Water-borne illness

Threats and opportunities

Lynne Strasfeld, MD

Medical Director, Transplant Infectious Diseases
Associate Medical Director, Department of Infection Prevention and Control

Learning objectives:

1. Increase knowledge of several important waterborne infections, including routes of transmission, risk factors for severe disease, and management

2. Understand facility-based, patient-directed, and public health approaches to risk mitigation for waterborne infection

3. Review opportunities for improving public health through wastewater surveillance

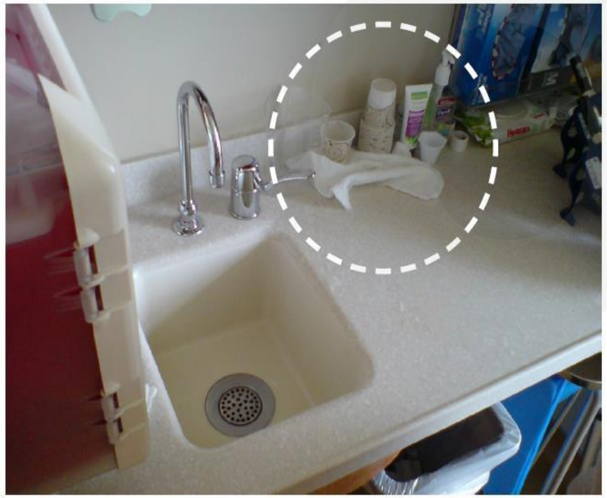
Connections

Pneumonia in older male smoker with COPD, Type 2 diabetes mellitus, and chronic kidney disease

Gram negative sepsis in patient with neutropenic fever

Diarrhea in patient with HIV/AIDS, CD4 < 100 cells/mL

Pruritic, tender skin nodules and low-grade fever in otherwise healthy individual



OHSU

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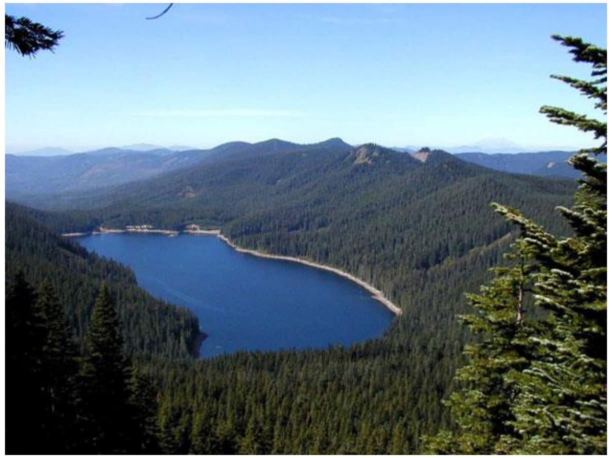
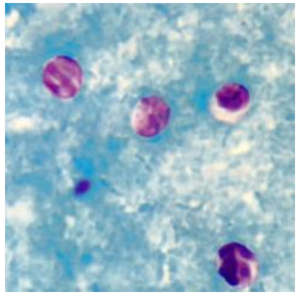
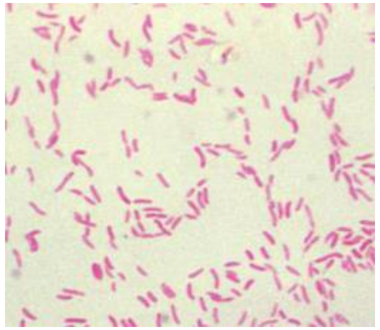


Portland Water Bureau

Google®

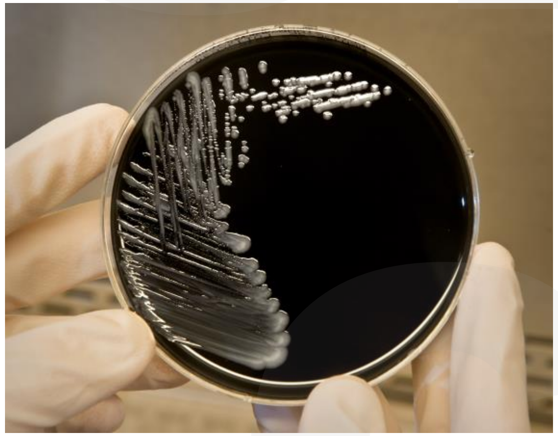




images from CDC resources

Opportunistic pathogens of premise plumbing

Legionella pneumophila



Pneumonia in older male smoker with COPD, Type 2 diabetes mellitus, and chronic kidney disease

The New England
Journal of Medicine

Volume 297 | DECEMBER 1, 1977 | Number 22

LEGIONNAIRES' DISEASE

Description of an Epidemic of Pneumonia

David W. Fraser, M.D., Theodore R. Tsai, M.D., Walter Orenstein, M.D., William E. Parkin, D.V.M., Dr. P.H., H. James Beecham, M.D., Robert G. Sharrar, M.D., John Harris, M.D., George F. Mallison, M.P.H., Stanley M. Martin, M.S., Joseph E. McDade, Ph.D., Charles C. Shepard, M.D., Philip S. Brachman, M.D., and the Field Investigation Team*

Abstract An explosive, common-source outbreak of pneumonia caused by a previously unrecognized bacterium affected primarily persons attending an American Legion convention in Philadelphia in July, 1976. Twenty-nine of 182 cases were fatal. Spread of the bacterium appeared to be air borne. The source of the bacterium was not found, but epidemiologic analysis suggested that exposure may have occurred in the lobby of the headquarters hotel or in the area immediately surrounding the hotel. Person-to-person spread seemed not to have occurred. Many hotel employees appeared to be immune, suggesting that the agent may have been present in the vicinity, perhaps intermittently, for two or more years. (N Engl J Med 297:1189-1197, 1977)

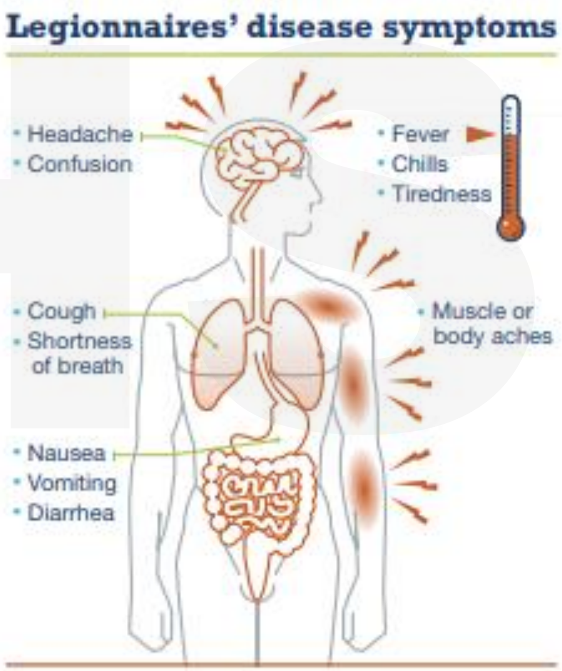
Bellevue-Stratford Hotel

Legionella

- > 60 species and > 70 serogroups
  - *L pneumophila* serogroup 1 most prevalent in US
- Environmental reservoir: water & soil
- Thermal range: 20-45°C
- Clinical presentation

  Legionnaires' disease
  - Mortality ~ 10%
  - At risk population: age ≥ 50, former/current smoker, chronic lung disease, immunocompromised
  - Incubation period: 2-10 days (median 4-6 days)

  Pontiac fever



Suggestive features:
- GI symptoms
- Hyponatremia
- Failure to respond to treatment for pneumonia with beta-lactam monotherapy

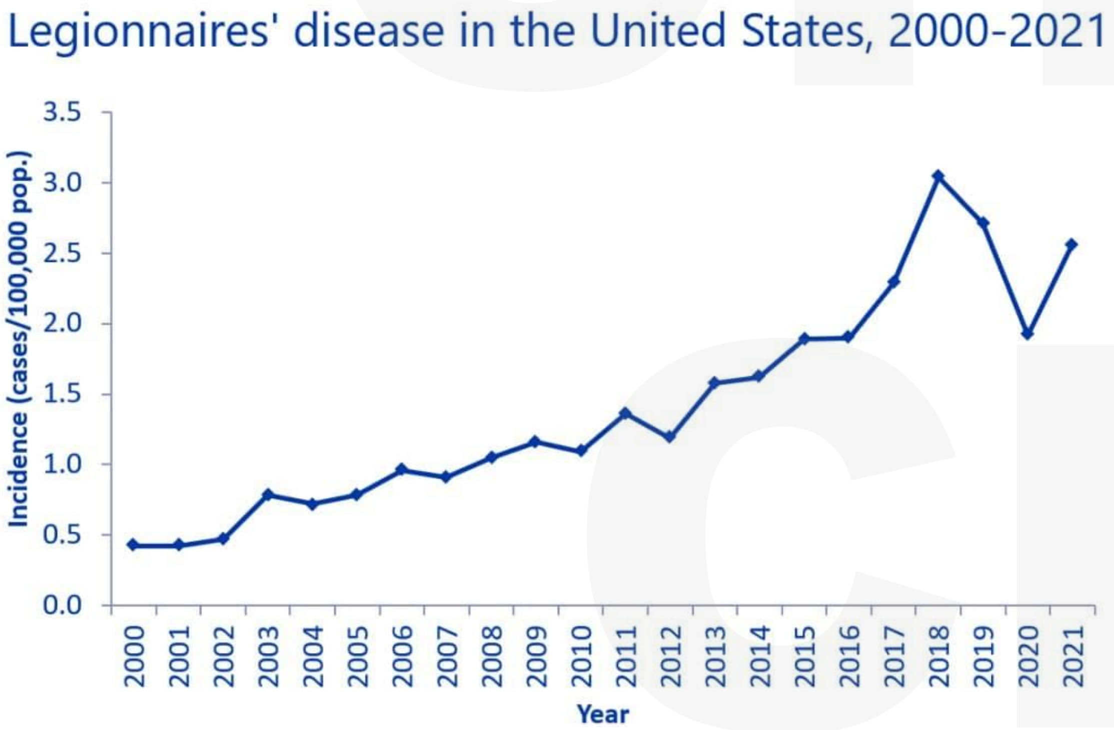
- Diagnostics
  - Legionella antigen
  - PCR
  - Culture - BCYE

- Treatment
  - Fluoroquinolones
  - Macrolides

images from CDC resources

Legionellosis epidemiology

Geographic variability



https://www.cdc.gov/legionella/php/surveillance/index.html

Han XY. *Applied and Environmental Microbiology* 2019

Legionella infection should be considered in any patient presenting with pneumonia.

- While infection can be acquired in healthcare settings, the majority of cases occur sporadically (community-acquired pneumonia).
- Tip offs: season (summer/fall), during known outbreaks, known or potential exposure to contaminated water source (e.g., hot tub, birthing pool, fountain, air conditioning system and cooling towers), soil/potting mix/compost exposure
- Whom to test?
  - All patients with moderate/severe CAP or with CAP requiring hospitalization
  - CAP or nosocomial pneumonia with known/possible exposure (e.g., outbreak)
  - Immunocompromised patients with pneumonia

