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
2017 Annual Report

March 2018

Prepared in accordance with Section 8.1 of the NYSDOH

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
PHL	Public Health Laboratory
UHF	United Hospital Fund
WDRAP	Waterborne Disease Risk Assessment Program

Acknowledgements

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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 diarrheal illness 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 progress, and data collected, during 2017.

I. DISEASE SURVEILLANCE

Active disease surveillance for giardiasis and cryptosporidiosis began in July 1993 and November 1994, respectively, and continued through 2010. This early surveillance involved laboratory visits or calls by DOHMH staff to ensure all positive tests were reported. In January 2011, active laboratory surveillance for giardiasis and cryptosporidiosis was replaced by an electronic reporting system. This report presents the number of cases and case rates for giardiasis and cryptosporidiosis in 2017 (and includes data from past years for comparison). Also, demographic information for cases of giardiasis and cryptosporidiosis in 2017 was gathered and is summarized in this report. Telephone interviews of cryptosporidiosis patients to gather potential risk exposure information continued, and selected results are presented. Giardiasis and cryptosporidiosis rates have been on an overall downward trend over the years of this surveillance program. The giardiasis case rate increased from 10.5 per 100,000 population in 2016 to 11.4 per 100,000 (975 cases) in 2017, but was within the range seen over the past decade (case rates 2006 – 2016: 9.2 – 11.4, median: 10.4). The cryptosporidiosis case rate decreased from 2.2 per 100,000 in 2016 to 1.9 per 100,000 (163 cases) in 2017, which is within the range of case rates seen in the last decade (case rates 2006 – 2016: 1.0 – 2.2, median 1.3). In 2015 the introduction of a new diagnostic test, a rapid multiplex polymerase chain reaction (PCR) test kit that can test for the presence of a wide range of enteric organisms including *Cryptosporidium*, coincided with an increasing trend in observed cases. The increased number of cases since 2015 are not thought by DOHMH to represent a true increase in disease, but rather an increase in the detection of cases. More years of data are needed to more fully assess the impact of the multiplex PCR kits on incidence of cryptosporidiosis in NYC.

II. SYNDROMIC SURVEILLANCE / OUTBREAK DETECTION

The tracking of sentinel populations (e.g., nursing homes) or surrogate indicators (e.g., drug sales) 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 may be 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; under a fourth system, DOHMH monitors and assists in the investigation of GI outbreaks in eight sentinel nursing homes.

A summary of syndromic surveillance findings for 2017 pertaining to GI illness is presented. Citywide trends and signals observed in the ED system were generally consistent with GI viral trends observed historically. There was no evidence of a drinking water-related outbreak in NYC in 2017.

III. INFORMATION SHARING AND RESPONSE PLANNING

Information on *Cryptosporidium* and *Giardia* is available on the websites of NYC's DEP and DOHMH as listed in Part III 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. With regard to response planning, in May 2017, DEP held a functional exercise of NYC's Hillview Reservoir *Cryptosporidium* & *Giardia* Action Plan (CGAP). A revised and updated version of the CGAP was issued by DEP in December 2017.

INTRODUCTION

The Waterborne Disease Risk Assessment Program (WDRAP) is a multi-faceted public health assessment program to provide 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 inter-agency agreement between DEP & DOHMH for continuation of WDRAP was updated and signed in 2017, laying out the organizational and the 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 diarrheal illness to ensure rapid detection of any outbreaks.

This report provides a summary of WDRAP highlights and data for the year 2017. (An explanation to some important terms is included in *Appendix A:* Supplemental Information. Note that throughout this document blue italics indicate cross-referencing for easy access to Figures and Tables.)

I. DISEASE SURVEILLANCE

Giardiasis

Giardiasis is a notifiable disease in NYC, per the DOHMH 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 are reported to DOHMH via an electronic laboratory reporting system.

During 2017, a total of 975 cases of giardiasis were reported to DOHMH resulting in an annual case rate of 11.4 per 100,000. Annual case numbers increased 8.4% from 2016 to 2017 but there has been an overall downward trend in giardiasis cases from 1994 to 2017 (range 767-2,484, median 957; decline of 60%), with the decline prominent in years 1994/1995 – 2005. Since 2005, giardiasis annual case numbers showed less variability with a range of 767-975 (median 872) *(Table 1). Figure 1* is a new figure added this year showing yearly counts over time since 1994 (Figure 1A) as well as monthly counts from the last five years (Figure 1B).

Table 1. Giardiasis, the number of cases and case rates, New York City, 1994 – 2017.

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

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 48 giardiasis cases were investigated in 2017. No cases were associated with outbreaks; none of the excluded patients were healthcare workers, one patient was a food handler, ten patients were children in day care, and 37 cases were investigated but patients were not found to be in a secondary transmission risk category.

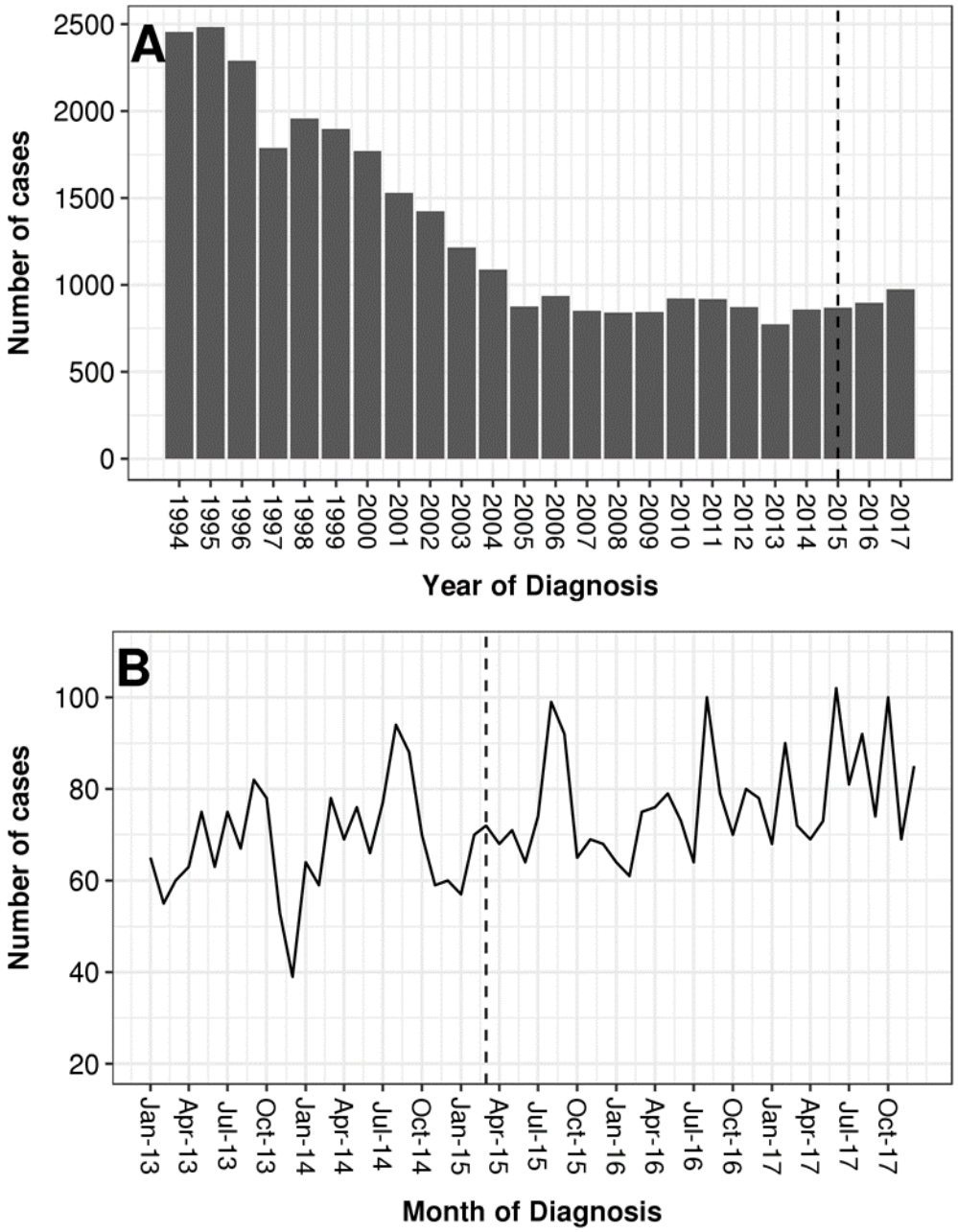

Figure 1. Annual giardiasis counts for all years in (A) and monthly counts for the last five years (B)*. The vertical dotted lines show the date when the first NYC laboratory began using multiplex polymerase chain reaction assays for enteric diseases.

The following provides some highlights from the surveillance data for giardiasis among NYC residents diagnosed from January 1 through December 31, 2017. Additional details for giardiasis cases broken down by category are included in the tables in Appendix B.

Borough of patient residence

Borough of patient residence was known for all 975 giardiasis patients who resided in NYC. Manhattan had the highest borough-specific annual case rate (22.9 cases per 100,000) (The highest United Hospital Fund (UHF) neighborhood-specific case rate was found in the Greenwich Village-Soho neighborhood in Manhattan (47.7 cases per 100,000), followed by Chelsea-Clinton (42.6 cases per 100,000) (*Figure* 2 and *Table* 4).

