduction of a new type of diagnostic test coincided with an increasing trend in observed cases of giardiasis and cryptosporidiosis. These assays, known as rapid syndromic multiplex polymerase chain reaction (PCR) panels, can test for the presence of a wide range of enteric organisms including *Cryptosporidium* and *Giardia*. Prior to the availability of these new tests, physicians would have to specifically request testing for *Cryptosporidium spp*. The poor sensitivity of traditional diagnostics in addition to specific testing requirements likely contributed to under-reporting of cryptosporidiosis. However, since 2015, physicians at an increasing number of hospitals and laboratories across NYC could order a single test for a patient with diarrheal disease and evaluate the presence of approximately 20 different pathogens. The increased number of cases of parasitic disease observed since 2015 are hypothesized to reflect an increase in the *detection* of cases and not a true increase in disease. This trend has also been observed across multiple jurisdictions in the United States.

Additionally, work by DOHMH suggests that cryptosporidiosis infections are commonly sexually transmitted infections among men who have sex with men in NYC.

SYNDROMIC SURVEILLANCE AND OUTBREAK DETECTION

The tracking of sentinel populations (e.g., nursing homes) or surrogate indicators of disease (e.g., drug sales) through "syndromic surveillance" can be useful in assessing gastrointestinal (GI) disease trends in the general population. Such tracking programs provide greater assurance against the possibility that a citywide outbreak would remain undetected. In addition, such programs can potentially play a role in limiting the extent of an outbreak by providing an early indication of an outbreak so that control measures are rapidly implemented.

DOHMH maintains four distinct and complementary outbreak detection systems: one system involves the tracking of chief complaints from hospital emergency department (ED) databases; a second system involves the monitoring of sales of over-the-counter (non-prescription) anti-diarrheal medications; a third system tracks the number of stool specimens submitted to a clinical laboratory for microbiological testing; the fourth system involves DOHMH monitoring and assisting in the investigation of GI outbreaks in eight sentinel nursing homes. A revision made to this year's annual report is that the description of the syndromic surveillance systems has been moved into a new Appendix (Appendix B).

A summary of syndromic surveillance findings for 2018 pertaining to GI illness is presented. Citywide trends and signals observed in the ED system were generally consistent with GI viral trends. There was no evidence of a drinking water-related outbreak in NYC in 2018.

INFORMATION SHARING AND RESPONSE PLANNING

Information on *Cryptosporidium* and *Giardia* is available on the websites of NYC's DEP and DOHMH as listed in Section 4 of this report. Included are annual reports on program activities, fact sheets on giardiasis and cryptosporidiosis, and results from the DEP's source water protozoa monitoring program. An updated version of NYC's *"Hillview Reservoir Cryptosporidium and Giardia Action Plan"* (CGAP) was issued in 2018. DOHMH developed a campaign to raise awareness of the risk of person-to-person transmission of enteric infections among men who have sex with men in 2018, with postcards and a specific informational webpage launched during the annual Pride Week 2018, a celebration of the lesbian, gay, bisexual, transgender and queer people and their allies.

1. INTRODUCTION

The Waterborne Disease Risk Assessment Program (WDRAP) is a multi-faceted public health assessment program that provides enhanced assurance of the microbial safety of New York City's (NYC) drinking water supply. This program is a critical element of NYC's Filtration Avoidance Program, which was developed in response to US Environmental Protection Agency's Surface Water Treatment Rule regulations. WDRAP is a joint agency program involving the NYC Department of Health & Mental Hygiene (DOHMH) and NYC Department of Environmental Protection (DEP). This partnership was originally established in 1993, under a joint-agency (DEP-DOHMH) Memorandum of Understanding. The intra-agency agreement between DEP and DOHMH for continuation of WDRAP was updated and signed in 2017, laying out the organizational & funding foundation for WDRAP until 2022.

The ongoing primary objectives of WDRAP are to:

- Obtain data on the rates of giardiasis and cryptosporidiosis, along with demographic and risk factor information on patients; and
- Provide a system to track gastrointestinal illness (diarrhea and vomiting) to ensure rapid detection of any waterborne disease outbreaks.

This report provides a summary of WDRAP highlights and data for the year 2018.

2. DISEASE SURVEILLANCE

2.1 Giardiasis

Giardiasis is a notifiable disease in NYC, per the NYC Health Code. From 1993 through 2010 active laboratory surveillance – involving visits or calls to labs by DOHMH staff – was conducted under WDRAP to ensure complete reporting of laboratory diagnosed cases of giardiasis. Since 2011, *Giardia* positive laboratory results have been reported to DOHMH via an electronic laboratory reporting system.

During 2018, a total of 1,112 cases of giardiasis were reported to DOHMH resulting in an annual case rate of 12.9 per 100,000 (Table 1). The annual case count increased 14% from 2017 to 2018. After a steep decline in giardiasis rates from 1994–2004 (rate range: 13.4–32.4 per 100,000, median 22.9 per 100,000, decline 59%) giardiasis rates remained relatively constant during 2005–2016 (rate range: 9.2–11.4 per 100,000, median: 10.5 per 100,000), as shown in Figure 1A. In 2017, the giardiasis rate was 11.4 per 100,000 and rose to 12.9 per 100,000 through 2018 (Figure 1B). The introduction of new syndromic multiplex panels started being used in clinical practice in 2015 may impact giardiasis incidence. (See further discussion later in this report).

Table 1: Giardiasis, the number of cases and case rates, New York City, 1994–2018.

Year	Number of Cases	Case Rate per 100,000
1994	2,457	32.3
1995	2,484	32.4
1996	2,288	29.6
1997	1,787	22.9
1998	1,959	24.9
1999	1,896	23.9
2000	1,771	22.1
2001	1,530	19.0
2002	1,423	17.6
2003	1,214	15.0
2004	1,088	13.4
2005	875	10.7
2006	938	11.4
2007	852	10.3
2008	840	10.0
2009	844	10.1
2010	923	11.3
2011	918	11.2
2012	872	10.7
2013	767	9.2
2014	864	10.4
2015	869	10.2
2016	899	10.5
2017	975	11.4
2018	1,112	12.9

Note:

- Active disease surveillance for giardiasis began in July 1993. Starting January 2011, active laboratory surveillance was replaced by an electronic reporting system.
- Case numbers in this table conform to the case numbers as they appear in the NYC Department of Health and Mental Hygiene Bureau of Communicable Disease surveillance database for the years 1994–2018, and rates have been accordingly adjusted. Minor variations in the data may be related to reporting delays, corrections, the removal of duplicate reports, and other data processing refinements. Yearly case numbers and rates in this table may therefore differ from case numbers and rates that appeared in prior WDRAP reports.

Since 1995, case investigations for giardiasis have been conducted only for patients who are known or suspected to be in a secondary transmission risk category (e.g., food handler, health care worker, child attending day care, or day care worker), or when giardiasis clusters or outbreaks are suspected. A total of 11 giardiasis cases were investigated in 2018 and five patients were excluded from work; no cases were associated with outbreaks. Two of the excluded patients were healthcare workers and three patients were food handlers. There were no known cases associated with day cares (either in children attending day care or adults who work in day cares) in 2018.

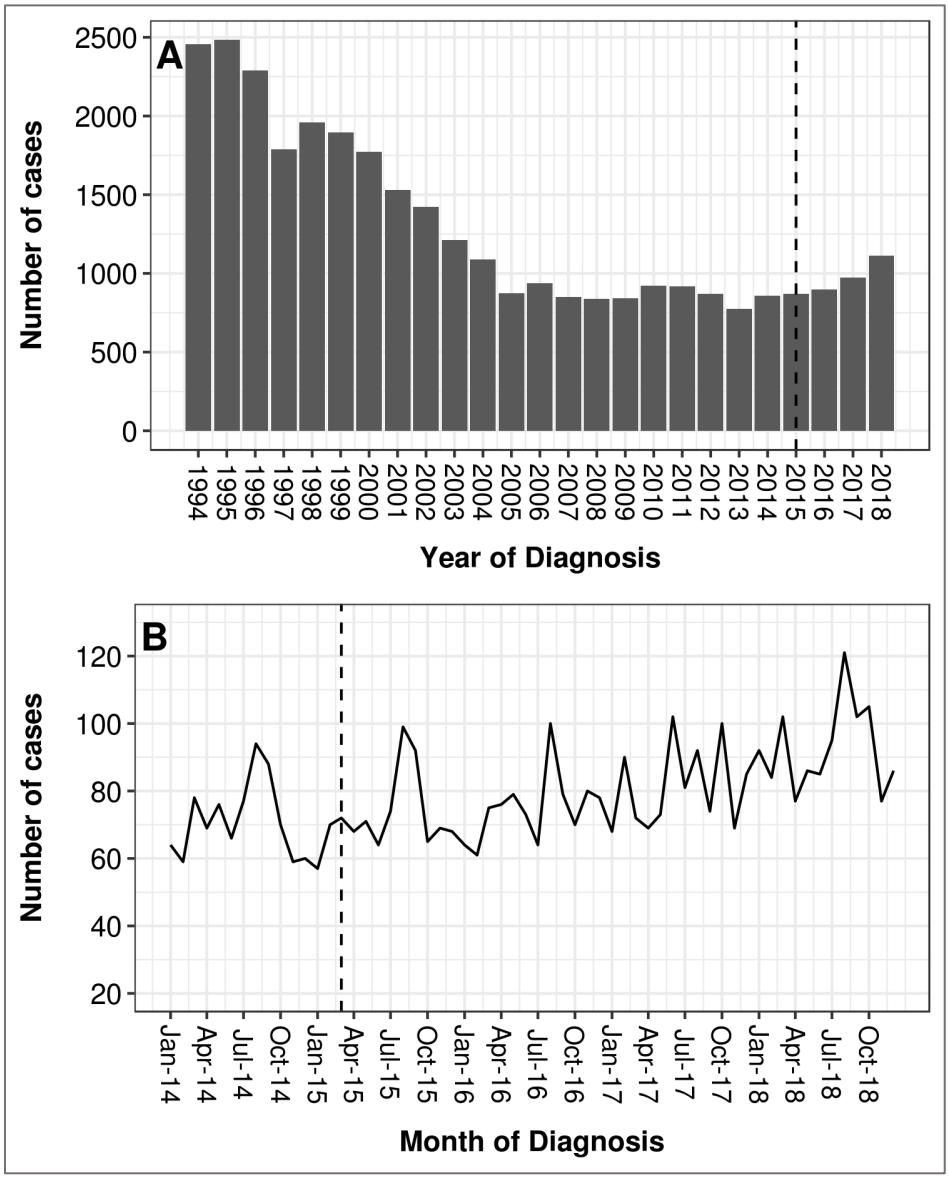

Figure 1: Annual **giardiasis** counts for all years in (A) and monthly counts for the last five years (B). The vertical dotted lines show the date when the first NYC laboratory reported results from using syndromic multiplex panels for enteric diseases.

The following provides highlights from the surveillance data for giardiasis among NYC residents diagnosed from January 1 through December 31, 2018. Data are presented in Figures 1 and 2 and Tables 1–6.

2.1.1 Borough of Patient Residence

Borough of patient residence was known for all 1,112 giardiasis patients who resided in NYC. Manhattan had the highest borough-specific annual case rate (24.7 cases per 100,000) (Table 3). The highest United Hospital Fund (UHF) neighborhood-specific case rate was found in the Chelsea-Clinton neighborhood in Manhattan (54.4 cases per 100,000) (Figure 2 and Table 4).