Legionella ecology

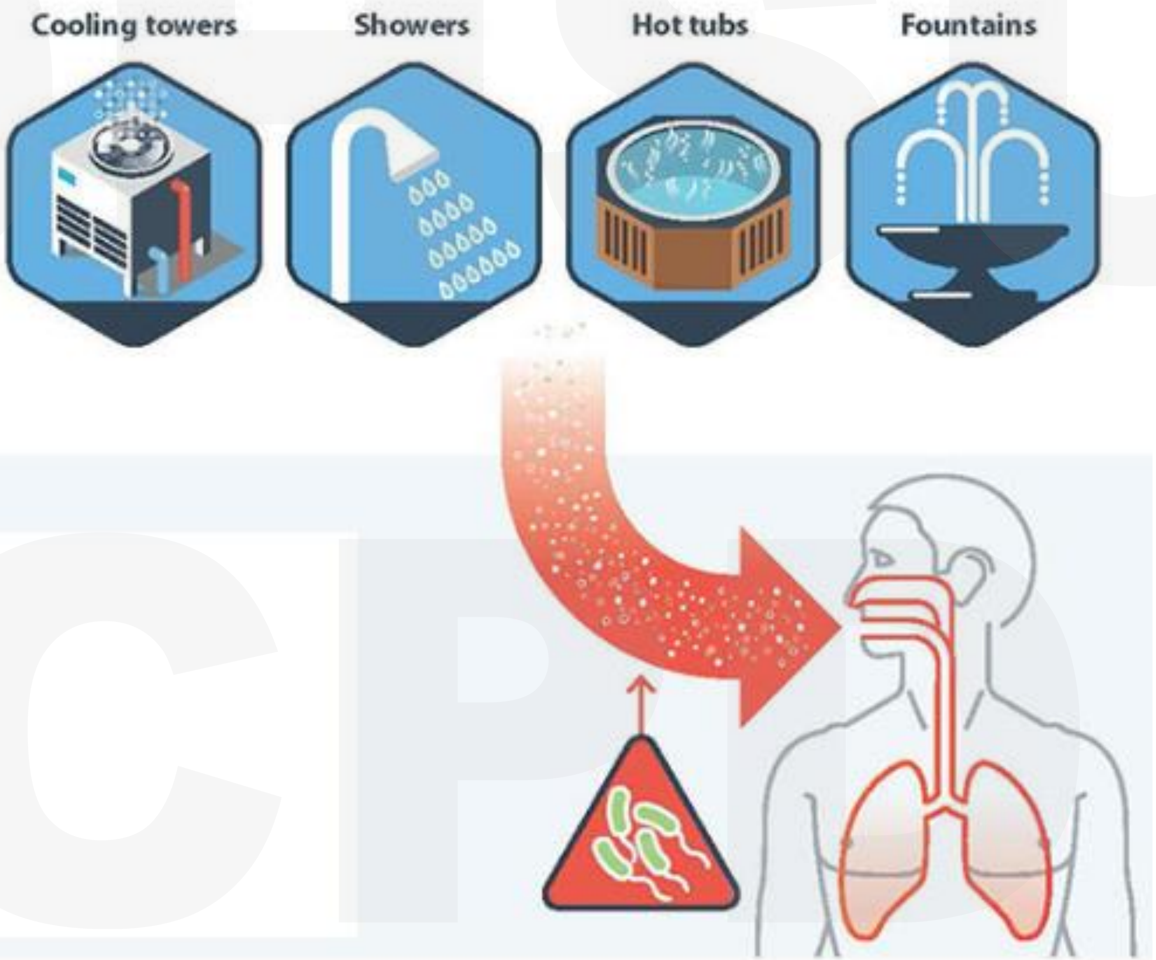
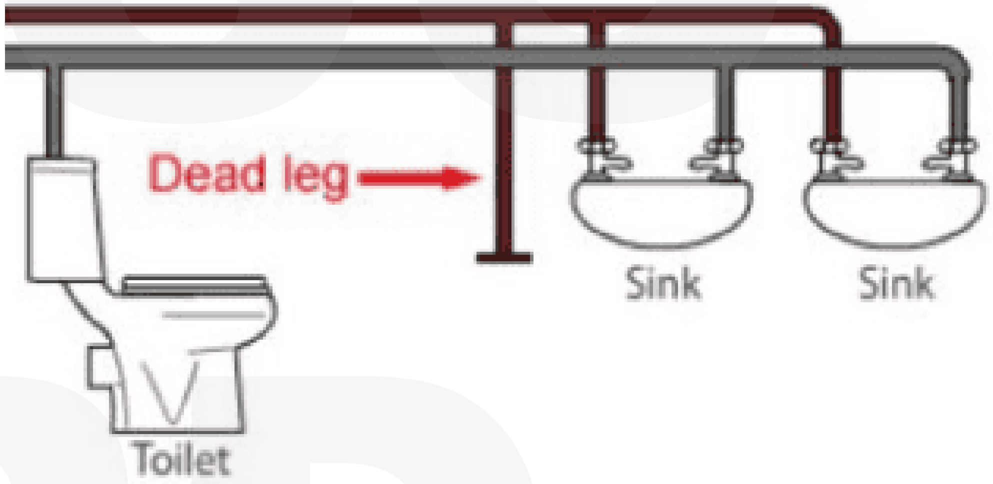


Image adapted from CDC resources: www.cdc.gov/legionella

Environmental risk factors

- Stagnancy (“dead legs”)
- Temperature deviation
- Biofilm



Hamilton KA, et al. *Water Research* 2018

Mitigation and monitoring in the healthcare setting

- Engineering controls:
  - Supply water infrastructure
  - Temperature & pH controls
  - Biocide (eg., chlorine)
- Environmental culturing (*variability in practice)
- Supplemental controls: point-of-use filters, flushing (often employed in the context of an outbreak)

Department of Veterans Affairs
Veterans Health Administration
Washington, DC 20420

VHA Directive 1061
Transmittal Sheet
August 13, 2014

PREVENTION OF HEALTHCARE-ASSOCIATED *LEGIONELLA* DISEASE AND SCALD INJURY FROM POTABLE WATER DISTRIBUTION SYSTEMS

1. REASON FOR ISSUE: This Veterans Health Administration (VHA) Directive addresses the prevention of healthcare-associated *Legionella* Disease and Scald Injury from Potable Water Distribution Systems in VHA buildings.

2. SUMMARY OF CONTENTS: This Directive establishes policy for the prevention and control of healthcare-associated *Legionella* disease in VHA-owned buildings in which patients, residents, or visitors stay overnight.

NIH Public Access
Author Manuscript
Infect Control Hosp Epidemiol. Author manuscript; available in PMC 2010 June 17.

Published in final edited form as:
Infect Control Hosp Epidemiol. 2009 August ; 30(8): 764–768. doi:10.1086/598855.

A cluster of nosocomial Legionnaire's disease linked to a contaminated hospital decorative water fountain

Tara N. Palmore, M.D.[1,2], Frida Stock, B.S.[1], Margaret White, M.S.[1], MaryAnn Bordner, M.S.[1], Angela Michelin, M.P.H.[1], John E. Bennett, M.D.[2], Patrick R. Murray, Ph.D.[1], and David K. Henderson, M.D[1]

[1]Warren Grant Magnusen Clinical Center, National Institutes of Health, Bethesda, Md.

[2]National Institute of Allergy and Infectious Diseases, National Institutes of Health, Bethesda, Md.

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journal homepage: www.ajicjournal.org

ELSEVIER

AJIC American Journal of Infection Control

Major Article

Hospital-acquired *Legionella* pneumonia outbreak at an academic medical center: Lessons learned

Michael A. Kessler MD[a,*], Fauzia Osman MPH[a], John Marx JrMPH[b], Aurora Pop-Vicas MD, MPH[a,b], Nasia Safdar MD, PhD[a,b,c]

[a] *Department of Medicine, University of Wisconsin-Madison, Madison, WI*
[b] *Department of Infection Control, University of Wisconsin Hospital, Madison, WI*
[c] *Department of Research and Development, William S. Middleton Memorial Veterans Hospital, University of Wisconsin-Madison, Madison, WI*

Health | Local News

2 people at UW Medical Center diagnosed with Legionnaires' disease

Nov. 4, 2023 at 6:54 pm

By Lauren Girgis
Seattle Times staff reporter

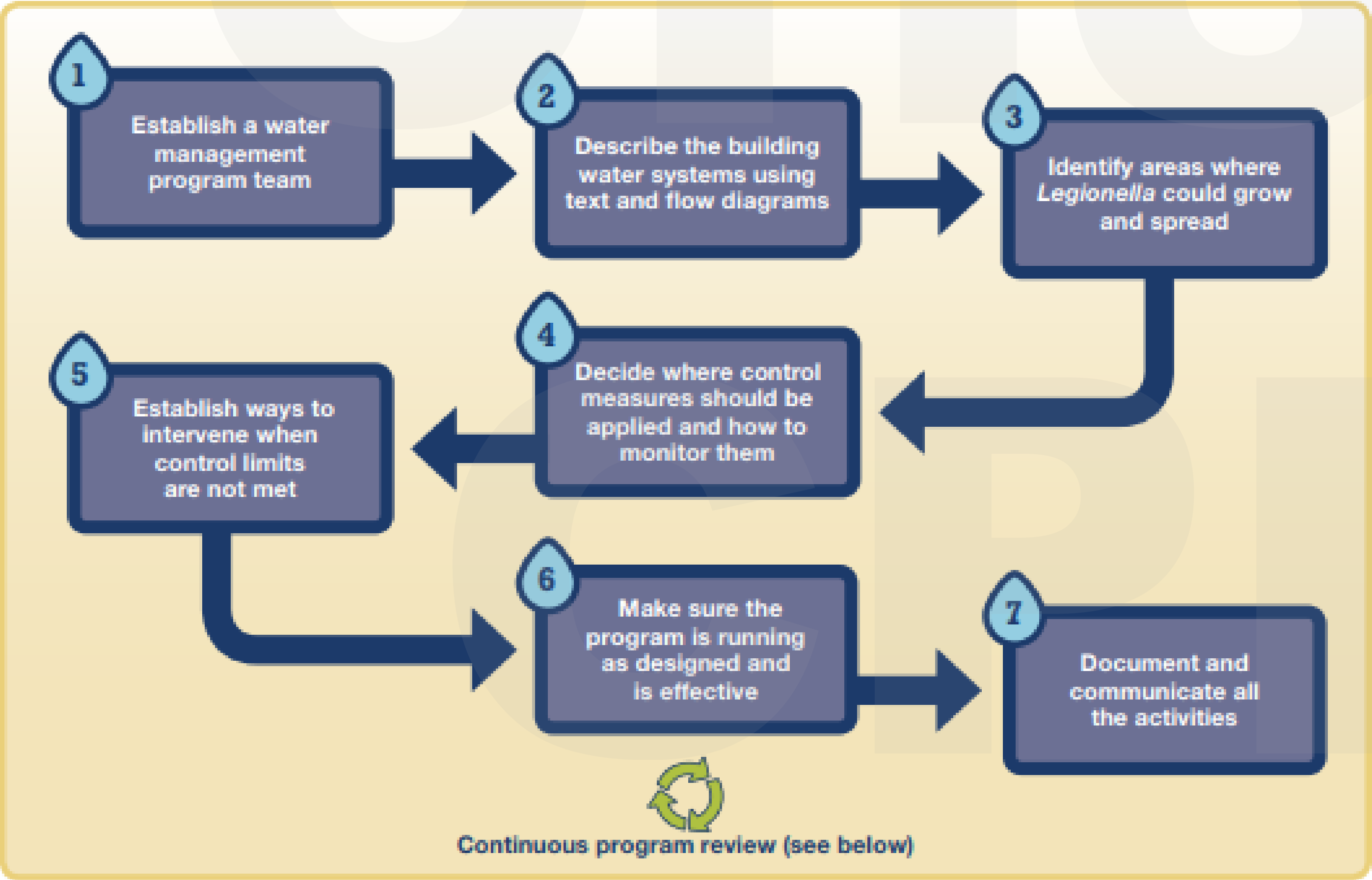
Two patients treated at the University of Washington Medical Center in Seattle's Montlake neighborhood have been diagnosed with Legionnaires' disease, and they may have gotten infected while they were being treated, according to UW Medicine.

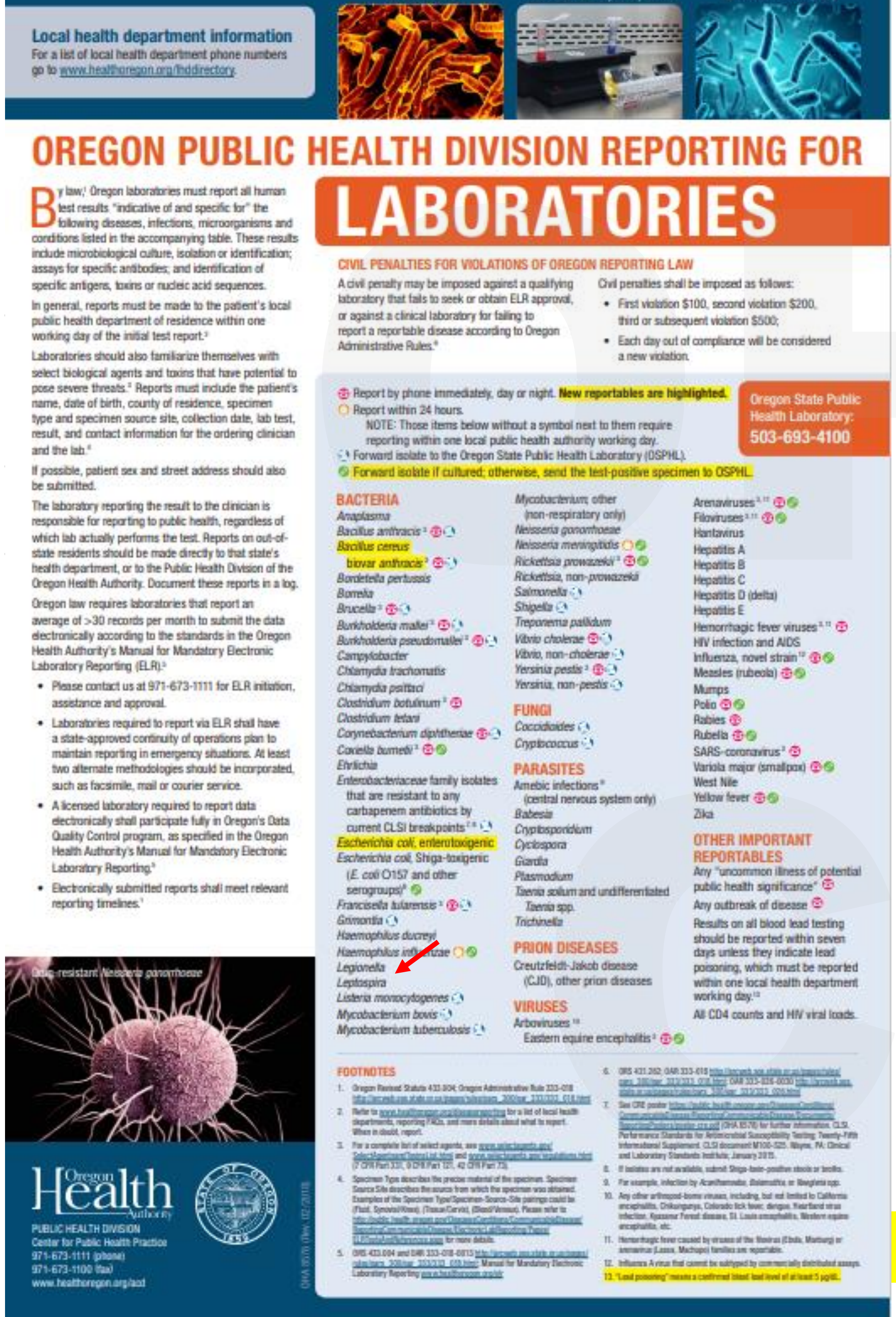
Both patients were treated in September. One of them has since been discharged, according to a Friday news release.