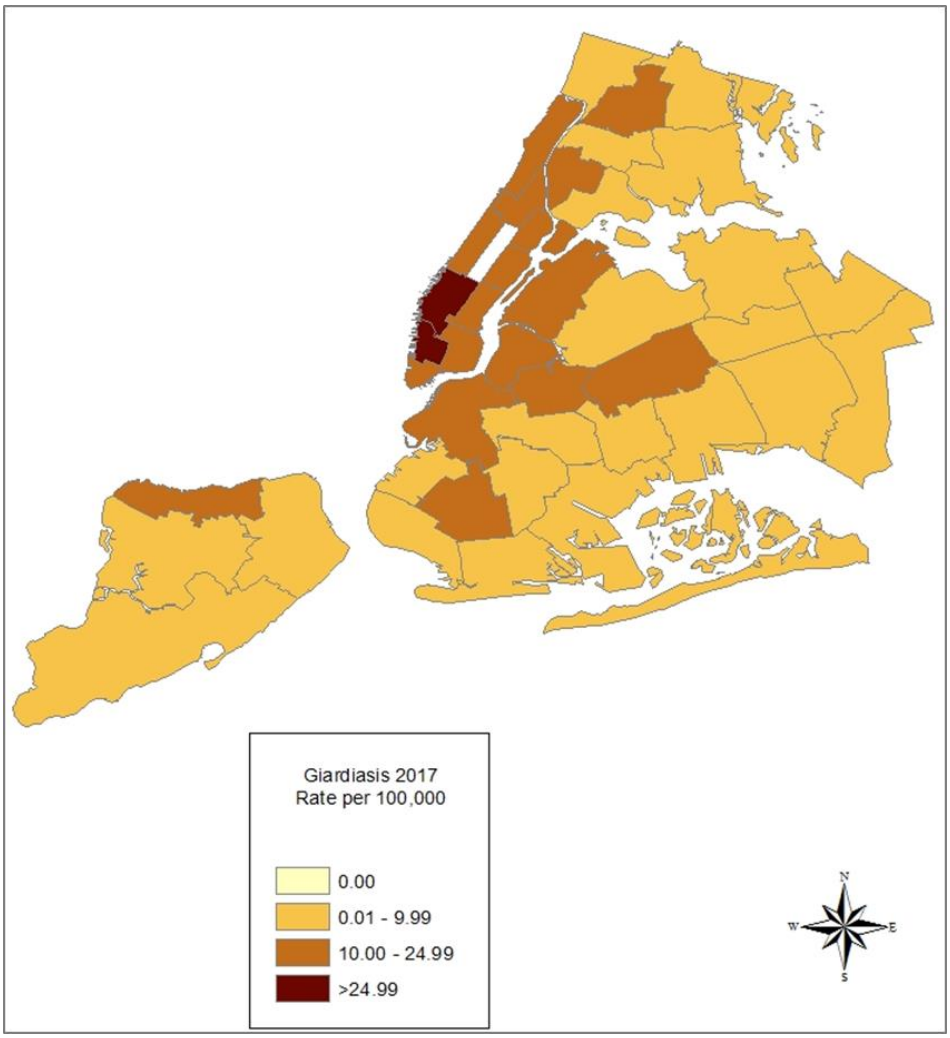

Figure 2. Map of giardiasis annual case rate per 100,000 population by United Hospital Fund Neighborhood, NYC, 2017.

Sex

Information regarding patient sex was available for all cases. The number and rate of giardiasis cases were higher in males than females, with 695 males (17.1 per 100,000) and 280 females (6.3 cases per 100,000) reported. The highest sex- and borough-specific case rate was observed among males residing in Manhattan (36.2 cases per 100,000) (Table *3*).

Age

Information regarding age was available for all cases. The highest age group-specific case rates, with all sexes combined, were among persons 20-44 years old (14.5 cases per 100,000), followed by children 5-9 years old (14.4 cases per 100,000). The highest age group and sex-specific case rate was among males 20-44 years old (24.0 cases per 100,000) (*Table 5*). The two highest age-group and borough-specific case rates were in persons 20-44 years old in Manhattan (28.9 cases per 100,000), followed by persons 45-59 years old in Manhattan (27.7 cases per 100,000) (*Table* 6).

Race/Ethnicity

Information regarding race/ethnicity was available for only 110 of 975 cases (12.6%). Ascertainment of race/ethnicity status for giardiasis was poor. As indicated above, 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. For the majority of giardiasis patients, race/ethnicity information, when provided, is not based upon self-report, but rather upon the impressions of health care providers, which may be inaccurate. For this reason, and because race/ethnicity information was missing from many giardiasis disease reports, race/ethnicity findings pertaining to giardiasis patients diagnosed in 2017 are not presented in this report.

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 11.4 to 18.9 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 medium and low poverty levels (*Table 7*). Based on data from 2017 and from previous analyses (Greene et al., 2015) [1], giardiasis is not typically associated with neighborhood poverty level in NYC. However, because giardiasis cases 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:* Supplemental Information for poverty definition).

Cryptosporidiosis

Cryptosporidiosis was added to the list of reportable diseases in the NYC Health Code in January 1994. Active disease surveillance for cryptosporidiosis 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 2017, a total of 163 cases of cryptosporidiosis were reported to DOHMH, all of which met the case definition for confirmed cryptosporidiosis. (Confirmed and probable cases are both included in the WDRAP reports. See Appendix A for further explanation). The 2017 annual case rate was 1.9 per 100,000. Annual case numbers decreased 17.8% from 2016 to 2017; case rates also decreased. Looking at the data from 1994 to 2017, annual case numbers were higher in the years 1994 – 1999 (range: 2.2-6.1 cases per 100,000, median 3.6 cases per 100,000) and lower in the years 2000 – 2014 (range: 1.0-2.1 cases per 100,000, median 1.5 cases per 100,000) (Table *2*).

Case numbers and rates in 2015, 2016 and 2017 were somewhat higher than preceding eight years, as discussed further below.

Table 2 Cryptosporidiosis, number of cases and case rates, New York City, 1994 ─ 2017.

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

Note: Active disease surveillance for cryptosporidiosis began in November 1994. Starting January 2011, active laboratory surveillance was discontinued as it had been 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 1989 – 2017, and rates have been accordingly adjusted. Yearly case numbers and rates in this table may therefore differ from case numbers and rates that have appeared in prior WDRAP reports.

An increase in cryptosporidiosis cases was noted in the fall of 2015 and continued through 2017 (*Figure 3*). The increase was observed especially in the area of one of the university hospitals starting in 2015. Further investigation linked many of the early cases to a multiplex polymerase chain reaction (PCR) test for multiple enteric organisms that had been recently implemented at this hospital's laboratory. This test is now being used in additional laboratories in NYC. Of all specimens from NYC residents that were initially diagnosed using PCR-based tests and sent to the New York State Department of Health (NYSDOH) Wadsworth Center Laboratory for laboratory confirmation, 84% were lab-confirmed in 2015, 75.3% were lab-confirmed in 2016 and 85.8% were lab-confirmed in 2017, showing a relatively high positive predictive value of the new multiplex assays. Cases diagnosed via rapid multiplex PCR are not considered to meet the case definition of confirmed unless they are confirmed as positive by the NYSDOH laboratory. When cases are not confirmed by NYSDOH, the patients are not interviewed. The increase in cryptosporidiosis cases observed in 2015 – 2017 is thought by DOHMH to represent an increase in testing rather than an increase in cases because of the new availability of the multiplex PCR tests. These PCR tests are ordered for people who may not ordinarily get a test for cryptosporidiosis. Cryptosporidiosis is believed to be underdiagnosed when PCR is not available as it is not included in a routine ova and parasite (O&P) test. The slight decline from 2016 to 2017 may be because of an actual decrease in disease incidence or changing practices related to culture independent diagnostic testing (CIDT) use in hospitals. More years of data are required to fully interpret the impact of CIDT on cryptosporidiosis incidence in NYC.

The number of cryptosporidiosis cases by year of diagnosis for the years 1995 – 2017 are presented in *Figure 3*. Figure 3 is a new figure added this year showing yearly counts over time since 1994 (Figure 3A) as well as monthly counts from the last five years (Figure 3B). 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 some highlights from the surveillance data for cryptosporidiosis among NYC residents from January 1 through December 31, 2017. Additional details for cryptosporidiosis cases broken down by category are included in the tables in *Appendix C:* Cryptosporidosis number of cases and case rates.