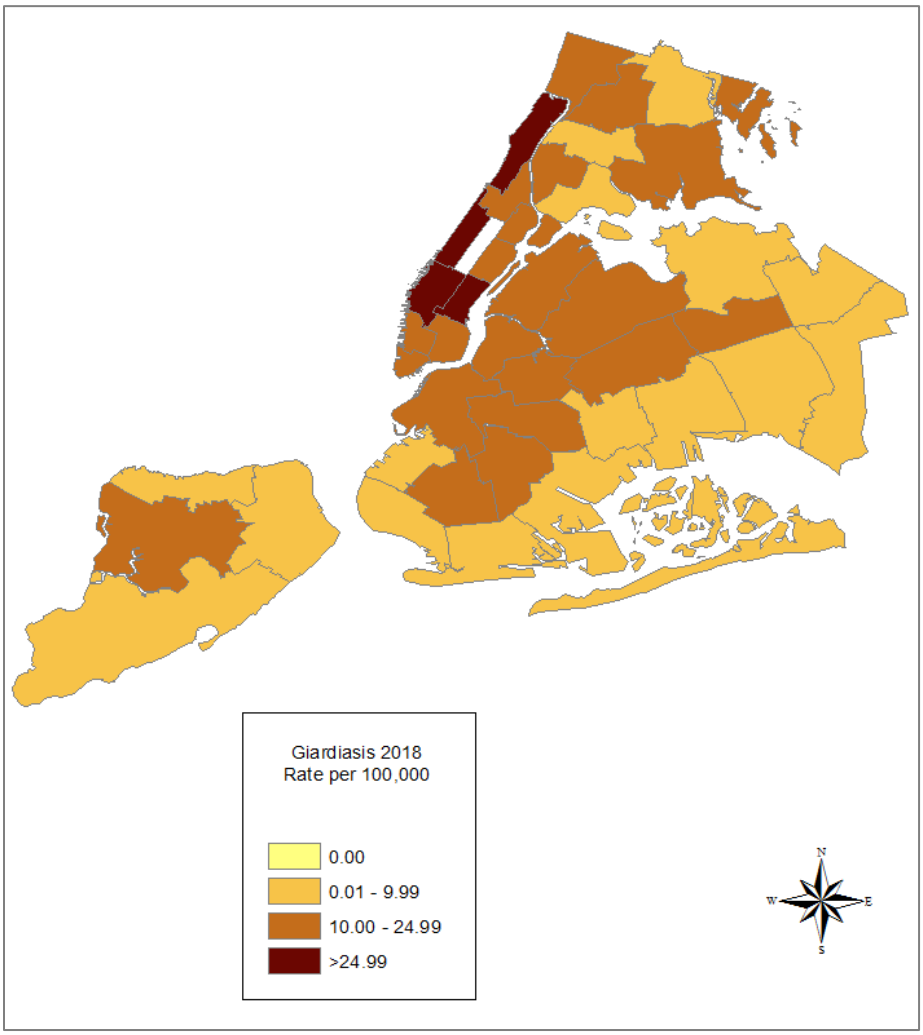

Figure 2. Map of giardiasis annual case rate per 100,000 population by United Hospital Fund Neighborhood, NYC, 2018.

2.1.2 Sex

Information regarding patient sex was available for all cases. The number and rate of giardiasis cases were higher in males than females, with 820 males (20.1 per 100,000) and 292 females (6.5 cases per 100,000) reported (Table 3). The highest sex- and borough-specific case rate was observed among males residing in Manhattan (41.8 cases per 100,000) (Table 3).

2.1.3 Age

Information regarding patient age was available for all cases. The highest age group-specific case rate was among persons aged 20–44 years (17.2 cases per 100,000). The highest age group and sex-specific case rate was among males aged 20–44 years (28.4 cases per 100,000) (Table 5). The two highest age-group and borough-specific case rates were in persons aged 45–59 years in Manhattan (38.7 cases per 100,000), followed by persons aged 20–44 years in Manhattan (30.5 cases per 100,000) (Table 6).

2.1.4 Race/Ethnicity

Information regarding patient race/ethnicity was available for only 141 of 1,112 (13%) cases. Ascertainment of race/ethnicity status for patients with giardiasis was poor. As mentioned, giardiasis patients are not routinely interviewed unless they are in occupations or settings that put them at increased risk for secondary transmission or if they are part of a suspected cluster or outbreak. Race/ethnicity information among giardiasis patients should be interpreted with caution as it may be based on the impressions of health care providers and may not reflect the patient's self-reported identity. For this reason, and because race/ethnicity information was missing for the majority of giardiasis disease reports, race/ethnicity findings pertaining to giardiasis patients diagnosed in 2018 are not presented in this report.

2.1.5 Census Tract Poverty Level

Age-adjusted case rates for giardiasis among four levels of census tract poverty, with levels encompassing low poverty to very high poverty, ranged from 13.6 to 20.3 cases per 100,000 population, with the lowest rate occurring in census tracts with very high poverty levels, and the highest rates occurring in census tracts with low poverty levels (Table 7). Based on data from earlier WDRAP reports and from previous analyses (Greene, Levin-Rector et al. 2015), giardiasis is not typically associated with neighborhood poverty level in NYC. However, because giardiasis patients are not routinely interviewed, specific risk factors for giardiasis (e.g. international travel) in areas of low poverty versus high poverty are not known (see APPENDIX A for poverty definition).

2.1.6 Laboratory Diagnosis Trends

Syndromic multiplex panels are highly sensitive and specific in the detection of giardiasis (Navidad, Griswold et al. 2013; Madison-Antenucci, Relich et al. 2016). These panels are also a more efficient and less expensive method to screen for a host of enteric pathogens, and their use has increased in recent years. In 2015, the proportion of giardiasis patients diagnosed exclusively by a syndromic multiplex panel at a hospital or commercial laboratory was 5%. This proportion grew to 12% in 2016, and rose to 16% in 2017. In 2018, almost a third (n=349, 32%) of all cases of giardiasis were exclusively diagnosed by a syndromic multiplex panel at a commercial or hospital laboratory. A variety of laboratories began using syndromic multiplex panels to test for giardiasis in 2018, including three large private hospitals, two high-volume commercial laboratories and one laboratory that serves a wide range of hospitals across the City. The adoption of syndromic multiplex panels for the diagnosis of giardiasis in NYC has been slower than for cryptosporidiosis, as discussed below. This may potentially be related to the higher sensitivity of traditional diagnostics like an ova and parasite exam for giardiasis compared to cryptosporidiosis. It may be that reported giardiasis incidence prior to 2015 was closer to the true burden of disease than was the reported incidence of cryptosporidiosis, given the relatively robust sensitivity of traditional diagnostic assays for giardiasis, and the fact that that the use of syndromic multiplex panels is not having a dramatic impact on reported giardiasis incidence in NYC.

2.2 Cryptosporidiosis

Cryptosporidiosis was added to the list of reportable diseases in the NYC Health Code in January 1994. Active disease surveillance for cryptosporidiosis involving lab visits and calls began in November 1994 and continued through 2010. Starting in 2011, active surveillance was replaced by electronic laboratory reporting. Patient interviews for demographic and risk factor data were initiated in 1995 and are ongoing.

During 2018, a total of 250 cases of cryptosporidiosis were reported to DOHMH, all of which met the case definition for confirmed cryptosporidiosis (see APPENDIX A for case definition description). The 2018 annual case rate was 2.9 per 100,000 (Table 2). The annual case count increased 53% from 2017 to 2018. After a sharp decline in cryptosporidiosis rates from 1995–2006 (rate range: 1.5–6.1 per 100,000, median 2.1 per 100,000, decline 75%), cryptosporidiosis rates remained relatively constant during 2007–2014 (rate range: 1.0–1.5 per 100,000, median: 1.3 per 100,000) as shown in Figure 3A. Cryptosporidiosis rates started to increase in 2015, rising from 1.6 per 100,000 to 2.9 per 100,000 in 2018.

Cryptosporidiosis is highly seasonal in NYC, as shown in Figure 3B. In 2018, cryptosporidiosis patients were most often diagnosed in August (35/250, 14%) or September (39/250, 16%). Because diagnosis may occur sometime after onset, information is collected in the interview regarding date of symptom onset. The date of onset can be used more accurately than date of

diagnosis to estimate when patients were likely exposed to *Cryptosporidium* and is used to determine the risk exposure period.

The following provides highlights from the surveillance data for cryptosporidiosis among NYC residents from January 1 through December 31, 2018. Data are presented in Figures 3─5 and Tables 7─18.

Table 2: Cryptosporidiosis, number of cases and case rates, New York City, 1994─2018

Year	Number of Cases	Case Rate per 100,000
1994	288	3.8
1995	471	6.1
1996	334	4.3
1997	172	2.2
1998	207	2.6
1999	261	3.3
2000	172	2.1
2001	122	1.5
2002	148	1.8
2003	126	1.6
2004	138	1.7
2005	148	1.8
2006	155	1.9
2007	105	1.3
2008	107	1.3
2009	81	1.0
2010	107	1.3
2011	86	1.1
2012	125	1.5
2013	80	1.0
2014	102	1.2
2015	133	1.6
2016	192	2.2
2017	163	1.9
2018	250	2.9

Note:

- Case numbers in this table conform to the case numbers as they appear in the NYC Department of Health and Mental Hygiene Bureau of Communicable Disease surveillance database for the years 1994-2018, and rates have been accordingly adjusted. Minor variations in the data may be related to reporting delays, corrections, the removal of duplicate reports, and other data processing refinements. Yearly case numbers and rates in this table may therefore differ from case numbers and rates that have appeared in prior WDRAP reports.

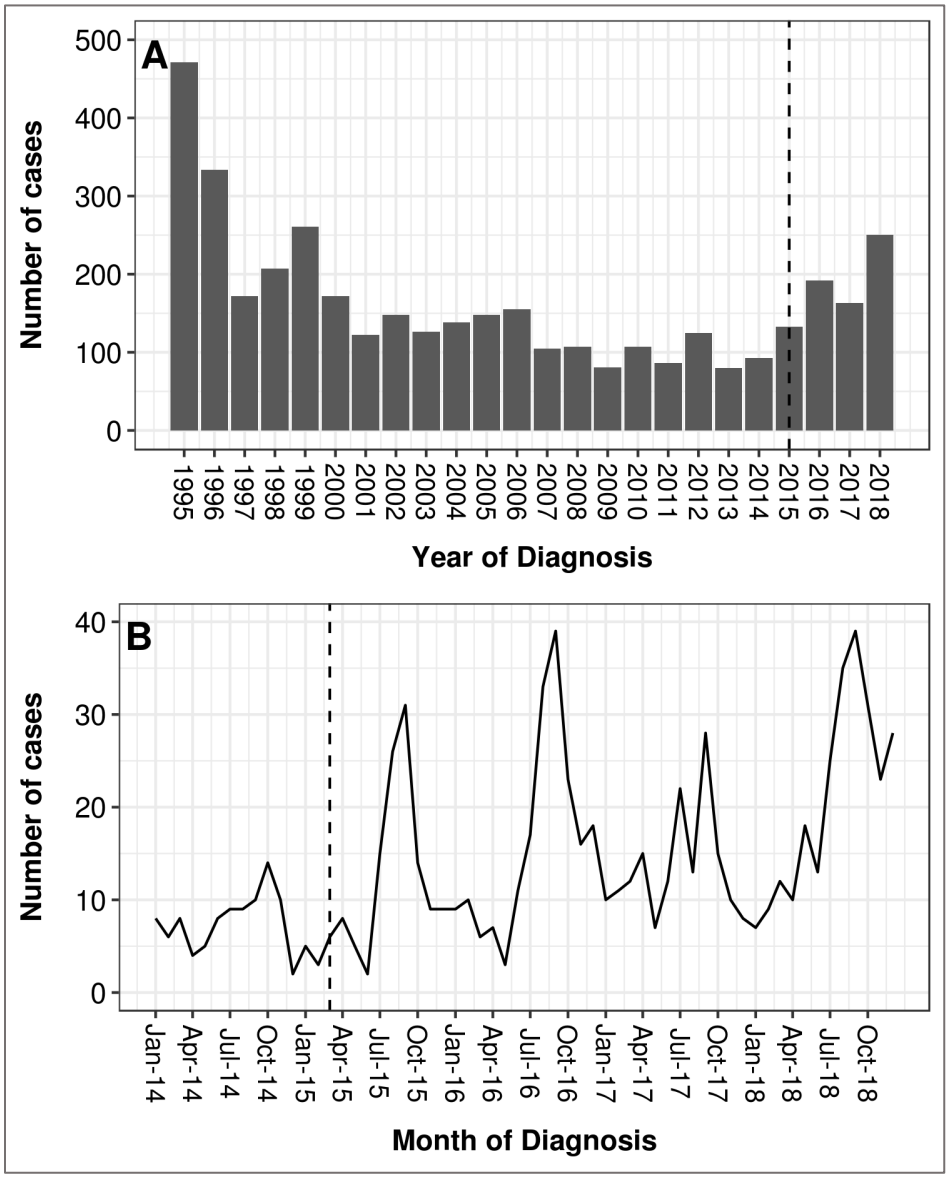

Figure 3: Annual **cryptosporidiosis** counts for all years in (A) and monthly counts for the last five years (B). The vertical dotted lines show the date when the first laboratory NYC reported results from syndromic multiplex panels for enteric diseases.