"We don't know the source of the patients' infections in these cases, and we may never know because often patients have very complex medical situations," Claire Brostrom-Smith, health care-associated infections manager at Public Health – Seattle & King County, said in a statement.

Developing a Water Management Program to Reduce *Legionella* Growth & Spread in Buildings

A PRACTICAL GUIDE TO IMPLEMENTING INDUSTRY STANDARDS




Local health department information
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Report within 24 hours.
NOTE: Those items below without a symbol next to them require reporting within one local public health authority working day.
Forward isolate to the Oregon State Public Health Laboratory (OSPHL).
Forward isolate if cultured; otherwise, send the test-positive specimen to OSPHL.

Oregon State Public Health Laboratory: 503-693-4100

BACTERIA
Anaplasma
Bacillus anthracis[3]
Bacillus cereus
biovar anthracis[3]
Bordetella pertussis
Borrelia
Brucella[3]
Burkholderia mallei[3]
Burkholderia pseudomallei[3]
Campylobacter
Chlamydia trachomatis
Chlamydia psittaci
Clostridium botulinum[3]
Clostridium tetani
Corynebacterium diphtheriae
Coxiella burnetii[3]
Ehrlichia
Enterobacteriaceae family isolates that are resistant to any carbapenem antibiotics by current CLSI breakpoints[7,8]
Escherichia coli, enterotoxigenic
Escherichia coli, Shiga-toxigenic (E. coli O157 and other serogroups)[8]
Francisella tularensis[3]
Grimontia
Haemophilus ducreyi
Haemophilus influenzae
Legionella
Leptospira
Listeria monocytogenes
Mycobacterium bovis
Mycobacterium tuberculosis
Mycobacterium, other (non-respiratory only)
Neisseria gonorrhoeae
Neisseria meningitidis
Rickettsia prowazekii[3]
Rickettsia, non-prowazekii
Salmonella
Shigella
Treponema pallidum
Vibrio cholerae
Vibrio, non-cholerae
Yersinia pestis[3]
Yersinia, non-pestis

FUNGI
Coccidioides
Cryptococcus

PARASITES
Amebic infections[9] (central nervous system only)
Babesia
Cryptosporidium
Cyclospora
Giardia
Plasmodium
Taenia solium and undifferentiated Taenia spp.
Trichinella

PRION DISEASES
Creutzfeldt-Jakob disease (CJD), other prion diseases

VIRUSES
Arboviruses[10]
Eastern equine encephalitis[3]
Arenaviruses[3,11]
Filoviruses[3,11]
Hantavirus
Hepatitis A
Hepatitis B
Hepatitis C
Hepatitis D (delta)
Hepatitis E
Hemorrhagic fever viruses[3,11]
HIV infection and AIDS
Influenza, novel strain[12]
Measles (rubeola)
Mumps
Polio
Rabies
Rubella
SARS-coronavirus[3]
Variola major (smallpox)
West Nile
Yellow fever
Zika

OTHER IMPORTANT REPORTABLES
Any "uncommon illness of potential public health significance"
Any outbreak of disease
Results on all blood lead testing should be reported within seven days unless they indicate lead poisoning, which must be reported within one local health department working day.[13]
All CD4 counts and HIV viral loads.

FOOTNOTES

Drug-resistant Neisseria gonorrhoeae

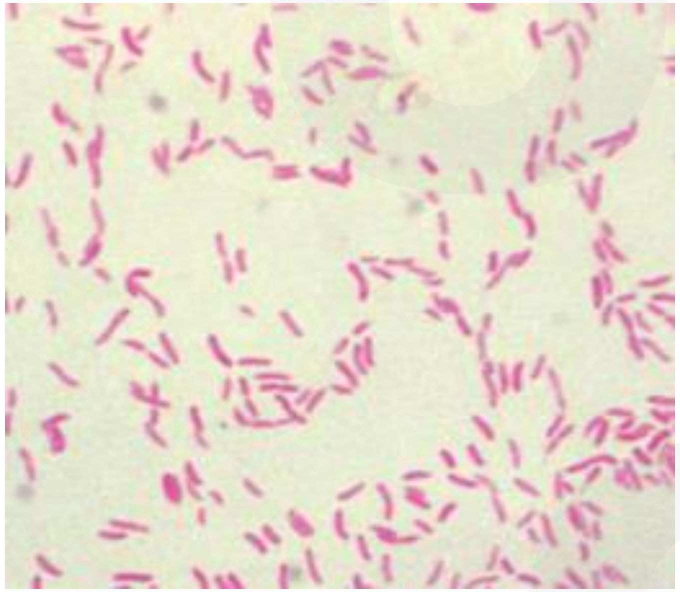
Oregon Health Authority
PUBLIC HEALTH DIVISION
Center for Public Health Practice
971-673-1111 (phone)
971-673-1100 (fax)
www.healthoregon.org/acd

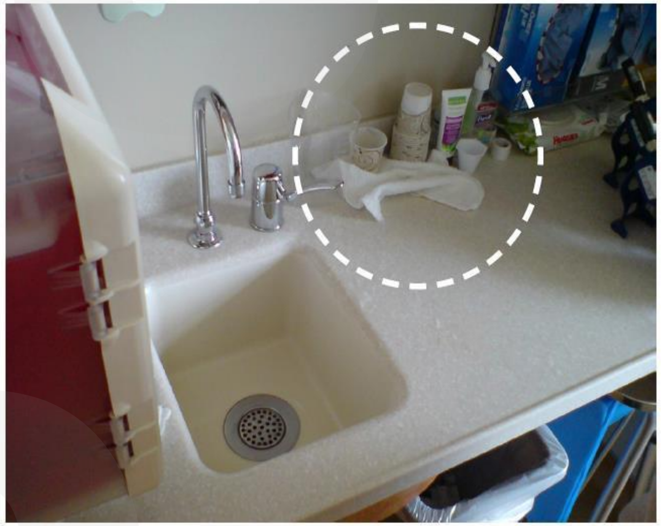
What should trigger concern for healthcare-associated infection?

Perform a full investigation for the source of *Legionella* when:

- ≥1 case of **definite** healthcare-associated Legionnaires' disease (a case in a patient who spent the entire 10 days prior to onset of illness in the facility) is identified at any time
- ≥2 cases of **possible** healthcare-associated Legionnaires' disease (cases in patients who spent part of the 10 days before symptoms began at the same facility) are identified within 12 months of each other (note that under certain circumstances, during a cooling tower outbreak for example, the interval may be shorter)

Pseudomonas aeruginosa





Folliculitis after hot tub exposure

Gram negative sepsis in patient with neutropenic fever

- Healthy patient in their 30s, presents with tender, pruritic papules on trunk & extremities accompanied by low-grade fever

Image from UpToDate

- Hot tube exposure the day prior to illness onset

- Patient with acute myelogenous leukemia, hospitalized for chemotherapy, neutropenic for 1 week (on levofloxacin prophylaxis) → neutropenic fever and sepsis

- Blood cultures with growth of *P aeruginosa*, rapidly progressive pneumonia, shock requiring transfer to the ICU + intubation

Susceptibility

	Pseudomonas aeruginosa SUSCEPTIBILITY-MIC
Cefepime	S
Ceftazidime	S
Ciprofloxacin	R
Gentamicin	S
Meropenem	R
Piperacillin/Tazobactam	S
Tobramycin	S

Pseudomonas hot tub folliculitis

- Infection of the upper portion of follicles
- Clinical presentation: numerous edematous, erythematous perifollicular papules and pustules, often pruritic, onset 8-48 hours post-exposure
- Increased risk: female sex, length of exposure, skin trauma
- Management:
  - Immunocompetent: self-limited, supportive care with spontaneous resolution in 1-2 weeks
  - Immunocompromised: at risk for systemic infection, antibiotics may be warranted

Prevention:

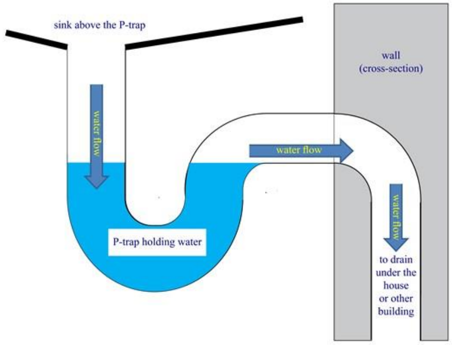
- CDC recommends the following disinfectant and pH levels:
  - Chlorine $\geq$ 3 parts per million (ppm or mg/L); bromine: 4–8 ppm
  - pH: 7.0–7.8
- Shower after hot tub use & wash swimsuit before next use
- Avoid shaving/hair removal immediately before using hot tub

Spernovasilis N, et al. Skin manifestations of Pseudomonas aeruginosa infections *Curr Opin Infect Dis* 2021

Waste-water drain sites and *P aeruginosa* infection in the healthcare setting

- Increasing appreciation of wastewater drain sites as source for healthcare-associated outbreaks with multi-drug-resistant Gram-negative bacilli, esp. *P aeruginosa*

Kizny Gordon AE, et al. *Clin Infect Dis*. 2017
Carling PC. *Infect Control Hosp Epidemiol*. 2018



- Risk factors/liabilities
  - Faucet spouts flowing directly into drain
  - Storage of patient care items on counter adjacent to sink
  - Shallow bowl depth
  - High water flow rate

Kotay SM, et al. *Applied and Environmental Microbiology* 2019
Gestrich SA, et al. *Infect Control Hosp Epi* 2018

OHSU experience

2019

Sink hygiene ("splash zone") bundle – **QI intervention**

- Remove all patient care items from the "splash zone"
- Limit use of sinks
- Offset faucet from drain
- Decrease water flow rate
- Rapid remediation of clogged drains
- Toilet lids down when flushing
- EVS daily room clean to include sink basin, area around sink, etc.
- SOP for facilities work & preventative maintenance

7/13/2020

Infection Control & Hospital Epidemiology (2024), 1–9
doi:10.1017/ice.2023.288

SHEA

Original Article

The impact of an intervention to reduce dispersal from wastewater drain sites on carbapenem-resistant *Pseudomonas aeruginosa* colonization and bloodstream infection on a hematopoietic cell transplant and hematologic malignancy unit

Lauren Fontana DO[1], Morgan Hakki MD[2], Egon A. Ozer MD, PhD[3,4], Amy Laird PhD[5] and Lynne Strasfeld MD[2,6]

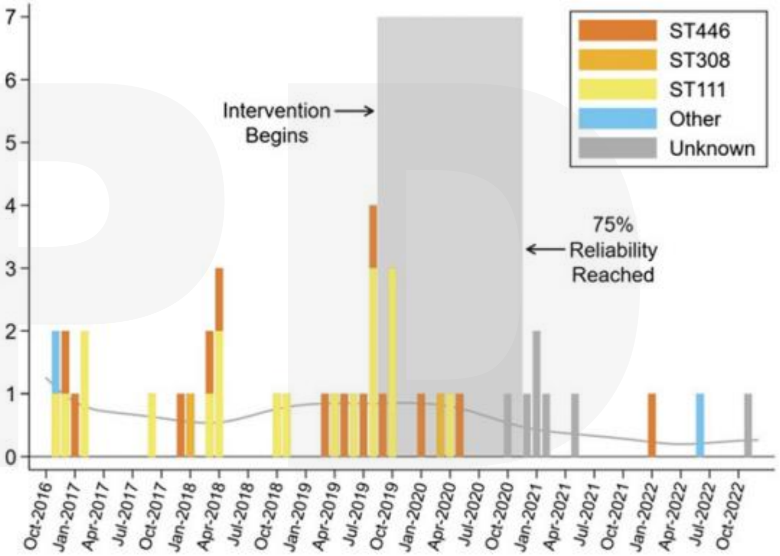
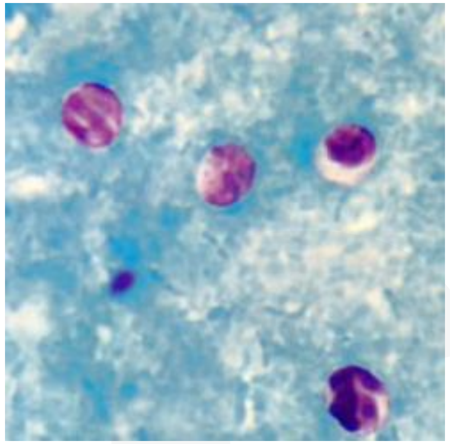
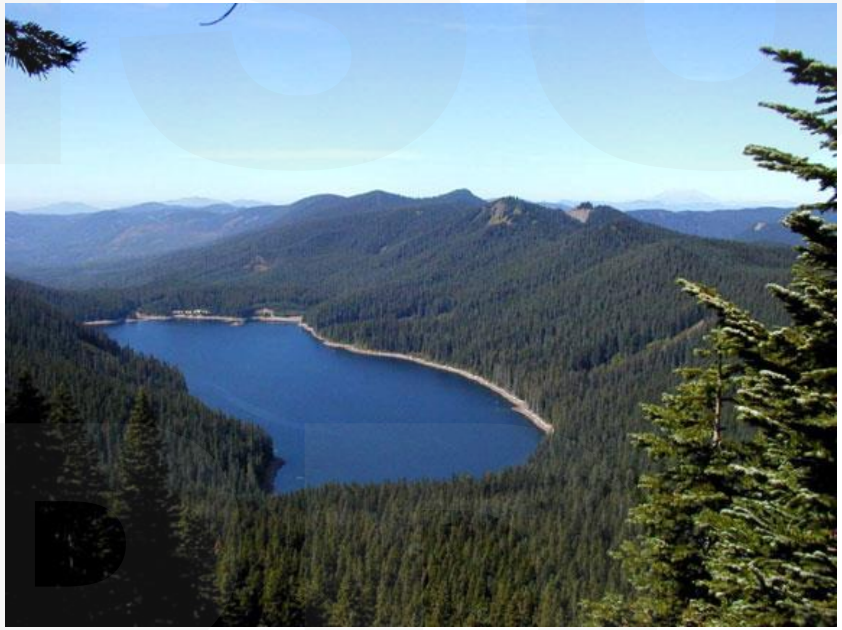