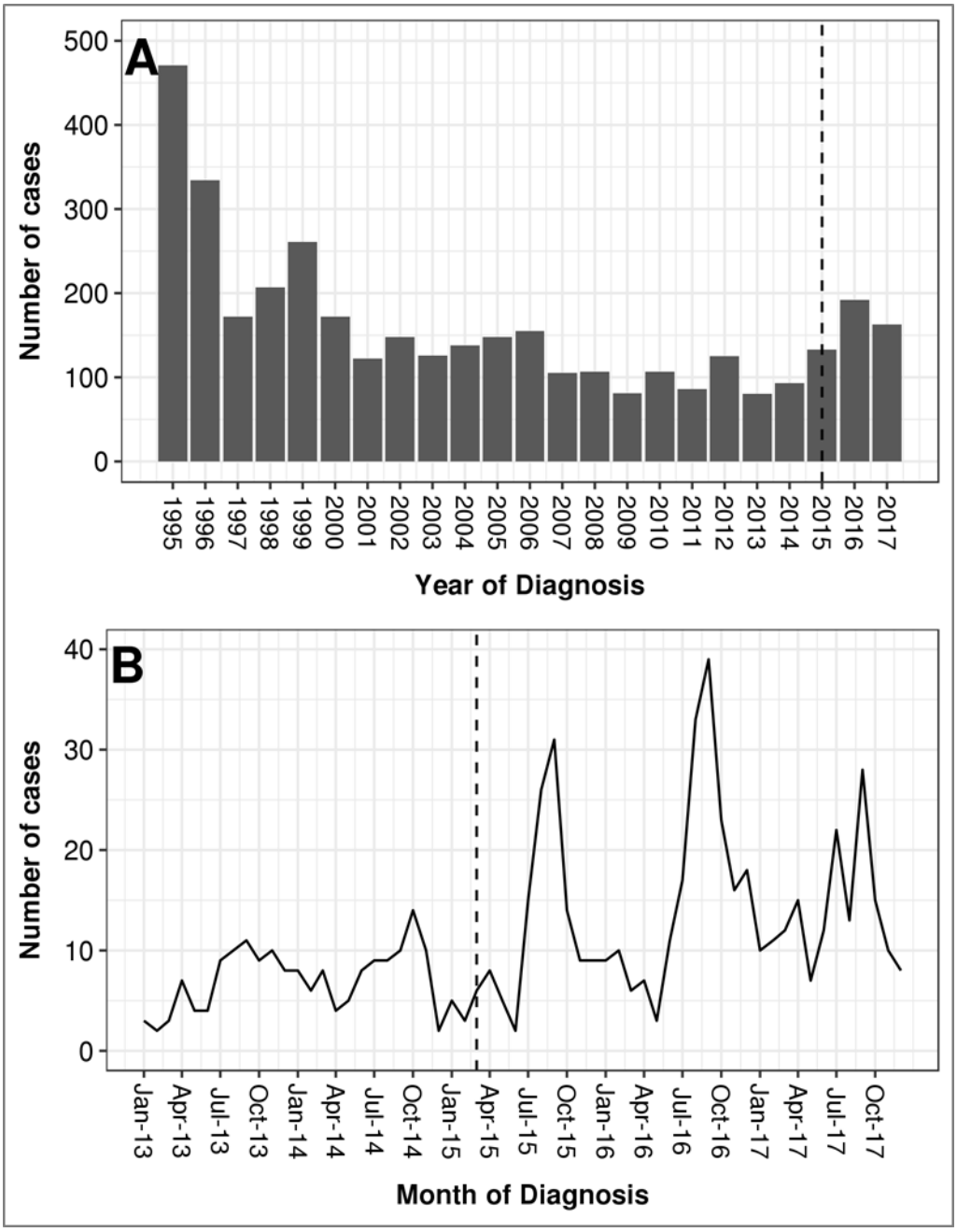

Figure 3. Annual cryptosporidiosis counts for all years in (A) and monthly counts for the last five years (B)*. The vertical dotted lines show the date when the first laboratory NYC began using multiplex polymerase chain reaction assays for enteric diseases.

Borough of patient residence

Information on borough of residence was available for all cases of cryptosporidiosis. Manhattan had the highest borough-specific annual case rate (4.7 cases per 100,000) (

Table 8). The highest UHF neighborhood-specific case rate was in the Chelsea-Clinton neighborhood in Manhattan (8.9 cases per 100,000), followed by Greenwich Village-Soho (7.3 cases per 100,000) (Figure *4* and *Table 9*).

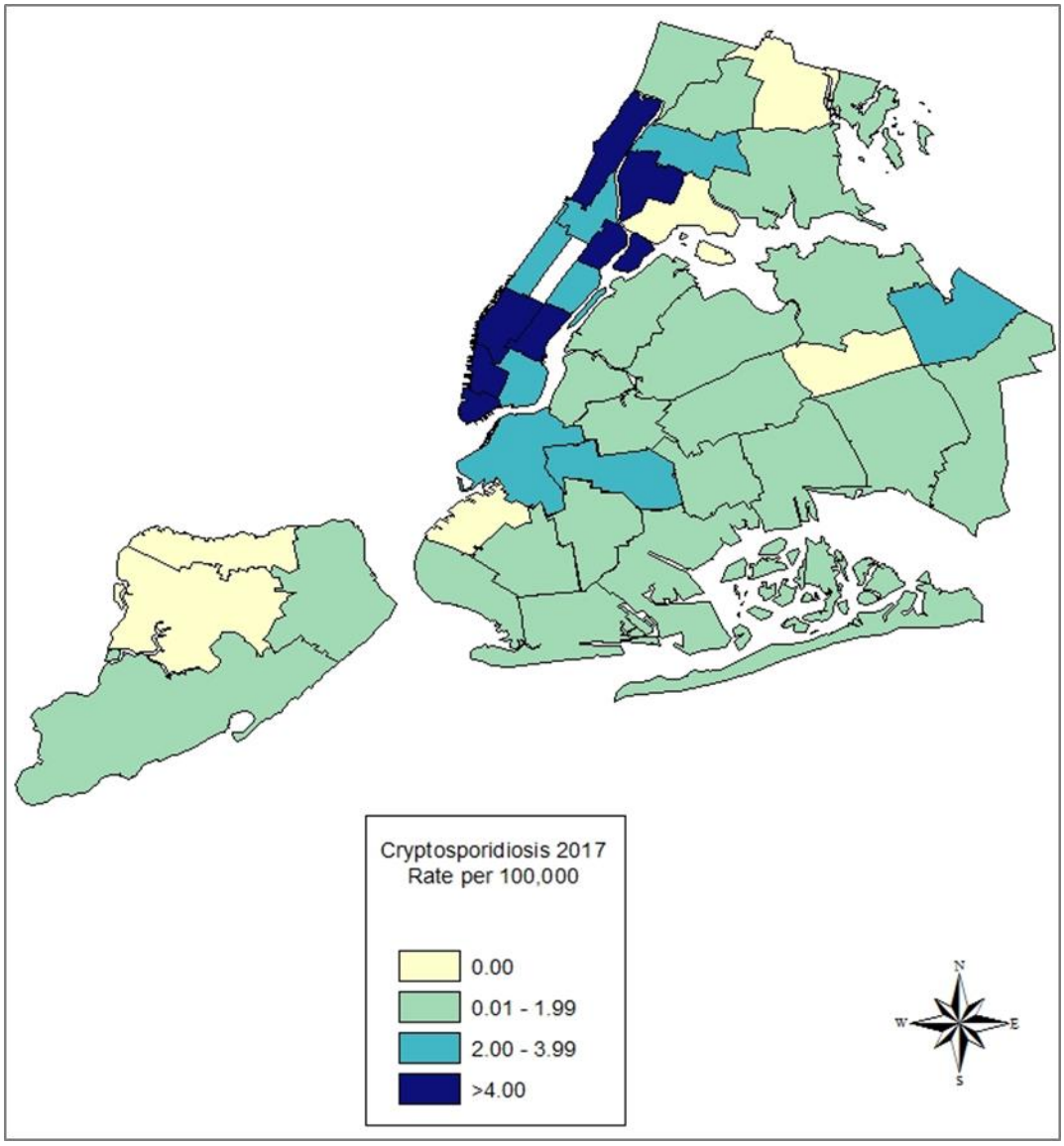

Figure 4. Map of cryptosporidiosis annual case rate per 100,000 population by United Hospital Fund neighborhood, NYC, 2017.

Sex

Information regarding sex was available for all cases. The number and rate of cryptosporidiosis cases was higher in males than females, with 93 males (2.3 cases per 100,000), and 70 females (1.6 cases per 100,000). The borough- and sex-specific case rate was highest for males in Manhattan (5.1 cases per 100,000) (*Table 8*).

Age

Information regarding age was available for all cases. The highest age group-specific case rates with all sexes combined, were among persons 20-44 years old (2.9 cases per 100,000), followed by children <5 years old (2.3 cases per 100,000). The highest age group- and sex-specific case rates were in males 20-44 years old (3.4 cases per 100,000) (*Table 10*). The highest age group and borough-specific case rates occurred in adults 20-44 years old in Manhattan (7.7 cases per 100,000), followed by children <5 years old in Manhattan (4.9 cases per 100,000) (*Table 11)*.

Race/Ethnicity

Race/ethnicity information was available for 151 of 163 cases (92.6%). Citywide, the racial/ethnic group-specific case rate was highest among Asian, non-Hispanics (2.9 cases per 100,000), followed by White, non-Hispanics (2.7 per 100,000). The highest race/ethnicity and borough-specific case rate occurred among Asian, non-Hispanics in Manhattan (6.0 cases per 100,000), followed by White, non-Hispanics (5.3 per 100,000) (*Table 12*). The highest age group and race/ethnicity-specific case rates occurred among 20-44 year old White, non-Hispanics (5.0 cases per 100,000), followed by Asian, non-Hispanics < 5 years old (4.2 per 100,000) (*Table 13*). Note, the number of Asian, non-Hispanics reported was very small (n=9) so caution must be used when interpreting rates for this race/ethnicity group.