2.2.1 Borough of patient residence

Information on borough of residence was available for all 250 cases of cryptosporidiosis. Manhattan had the highest borough-specific annual case rate (5.8 cases per 100,000) (Table 8). The highest UHF neighborhood-specific case rate was in the Greenpoint neighborhood in Brooklyn (13.8 cases per 100,000), followed by Chelsea-Clinton in Manhattan (10.6 cases per 100,000) (Figure 4 and Table 9).

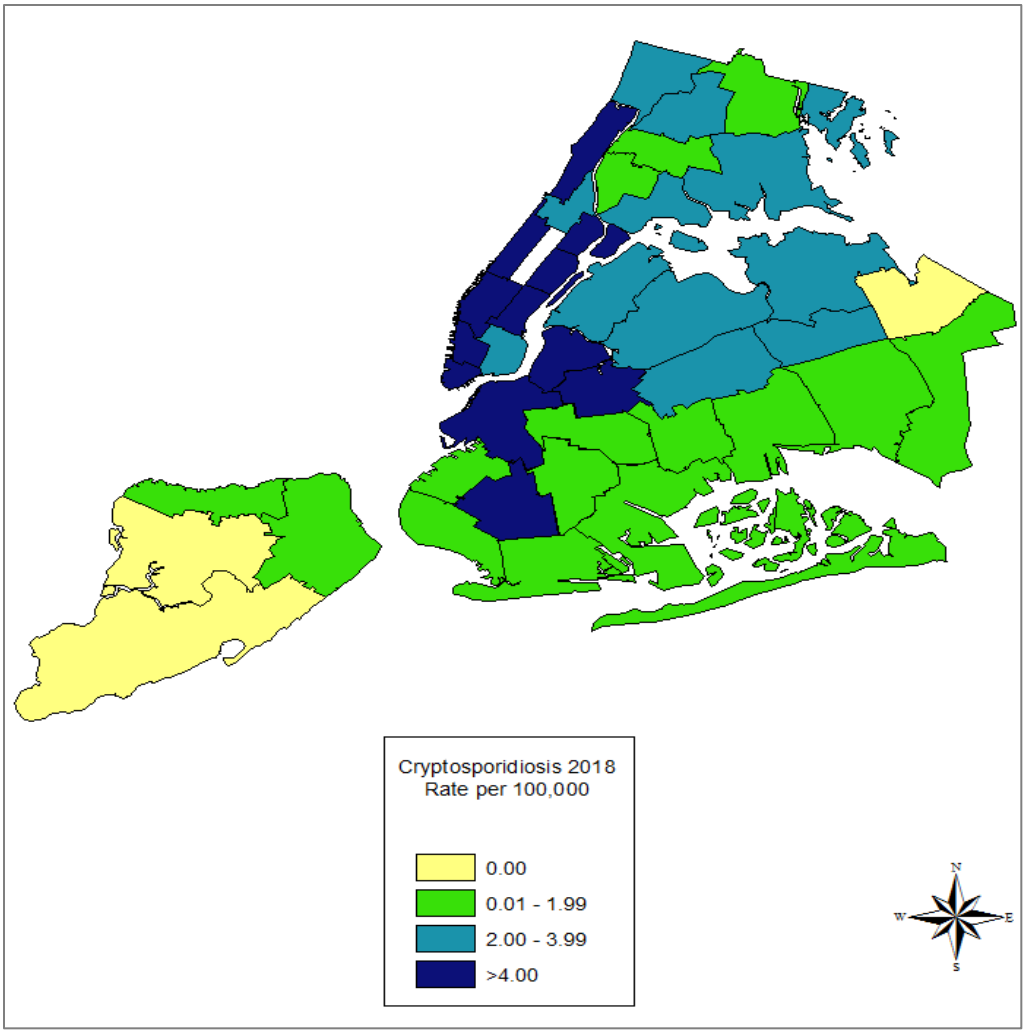

Figure 4: Map of cryptosporidiosis annual case rate per 100,000 population by United Hospital Fund neighborhood, NYC, 2018.

2.2.2 Sex

Information regarding patient sex was available for all cases. The number and rate of cryptosporidiosis cases was higher in males than females, with 167 males (4.1 cases per 100,000), and 83 females (1.9 cases per 100,000) (Table 8). The borough- and sex-specific case rate was highest for males in Manhattan (8.2 cases per 100,000) (Table 8).

2.2.3 Age

Information regarding patient age was available for all cases. The highest age group-specific case rates were in children aged <5 years (5.6 cases per 100,000), followed by persons aged 20–44 years (4.2 cases per 100,000). The highest age group- and sex-specific case rates were in males aged 20–44 years (6.1 cases per 100,000) (Table 10). The highest age group and borough-

specific case rates occurred in adults aged 20–44 years in Manhattan (8.4 cases per 100,000), followed by children aged <5 years in Brooklyn (7.8 cases per 100,000) (Table 11).

2.2.4 Race/Ethnicity

Patient race/ethnicity information was available for 226 of 250 cases (90%). Among the major racial/ethnic groups, White, non-Hispanic persons had the highest cryptosporidiosis rate (4.3 per 100,000) followed by Hispanic persons (2.1 per 100,000) and Black/African American, non-Hispanic persons (1.3 per 100,000) (Table 12). Cryptosporidiosis rates were highest in all racial/ethnic groups in the borough of Manhattan, followed by the Bronx for Hispanic persons and Black/African American, non-Hispanic persons and Brooklyn for White, non-Hispanic persons (Table 12). Rates were highest in children aged <5 years and adults aged 20–44 years in White, non-Hispanic persons. For persons of Hispanic ethnicity, rates were also highest in children aged <5 years, and fairly evenly distributed among the persons aged >5 years. For Black/African American, non-Hispanic persons, rates were highest in adults aged 20–44 and 45–59 years (Table 13).

2.2.5 Census Tract Poverty Level

Age-adjusted case rates for cryptosporidiosis among four levels of census tract poverty ranged from 2.8–4.4 cases per 100,000 population, with no clear pattern between age-adjusted rate and increasing or decreasing census tract poverty level in 2018 (Table 14).

2.2.6 Laboratory Diagnosis Trend

In 2015, the proportion of cryptosporidiosis patients diagnosed exclusively by a syndromic multiplex panel at a hospital or commercial laboratory was 20%. This proportion grew to 34% in 2016, and rose to 48% in 2017. In 2018, three-quarters (n=184, 75%) of all cases of cryptosporidiosis were exclusively diagnosed by a syndromic multiplex panel at a commercial or hospital laboratory. This trend has been mirrored across a number of different jurisdictions in the United States (Huang, Henao et al. 2016; Marder, Cieslak et al. 2017). These new assays are more sensitive and specific for the detection of cryptosporidiosis than traditional microscopic diagnostic techniques (Navidad, Griswold et al. 2013; Buss, Leber et al. 2015), and also considerably less expensive.

A number of large healthcare facilities in NYC began to report cryptosporidiosis diagnosed by syndromic multiplex panels to DOHMH during 2015─2017. In 2018, a variety of additional laboratories in NYC adopted syndromic multiplex panels and began routinely testing for cryptosporidiosis, including three large private hospitals, two high-volume commercial laboratories and one laboratory that serves a wide range of hospitals across NYC. The increased range of hospitals and laboratories using the syndromic multiplex panels is leading to an increase in reported incidence of cryptosporidiosis across a range of neighborhoods in NYC. Importantly, DOHMH has observed substantial increases in reported incidence of a range of additional enteric

infections included on syndromic multiplex panels across NYC. Some infections with increasing incidence due to the use of syndromic multiplex panels, such as norovirus, are transmitted predominately by person-to-person contact or fecal-oral contact, and are not normally related to waterborne transmission. DOHMH is working to adjust its surveillance system to account for syndromic multiplex panel adoption to reduce over-signaling (Peterson, Fireteanu et al. 2018).

2.2.7 Cryptosporidiosis and Immune Status

Trends observed over the years in reported numbers of cryptosporidiosis cases have differed between persons living with HIV/AIDS and those who are immunocompetent. Reported cryptosporidiosis cases among persons living with HIV/AIDS declined dramatically during 1995─1997, corresponding with the introduction of highly active antiretroviral therapy for HIV/AIDS. The count of cryptosporidiosis cases among persons living with HIV/AIDS has continued to decline since then, with only 48 cases reported in 2018 (representing 19% of all cases). The count of cryptosporidiosis cases among immunocompetent patients has increased since 2015, however, rising from 78 to 182 in 2018 (133% increase) (Figure 5). This trend is also related to the introduction of syndromic multiplex panels in 2015. Prior to the use of these diagnostic tests, physicians would have to specifically request testing for *Cryptosporidium spp.* for patients. As cryptosporidiosis infection can be particularly severe among people living with HIV/AIDS (Blanshard, Jackson et al. 1992; Poznansky, Coker et al. 1995; Rashmi and Kumar 2013), physicians were historically more likely to consider cryptosporidiosis in their differential diagnosis of diarrheal disease among persons living with HIV/AIDS than in a person without HIV/AIDS. However, now that syndromic multiplex panels are ordered for diagnosis of any diarrheal infection in hospitals that have adopted these assays, cryptosporidiosis is more frequently identified in immunocompetent patients who likely would not have been tested for cryptosporidiosis before 2015.

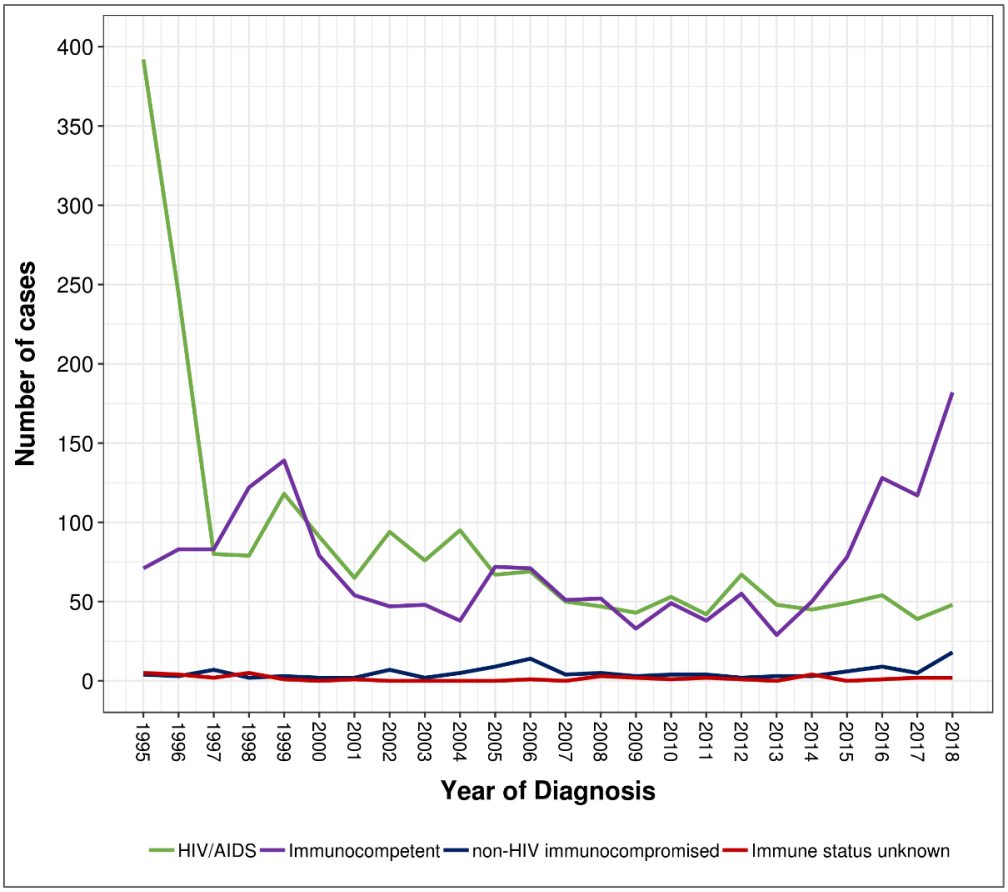

Figure 5: Cryptosporidiosis, number of cases by year of diagnosis and immune status, New York City, 1995–2018.