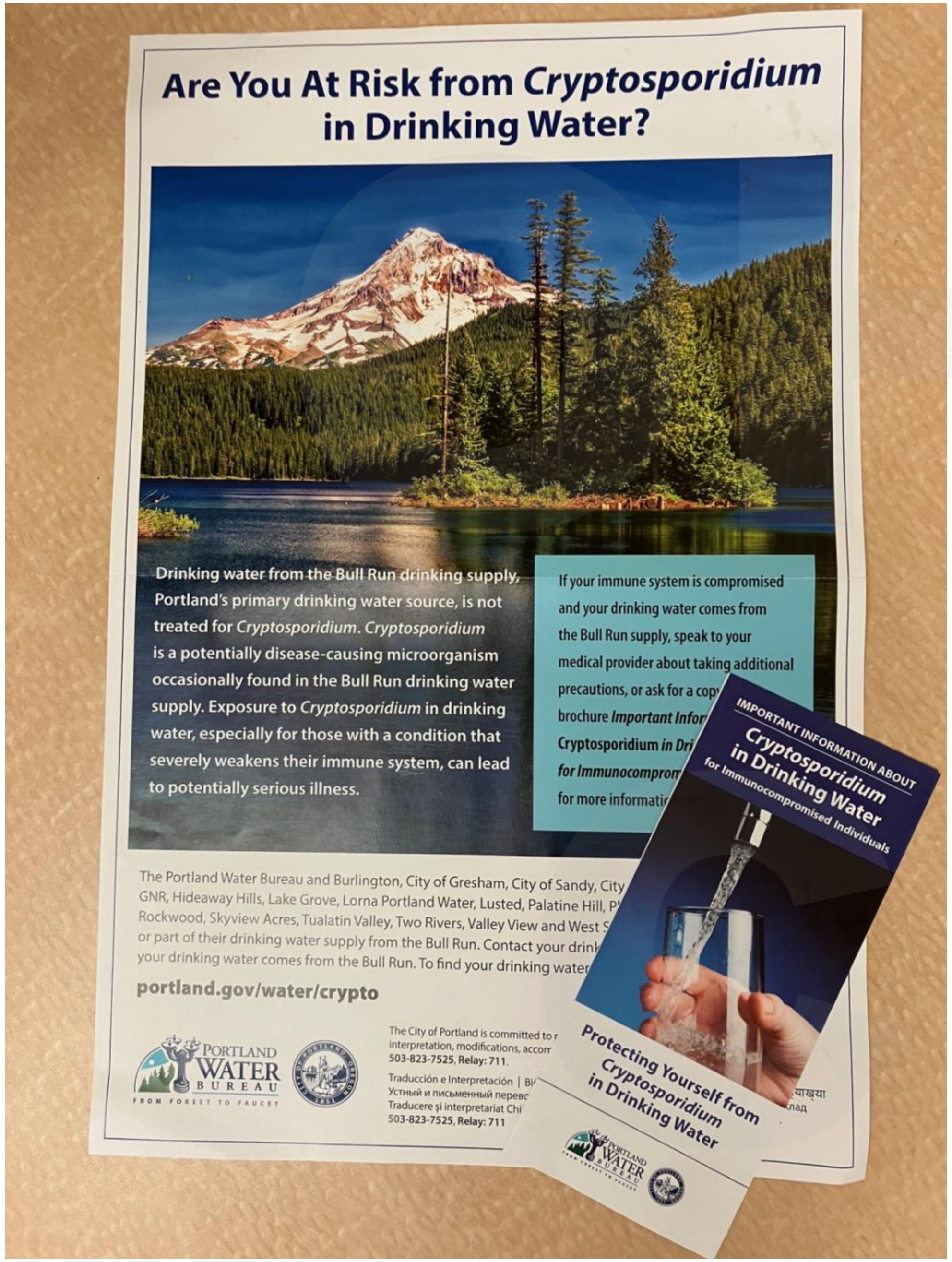
Figure 4. Monthly meropenem-nonsusceptible *P. aeruginosa* BSI events by sequence type, from start of sequencing October 2016 through December 2022.

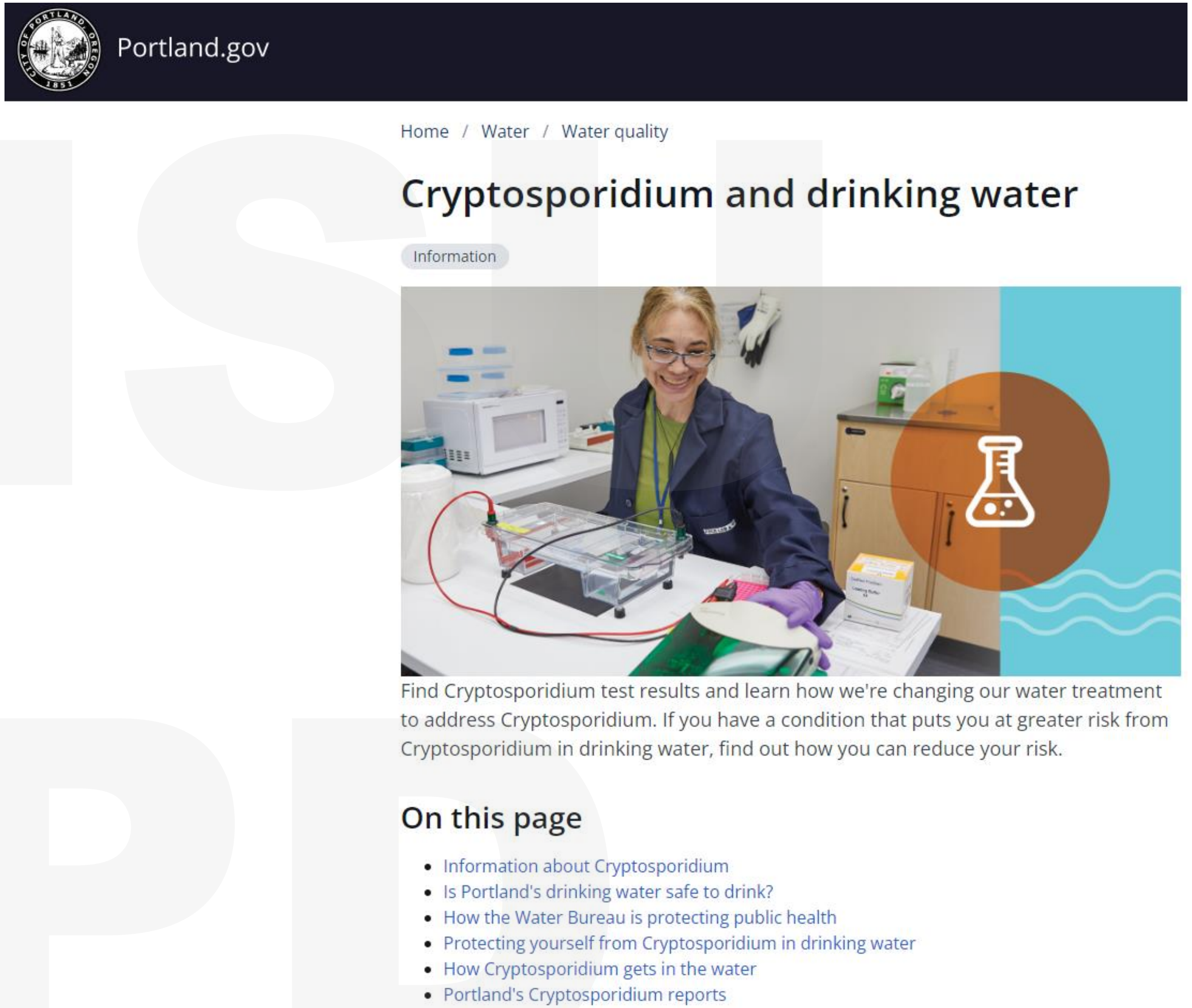
Cryptosporidium parvum





Diarrhea in patient with HIV/AIDS, CD4 < 100 cells/mL




Portland.gov

Home / Water / Water quality

Cryptosporidium and drinking water

Information

Find Cryptosporidium test results and learn how we're changing our water treatment to address Cryptosporidium. If you have a condition that puts you at greater risk from Cryptosporidium in drinking water, find out how you can reduce your risk.

On this page

- Information about Cryptosporidium
- Is Portland's drinking water safe to drink?
- How the Water Bureau is protecting public health
- Protecting yourself from Cryptosporidium in drinking water
- How Cryptosporidium gets in the water
- Portland's Cryptosporidium reports

https://www.portland.gov/water/water-quality/cryptosporidium

30s-year-old with Type 1 DM and history of ESRD, s/p deceased-donor kidney transplant in December 2023

- Diarrhea onset ~2 weeks post-transplant
  - Diarrhea (non-bloody, liquid stools every 1-1.5 hours) followed by cramping and nausea
- Stool testing 19 days after diarrhea onset

CRYPTOSPORIDIUM EXAM, STOOL

Status: Final result   Visible to patient: Yes (seen)   Dx: Kidney replaced by transplant; Deceas...

1 Result Note

Component Ref Range & Units	2 mo ago
CRYPTOSPORIDIUM Negative	Positive !

Comment: Performed By: ARUP Laboratories

OVA AND PARASITE EXAM

Status: Final result   Visible to patient: Yes (seen)   Dx: Kidney replaced by transplant; Deceas...

1 Result Note

Component Ref Range & Units	2 mo ago
OVA AND PARASITE, FECAL INTERPRETA-TION Negative	Negative

Comment:
INTERPRETIVE INFORMATION: Ova and Parasite, Fecal

- No ill contacts. Did not dine out. Washed fruits/vegetables with vinegar solution. Drank tap water from faucet. Last recreational water exposure was swimming in river in Medford area in August.

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503-693-4100

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Anaplasma
Bacillus anthracis[3]
Bacillus cereus biovar *anthracis*[3]
Bordetella pertussis
Borrelia
Brucella[3]
Burkholderia mallei[3]
Burkholderia pseudomallei[3]
Campylobacter
Chlamydia trachomatis
Chlamydia psittaci
Clostridium botulinum[3]
Clostridium tetani
Corynebacterium diphtheriae
Coxiella burnetii[3]
Ehrlichia
Enterobacteriaceae family isolates that are resistant to any carbapenem antibiotics by current CLSI breakpoints[7,8]
Escherichia coli, enterotoxigenic
Escherichia coli, Shiga-toxigenic (*E. coli* O157 and other serogroups)[8]
Francisella tularensis[3]
Grimontia
Haemophilus ducreyi
Haemophilus influenzae
Legionella
Leptospira
Listeria monocytogenes
Mycobacterium bovis
Mycobacterium tuberculosis
Mycobacterium, other (non-respiratory only)
Neisseria gonorrhoeae
Neisseria meningitidis
Rickettsia prowazekii[3]
Rickettsia, non-*prowazekii*
Salmonella
Shigella
Treponema pallidum
Vibrio cholerae
Vibrio, non-*cholerae*
Yersinia pestis[3]
Yersinia, non-*pestis*

FUNGI
Coccidioides
Cryptococcus

PARASITES
Amebic infections[9] (central nervous system only)
Babesia
Cryptosporidium
Cyclospora
Giardia
Plasmodium
Taenia solium and undifferentiated *Taenia* spp.
Trichinella

PRION DISEASES
Creutzfeldt-Jakob disease (CJD), other prion diseases

VIRUSES
Arboviruses[10]
Eastern equine encephalitis[3]
Arenaviruses[3,11]
Filoviruses[3,11]
Hantavirus
Hepatitis A
Hepatitis B
Hepatitis C
Hepatitis D (delta)
Hepatitis E
Hemorrhagic fever viruses[3,11]
HIV infection and AIDS
Influenza, novel strain[12]
Measles (rubeola)
Mumps
Polio
Rabies
Rubella
SARS-coronavirus[3]
Variola major (smallpox)
West Nile
Yellow fever
Zika

OTHER IMPORTANT REPORTABLES
Any "uncommon illness of potential public health significance"[2]
Any outbreak of disease
Results on all blood lead testing should be reported within seven days unless they indicate lead poisoning, which must be reported within one local health department working day.[13]
All CD4 counts and HIV viral loads.