Census Tract Poverty Level

Age-adjusted case rates for cryptosporidiosis among four levels of census tract poverty ranged from 2.5-2.7 cases per 100,000 population, with very little difference between age-adjusted rate and census tract poverty level in 2017 (*Table 14*).

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 (*Figure 5*). Reported cryptosporidiosis cases among persons living with HIV/AIDS decreased from 392 in 1995 to 39 in 2017, thus causing a decline in the overall number of cryptosporidiosis cases in NYC. During the same period (1995 – 2017), the number of cases of cryptosporidiosis among immunocompetent persons has shown less variation, with a maximum of 139 cases in 1999 and a range of 29 to 128 cases in the years 2001 – 2017 (5). An analysis of trends using Poisson regression to compare the number of cases of cryptosporidiosis among person with HIV/AIDS to the number of cases among the immunocompetent indicates that the overall decline from 1995 to 2017 was significantly greater in patients who were immunocompromised than those who were not ($p<0.01$). This decline is generally thought to be because of highly active antiretroviral therapy, which was introduced in 1996 – 1997 for persons living with HIV/AIDS.

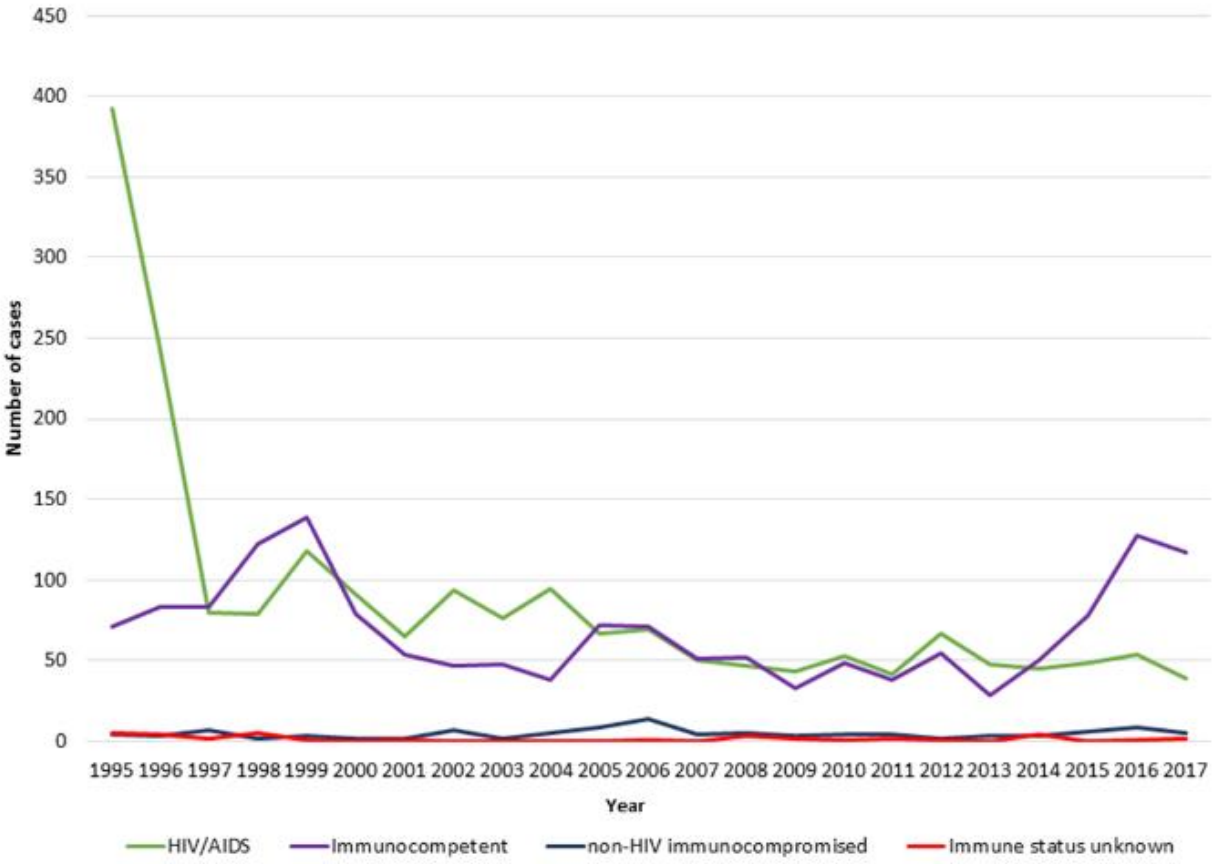

Figure 5 Cryptosporidiosis, number of cases by year of diagnosis and immune status, New York City, 1995 – 2017.

Cryptosporidiosis and Potential Risk Exposures

Of the 163 cryptosporidiosis cases diagnosed among NYC residents in 2017, questionnaires concerning potential exposures were completed in 133 cases (81.6%). Reasons for non-completion of questionnaires were: unable to locate patient (16 cases, 9.8%) and refused (10 cases, 6.1%). Of the immunocompetent patients, interviews were completed for 105 patients (90%). Among persons with HIV/AIDS, interviews were completed for 24 patients (61.5%), and interviews were completed for 4 patients (80%) who were immunocompromised for reasons other than HIV/AIDS. Summary data for 1995 through 2017 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 Appendix D: *Table 15* and *Table 16*, respectively.

Information has also been collected regarding type of tap water consumption, and is presented in Appendix D: *Table 17* and *Table 18*. Tables 15 to 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. Looking at four potential risk categories (see Appendix D: *Table 15* and *Table 16)* using the chi-square test for comparison of data since 2001, the following results were observed. Patients who were immunocompetent were significantly more likely ($p<0.01$) to report international travel for 16/17 years (94%), and to report exposure to recreational water in 12/17 years (71%). There was no statistically significant difference between patients who are immunocompromised because of HIV/AIDS and patients who are immunocompetent in the proportion of patients reporting animal contact from 2001 to 2017, or reporting high-risk sex from 2001 ─ 2005, 2007, and 2009 – 2016. In 2006, 2008 and 2017, the proportion of patients reporting high-risk sex was significantly higher among persons with HIV/AIDS than among immunocompetent persons ($p<0.01$). 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. 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.

II: SYNDROMIC SURVEILLANCE/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 may rapidly be implemented. Beginning in the 1990s, NYC established and has maintained a number of distinct and complementary outbreak detection systems. One system monitors and assists in the investigation of GI outbreaks in sentinel nursing homes. Another system monitors the number of stool specimens submitted to a participating clinical laboratory for microbiological testing, and a third system utilizes hospital emergency department (ED) chief complaint logs to monitor for outbreaks. The ED system is relied upon most for monitoring the burden of diarrheal illness in NYC. DOHMH also uses two systems for monitoring sales of anti-diarrheal medications: the Anti-Diarrheal Monitoring System (ADM) and the over-the-counter medication (OTC) system. These pharmacy systems were merged in 2012 as the OTC-ADM system. (Note: both the ADM and OTC

systems track sales of non-prescription anti-diarrheal medications. The program names were chosen simply as a way to distinguish the two systems).

Other than the ED system, which is now 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 2016 is provided in the final section of Part III and in *Appendix E: Syndromic Surveillance Observations*

Program Components – Overviews and Updates

A. 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. Throughout 2017, DOHMH received electronic data from all of NYC's 53 EDs reporting, approximately, 11,500 visits per day. 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 is 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.* [2].

B. 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. Sales of anti-diarrheal medications such as Imodium® and bismuth subsalicylate, also known as Pepto-Bismol® (used to treat diarrhea in adults and teenagers), are monitored. 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 was lost, but two additional pharmacy chains were gained. 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, looking 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.

During 2017, data were received daily from approximately 570 stores. An enhancement made to the system in 2017 was the implementation of a new visualization dashboard for the daily ADM data which displays both temporal trends and zip-code level spatial signals on maps.

C. Clinical Laboratory Monitoring System

The number of stool specimens submitted to clinical laboratories for bacterial and parasitic testing also provides 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.* [3].

D. Nursing Home Sentinel Surveillance

The nursing home surveillance system began in 1997 and was substantially modified in 2002. Under the current protocol, when a participating nursing home notes 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 (PHL), where culture and sensitivity testing is performed. In 2011, DOHMH PHL discontinued parasitology testing. Specimens designated for ova and parasite tests, *Cryptosporidium* as well as for virus and *C. difficile* toxin testing are now 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.

WDRAP team members made site visits to seven of eight nursing homes participating in the Nursing Home Sentinel Surveillance system in 2017. The remaining nursing home was visited in February 2018. During the site visits, DOHMH staff members reviewed with nursing administration or infection control staff the rationale for the program and program protocol. In addition, the DOHMH staff members verified that the nursing homes had adequate stool collection supplies on hand. All participating nursing homes are visited on an annual basis to help ensure compliance with the program protocol.

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 see whether or not there are concurrent signals. In this report, *Appendix E: Syndromic Surveillance (*Figures 6 to 9) 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 and Figure 9 summarize signal results from all syndromic surveillance systems operated by DOHMH, as described further below, during 2017.