2.2.8 Cryptosporidiosis and Potential Risk Exposures

Of the 250 cryptosporidiosis cases diagnosed among NYC residents in 2018, questionnaires concerning potential exposures were completed for 212 (85%) patients. For patients with missing interview data, investigators were either unable to locate the patient (22 cases, 9%) or the patient refused interview (15 cases, 6%) and one patient was unable to be interviewed due to incapacitating illness. Of the immunocompetent patients, interviews were completed for 158 patients (87%). Among persons with HIV/AIDS, interviews were completed for 39 patients (81%), and interviews were completed for 15 patients (83%) who were immunocompromised for reasons other than HIV/AIDS. Summary data for 1995 through 2018 on commonly reported potential risk exposures, obtained from patient interviews of persons with HIV/AIDS and from interviews of persons who are immunocompetent, are presented in Table 15 and Table 16, respectively. Information has also been collected regarding type of tap water consumption, and is presented in Table 17 and Table 18. Patterns of drinking water use among immunocompetent patients were not noticeably different in 2018 compared with previous years. Patterns of drinking water use reported among patients with HIV/AIDS suggested some possible shifts, e.g., plain tap water consumption appeared somewhat lower, and “incidental plain tap water only” consumption

appeared higher (33%) in 2018 compared with earlier years, though it is unclear what drove these reported changes.

Tables 15─18 indicate the percentage of patients who reported engaging in each of the listed potential risk exposures for cryptosporidiosis before disease onset. However, it must be noted that the determination of an association between exposure to possible risk factors for cryptosporidiosis and acquisition of cryptosporidiosis cannot be made without reference to a suitable control population (i.e., non-*Cryptosporidium*-infected controls). As exposure data for a control population are not available, such determinations of association cannot be made.

Though no conclusions about association can be reached, in an attempt to assess if there are any patterns of interest, data have been compared between patients who are immunocompromised because of HIV/AIDS and patients who are immunocompetent. In 2018, interviewed patients who were immunocompetent were significantly more likely to report international travel (44%) compared to patients with HIV/AIDS (7%) ($p<0.0001$, Fishers exact test). Additionally, interviewed immunocompetent patients were also more likely to report exposure to recreational water (32%) compared to patients with HIV/AIDS (5%) ($p=0.0002$, Fishers exact test). There were no significant differences in reported contact with an animal between the two groups (31% and 43%, respectively, $p=0.1841$, chi-square test). Finally, interviewed patients with HIV/AIDS were more likely to report high-risk sexual activity (42%) compared to immunocompetent patients (17%) ($p=0.0037$, chi-square test). The proportion of patients with HIV/AIDS reporting high-risk sexual activity was greater in 2018 compared to all previous years (Table 15). It should be noted that high-risk sex in this context refers to having a penis, finger or tongue in a partner's anus. Information about sexual practices is gathered via phone interview and may not be reliable. More years' worth of data are needed to understand whether this will be a sustained trend. It is unclear what could be the cause of these reported changes in sexual practices among patients with HIV/AIDS, but they might relate to an increase in pre-exposure prophylaxis treatment for HIV in this population (Traeger, Schroeder et al. 2018). Overall, these data indicate that, for most years, immunocompetent patients were more likely to travel internationally and have greater recreational water exposure than immunocompromised patients. International travel and exposure to recreational water may be more likely risk factors for the acquisition of cryptosporidiosis in the immunocompetent group. However, as noted above, the extent to which these risk factors may have been associated with cryptosporidiosis cannot be determined without comparison to a control population.

2.2.9 Cryptosporidiosis as a Sexually Transmitted Infection

As in all previous years, the largest age/sex demographic group diagnosed with cryptosporidiosis in 2018 was adult men aged 20─44 years (39%). Adult men aged 45─59 years accounted for an additional 9% of all people diagnosed with cryptosporidiosis in 2018. This demographic group has been consistently over-represented in surveillance data since the WDRAP began. Furthermore, cryptosporidiosis rates have historically and consistently been elevated in Chelsea-Clinton, a neighborhood in Manhattan with a higher prevalence of men who have sex with men

compared to the rest of NYC (Bureau of Epidemiology Services New York City Department of Health and Mental Hygiene 2017). Therefore, it is hypothesized that cryptosporidiosis is often an infection of men who have sex with men in NYC. Men who have sex with men are historically at greater risk for cryptosporidiosis, not only because of a higher prevalence of AIDS in this population (Centers for Disease Control and Prevention 2006), but also because of higher risk sexual practices, such as anilingus, that entail a low risk for HIV transmission but increase the risk for fecal contact (Hellard, Hocking et al. 2003). In 2018, there were a total of 88 adult men aged 20─59 years who answered questions related to sexual behavior in their cryptosporidiosis incubation period. There were a total of 61 other adults (men aged 18 and 19 years and men aged >59 years as well as all women ≥18 years) who answered the sexual behavior questions during interview. Among men diagnosed with cryptosporidiosis aged 20─59 years, 43% (38/88) reported high-risk sexual practices, compared to 7% (4/61) of all other adult cryptosporidiosis patients ($p<0.001$, Fishers exact test). There are considerable limitations with large amounts of missing data in the sexual behavior questions. However, the data suggest that adult men diagnosed with cryptosporidiosis are likely to admit to engaging in sexual behaviors that increase the risk of fecal/oral contact.

3. SYNDROMIC SURVEILLANCE AND OUTBREAK DETECTION

The tracking of sentinel populations or surrogate indicators of disease ("syndromic surveillance") can be useful in assessing gastrointestinal (GI) disease trends in the general population. Such tracking programs provide greater assurance against the possibility that a citywide outbreak would remain undetected. In addition, such programs can potentially play a role in limiting the extent of an outbreak by providing an early indication of a problem so that control measures are rapidly implemented. Beginning in the 1990s, NYC established and has maintained a number of distinct and complementary outbreak detection systems. One system utilizes hospital emergency department (ED) chief complaint logs to monitor for outbreaks. The ED system is relied upon most heavily for monitoring the burden of diarrheal illness in NYC. A second DOHMH system monitors sales of anti-diarrheal medications: the Anti-Diarrheal Monitoring System (ADM)/over-the-counter medication (OTC) system. A third system monitors the number of stool specimens submitted to a participating clinical laboratory for microbiological testing. Finally, the fourth system monitors for GI outbreaks in sentinel nursing homes and DOHMH staff assist in the investigation of any identified outbreaks. A full description of each system can be found in APPENDIX B.

Other than the ED system, which is mandated under the NYC Health Code, all systems rely upon the voluntary participation of the organizations providing the syndromic data. A summary of syndromic surveillance findings pertaining to GI illness for 2018 is provided in the final section of Section 3.1 and in Figure 6, Figure 7, and Figure 8.

Throughout 2018, DOHMH received electronic data from all of NYC's 53 EDs, which reported approximately, 11,500 visits per day. Additionally, data were received daily from approximately 560 pharmacies in 2018 as part of the ADM/OTC system. Finally, WDRAP team members made

site visits to seven of eight nursing homes participating in the Nursing Home Sentinel Surveillance system in 2018. The remaining nursing home was visited in January 2019.

3.1 Findings: Summary of Syndromic Surveillance Signals

Syndromic surveillance signals alone cannot be used to determine etiologic diagnoses. Also, experience has shown that most signals, especially localized spatial signals in the emergency department system or signals in the laboratory or ADM monitoring systems, may be statistical aberrations and not related to public health events. The systems are therefore used in concert. A signal in one system is compared to other systems to evaluate the presence of concurrent signals. In this report, Figures 6─8 summarize GI disease signals from NYC's syndromic surveillance systems. Figure 6 and Figure 7 summarize ED system trends and signals from the Emergency Department system only. Figure 8 summarizes signal results from all syndromic surveillance systems operated by DOHMH during 2018.

Of note, DOHMH saw a sustained increase in norovirus reports through routine surveillance activities during November 2017—April 2018 compared to previous years. Additionally, there was a prolonged rotavirus season in 2018, beginning in January 2018—April 2018. For the most up to date data on all communicable diseases from DOHMH, please see the Epiquery webpage (New York City Department of Health and Mental Hygiene 2019).

Figure 6 shows the ratio of daily ED visits for the diarrhea syndrome to all other daily ED visits for syndromes not tracked by ED syndromic surveillance ("other visits") from January 1 to December 31, 2018. The graph also indicates the occurrence of citywide signals and of the spatial residential zip code and hospital signals. There were several citywide signals in January, March, and April of 2018, which are likely related to the increased norovirus and rotavirus reports mentioned. There were two signals for the diarrheal illness syndrome in July 2018 (July 6 and July 8), followed by both a residential zip code signal (July 13─14) and hospital signals (July 13─14). The zip code and hospital signals were related to one large hospital that upgraded to a new electronic health record system. This new system caused a change to the way chief complaint data are recorded. The baseline count of cases for this hospital was artificially low and subsequently resulted in spurious signals. This will be corrected once there are enough new data in the baseline.

Figure 7 shows the ratio of daily ED visits for the vomiting syndrome compared to all other daily ED visits for syndromes not tracked by ED syndromic surveillance for 2018. There were several citywide signals in January, February and March, corresponding to viral gastroenteritis. There were single-day, citywide signals in June, August and September. Given the lack of ED signal duration and corresponding lack of signals in the other monitoring systems, these were not determined to be related to a waterborne disease outbreak.

Figure 8 shows the timing of signals from all four surveillance systems in 2018. The January–April ED signals of vomiting and diarrhea as discussed overlapped with sustained OTC/ADM signals, which were concentrated between early January and mid-February and then again

between mid-April and early May. The majority of the OTC/ADM signals were found to be related to promotional sales at the pharmacy chains, specifically for Pepto Bismol®/Bismuth sales. After May, there were only a few sporadic OTC/ADM signals for the remainder of the year (September and December). There was no evidence to suggest these were related to a waterborne disease outbreak. There were several signals in the Clinical Laboratory surveillance system, occurring during several months of the year. All signals lasted for only a single day, with the exception of a signal in August. This signal occurred from August 3–4 and was not associated with any changes in business practices; during the week of July 29–August 4, there were no positive stool specimens for *Cryptosporidium* in a NYC resident.