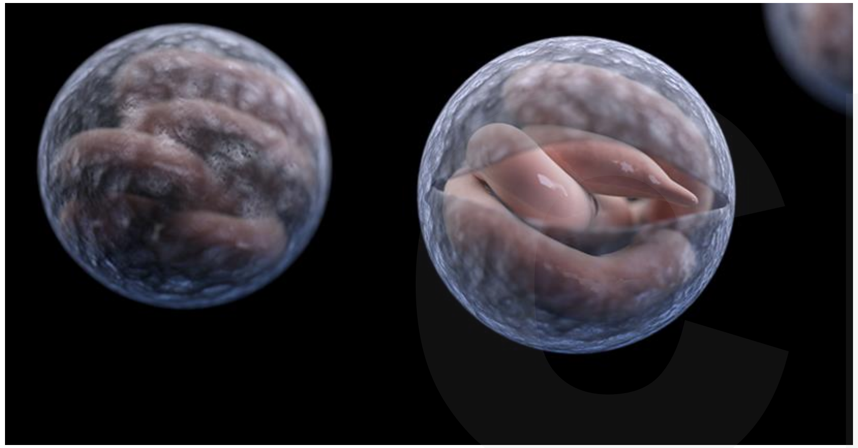
FOOTNOTES
1. Oregon Revised Statute 433.004; Oregon Administrative Rule 333-018 [illegible]
2. Refer to [illegible] for a list of local health departments, reporting FAQs, and more details about what to report. When in doubt, report.
3. For a complete list of select agents, see [illegible] and [illegible] (7 CFR Part 331, 9 CFR Part 121, 42 CFR Part 73).
4. Specimen Type describes the precise material of the specimen. Specimen Source Site describes the source from which the specimen was obtained. Examples of the Specimen Type/Specimen-Source-Site pairings could be (Fluid, Synovial/Knee), (Tissue/Cervix), (Blood/Venous). Please refer to [illegible] for more details.
5. ORS 433.004 and OAR 333-018-0015 [illegible]; Manual for Mandatory Electronic Laboratory Reporting [illegible]
6. ORS 431.262; OAR 333-018 [illegible]; OAR 333-026-0030 [illegible]
7. See CRE poster [illegible] (OHA 8576) for further information. CLSI. Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Fifth Informational Supplement. CLSI document M100-S25. Wayne, PA: Clinical and Laboratory Standards Institute; January 2015.
8. If isolates are not available, submit Shiga-toxin-positive stools or broths.
9. For example, infection by Acanthamoeba, Balamuthia or Naegleria spp.
10. Any other arthropod-borne viruses, including, but not limited to California encephalitis, Chikungunya, Colorado tick fever, dengue, Heartland virus infection, Kyasanur Forest disease, St. Louis encephalitis, Western equine encephalitis, etc.
11. Hemorrhagic fever caused by viruses of the filovirus (Ebola, Marburg) or arenavirus (Lassa, Machupo) families are reportable.
12. Influenza A virus that cannot be subtyped by commercially distributed assays.
13. "Lead poisoning" means a confirmed blood lead level of at least 5 µg/dL.

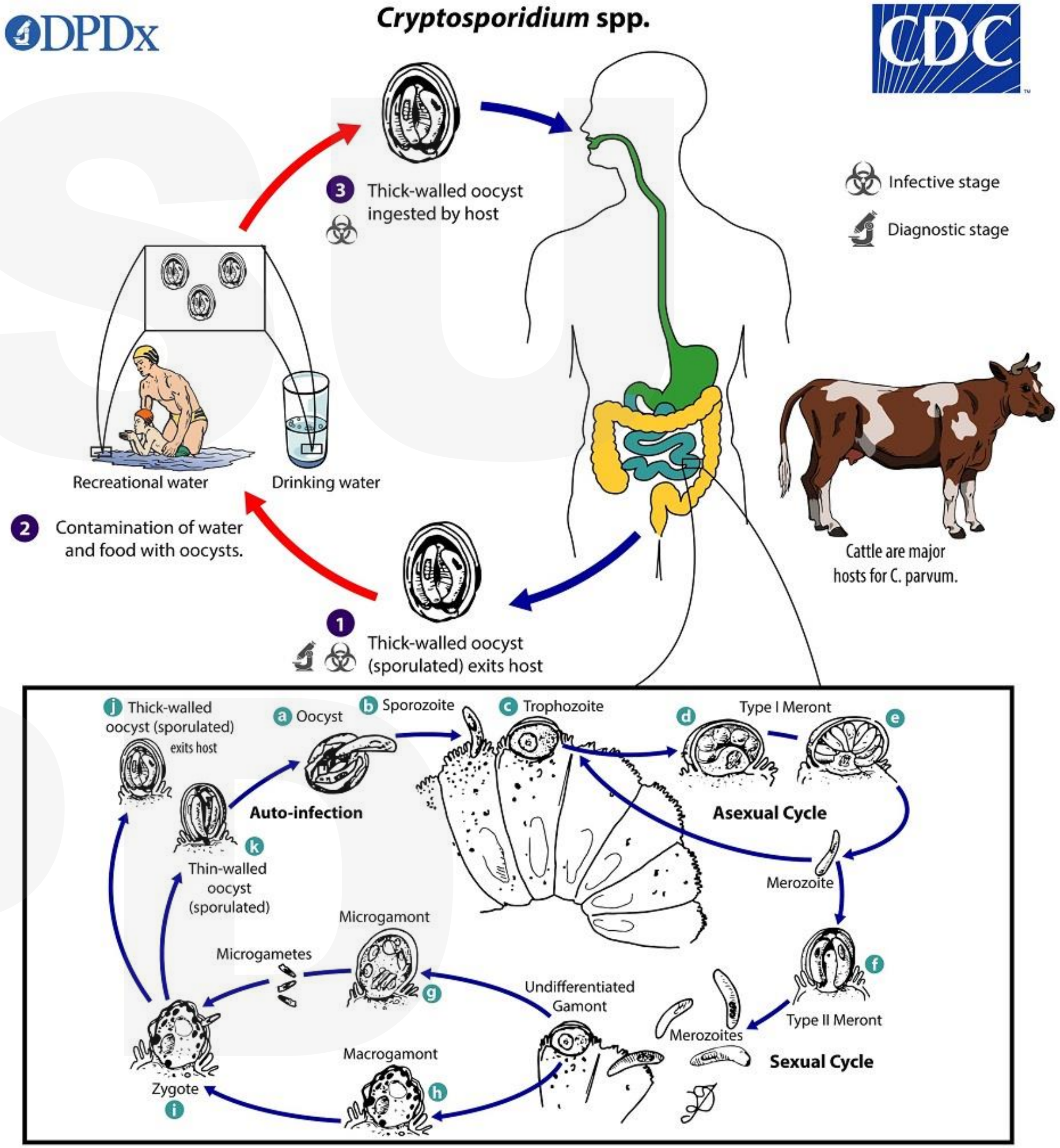
Oregon Health Authority
PUBLIC HEALTH DIVISION
Center for Public Health Practice
971-673-1111 (phone)
971-673-1100 (fax)
www.healthoregon.org/acd

OHA 8576 (Rev. 02/2018)

Cryptosporidium

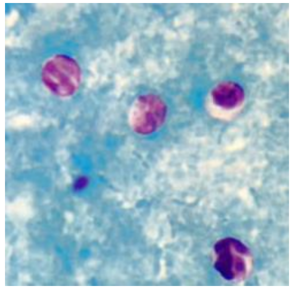
- Intracellular protozoan parasite
- Main species responsible for human disease: *C parvum*
    - *C hominis* (formerly *C parvum* genotype 1) → mainly humans
    - *C parvum* (formerly *C parvum* genotype 2) → animals and humans





images from CDC resources

Cryptosporidium



Clinical presentation

- Watery diarrhea
- Malaise, nausea/vomiting, cramping, and low-grade fever
- Up to 30% asymptomatic
- Immunocompromised hosts: can result in protracted diarrhea
- Incubation period ~ 7-10 days

Diagnosis

- Microscopy (modified acid-fast stain)
- Fecal immunoassay (DFA)
- PCR (included in GI multiplex panel)

* Routine ova and parasite examination low yield for detection of cryptosporidia oocysts

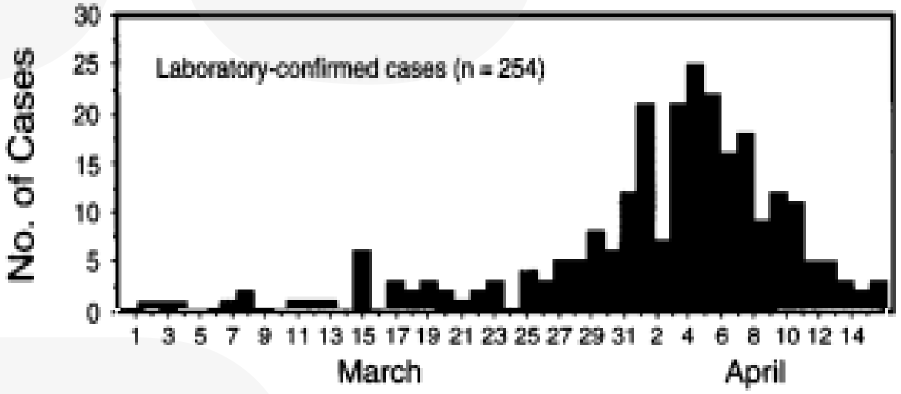
Treatment

- Supportive care
- Transplant: reduce immune suppression if able + nitazoxanide (or paromomycin +/- azithromycin)
- HIV: ART to restore immune function (CD4 >100) +/- antibiotic

Cryptosporidium outbreaks & incidence

Largest US waterborne disease outbreak (to date): Milwaukee, WI in 1993

- 285 laboratory-confirmed infections
- Estimated 403,000 people had watery diarrhea attributed to this outbreak!!



Mac Kenzie WR, et al. A massive outbreak in Milwaukee of Cryptosporidium infection transmitted through the public water supply. *N Engl J Med* 1994

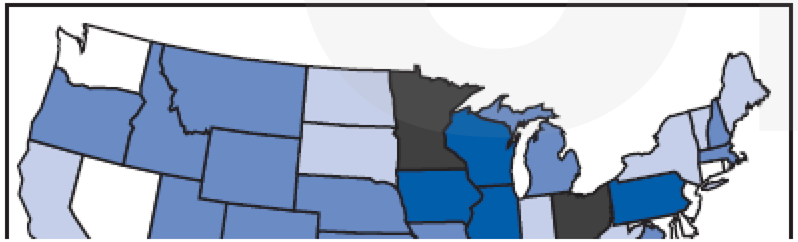
2019 CDC report: 823,000 illnesses/year in the US, < 2% reported to CDC

Cryptosporidiosis Outbreaks — United States, 2009–2017

Radhika Gharpure, DVM[1,2]; Ariana Perez, MPH[1,3]; Allison D. Miller, MPH[1,4]; Mary E. Wikswo, MPH[5]; Rachel Silver, MPH[1,3]; Michele C. Hlavsa, MPH[1]

MMWR / June 28, 2019 / Vol. 68 / No. 25

FIGURE 1. Reported cryptosporidiosis outbreaks (N = 444), by exposure jurisdiction* — United States, 2009–2017†