Figure 6. Emergency Department Syndromic Surveillance, Trends in visits for the diarrhea syndrome, New York City, January 1, 2017 – December 31, 2017. shows a graphic representation of 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, 2017. The graph also indicates the occurrence of citywide signals and of the spatial residential zip code and hospital signals. Appendix E Figure 7 shows the same graph for the syndrome of vomiting. Appendix E, Figures 8 and 9 indicate that citywide signals for vomiting and/or diarrhea occurred in every month of 2017 with the exception of January and June. There were sustained (i.e., >1-day) citywide diarrhea signals in March, April, May, October, November and December. Sustained diarrheal signals during these months occurred only once per month and were a mean of 3.6 days (range 3-5 days), with the exception of December where there were 3 signals, each 3 days in length.

There were sustained citywide vomiting signals in March, April, September, October, November and December. The average sustained vomiting signal duration was 3.1 days (range 2-6 days). Multiple vomiting signals occurred in March, November and December. For specific date ranges please refer to *Appendix E:* Syndromic Surveillance (Figures 6 to 9). ED signals for diarrhea (Figure 6) and vomiting (Figure *7*) in the winter and the early spring (e.g., March, October, November and December) are consistent with historical experience showing a seasonal increase in viral gastroenteritis related to norovirus and/or rotavirus. Case incidence data for norovirus and

rotavirus are routinely reviewed by BCD staff members to monitor such trends. Citywide signals in April, May and September were not found to be related to any specific exposure.

Appendix E also shows time-series plots of signals from NYC syndromic surveillance systems for the GI syndrome covering the period January 1 to June 3 (Figure *8*) and July 1 to December 31, 2017 (Figure *9*), respectively. Results from all of the GI syndromic surveillance systems are included (i.e., the ED, clinical laboratory, OTC-ADM, and sentinel nursing home systems). In reviewing trends in reported norovirus and rotavirus data in BCD's surveillance database, norovirus case reporting was elevated in January and February 2017, followed by a large increase in November and December 2017. Elevated rotavirus reporting occurred in March and April 2017.

In the Clinical Laboratory Monitoring system, there was a sustained signal August 1 – 2, 2017. During this period, there was no evidence of a cryptosporidiosis based on the number of positive *Cryptosporidium* cases.

In the OTC-ADM system there were sustained signals for bismuth subsalicylate sales August 1 – 8, 2017. Investigations were conducted for each signal and the August increase was determined to be driven by a promotional sale at one of the participating pharmacies. A similar increase was not seen in sales of other types of anti-diarrheal medications.

In summary, for the period of January – December 2017, there were multiple citywide signals for GI illness in the ED system in every month of 2017 with the exception of January and June. Sustained citywide signals in the ED system in the beginning and end of the year are consistent with annual GI viral trends. There was no evidence of a drinking water-related outbreak in NYC in 2017.

III: 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

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 key water supply monitoring locations. 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 May 2017, DEP held a functional exercise of the CGAP. Representatives from DEP, DOHMH, NYSDOH, and the US Environmental Protection Agency participated in the exercise. A revised and updated version of CGAP was issued by DEP in December 2017. Related to these activities, public notice templates and fact sheets relating to giardiasis and cryptosporidiosis were reviewed, and some revisions were made.

IV: REFERENCES

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5. Klein RJ, Schoenborn CA (2001) Age Adjustment Using the 2000 Projected U.S. Population. Hyattsville, Maryland: Centers for Disease Control and Prevention, National Center for Health Statistics.

V: APPENDICES

Appendix A: Supplemental Information

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 2015, 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 [4]. Because rates for the years 2001 through 2009 and the rates for the years 2014 through 2015 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 2016 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 6 & 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 (<24 years old, 25-44 years old, and ≥45 years old) [5].

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 only interviews cases that are found to be confirmed or probable by NYS DOH Wadsworth Center.

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.

Appendix B: Giardiasis number of cases and case rates

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, 2017.

		Borough of residence				
Sex	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Male	695	282	88	199	105	21
	(17.1)	(36.2)	(12.8)	(16.0)	(9.3)	(9.1)
Female	280	95	36	70	70	9
	(6.3)	(11.0)	(4.7)	(5.1)	(5.8)	(3.7)
Total	975	377	124	269	175	30
	(11.4)	(22.9)	(8.5)	(10.2)	(7.5)	(6.3)

Table 4: Giardiasis, number of cases and annual case rate per 100,000 by United Hospital Fund neighborhood of residence, New York City, 2017.

United Hospital Fund Neighborhood	Borough	Number	Population	Rate
Greenwich Village-Soho	Manhattan	39	81,767	47.7
Chelsea-Clinton	Manhattan	67	157,336	42.6
Gramercy Park-Murray Hill	Manhattan	32	131,866	24.3
Downtown-Heights-Slope	Brooklyn	59	260,857	22.6
Washington Heights-Inwood	Manhattan	55	269,275	20.4
Upper West Side	Manhattan	45	220,431	20.4
Union Sq-Lower East Side	Manhattan	37	197,852	18.7
East Harlem	Manhattan	21	112,707	18.6
C.Harlem-Morningside Heights	Manhattan	32	175,041	18.3
Upper East Side	Manhattan	39	219,183	17.8
Greenpoint	Brooklyn	25	142,298	17.6
Williamsburg-Bushwick	Brooklyn	37	220,423	16.8
Long Island City-Astoria	Queens	34	215,789	15.8
Lower Manhattan	Manhattan	8	62,197	12.9
Ridgewood-Forest Hills	Queens	31	251,505	12.3
Fordham-Bronx Park	Bronx	31	260,039	11.9
Port Richmond	Staten Island	8	67,820	11.8
Borough Park	Brooklyn	38	348,619	10.9
High Bridge-Morrisania	Bronx	24	222,475	10.8
Kingsbridge-Riverdale	Bronx	9	92,547	9.7
Rockaway	Queens	11	120,518	9.1
Bed Stuyvesant-Crown Heights	Brooklyn	30	329,259	9.1
Fresh Meadows	Queens	9	101,491	8.9
Crotona-Tremont	Bronx	17	220,195	7.7
West Queens	Queens	36	478,881	7.5
Pelham-Throgs Neck	Bronx	22	310,847	7.1
Hunts Point-Mott Haven	Bronx	10	145,986	6.8
Coney Island-Sheepshead Bay	Brooklyn	19	286,152	6.6
Bensonhurst-Bay Ridge	Brooklyn	14	214,005	6.5
East Flatbush-Flatbush	Brooklyn	19	301,024	6.3
East New York	Brooklyn	11	186,437	5.9
Southwest Queens	Queens	17	293,262	5.8
Flushing-Clearview	Queens	15	264,618	5.7
Willowbrook	Staten Island	5	88,373	5.7
South Beach-Tottenville	Staten Island	11	194,921	5.6
Northeast Bronx	Bronx	11	205,220	5.4
Sunset Park	Brooklyn	7	133,629	5.2
Canarsie-Flatlands	Brooklyn	10	206,447	4.8
Stapleton-St. George	Staten Island	6	124,900	4.8
Jamaica	Queens	13	317,193	4.1
Southeast Queens	Queens	8	212,809	3.8
Bayside-Littleneck	Queens	1	91,478	1.1

Note: this table does not include two 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, 2017.

	Sex		
Age Group	Male	Female	Total
<5 years	44	29	73
	(15.6)	(10.7)	(12.8)
5-9 years	29	41	70
	(11.4)	(16.9)	(14.4)
10-19 years	38	21	59
	(8.0)	(4.6)	(6.3)
20-44 years	384	99	483
	(24.0)	(5.8)	(14.5)
45-59 years	136	44	180
	(17.5)	(4.1)	(10.9)
≥ 60 years	64	46	110
	(9.3)	(4.9)	(6.9)
Total	695	280	975
	(17.1)	(6.3)	(10.5)

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, 2017.

	Borough of residence					
Age Group	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
<5 years	73	12	14	26	17	4
	(12.8)	(14.8)	(13.1)	(13.4)	(11.7)	(14.9)
5-9 years	70	7	16	25	18	4
	(14.4)	(10.6)	(15.6)	(14.9)	(13.8)	(13.8)
10-19 years	59	12	15	15	14	3
	(6.3)	(9.3)	(7.6)	(5.0)	(5.7)	(5.0)
20-44 years	483	211	45	151	67	9
	(14.5)	(28.9)	(8.4)	(14.7)	(7.8)	(5.8)
45-59 years	180	84	24	33	36	3
	(10.9)	(27.7)	(8.8)	(7.0)	(7.4)	(2.9)
≥ 60 years	110	51	10	19	23	7
	(6.9)	(15.2)	(4.2)	(4.0)	(4.9)	(6.8)
Total	975	377	124	269	175	30
	(11.4)	(22.9)	(8.5)	(10.2)	(7.5)	(6.3)

Table 7: Giardiasis, number of cases and case rates by census tract poverty level, New York City, 2017.

Census Tract Poverty Level	Number of cases	Case Rate per 100,000	Age adjusted rate
Low [a]	286	13.0	18.0
Medium [b]	332	13.1	18.9
High [c]	187	10.2	14.6
Very high [d]	166	8.4	11.4

Poverty levels are defined by the American Community Survey, 2014 – 2016 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: four cases (0.4%) were excluded from this table because geolocating information for census tract identification was unavailable.