There was one GI outbreak in a sentinel nursing home in 2018. The sentinel nursing home GI outbreak occurred in a facility in Manhattan, beginning on June 10, 2018. Eighteen patients on two units and one staff member were affected. The symptoms were diarrhea and vomiting, and there were no deaths or hospitalizations. The facility sent 11 stool specimens from five residents to facility-associated laboratories for testing. Three samples were sent for bacterial testing, three samples were sent for parasitic testing including *Cryptosporidium,* two samples were sent for *C. difficile* testing and three samples were sent for viral testing. Two of the viral specimens were not tested due to insufficient specimen. The remaining nine specimens were negative. Given the clinical description of the cases and the lack of an identified bacterial or parasitic etiology, it is likely that this outbreak was caused by norovirus. DOHMH staff members reviewed the Sentinel Nursing Home Surveillance Protocol with the Infection Control Nurse at the nursing home to help ensure that in the event of future outbreaks, specimens are tested at the Public Health Laboratory, and notification is done in a timely manner.

In summary, there were multiple citywide signals for GI illness in the ED system in 2018, which coincided with large increases in reporting of norovirus and rotavirus in NYC. Antidiarrheal medication sale signals also occurred early in 2018 as well as in April/May, which were found to be related to promotional sales.

In conclusion, during 2018, there were no signals consistent with a waterborne disease outbreak from the four syndromic surveillance systems set up to detect an outbreak related to the water supply. This finding is consistent with all prior years of WDRAP surveillance.

4. INFORMATION SHARING AND RESPONSE PLANNING

Information pertaining to NYC's Waterborne Disease Risk Assessment Program and related issues are available on both the DEP and DOHMH websites, including results from the City's source water protozoa monitoring program. Documents on the websites include:

DOHMH Webpages:

- *Giardiasis fact sheet*
  https://www1.nyc.gov/site/doh/health/health-topics/giardiasis.page

- *Cryptosporidiosis fact sheet*

http://www1.nyc.gov/site/doh/health/health-topics/cryptosporidiosis.page

- Communicable Disease Surveillance Data
  https://a816-healthpsi.nyc.gov/epiquery/CDSS/index.html

- Diarrheal Infections in Gay Men and Other Men Who Have Sex with Men
  https://www1.nyc.gov/site/doh/health/health-topics/diarrheal-infections.page

DEP Webpages:

- *DEP Water Supply Testing Results for Giardia and Cryptosporidium*
  (Data are collected and entered on the website each week. Historical data are also included).
  http://www.nyc.gov/html/dep/html/drinking_water/pathogen.shtml

- *Waterborne Disease Risk Assessment Program's Annual Reports, 1997—Present*
  http://www.nyc.gov/html/dep/html/drinking_water/wdrap.shtml

- *New York City Drinking Water Supply and Quality Statement, 1997–Present*
  http://www.nyc.gov/html/dep/html/drinking_water/wsstate.shtml

With regard to response planning, NYC has developed an action plan for responding to elevations in levels of either *Giardia* cysts or *Cryptosporidium* oocysts at a key water supply monitoring location. The initial response plan was developed in 2001. The plan in its current form is known as, NYC's *"Hillview Reservoir Cryptosporidium and Giardia Action Plan* (CGAP)*,* and the plan is reviewed & updated annually.

In 2018, DOHMH developed a multifaceted campaign to target men who have sex with men in NYC to raise awareness of the risk of cryptosporidiosis and other enteric infections that can be transmitted by fecal/oral contact. DOHMH developed a postcard that was distributed during Pride Week 2018 (a week of celebration of gay, lesbian, bisexual, transgender, and queer people and allies) and created a website highlighting common symptoms, transmission pathways and how to avoid infection specifically for men who have sex with men. This targeted messaging will continue in 2019.

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6. TABLES AND FIGURES

Table 3: Giardiasis, number of cases and annual case rate per 100,000 population (in parentheses) by sex and borough of residence, New York City, 2018.

		Borough of residence				
Sex	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Male	820	330	104	212	153	21
	(20.1)	(41.8)	(15.0)	(16.8)	(13.4)	(9.0)
Female	292	82	50	87	61	12
	(6.5)	(9.4)	(6.4)	(6.2)	(5.0)	(4.9)
Total	1,112	412	154	299	214	33
	(12.9)	(24.7)	(10.5)	(11.3)	(9.1)	(6.9)

Table 4: Giardiasis, number of cases and annual case rate per 100,000 by United Hospital Fund neighborhood of residence, New York City, 2018.

United Hospital Fund Neighborhood	Borough	Number Of Cases	Population	Case Rate
Chelsea-Clinton	Manhattan	87	160011	54.4
Gramercy Park-Murray Hill	Manhattan	36	131615	27.4
Upper West Side	Manhattan	57	221917	25.7
Washington Heights-Inwood	Manhattan	70	278591	25.1
Downtown-Heights-Slope	Brooklyn	59	258924	22.8
Greenwich Village-Soho	Manhattan	19	84692	22.4
Upper East Side	Manhattan	47	224885	20.9
Long Island City-Astoria	Queens	42	217761	19.3
Union Sq-Lower East Side	Manhattan	38	198425	19.2
Lower Manhattan	Manhattan	11	60043	18.3
C.Harlem-Morningside Heights	Manhattan	29	181803	16.0
Greenpoint	Brooklyn	21	138051	15.2
Borough Park	Brooklyn	53	349436	15.2
High Bridge-Morrisania	Bronx	32	221054	14.5
West Queens	Queens	67	478618	14.0
East Harlem	Manhattan	16	115799	13.8
Fordham-Bronx Park	Bronx	33	264847	12.5
Ridgewood-Forest Hills	Queens	31	255484	12.1
Williamsburg-Bushwick	Brooklyn	27	225065	12.0
Bed Stuyvesant-Crown Heights	Brooklyn	38	333494	11.4
Willowbrook	Staten Island	10	90139	11.1
Fresh Meadows	Queens	11	102566	10.7
Kingsbridge-Riverdale	Bronx	10	94018	10.6
Pelham-Throgs Neck	Bronx	32	312855	10.2
East Flatbush-Flatbush	Brooklyn	31	306578	10.1
Hunts Point-Mott Haven	Bronx	14	145897	9.6
Coney Island-Sheepshead Bay	Brooklyn	28	293411	9.5
Sunset Park	Brooklyn	12	134024	9.0
Bensonhurst-Bay Ridge	Brooklyn	18	212964	8.5
Crotona-Tremont	Bronx	18	219387	8.2
Rockaway	Queens	9	124042	7.3
Stapleton-St.George	Staten Island	9	125888	7.1
Northeast Bronx	Bronx	14	205747	6.8
South Beach-Tottenville	Staten Island	11	194909	5.6
Southwest Queens	Queens	15	297023	5.1
Southeast Queens	Queens	10	215871	4.6
Bayside-Littleneck	Queens	4	91278	4.4
Port Richmond	Staten Island	3	68522	4.4
Jamaica	Queens	14	323963	4.3
Flushing-Clearview	Queens	11	266276	4.1
East New York	Brooklyn	6	188219	3.9
Canarsie-Flatlands	Brooklyn	5	208606	2.4

Note: this table does not include four cases of giardiasis in which UHF neighborhood could not be determined.

Table 5: Giardiasis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and sex, New York City, 2018.

		Sex	
Age Group	Total	Male	Female
<5 years	60	32	28
	(10.9)	(11.3)	(10.4)
5-9 years	72	39	33
	(14.6)	(15.4)	(13.7)
10-19 years	77	55	22
	(8.3)	(11.7)	(4.8)
20–44 years	568	456	112
	(17.2)	(28.4)	(6.6)
45–59 years	219	168	51
	(13.4)	(21.7)	(6.0)
≥ 60 years	116	70	46
	(6.8)	(9.6)	(4.7)
Total	1,112	820	292
	(12.9)	(20.1)	(6.5)

Table 6: Giardiasis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and borough of residence, New York City, 2018.

	Borough of residence					
Age Group	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
<5 years	60	3	16	25	16	0
	(10.9)	(3.7)	(15.1)	(12.9)	(11.0)	
5–9 years	72	5	28	20	17	2
	(14.6)	(7.6)	(27.2)	(12.0)	(13.1)	(7.0)
10–19 years	77	13	18	18	24	4
	(8.3)	(10.1)	(9.2)	(6.1)	(9.8)	(6.7)
20–44 years	568	223	53	174	103	15
	(17.2)	(30.5)	(9.9)	(16.9)	(12.0)	(9.7)
45–59 years	219	117	22	38	36	6
	(13.4)	(38.7)	(8.0)	(8.1)	(7.4)	(5.9)
≥ 60 years	116	51	17	24	18	6
	(6.8)	(14.3)	(6.7)	(4.8)	(3.6)	(5.6)
Total	1,112	412	154	299	214	33
	(12.9)	(24.7)	(10.5)	(11.3)	(9.1)	(6.9)

Table 7: Giardiasis, number of cases and case rates by census tract poverty level, New York City, 2018.

Census Tract Poverty Level	Number of cases	Case Rate per 100,000	Age adjusted rate
Low [a]	325	14.5	20.3
Medium [b]	358	13.5	18.7
High [c]	240	13.6	18.0
Very high [d]	184	9.4	13.6

Poverty levels are defined by the American Community Survey, 2013–2017 and are defined as the proportion of residents that have household incomes below 100% of the federal poverty level: [a] Low poverty: <10%; [b] Medium poverty: 10–19%; [c] High poverty: 20–29%; [d] Very high poverty: ≥30%.

Note: five cases (0.4%) were excluded from this table because geolocating information for census tract identification was unavailable.

Table 8: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by sex and borough of residence, New York City, 2018.

	Borough of residence					
Sex	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Male	167	65	23	47	30	2
	(4.1)	(8.2)	(3.3)	(3.7)	(2.6)	(0.9)
Female	83	32	9	29	13	0
	(1.9)	(3.7)	(1.2)	(2.1)	(1.1)	(0)
Total	250	97	32	76	43	2
	(2.9)	(5.8)	(2.2)	(2.9)	(1.8)	(0.4)

Table 9: Cryptosporidiosis, number of cases and annual case rate per 100,000 population by United Hospital Fund neighborhood of residence, New York City, 2018

United Hospital Fund Neighborhood	Borough	Number Of Cases	Population	Case Rate
Greenpoint	Brooklyn	19	138051.4	13.8
Chelsea-Clinton	Manhattan	17	160011	10.6
Gramercy Park-Murray Hill	Manhattan	12	131615	9.1
Lower Manhattan	Manhattan	5	60043	8.3
Greenwich Village-Soho	Manhattan	7	84692	8.3
Upper East Side	Manhattan	15	224885	6.7
Williamsburg-Bushwick	Brooklyn	14	225065	6.2
East Harlem	Manhattan	6	115799	5.2
Washington Heights-Inwood	Manhattan	14	278591	5.0
Borough Park	Brooklyn	17	349436	4.9
Downtown Heights-Slope	Brooklyn	12	258924	4.6
Upper West Side	Manhattan	9	221917	4.1
C Harlem-Morningside Heights	Manhattan	6	181803	3.3
Ridgewood-Forest Hills	Queens	8	255484	3.1
Union Sq-Lower East Side	Manhattan	6	198425	3.0
Fordham-Bronx Park	Bronx	8	264847	3.0
Fresh Meadows	Queens	3	102566	2.9
Long Island City-Astoria	Queens	6	217761	2.8
Pelham-Throgs Neck	Bronx	8	312855	2.6
West Queens	Queens	11	478618	2.3
Flushing-Clearview	Queens	6	266276	2.3
Kingsbridge-Riverdale	Bronx	2	94018	2.1
Hunts Point-Mott Haven	Bronx	3	145897	2.1
Northeast Bronx	Bronx	4	205747	1.9
Crotona-Tremont	Bronx	4	219387	1.8
Rockaway	Queens	2	124042	1.6
Port Richmond	Staten Island	1	68522	1.5
High Bridge-Morisania	Bronx	3	221054	1.4
Southwest Queens	Queens	4	297023	1.3
Bed Stuyvesant-Crown Heights	Brooklyn	4	333494	1.2
East New York	Brooklyn	2	188219	1.1
East Flatbush-Flatbush	Brooklyn	3	306578	1.0
Stapleton-St. George	Staten Island	1	125888	0.8
Sunset Park	Brooklyn	1	134024	0.7
Coney Island-Sheepshead Bay	Brooklyn	2	293411	0.7
Jamaica	Queens	2	323963	0.6
Canarsie-Flatlands	Brooklyn	1	208606	0.5
Bensonhurst-Bay Ridge	Brooklyn	1	212964	0.5
Southeast Queens	Queens	1	215871	0.5

Table 10: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and sex, New York City, 2018.