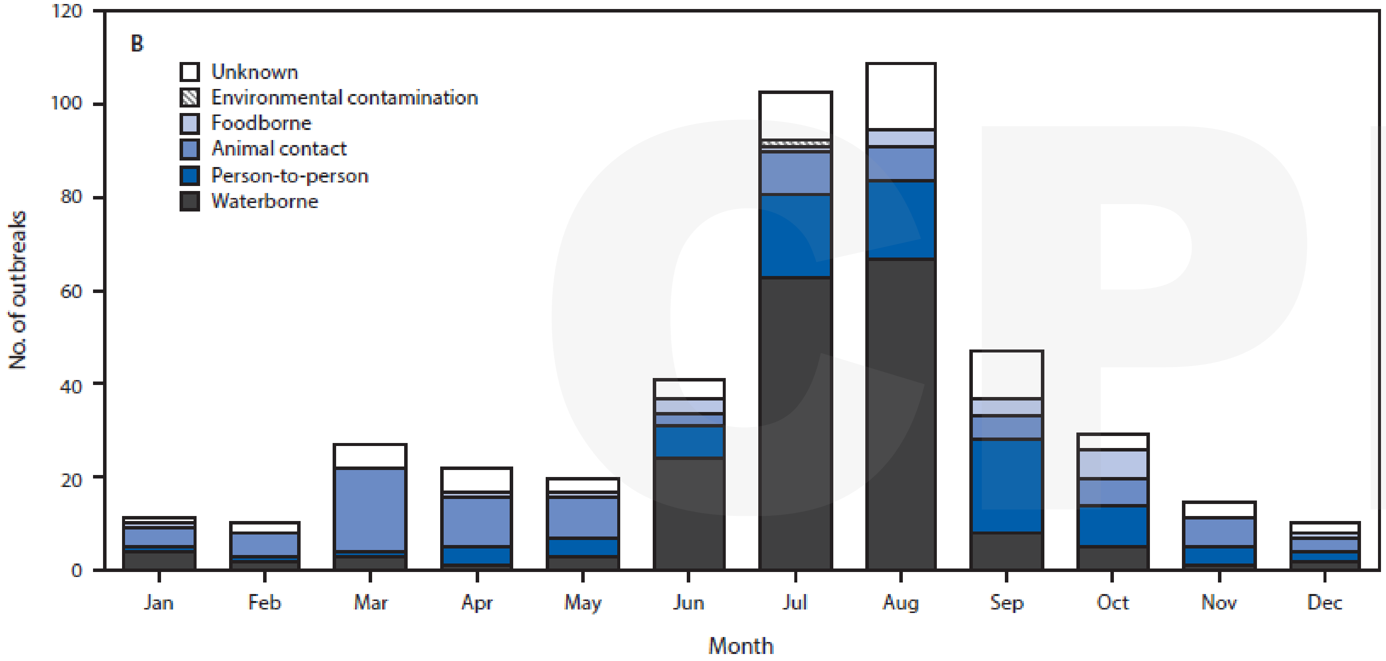
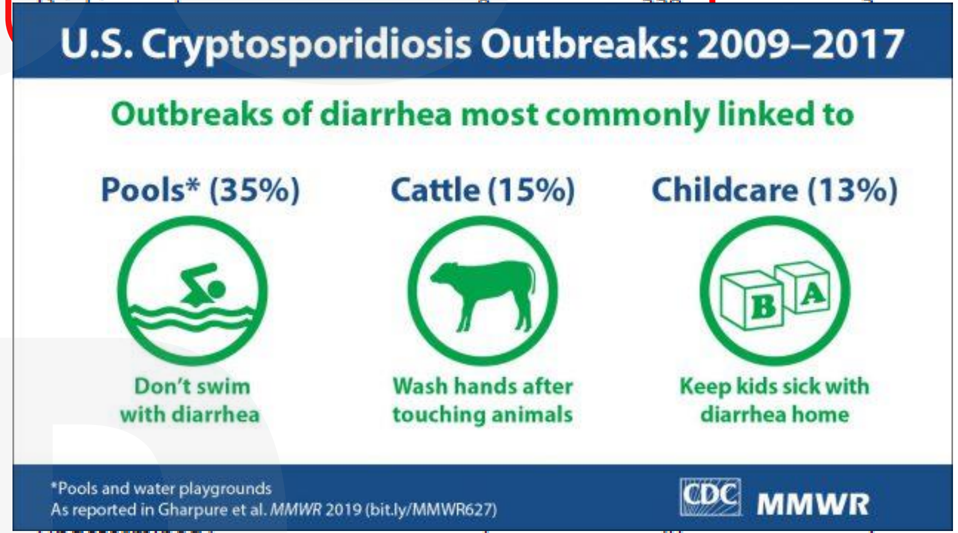


TABLE. Cryptosporidiosis outbreaks (N = 444), cases, and hospitalizations, by mode of transmission and exposure — 40 states and Puerto Rico, 2009–2017

Transmission mode	No. (%) Outbreaks	Cases	Hospitalizations
All modes	**444 (100)**	**7,465 (100)**	**287 (100)**
Waterborne, exposure source	**183 (41.2)**	**5,015 (67.2)**	**194 (67.6)**
Recreational water			
Treated (e.g., pool)	156	4,232	183
Untreated (e.g., lake)	14	263	3
Undetermined§	7	30	2
Foodborne, vehicle	**22 (5.0)**	**283 (3.8)**	**11 (3.8)**
Milk, unpasteurized	9	52	4
Apple cider, unpasteurized	4	36	1
Fresh produce¶	2	14	1
Undetermined§	7	181	5
Environmental contamination**	**2 (0.5)**	**9 (0.1)**	**1 (0.3)**
Unknown††	**63 (14.2)**	**616 (8.3)**	**23 (8.0)**



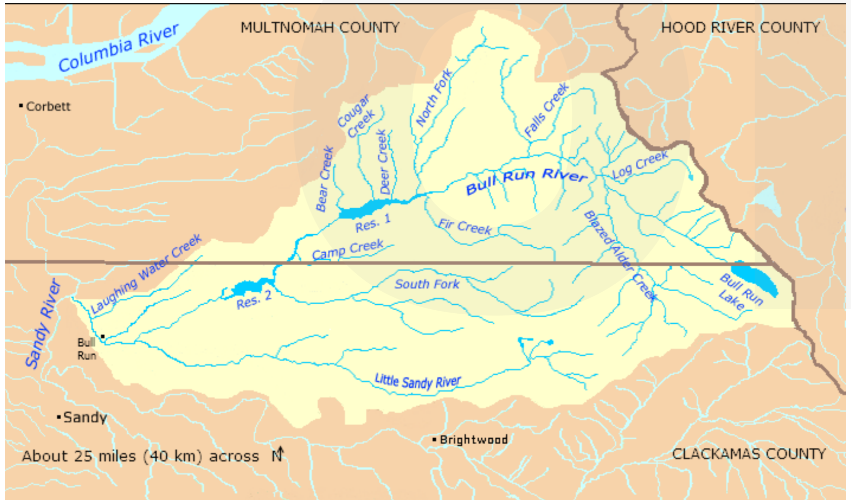
Healthy Swimming

EXPLORE TOPICS

Preventing Swimming-related Illnesses

https://www.cdc.gov/healthy-swimming/prevention/index.html

Bull Run Watershed



Bull Run Reservoir 1

Oh deer, that's a dam.

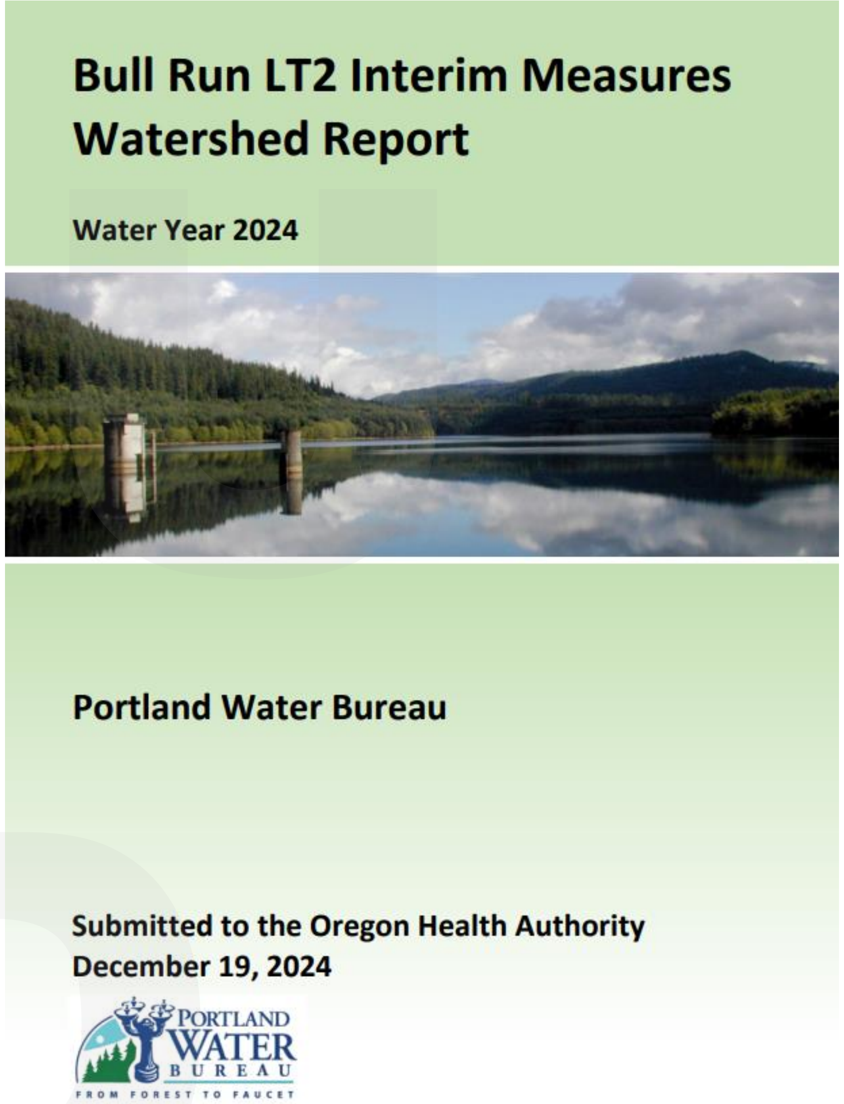
Bull Run Reservoir 2

EPA Long Term 2 Enhanced Surface Water Treatment Rule

2012-2017: PWB granted a variance to requirements by OHA

December 2017: Variance revoked due to a series of low-level detections of Cryptosporidium in early 2017

2017-2027: Bilateral Compliance Agreement with OHA, pending completion of the new filtration facility


Bull Run LT2 Interim Measures Watershed Report

Water Year 2024

Portland Water Bureau

Submitted to the Oregon Health Authority
December 19, 2024

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

- Diversion pool, soil erosion area, and sanitary facility inspections
- Tributary stream and wildlife scat monitoring

Table of *Cryptosporidium* test results by year

Test dates	Number of samples tested	Number of positive samples	Number of oocysts detected	Liters of water tested (approximate)
Jan.1-Dec. 31, 2024	178	33	57	8,100
Jan. 1-Dec. 31, 2023	217	59	156	8,950
Jan. 1-Dec. 31, 2022	179	46	79	7,980
Jan. 1-Dec. 31, 2021	200	33	58	8,600
Jan. 1–Dec. 31, 2020	185	39	52	8,450
Jan. 1–Dec. 31, 2019	179	41	50	8,450
Jan. 1–Dec. 31, 2018	271	15	19	7,690
Jan. 1–Dec. 31, 2017	378	35	43	11,510
Jan. 1–Dec. 31, 2016	208	0	0	5,370

Portland Water Bureau Interim Measures Watershed Report for Water Year 2023

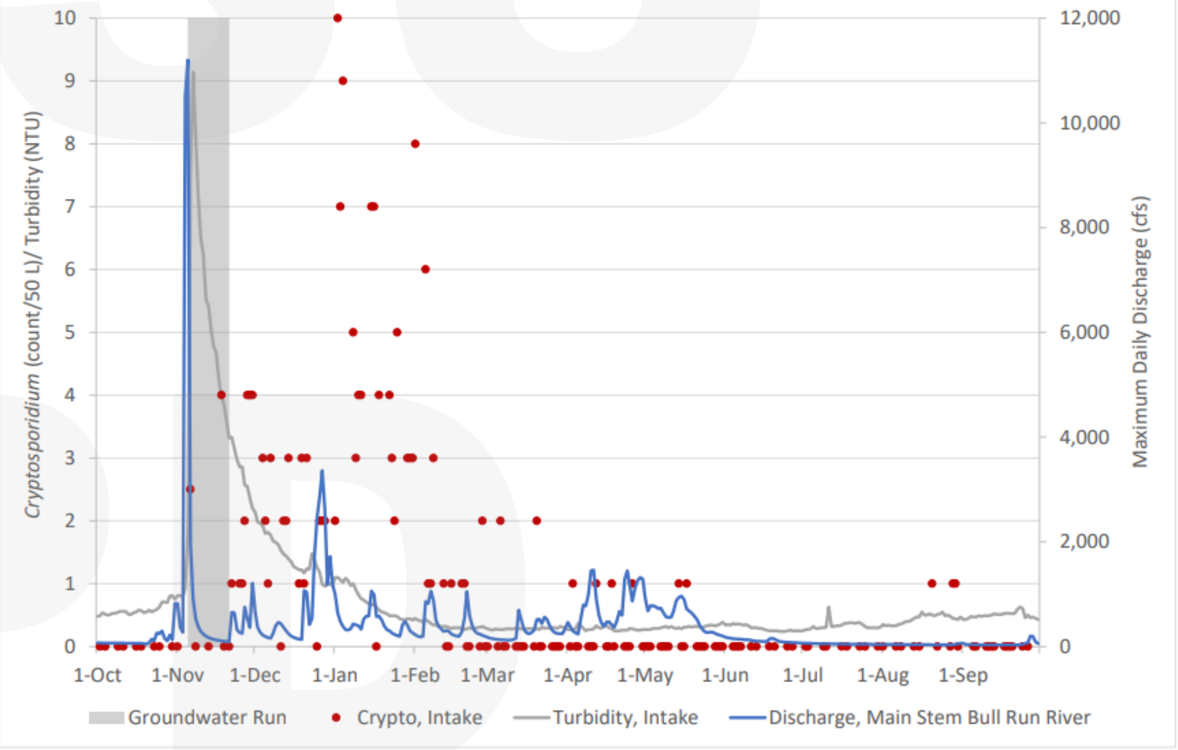


Figure 2. Average Weekly Concentrations of Cryptosporidium at PWB's Intake during Water Year 2023 Plotted in Time Series with Intake Turbidity and Stream Flow at Main Stem Bull Run River.