Appendix C: Cryptosporidosis number of cases and case rates

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, 2017.

	Borough of residence					
Sex	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Male	93	40	21	18	12	2
	(2.3)	(5.1)	(3.1)	(1.4)	(1.1)	(0.9)
Female	70	37	7	12	14	0
	(1.6)	(4.3)	(0.9)	(0.9)	(1.2)	(0)
Total	163	77	28	30	26	2
	(1.9)	(4.7)	(1.9)	(1.1)	(1.1)	(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, 2017.

United Hospital Fund Neighborhood	Borough	Number	Population	Rate
Chelsea-Clinton	Manhattan	14	157,336	8.9
Greenwich Village-Soho	Manhattan	6	81,767	7.3
Gramercy Park-Murray Hill	Manhattan	7	131,866	5.3
Washington Heights-Inwood	Manhattan	14	269,275	5.2
Lower Manhattan	Manhattan	3	62,197	4.8
High Bridge-Morisania	Bronx	10	222,475	4.5
East Harlem	Manhattan	5	112,707	4.4
Upper West Side	Manhattan	8	220,431	3.6
Union Sq-Lower East Side	Manhattan	7	197,852	3.5
C Harlem-Morningside Heights	Manhattan	6	175,041	3.4
Upper East Side	Manhattan	7	219,183	3.2
Crotona-Tremont	Bronx	7	220,195	3.2
Downtown Heights-Slope	Brooklyn	7	260,857	2.7
Bayside-Littleneck	Queens	2	91,478	2.2
Bed Stuyvesant-Crown Heights	Brooklyn	7	329,259	2.1
Fordham-Bronx Park	Bronx	5	260,039	1.9
Long Island City-Astoria	Queens	4	215,789	1.9
Pelham-Throgs Neck	Bronx	5	310,847	1.6
Ridgewood-Forest Hills	Queens	4	251,505	1.6
Southeast Queens	Queens	3	212,809	1.4
Greenpoint	Brooklyn	2	142,298	1.4
Williamsburg-Bushwick	Brooklyn	3	220,423	1.4
West Queens	Queens	6	478,880	1.3
Borough Park	Brooklyn	4	348,619	1.1
1Kingsbridge-Riverdale	Bronx	1	92,547	1.1
East New York	Brooklyn	2	186,437	1.1
Southwest Queens	Queens	3	293,262	1.0
Rockaway	Queens	1	120,518	0.8
Stapleton-St. George	Staten Island	1	124,900	0.8
Flushing-Clearview	Queens	2	264,618	0.8
East Flatbush-Flatbush	Brooklyn	2	301,024	0.7
South Beach-Tottenville	Staten Island	1	194,921	0.5
Canarsie-Flatlands	Brooklyn	1	206,447	0.5
Bensonhurst-Bay Ridge	Brooklyn	1	214,005	0.5
Coney Island-Sheepshead Bay	Brooklyn	1	286,152	0.3
Jamaica	Queens	1	317,193	0.3

Table 10: Cryptosporidiosis, number of cases and annual case rate per 100,000 population (in parentheses) by age group and sex, New York City, 2017.

	Sex		
Age Group	Male	Female	Total
<5 years	8	5	13
	(2.8)	(1.8)	(2.3)
5-9 years	3	3	6
	(1.2)	(1.2)	(1.2)
10-19 years	4	4	8
	(0.8)	(0.9)	(0.9)
20-44 years	55	43	98
	(3.4)	(2.5)	(2.9)
45-59 years	16	9	25
	(2.1)	(1.0)	(1.5)
≥ 60 years	7	6	13
	(1.0)	(0.6)	(0.8)
Total	93	70	163
	(2.3)	(1.6)	(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, 2017.

	Borough of residence					
Age Group	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
<5 years	13	4	4	2	3	0
	(2.3)	(4.9)	(3.7)	(1.0)	(2.1)	(0)
5-9 years	6	2	2	0	2	0
	(1.2)	(3.0)	(1.9)	(0)	(1.5)	(0)
10-19 years	8	1	3	2	2	0
	(0.9)	(0.8)	(1.5)	(0.7)	(0.8)	(0)
20-44 years	98	56	10	20	12	0
	(2.9)	(7.7)	(1.9)	(2.0)	(1.4)	(0)
45-59 years	25	11	5	4	3	2
	(1.5)	(3.6)	(1.8)	(0.8)	(0.6)	(1.9)
≥ 60 years	13	3	4	2	4	0
	(0.8)	(0.9)	(1.7)	(0.4)	(0.9)	(0)
Total	163	77	28	30	26	2
	(1.9)	(4.7)	(1.9)	(1.1)	(1.1)	(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, 2017.

	Borough of residence					
Race/Ethnicity	Citywide	Manhattan	Bronx	Brooklyn	Queens	Staten Island
Hispanic	43	14	14	4	10	1
	(1.7)	(3.3)	(1.7)	(0.8)	(1.5)	(1.1)
White, non-Hispanic	73	41	4	18	10	0
	(2.7)	(5.3)	(3.0)	(1.9)	(1.7)	(0)
Black, non-Hispanic	26	8	10	5	3	0
	(1.4)	(3.9)	(2.3)	(0.6)	(0.7)	(0)
Asian, non-Hispanic	9	5	0	2	2	0
	(2.9)	(6.0)	(3.4)	(2.8)	(1.3)	(0.6)
Pacific Islander, Native Hawaiian, non-Hispanic American Indian, two or more races, other	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)
Unknown	12	9	0	1	1	1
Total	163	77	28	30	26	2
	(1.9)	(4.7)	(1.9)	(1.1)	(1.1)	(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, 2017.

	Age group						
Race/Ethnicity	<5 years	5-9 years	10-19 years	20-44 years	45-59 years	≥ 60 years	Total
Hispanic	4	4	5	18	5	7	43
	(2.1)	(2.2)	(1.5)	(1.8)	(1.1)	(2.0)	(1.7)
White, non-Hispanic	2	1	2	53	11	4	73
	(1.3)	(0.8)	(0.9)	(5.0)	(2.2)	(0.6)	(2.7)
Black, non-Hispanic	3	1	1	12	7	2	26
	(2.6)	(0.4)	(0.4)	(1.8)	(1.7)	(0.5)	(1.4)
Asian, non-Hispanic	3	0	0	5	1	0	9
	(4.2)	(0)	(0)	(1.0)	(0.4)	(0)	(0.7)
Pacific Islander, Native Hawaiian, non-Hispanic American Indian, two or more races, other	0	0	0	0	0	0	0
	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Unknown	1	0	0	10	1	0	12
Total	13	6	8	98	25	13	163
	(3.0)	(1.9)	(2.4)	(3.1)	(1.8)	(0.6)	(1.9)

Table 14: Cryptosporidiosis, number of cases and case rates by census tract poverty level, New \York City, 2017.

Census Tract Poverty Level	Number of cases	Case Rate per 100,000	Age adjusted rate
Low [a]	45	2.1	2.7
Medium [b]	51	2.0	2.7
High [c]	28	1.5	2.5
Very high [d]	39	2.0	2.6

Poverty levels are defined by the American Community Survey, 2014 – 2016 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%.

Appendix D: Cryptosporidiosis Patient Interviews: Risk Exposure Results

Table 15: Percentage of interviewed **cryptosporidiosis** patients reporting selected potential risk exposures before disease onset [a] persons with HIV/AIDS, New York City 1995 – 2017, median (range).

Exposure Type	Persons with HIV/AIDS					
	1995-1999	2000-2004	2005-2009	2010-2014	2015-2016	2017
Contact with an animal[b]	35% (33%-36%)	40% (24%-43%)	38% (31%-44%)	34% (20%-43%)	38% (30%-45%)	25%
High-risk sexual activity[c] (≥ 18 years old)	20% (9%-22%)	24% (16% - 34%)	31% (21%-39%)	17% (7%-25%)	27% (21% -32%)	33%
International travel[d]	9% (9%-18%)	13% (10%-15%)	8% (6%-17%)	6% (4%-13%)	10% (9%-11%)	13%
Recreational water contact[e]	16% (8%-16%)	13% (8%-21%)	14% (5%-18%)	10% (4%-14%)	13% (12%-13%)	8%

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 (2017).

c: High-risk sexual activity: includes having a penis, finger or tongue in a sexual partner's anus (1995 – 2017)

d: International travel: travel outside of the United States (1995 – 2017)

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 (2017).

Table 16: Percentage of interviewed **cryptosporidiosis** patients reporting selected potential risk exposures before disease onset [a], immunocompetent persons, New York City, 1995 – 2017, median (range).

Exposure Type	Immunocompetent persons					
	1995-1999	2000-2004	2005-2009	2010-2014	2015-2016	2017
Contact with an animal[b]	35% (7%-41%)	34% (23%-37%)	36% (28%-40%)	34% (18%-41%)	38% (34%-41%)	30%
High-risk sexual activity[c] (≥ 18 years old)	12% (10%-25%)	23% (13%-31%)	17% (7%-19%)	8% (4%-11%)	22% (14% -29%)	8%
International travel[d]	28% (26%-30%)	45% (33%-47%)	45% (37%-52%)	44% (35%-62%)	42% (41%-42%)	45%
Recreational water contact[e]	24% (21%-40%)	34% (32%-35%)	40% (28%-52%)	35% (32%-48%)	37% (35%-39%)	26%

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 (2017).

c: High-risk sexual activity: includes having a penis, finger or tongue in a sexual partner's anus (1995 – 2017)

d: International travel: travel outside of the United States (1995 – 2017)

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 (2017).