	Sex		
Age Group	Total	Male	Female
<5 years	31	16	15
	(5.6)	(5.7)	(5.6)
5–9 years	11	8	3
	(2.2)	(3.2)	(1.2)
10–19 years	14	8	6
	(1.5)	(1.7)	(1.3)
20–44 years	140	98	42
	(4.2)	(6.1)	(2.5)
45–59 years	35	23	12
	(2.1)	(3.0)	(1.4)
≥ 60 years	19	14	5
	(1.1)	(1.9)	(0.5)
Total	250	167	83
	(2.9)	(4.1)	(1.9)

Table 11: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and borough, New York City, 2018.

	Borough of residence					
Age Group	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
<5 years	31	5	5	15	6	0
	(5.6)	(6.2)	(4.7)	(7.8)	(4.1)	(0)
5–9 years	11	3	2	4	2	0
	(2.2)	(4.6)	(1.9)	(2.4)	(1.5)	(0)
10–19 years	14	1	4	5	4	0
	(1.5)	(0.8)	(2.0)	(1.7)	(1.6)	(0)
20–44 years	140	61	14	45	19	1
	(4.2)	(8.4)	(2.6)	(4.4)	(2.2)	(0.6)
45–59 years	35	18	5	6	5	1
	(2.1)	(6.0)	(1.8)	(1.3)	(1.0)	(1.0)
≥ 60 years	19	9	2	1	7	0
	(1.1)	(2.5)	(0.8)	(0.2)	(1.4)	(0)
Total	250	97	32	76	43	2
	(2.9)	(5.8)	(2.2)	(2.9)	(1.8)	(0.4)

Table 12: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by race/ethnicity and borough of residence, New York City, 2018

	Borough of residence					
Race/Ethnicity	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Hispanic	54	18	17	6	13	0
	(2.1)	(4.1)	(2.1)	(1.2)	(2.0)	
White, non-Hispanic	118	51	2	53	11	1
	(4.3)	(6.6)	(1.5)	(5.5)	(1.9)	(0.3)
Black/African American, non-Hispanic	24	6	7	9	1	1
	(1.3)	(2.9)	(1.6)	(1.1)	(0.2)	(2.2)
Asian, non-Hispanic	14	5	0	0	9	0
	(1.1)	(2.4)			(1.4)	
Pacific Islander, Native Hawaiian, American Indian, non-Hispanic	0	0	0	0	0	0
Two or more races, other, non-Hispanic	16	5	2	3	6	0
	(10.8)	(15.2)	(14.4)	(6.3)	(12.6)	
Unknown	24	12	4	5	3	0
Total	250	97	32	76	43	2
	(2.9)	(5.9)	(2.2)	(2.9)	(1.8)	(0.4)

Table 13: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by race/ethnicity and age group, New York City, 2018.

	Age group						
Race/Ethnicity	Total	<5 years	5–9 years	10–19 years	20–44 years	45–59 years	≥ 60 years
Hispanic	54	8	4	5	22	9	6
	(2.1)	(4.2)	(2.2)	(1.5)	(2.3)	(2.0)	(1.6)
White, non-Hispanic	118	12	5	6	73	15	7
	(4.3)	(7.9)	(3.9)	(2.6)	(6.9)	(3.0)	(1.0)
Black/African American, non-Hispanic	24	1	0	1	14	8	0
	(1.3)	(0.9)		(0.4)	(2.1)	(2.0)	
Asian, non-Hispanic	14	3	1	0	6	2	2
	(1.1)	(4.1)	(1.6)	(0)	(1.1)	(0.8)	(0.8)
Pacific Islander, Native Hawaiian, American Indian, non-Hispanic	0	0	0	0	0	0	0
Two or more races, other, non-Hispanic	16 (10.8)	4 (18.1)	1 (6.3)	2 (9.9)	6 (11.0)	0	3 (19.3)
Unknown	24	3	0	0	19	1	1
Total	250	31	11	14	140	35	19
	(2.9)	(5.6)	(2.2)	(1.5)	(4.2)	(2.1)	(1.1)

Table 14: Cryptosporidiosis, number of cases and case rates by census tract poverty level, New York City, 2018.

Census Tract Poverty Level	Number of cases	Case Rate per 100,000	Age adjusted rate
Low [a]	77	3.4	4.4
Medium [b]	57	2.1	2.8
High [c]	51	2.9	3.7
Very high [d]	65	3.3	3.8

Poverty levels are defined by the American Community Survey, 2013–2017 and are defined as the proportion of residents that have household incomes below 100% of the federal poverty level: [a] Low poverty: <10%; [b] Medium poverty: 10–19%; [c] High poverty: 20–29%; [d] Very high poverty: ≥30%.

Table 15: Percentage of interviewed **cryptosporidiosis** patients reporting selected potential risk exposures before disease onset, persons with HIV/AIDS, New York City 1995–2018, median (range).

Exposure Type[a]	Persons with HIV/AIDS					
	1995–1999	2000–2004	2005–2009	2010–2014	2015–2017	2018
Contact with an animal[b]	35% (33%–36%)	40% (24%–43%)	38% (31%–44%)	34% (20%–43%)	30% (25%–45%)	43%
High-risk sexual activity[c] (aged ≥ 18 years)	20% (9%–22%)	24% (16%–34%)	31% (21%–39%)	17% (7%–25%)	32% (21% – 33%)	42%
International travel[d]	9% (9%–18%)	13% (10%–15%)	8% (6%–17%)	6% (4%–13%)	11% (9%–13%)	7%
Recreational water contact[e]	16% (8%–16%)	13% (8%–21%)	14% (5%–18%)	10% (4%–14%)	12% (8%–13%)	5%

Note:

Determination of an association between exposure to possible risk factors for cryptosporidiosis and acquisition of cryptosporidiosis cannot be made without reference to a suitable control population (i.e., non-*Cryptosporidium*-infected controls).

The format of the patient interview form changed in 1997, 2001, 2002 and 2010:

a: From January 1, 1995 to April 25, 2010, patients were asked about potential risk exposures during the month before disease onset. Beginning April 26, 2010, patients were asked about potential risk exposures during the 14 days before onset.

b: Contact with an animal: includes having a pet, or visiting a farm or petting zoo (1995–1996); expanded to include: visiting a pet store, or veterinarian office (1997–2012); or other animal exposure (20178).

c: High-risk sexual activity: includes having a penis, finger or tongue in a sexual partner's anus (1995–2018)

d: International travel: travel outside of the United States (1995–2018)

e: Recreational water contact: includes swimming in a pool, or swimming in or drinking from a stream, lake, river or spring (1995–1996); expanded to include: swimming in the ocean or visiting a recreational water park (1997–2012); swimming in a hot tub or swimming or drinking water from a pond or body of water (2018).

Table 16: Percentage of interviewed **cryptosporidiosis** patients reporting selected potential risk exposures before disease onset, immunocompetent persons, New York City, 1995–2018, median (range).

Exposure Type[a]	Immunocompetent persons					
	1995–1999	2000–2004	2005–2009	2010–2014	2015–2017	2018
Contact with an animal[b]	35% (7%–41%)	34% (23%–37%)	36% (28%–40%)	34% (18%–41%)	31% (30%–41%)	31%
High-risk sexual activity[c] (aged ≥18 years)	12% (10%–25%)	23% (13%–31%)	17% (7%–19%)	8% (4%–11%)	18% (14% – 29%)	17%
International travel[d]	28% (26%–30%)	45% (33%–47%)	45% (37%–52%)	44% (35%–62%)	42% (41%–45%)	44%
Recreational water contact[e]	24% (21%–40%)	34% (32%–35%)	40% (28%–52%)	35% (32%–48%)	35% (26%–39%)	32%

Note:

Determination of an association between exposure to possible risk factors for cryptosporidiosis and acquisition of cryptosporidiosis cannot be made without reference to a suitable control population (i.e., non-*Cryptosporidium*-infected controls).

The format of the patient interview form changed in 1997, 2001, 2002 and 2010:

a: From January 1, 1995 to April 25, 2010, patients were asked about potential risk exposures during the month before disease onset. Beginning April 26, 2010, patients were asked about potential risk exposures during the 14 days before onset.

b: Contact with an animal: includes having a pet, or visiting a farm or petting zoo (1995–1996); expanded to include: visiting a pet store, or veterinarian office (1997–2012); or other animal exposure (2018).

c: High-risk sexual activity: includes having a penis, finger or tongue in a sexual partner's anus (1995–2018)

d: International travel: travel outside of the United States (1995–2018)

e: Recreational water contact: includes swimming in a pool, or swimming in or drinking from a stream, lake, river or spring (1995–1996); expanded to include: swimming in the ocean or visiting a recreational water park (1997–2012); swimming in a hot tub or swimming or drinking water from a pond or body of water (2018).

Table 17: Percentage of interviewed **cryptosporidiosis** patients by type of tap water exposure before disease onset, persons with HIV/AIDS, New York City, 1995–2018, median (range).

Exposure Type[a]	Persons with HIV/AIDS					
	1995–1999	2000–2004	2005–2009	2010–2014	2015–2017	2018
Plain tap[b]	69% (64%–71%)	55% (49%–77%)	67% (58%–76%)	63% (50%–71%)	55% (50%–63%)	46%
Filtered tap[c]	12% (9%–20%)	20% (13%–22%)	14% (7%–18%)	11% (8%–25%)	13% (8%–15%)	8%
Boiled tap[d]	5% (3%–7%)	6% (0%–6%)	7% (0%–11%)	4% (2%–11%)	0% (0–4%)	8%
Incidental plain tap only[e]	15% (8%–16%)	15% (4%–19%)	10% (4%–17%)	18% (8%–20%)	24% (13%–24%)	33%
No tap[f]	2% (0%–5%)	4% (2%–6%)	2% (0%–6%)	4% (0%–4%)	6% (0%–13%)	3%

Note:

Determination of an association between exposure to possible risk factors for cryptosporidiosis and acquisition of cryptosporidiosis cannot be made without reference to a suitable control population (i.e., non-*Cryptosporidium*-infected controls).

The format of the patient interview form changed in 1997, 2001, 2002 and 2010:

a: From January 1, 1995 to April 25, 2010, patients were asked about tap water exposure during the month before disease onset. Beginning April 26, 2010, patients were asked about tap water exposure during the 14 days before onset.

b: Plain tap: drank unboiled/unfiltered NYC tap water (1995–5/10/2001) or drank greater than 0 cups of unboiled/unfiltered NYC tap water (5/11/2001–12/31/2013).

c: Filtered tap: drank filtered NYC tap water (1995–5/10/2001) or drank greater than 0 cups of filtered NYC tap water, and 0 or more cups of boiled NYC tap water, and no unboiled/unfiltered NYC tap water (5/11/2001–12/13/2018).

d: Boiled tap: drank boiled NYC tap water (1995–5/10/2001) or drank greater than 0 cups of boiled NYC tap water, and no unboiled/unfiltered NYC tap water, and no filtered NYC tap water (5/11/2001–12/31/2018).

e: Incidental plain tap only: did not drink any NYC tap water but did use unboiled/unfiltered NYC tap water to brush teeth, or to wash vegetables/fruits, or to make ice (1995–1996), expanded to include make juice from concentrate (1997–2018).

f: No tap: did not drink any NYC tap water and did not use unboiled/unfiltered NYC tap water to brush teeth, or to wash vegetables/fruits, or to make ice (1995–1996); expanded to include make juice from concentrate (1997–2018).