https://www.portland.gov/water/water-quality/test-results#toc-cryptosporidium

Table 14. Information on Named *Cryptosporidium* Types Found in Scat Samples in the Bull Run Watershed in Water Year 2024

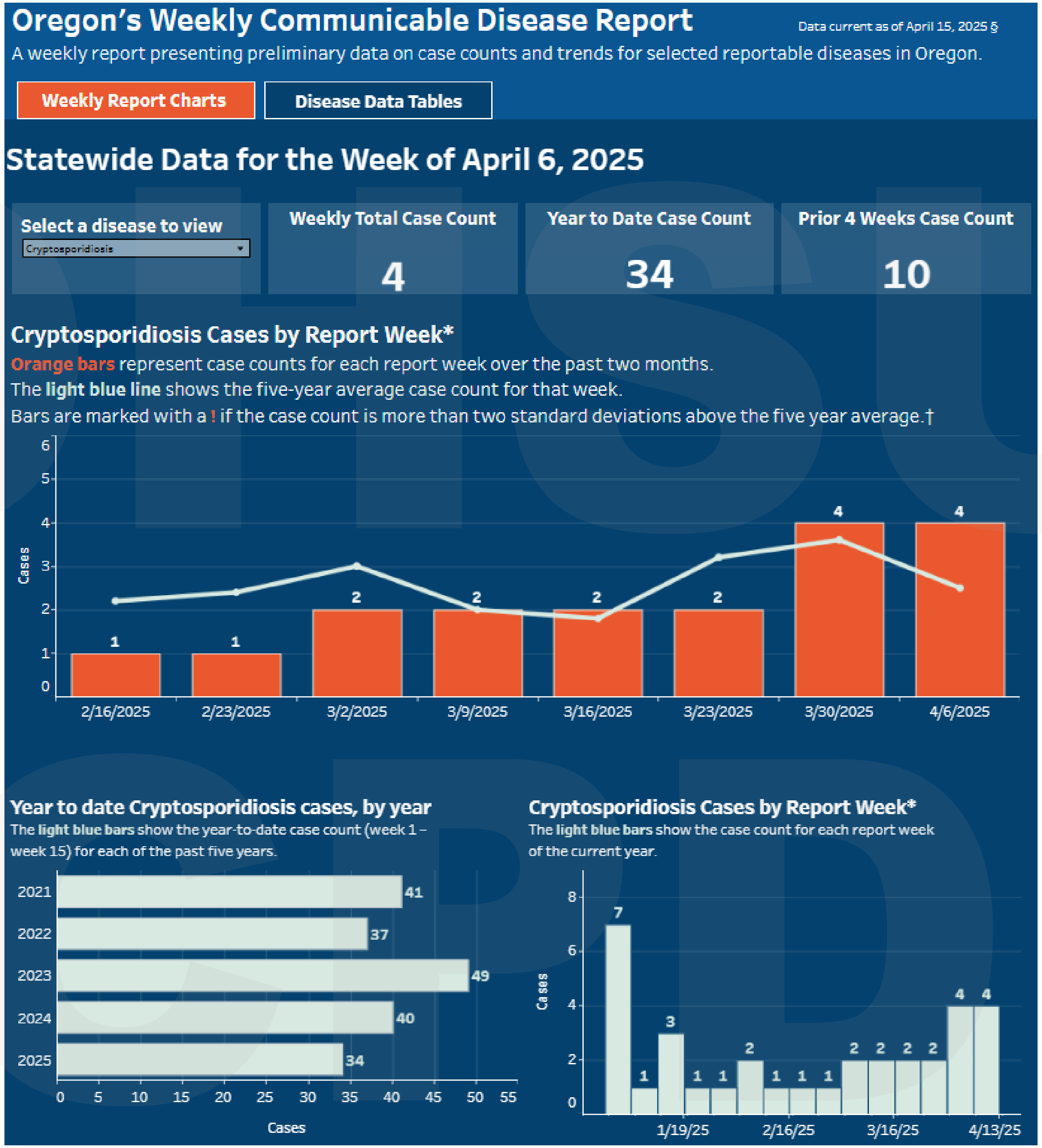
Sequence Identification	Number Identified in Water Year 2024	Bull Run Wildlife Host(s)[a]	Typical Host	Association with Human Cryptosporidiosis	GenBank Accession Number	Accession References
PNW18a	3	Bat	Unknown	No known association	MN446005[b]	PWB 2018b
C. galli	1	Bobcat, Grouse	Avian	No known association	KY490554	Wait et al. 2017
C. sp. Sbld05d ground squirrel isolate	1	Deer mouse	Rodents	No known association	DQ295015	Kilonzo et al. 2017.
C. parvum	1	Bat, Bobcat, Black-tailed deer, Deer mouse, Roosevelt elk, Snowshoe hare, River otter, Pika	Mammals including humans	Common in sporadic cases and outbreaks (Chalmers 2012, Ryan et al. 2021a)	KU679364	Hofmannová et al. 2016

[a] Includes wildlife hosts from previous years
[b] GenBank Accession number(s) submitted by PWB

Table 17. Summary of *Cryptosporidium* Species and Genotypes Detected in Bull Run Water Samples from Water Years 2017-2024

Cryptosporidium Types[a]	Total Number Water Years 2017 – 2024	Total Number Water Year 2024	100% Match to Bull Run Scat Samples
PNW17a (deer mouse/ground squirrel) isolate	16		✓
C. ubiquitum	12		✓
C. spp. isolates[b,c]	7	1	
C. sp. deer mouse genotype III (W1)	5		
C. sp. deer mouse genotype IV (W3)	5		✓
C. andersoni	4		✓
C. avian	3		
C. sp. skunk genotype	3	2	✓
C. sp. vole genotype (W15)	3		
PNW17b (deer mouse) isolate	2		✓
C. spp. meadow vole isolates[c]	2		
C. sp. muskrat genotype I (W17)	2		
C. sp. novel[d]	2		
C. sp. deer mouse isolate (NYC17)	1		
C. sp. genotype W29 (deer mouse)	1		
C. sp. ground squirrel genotype I	1		
C. sp. ground squirrel genotype II	1		
C. sp. muskrat genotype II (W16)	1		
C. sp. rat isolate	1		
C. meleagridis	1		
PNW15a (mountain beaver isolate)	1		✓

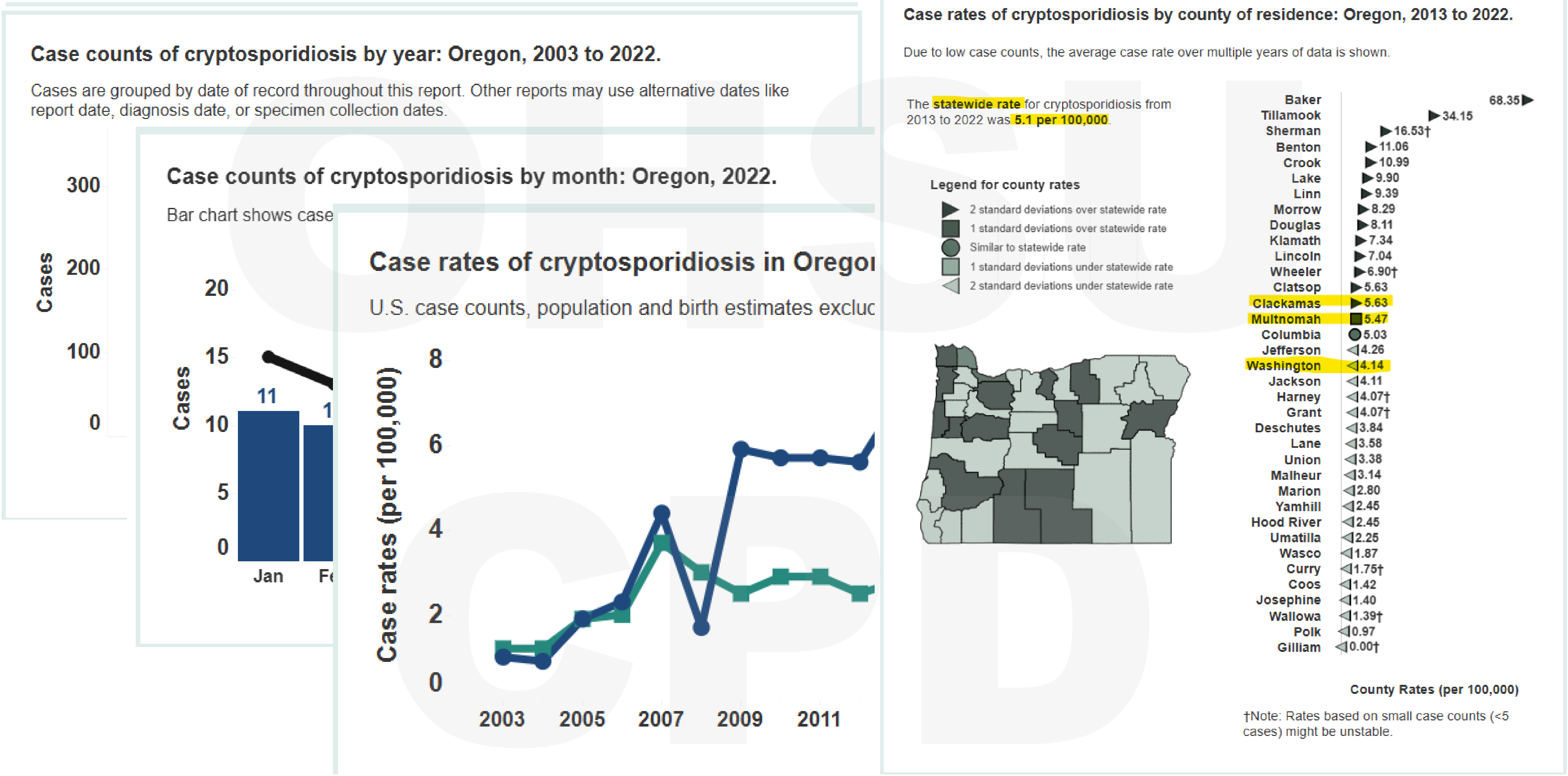
https://www.portland.gov/water/documents/bull-run-interim-measures-watershed-report-water-year-2024/download



https://public.tableau.com/app/profile/oregon.public.health.division.acute.and.communicable.disease.pre/viz/WeeklyCommunicableDiseaseReport/ACDPWeeklyReport

Oregon's 2022 Selected Reportable Communicable Disease Summary

Data current as of 10/9/2023; data are provisional and subject to change.



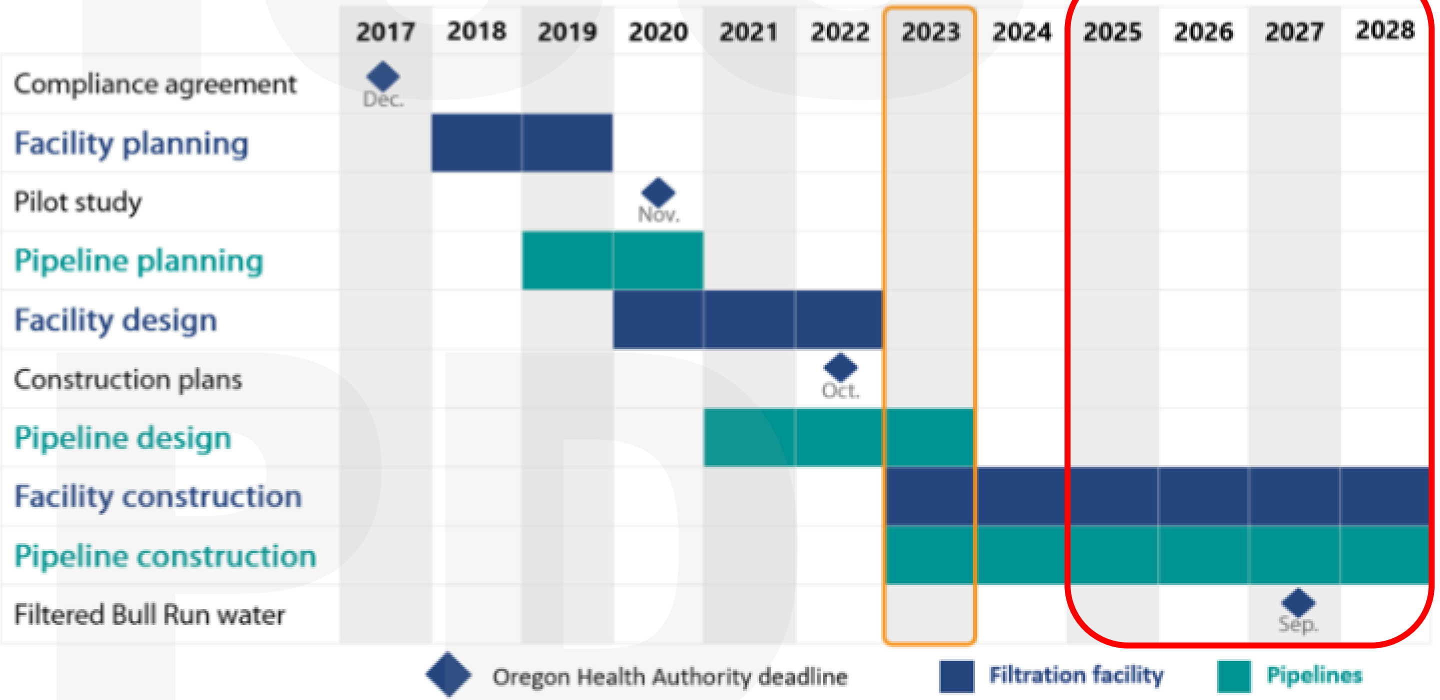
https://public.tableau.com/app/profile/oregon.public.health.division.acute.and.communicable.disease.pre/viz/2022SelectedReportableCommunicableDiseaseSummary/TableofContents

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Bull Run TREATMENT PROJECTS

Our water: Safe and abundant for generations to come

Bull Run Filtration schedule



Schedule for Bull Run Filtration Project showing key compliance milestones.

https://www.portland.gov/water/bullruntreatment/filtration/about#toc-project-overview

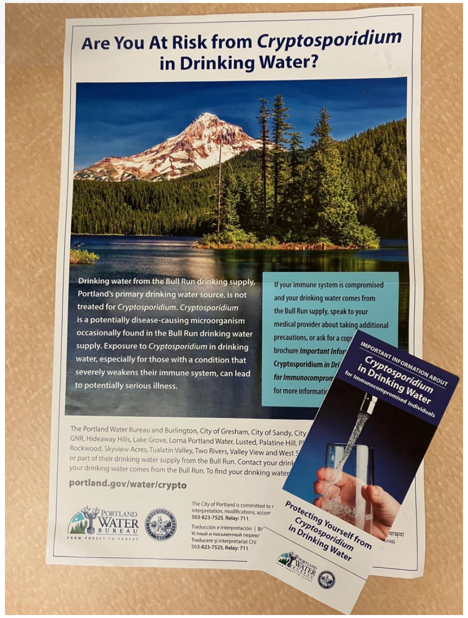
What should you advise your patients?