Table 17: Percentage of interviewed **cryptosporidiosis** patients by type of tap water exposure before disease onset [a], persons with HIV/AIDS, New York City, 1995 – 2017, median (range).

Exposure Type	Persons with HIV/AIDS					
	1995-1999	2000-2004	2005-2009	2010-2014	2015-2016	2017
Plain tap[b]	69% (64%-71%)	55% (49%-77%)	67% (58%-76%)	63% (50%-71%)	59% (55%-63%)	50%
Filtered tap[c]	12% (9%-20%)	20% (13%-22%)	14% (7%-18%)	11% (8%-25%)	14% (13%-15%)	21%
Boiled tap[d]	5% (3%-7%)	6% (0%-6%)	7% (0%-11%)	4% (2%-11%)	0% (0%)	4%
Incidental plain tap only[e]	15% (8%-16%)	15% (4%-19%)	10% (4%-17%)	18% (8%-20%)	24% (24%)	13%
No tap[f]	2% (0%-5%)	4% (2%-6%)	2% (0%-6%)	4% (0%-4%)	3% (0%-6%)	13%

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 – 12/13/2017).

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 – 12/31/2017).

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 – 2017).

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 – 199); expanded to include make juice from concentrate (1997 – 2017).

Table 18: Percentage of interviewed **cryptosporidiosis** patients by type of tap water exposure before disease onset [a], immunocompetent persons, New York City, 1995 – 2017, median (range).

Exposure Type	Immunocompetent persons					
	1995-1999	2000-2004	2005-2009	2010-2014	2015-2016	2017
Plain tap[b]	58% (56%-67%)	36% (27%-56%)	30% (27%-47%)	33% (28%-49%)	39% (38%-39%)	47%
Filtered tap[c]	21% (17%-25%)	31% (17%-44%)	23% (20%-30%)	24% (17%-27%)	23% (19% -26%)	11%
Boiled tap[d]	8% (3%-11%)	2% (0%-7%)	5% (0%-14%)	2% (0%-7%)	6% (5%-6%)	2%
Incidental plain tap only[e]	9% (7%-12%)	16% (8%-21%)	25% (14%-28%)	15% (11%-22%)	20% (14%-25%)	29%
No tap[f]	4% (2%-7%)	9% (2%-21%)	14% (3%-27%)	21% (11%-29%)	14% (13%-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 – 12/13/2017).

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 – 12/31/2017).

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 – 2017).

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 – 199); expanded to include make juice from concentrate (1997 – 2017).

Appendix E: Syndromic Surveillance Observations

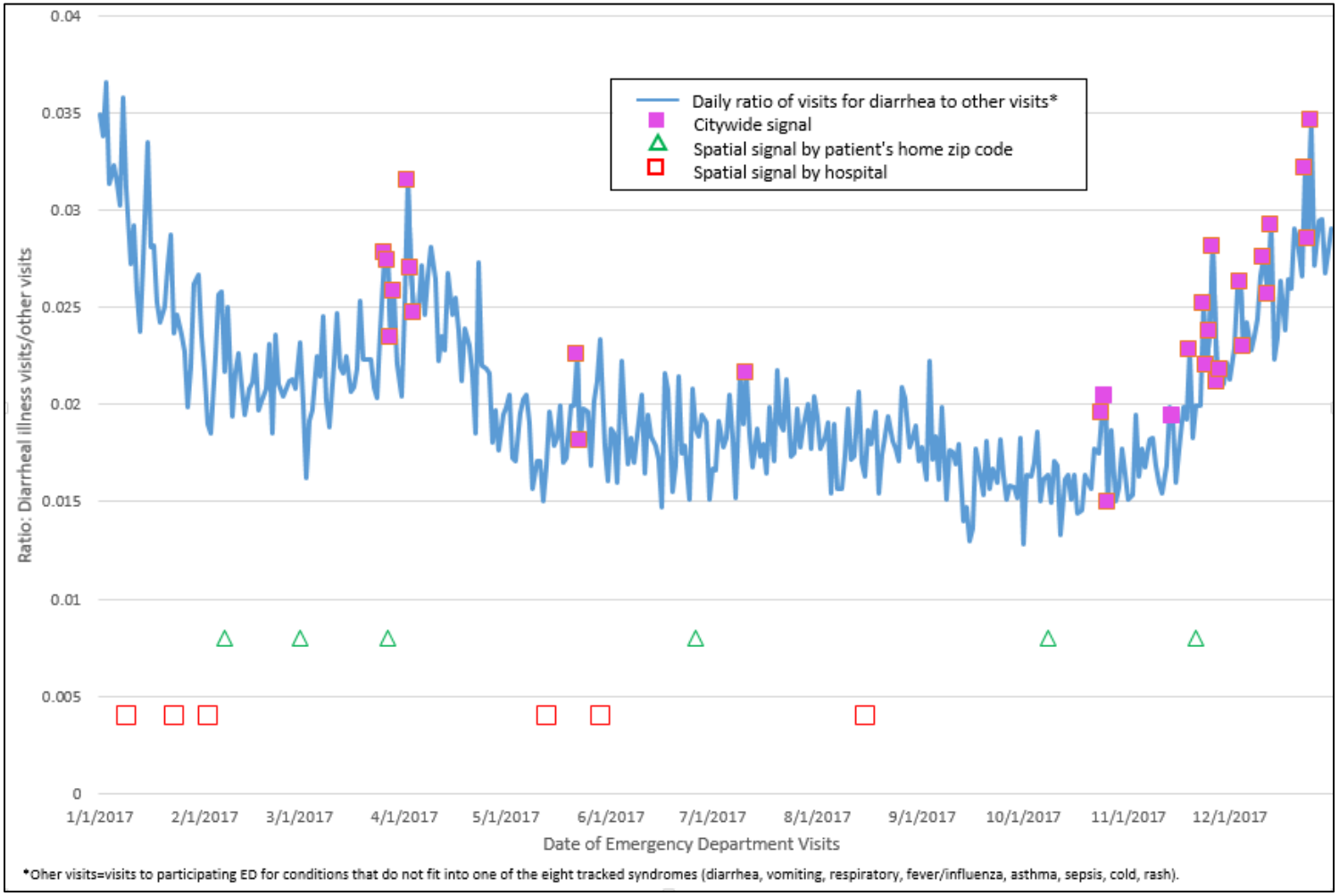

Figure 6. Emergency Department Syndromic Surveillance, Trends in visits for the diarrhea syndrome, New York City, January 1, 2017 – December 31, 2017.