Table 18: Percentage of interviewed **cryptosporidiosis** patients by type of tap water exposure before disease onset, immunocompetent persons, New York City, 1995–2018, median (range).

Exposure Type[a]	Immunocompetent persons					
	1995–1999	2000–2004	2005–2009	2010–2014	2015–2017	2018
Plain tap[b]	58% (56%–67%)	36% (27%–56%)	30% (27%–47%)	33% (28%–49%)	39% (38%–47%)	38%
Filtered tap[c]	21% (17%–25%)	31% (17%–44%)	23% (20%–30%)	24% (17%–27%)	19% (11% –26%)	26%
Boiled tap[d]	8% (3%–11%)	2% (0%–7%)	5% (0%–14%)	2% (0%–7%)	5% (2%–6%)	2%
Incidental plain tap only[e]	9% (7%–12%)	16% (8%–21%)	25% (14%–28%)	15% (11%–22%)	25% (14%–29%)	21%
No tap[f]	4% (2%–7%)	9% (2%–21%)	14% (3%–27%)	21% (11%–29%)	13% (12%–14%)	12%

Note:

Determination of an association between exposure to possible risk factors for cryptosporidiosis and acquisition of cryptosporidiosis cannot be made without reference to a suitable control population (i.e., non-*Cryptosporidium*-infected controls).

The format of the patient interview form changed in 1997, 2001, 2002 and 2010:

a: From January 1, 1995 to April 25, 2010, patients were asked about tap water exposure during the month before disease onset. Beginning April 26, 2010, patients were asked about tap water exposure during the 14 days before onset.

b: Plain tap: drank unboiled/unfiltered NYC tap water (1995–5/10/2001) or drank greater than 0 cups of unboiled/unfiltered NYC tap water (5/11/2001–12/31/2013).

c: Filtered tap: drank filtered NYC tap water (1995–5/10/2001) or drank greater than 0 cups of filtered NYC tap water, and 0 or more cups of boiled NYC tap water, and no unboiled/unfiltered NYC tap water (5/11/2001–12/13/2018).

d: Boiled tap: drank boiled NYC tap water (1995–5/10/2001) or drank greater than 0 cups of boiled NYC tap water, and no unboiled/unfiltered NYC tap water, and no filtered NYC tap water (5/11/2001–12/31/2018).

e: Incidental plain tap only: did not drink any NYC tap water but did use unboiled/unfiltered NYC tap water to brush teeth, or to wash vegetables/fruits, or to make ice (1995–1996), expanded to include make juice from concentrate (1997–2018).

f: No tap: did not drink any NYC tap water and did not use unboiled/unfiltered NYC tap water to brush teeth, or to wash vegetables/fruits, or to make ice (1995–1996); expanded to include make juice from concentrate (1997–2018).

Figure 6: Emergency Department Syndromic Surveillance, Trends in visits for the diarrhea syndrome, New York City, January 1, 2017–December 31, 2018.

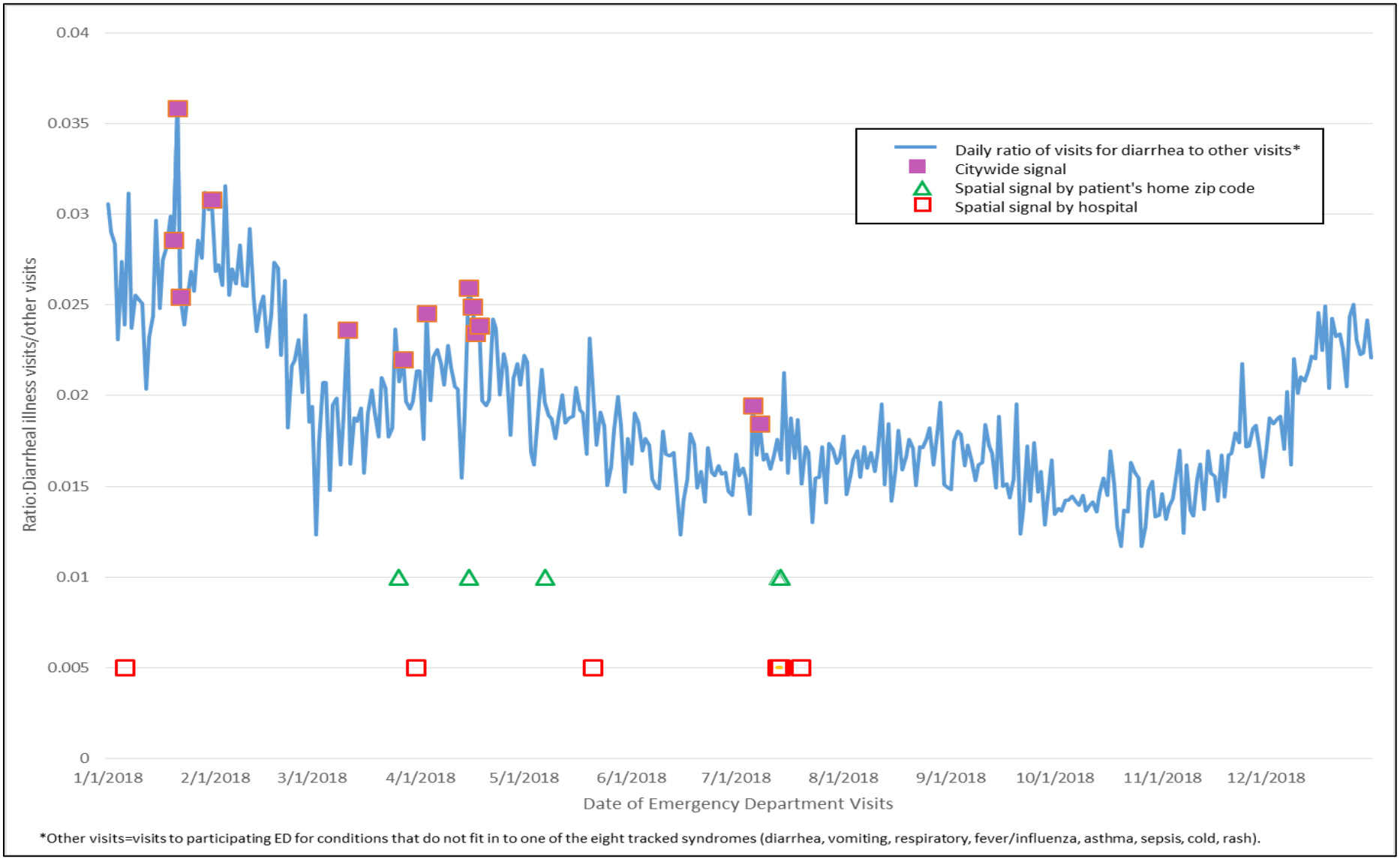


Figure 7: Emergency Department Syndromic Surveillance, Trends in visits for the vomiting syndrome, New York City, January 1, 2017–December 31, 2018.

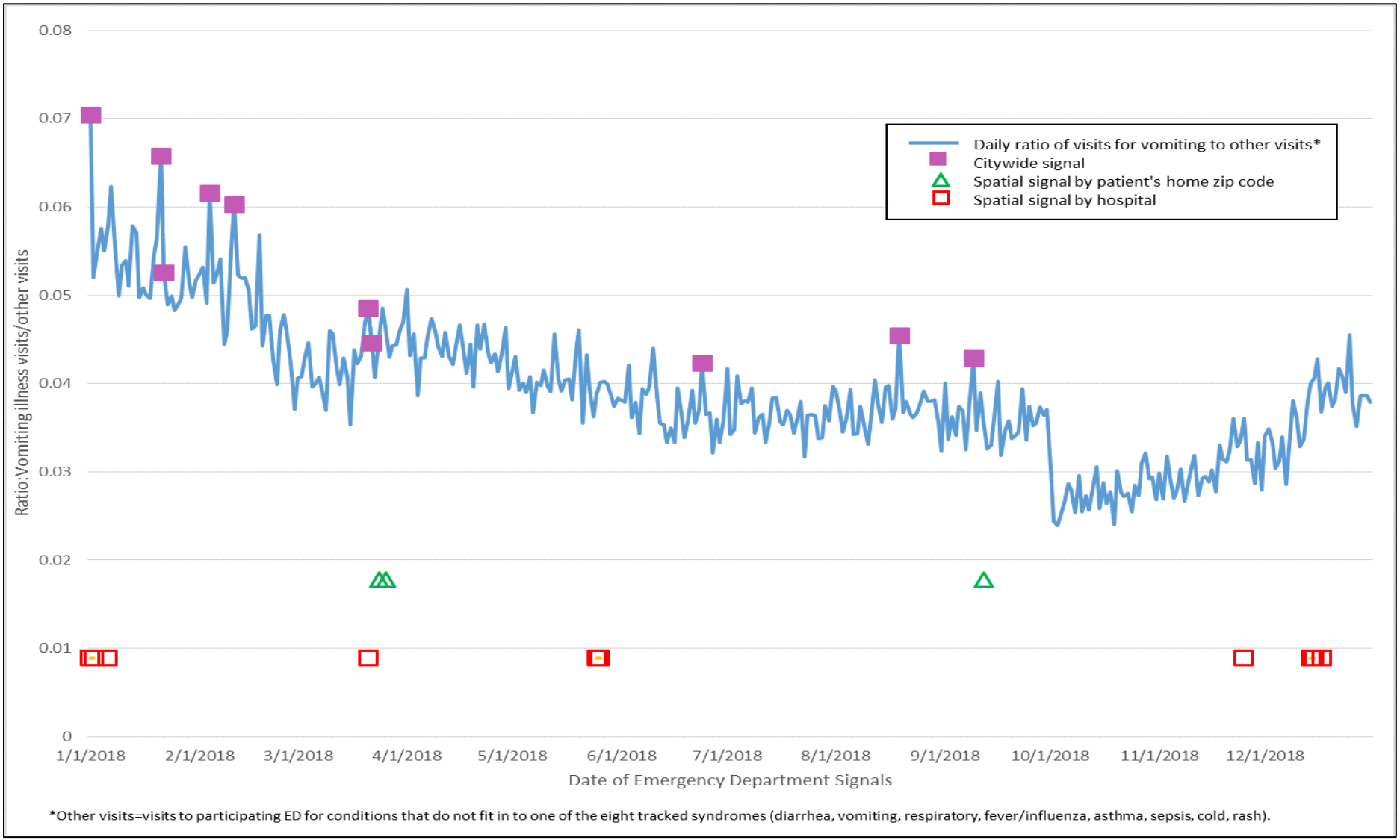
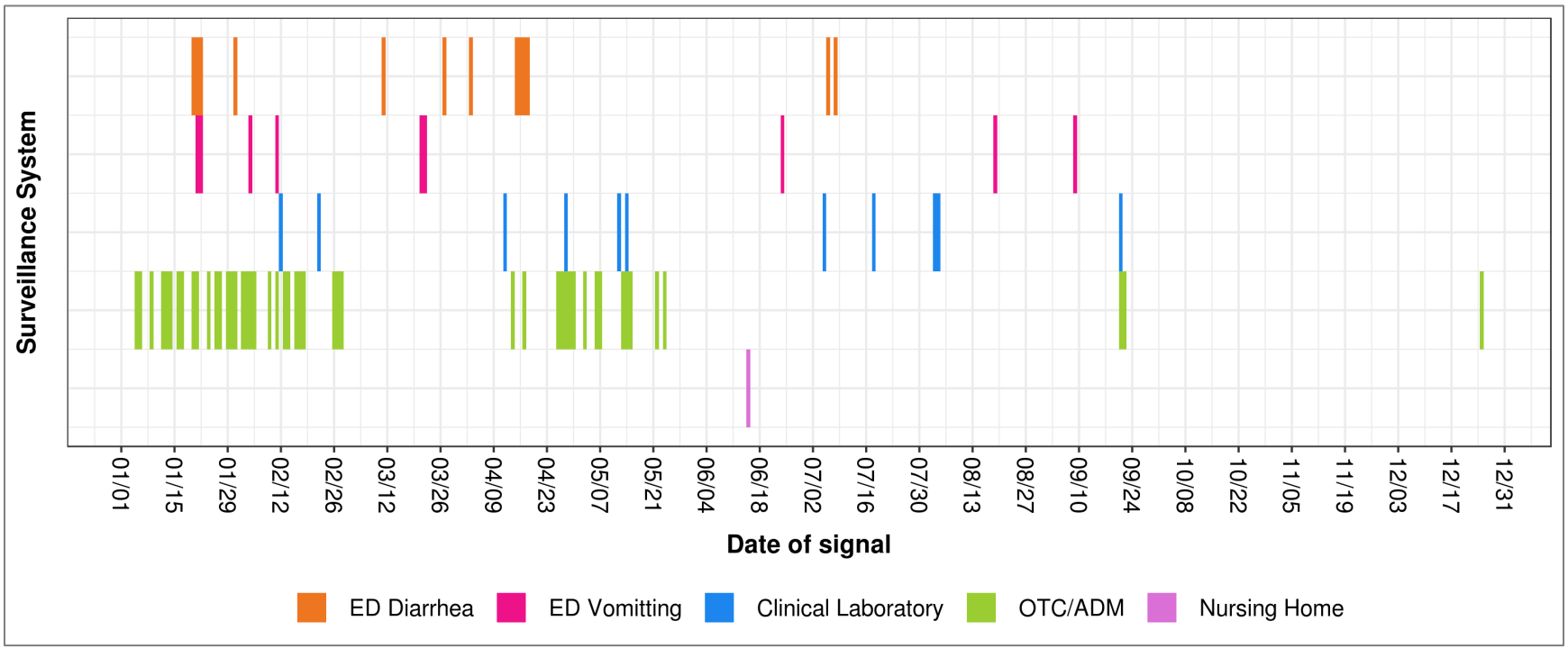


Figure 8: Signals for Gastrointestinal Illness, Syndromic Surveillance Systems, New York City, 2018.



7. APPENDIX A: Information on calculation of rates, case definitions and risk factor collection

Population denominators

The population denominators used to calculate rates were intercensal population estimates for all years except 2000 and 2010 to 2012. For the years 1994 through 1999, intercensal population estimates per year were used based upon linear interpolation between 1990 and 2000 NYC Census. For the years 2001 through 2009 and 2013 through 2018, intercensal population estimates for each year were used from data produced by DOHMH based on the US Census Bureau Population Estimate Program and housing unit data obtained from the NYC Department of City Planning. For 2010 to 2012, the year 2010 NYC Census data were used (New York City Department of City Planning 2010). Because rates for the years 2001 through 2009 and the rates for the years 2014 through 2018 were calculated for this report using intercensal population estimates, they may differ from previously reported rates based on year 2000 and 2010 NY Census data. Other variations in data between this report and previous reports may be because of factors such as disease reporting delays, correction of errors, and refinements in data processing (for example, the removal of duplicate disease reports). All rates in this report are annual rates. Caution must be exercised when interpreting rates based on very small case numbers.

UHF Zones

For mapping purposes, the United Hospital Fund (UHF) neighborhood of patient residence was used. New York City is divided on the basis of zip code into 42 UHF neighborhoods. Maps illustrating annual case rates by UHF neighborhood are included in this report.

Race-Ethnicity Categories

In this report, race/ethnicity-specific case rates for 2018 are based upon intercensal population estimates and include the race/ethnicity categories used by the US Census Bureau Population Estimate Program. Prior to 2011, there was one race/ethnicity category entitled “Asian, Pacific Islander, American Indian, Alaskan Native, non-Hispanic”. Since 2011, separate categories have been used for non-Hispanic Asians, non-Hispanic Pacific Islanders and Native Hawaiians, non-Hispanic American Indian and non-Hispanic of two or more races.

Socioeconomic Status

Beginning with the 2011 WDRAP Annual Report, socioeconomic status (SES) is now included as a measure as part of the demographic description of cases of giardiasis and cryptosporidiosis in NYC. Differences in SES among cases of a disease may indicate economically-related disparities in health. Neighborhood poverty can be used as a proxy for individual SES. The poverty level of the neighborhood of patient resident is measured as the percentage of individuals in the neighborhood who live below the federal poverty level, as reported in census data. Four categories of poverty level were used for the WDRAP analysis (see Tables 7 & 14). Further explanation of how SES designations were made can be found in the 2011–2014 WDRAP Annual reports.

Age-adjusted case rates

Age-adjusted case rates were calculated for each of the four neighborhood poverty levels using direct standardization and weighing by the US 2000 Standard Population. Cases were grouped into three age group categories (aged <24 years, 25–44 years, and ≥45 years) (Klein and Schoenborn 2001).

Confirmed and Probable cases

As was first described in the 2012 Annual Report, confirmed and probable cryptosporidiosis cases are now included in the WDRAP reports. Confirmed cases are those in which the laboratory method used has a high positive predictive value (such as light microscopy of stained slide, enzyme immunoassay, polymerase chain reaction, and direct fluorescent antibody test). Probable cases are those in which the laboratory method used has a low positive predictive value (such as the immunochromatographic card/rapid test) or in which the method used for diagnostic testing was not known. The probable case classification for cryptosporidiosis also includes those cases in which laboratory confirmation was not obtained, but the case was epidemiologically linked to a confirmed case and clinical illness was consistent with cryptosporidiosis. DOHMH BCD reports both confirmed and probable cryptosporidiosis cases to the Centers for Disease Control and Prevention through the National Electronic Telecommunications System for Surveillance. BCD interviews all cases. However, if cases are not confirmed at NYS DOH Wadsworth Center then these patients are not considered to be a case and are not included in the final annual count.

Cryptosporidiosis and Potential Risk Factors

Tables 15, 16, 17, and 18–a change to table format was introduced, starting with the 2015 annual report. This change involves grouping and summarizing data in 5-year sets (e.g., 1995– 1999, 2000–2004, etc.). This change was made to continue providing historical data for comparison, and to allow for easier comprehension of trends. Potential risk exposure data for individual years, rather than grouped years, can be viewed in the earlier WDRAP Annual Reports. Only the new data (i.e., the year of the report) is listed independently as a single year.

8. APPENDIX B: Syndromic Surveillance System Descriptions

Hospital Emergency Department (ED) Monitoring

NYC initiated monitoring of hospital ED visits as a public health surveillance system in 2001, and this system has been in operation since that time. Hospitals transmit electronic files each morning containing chief complaint and demographic information for patient visits during the previous 24 hours. Patients are classified into syndrome categories, and daily analyses are conducted to detect any unusual patterns or signals. The two syndromes used to track GI illness are the vomiting syndrome and the diarrhea syndrome. Temporal citywide analyses assess whether the frequency of ED visits for the syndrome has increased in the last one, two, or three days compared to the previous 14 days. Clustering is examined by both hospital location and residential zip code. Statistical significance is based on Monte Carlo probability estimates that adjust for the multiple comparisons inherent in examining many candidate clusters each day. The threshold of significance for citywide and spatial signals was originally set at $p<0.01$, indicating that less than 1 out of every 100 analyses would generate a cluster due to chance alone. Beginning in 2005, the threshold of significance for spatial signals was changed to $p<0.005$, while the threshold of significance for citywide signals remained at $p<0.01$. The system is described further in Heffernan *et al.* (Heffernan, Mostashari et al. 2004).

Anti-Diarrheal Medication Monitoring

NYC began tracking anti-diarrheal drug sales as an indicator of GI illness trends in 1995 via a system operated by DEP. Major modifications and enhancements to NYC's anti-diarrheal medication surveillance program have been made over the years, including: utilization of different data sources, initiation and expansion of DEP's ADM program, initiation of DOHMH's OTC program in 2002, and in 2012, the merger of the ADM and the OTC systems. The ADM and OTC systems were merged to simplify the processing and analysis of pharmacy data, and combine the strengths of the two systems. The combined OTC/ADM system is operated by DOHMH, and the first full year of operation of the merged system was 2013. DOHMH conducted an evaluation of the impact of the merger of the two systems (final report completed in 2014). In 2015, one ADM pharmacy chain data source dropped out of the program, but two additional pharmacy chains were added. Surveillance with both additional pharmacy chains began in 2016.

In summary, the current system involves tracking of sales of over-the-counter, non-bismuth-containing anti-diarrheal medications and of bismuth subsalicylate medications, searching for citywide as well as local signals. DOHMH Bureau of Communicable Disease (BCD) staff review signals on a daily basis to evaluate whether there are any new or sustained signals at citywide and zip-code levels. If there are sustained signals, BCD staff will perform reviews of reportable GI illness, including norovirus and rotavirus, to attempt to rule out a potential waterborne outbreak. Also, information on product promotions (e.g., price discounts) are considered, as these are known to impact on sales volume).

Clinical Laboratory Monitoring System

The number of stool specimens submitted to clinical laboratories for bacterial and parasitic testing also can be a source of information on GI illness trends in the population. The clinical laboratory monitoring system currently collects data from one large laboratory, designated as Laboratory A in this report. The number of participating laboratories has changed over time, as reported in prior WDRAP reports. Laboratory A transmits data by fax to DOHMH BCD 3─4 times per week, indicating the number of stool specimens examined per day for: (a) bacterial culture and sensitivity, (b) ova and parasites, and (c) *Cryptosporidium*.

The Clinical Laboratory Monitoring results are reviewed upon their receipt. Beginning in 2004, DOHMH implemented a model to establish statistical cut-offs for significant increases in clinical laboratory submissions. The model uses the entire historical dataset from November 1995 for Laboratory A. Sundays and holidays are removed because the laboratories do not test specimens on those days. Linear regression is used to adjust for average day-of-week and day-after-holiday effects as certain days routinely have higher volumes than other days. The cumulative sums (CUSUM) method is applied to a two-week baseline to identify statistically significant aberrations (or signals) in submissions for ova and parasites and for bacterial culture and sensitivity. CUSUM is a quality control method that has been adapted for aberration-detection in public health surveillance. CUSUM is described further in Hutwagner, *et al.* (Hutwagner, Maloney et al. 1997).

Nursing Home Sentinel Surveillance

The nursing home surveillance system began in 1997. Under the current protocol, when a participating nursing home documents an outbreak of GI illness that is legally reportable to NYSDOH, the nursing home also notifies the WDRAP team at DOHMH. Such an outbreak is defined as onset of diarrhea and/or vomiting involving three or more patients on a single ward/unit within a seven-day period, or more than expected (baseline) number of cases within a single facility. All participating nursing homes have been provided with stool collection kits in advance. When such an outbreak is noted, specimens are to be collected for testing for bacterial culture and sensitivity, ova and parasites, *Cryptosporidium* spp., viruses, and *Clostridium difficile* toxin. Though *C. difficile* is not a waterborne pathogen, *C. difficile* toxin testing was added in 2010 to address a need expressed by infection control practitioners in the nursing homes, and was intended to help ensure compliance with the sentinel nursing home protocol.

DOHMH BCD staff facilitates transportation of the specimens to the DOHMH Public Health Laboratory, where culture and sensitivity testing is performed. Specimens designated for ova and parasite tests, *Cryptosporidium* as well as for virus and *C. difficile* toxin testing are sent to NYSDOH Wadsworth Center Laboratory. There are currently eight nursing homes participating in the program. Three are in Manhattan, two are in the Bronx, two are in Queens, and one is in Brooklyn. As feedback for their role in outbreak detection, participating nursing homes are provided with copies of the WDRAP annual report.

All participating nursing homes are visited on an annual basis to help ensure compliance with the program protocol. During the site visits, DOHMH staff members reviewed the rationale for the program and program protocol with nursing administration or infection control staff. In addition, the DOHMH staff members verified that the nursing homes had adequate stool collection supplies on hand.