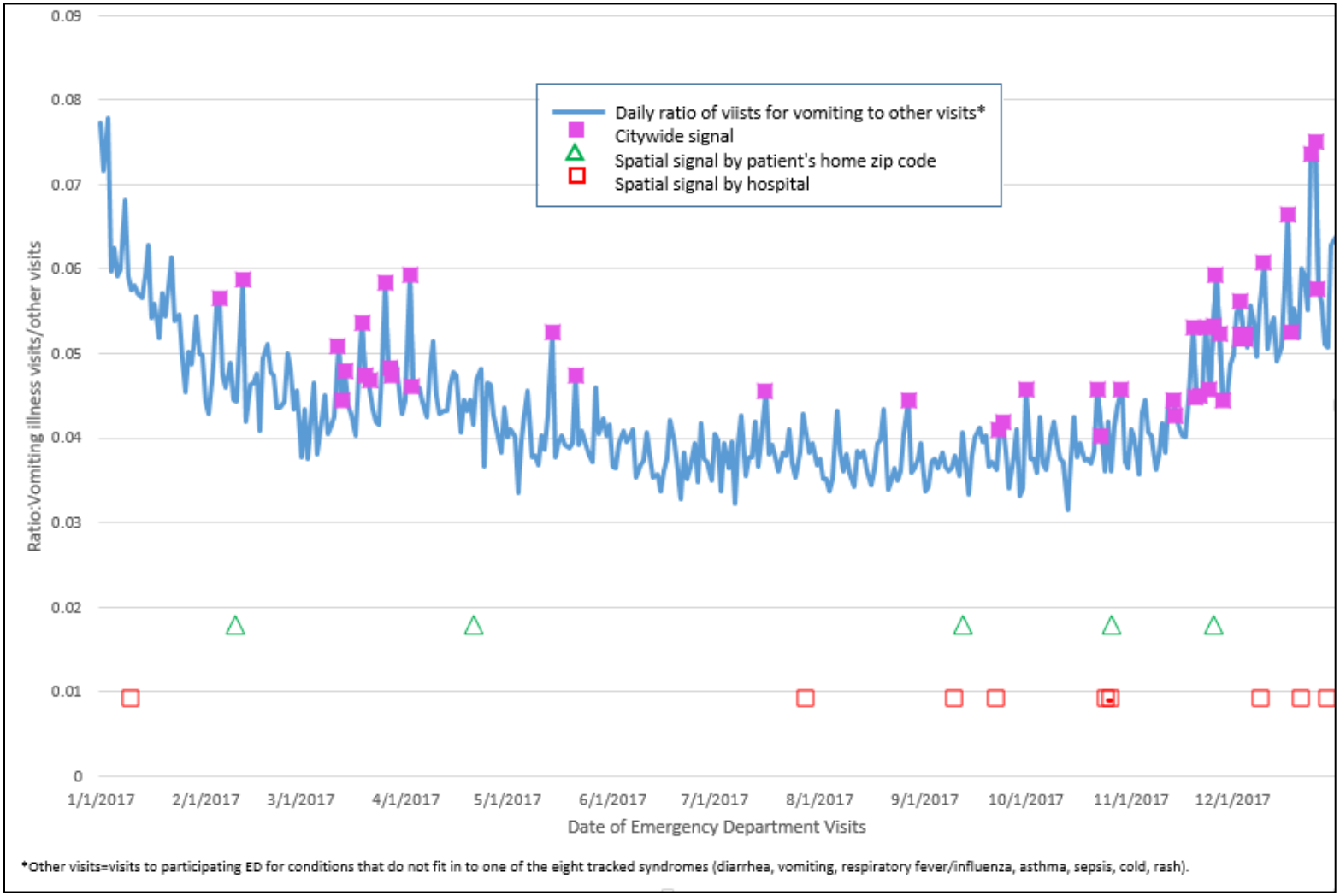

Figure 7. Emergency Department Syndromic Surveillance, Trends in visits for the vomiting syndrome, New York City, January 1, 2017 – December 31, 2017.

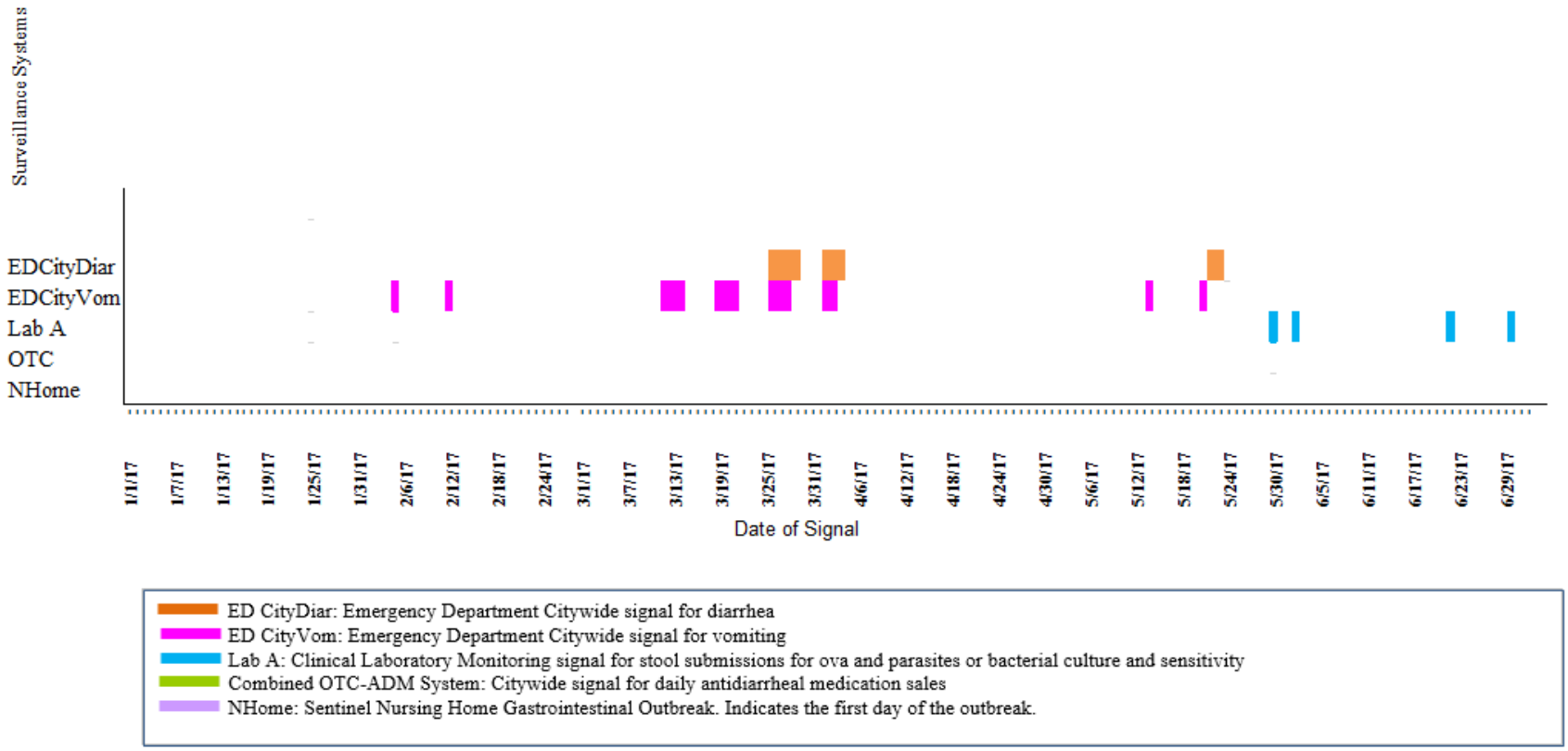

Figure 8. Signals for Gastrointestinal Illness, Syndromic Surveillance Systems, New York City, January 1, 2017 – June 30, 2017.

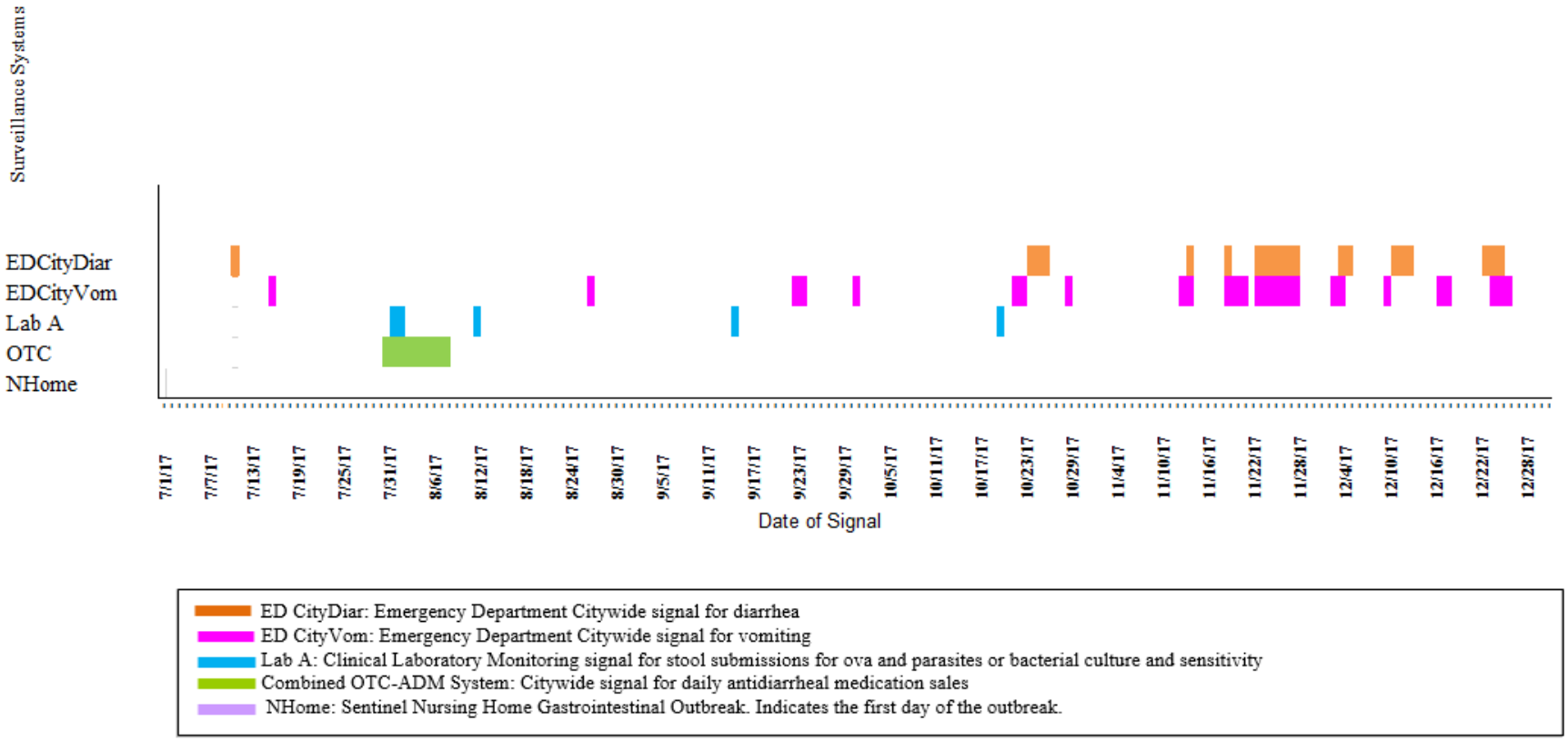

Figure 9. Signals for Gastrointestinal Illness, Syndromic Surveillance Systems, New York City, July 1, 2017 – December 31, 2017.