- Yearly reminder regarding risk: *"People with compromised immune systems may wish to take the precautions listed below."*

Protecting yourself from *Cryptosporidium* in drinking water

Exposure to *Cryptosporidium* in drinking water, especially for those with a condition that severely weakens their immune system, can lead to potentially serious illness. While the general public does not need to take additional precautions for *Cryptosporidium*, people with compromised immune systems may wish to take the precautions listed below. If you choose to store boiled, filtered, or distilled water in water bottles and ice trays, per the options below, clean them well with soap and water before you fill them.

- **Safe commercially bottled water:** Water labeled with any of the following messages has been processed by a method effective against *Cryptosporidium*: reverse osmosis, distilled, filtered through an absolute 1 micron or smaller filter, or "one micron absolute."
- **Boiling water before consuming:** Boiling is the best extra measure to ensure that your water is free of *Cryptosporidium* and other microbes. Heating water at a rolling boil for one minute kills *Cryptosporidium* and other microbes. After the boiled water cools, put it in a clean bottle or pitcher with a lid and store it in the refrigerator. Use the water for drinking, cooking, or making ice.
- **Filtering your tap water:** Some, but not all, home water filters remove *Cryptosporidium*. Filters that have the words "reverse osmosis" on the label protect against *Cryptosporidium*, as do filters with "absolute one micron." Also look for the words "cyst reduction" or "cyst removal" for a tested filter that works against *Cryptosporidium*. The wording should indicate that the filter is listed and labeled to NSF/ANSI standard 53 or 58 by an ANSI-accredited certification organization. Filters collect microorganisms from your water, so someone who is not immunocompromised should change the filter cartridges for you; if you do it yourself, wear gloves and wash your hands well with soap and water afterwards. Filters may not work as well on *Cryptosporidium* as boiling does because filters may sometimes have manufacturing flaws that allow a small amount of *Cryptosporidium* to get past the filter. Poor filter maintenance or failure to replace filter cartridges as recommended by the manufacturer can also cause your filter to fail.
- **Using a home distiller:** You can remove *Cryptosporidium* and other microorganisms from your water with a home distiller. If you use one, you need to carefully store your water. After purification, put the water in a clean bottle or pitcher with a lid and store it in the refrigerator.



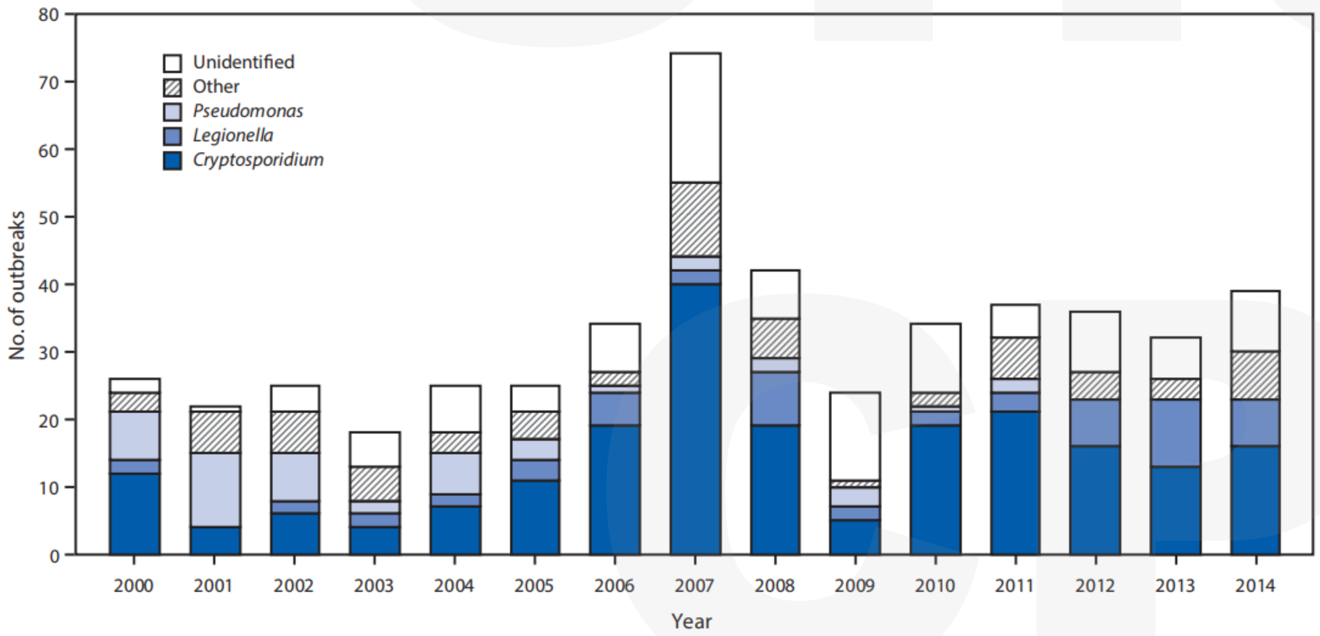
https://www.portland.gov/water/water-quality/cryptosporidium#toc-protecting-yourself-from-cryptosporidium-in-drinking-water

Where did our patient acquire *Cryptosporidium*?

Outbreaks Associated with Treated Recreational Water — United States, 2000–2014

Michele C. Hlavsa, MPH[1]; Bryanna L. Cikesh, MPH[1,2]; Virginia A. Roberts, MSPH[1]; Amy M. Kahler, MS[1]; Marissa Vigar, MPH[1,2]; Elizabeth D. Hilborn, DVM[3]; Timothy J. Wade, PhD[3]; Dawn M. Roellig, PhD[1]; Jennifer L. Murphy, PhD[1]; Lihua Xiao, DVM, PhD[1]; Kirsten M. Yates, MPH[1]; Jasen M. Kunz, MPH[4]; Matthew J. Arduino, DrPH[5]; Sujan C. Reddy, MD[5]; Kathleen E. Fullerton, MPH[1]; Laura A. Cooley, MD[6]; Michael J. Beach, PhD[1]; Vincent R. Hill, PhD[1]; Jonathan S. Yoder, MPH[1]

FIGURE 2. Number of outbreaks associated with treated recreational water (N = 493), by etiology and year — United States, 2000–2014*



* Includes outbreaks with the following etiologies: *Bacillus, Campylobacter, Escherichia coli*, methicillin-resistant *Staphylococcus aureus*, nontuberculous mycobacteria, *Salmonella, Shigella, Staphylococcus, Giardia*, echovirus, norovirus, or excess chlorine/disinfection by-product/altered pool chemistry.

TABLE. Number of outbreaks associated with treated recreational water, total and median number of cases, by etiology — United States, 2000–2014

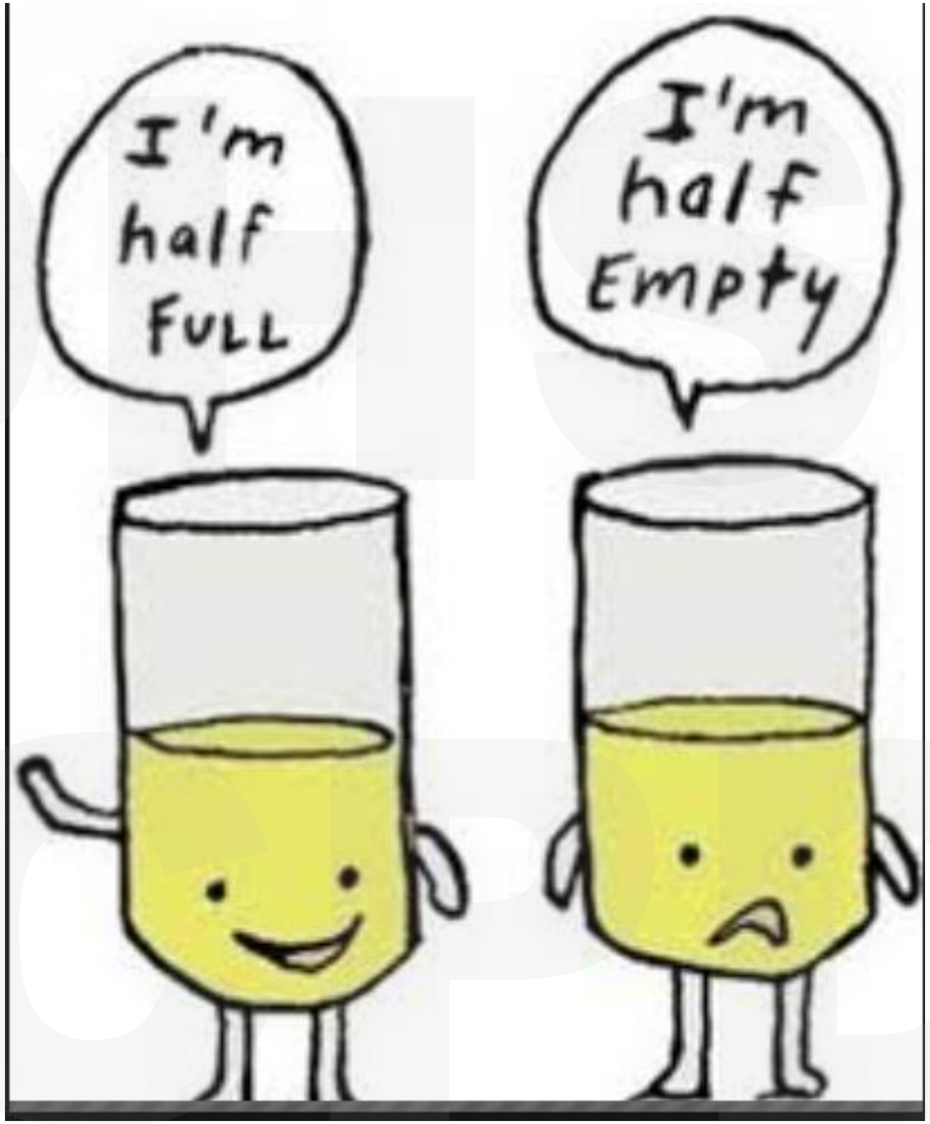
Etiology	No. (%) of outbreaks	No. (%) of cases	Median no. (range) of cases per outbreak
Total	**493 (100)**	**27,219 (100)**	**10 (2–5,697)**
Bacterium	**129 (26)**	**1,899 (7)**	**6 (2–119)**
Bacillus	1 (0)	20 (0)	20 (—*)
Campylobacter	2 (0)	10 (0)	5 (4–6)
Escherichia coli	6 (1)	86 (0)	12.5 (2–31)
Legionella	57 (12)	624 (2)	3 (2–107)
MRSA	1 (0)	10 (0)	10 (—)
Nontuberculous mycobacteria	2 (0)	14 (0)	7 (3–11)
Pseudomonas	47 (10)	920 (3)	10 (2–119)
Salmonella	1 (0)	5 (0)	5 (—)
Shigella	11 (2)	207 (1)	12 (3–56)
Staphylococcus	1 (0)	3 (0)	3 (—)
Parasite	**220 (45)**	**21,976 (81)**	**14 (2–5,697)**
Cryptosporidium	208 (42)	21,626 (79)	14.5 (2–5,697)
Giardia	8 (2)	210 (1)	8.5 (3–149)
Cryptosporidium, Giardia	4 (1)	140 (1)	37 (3–63)
Virus	**14 (3)**	**578 (2)**	**36 (6–140)**
Echovirus	1 (0)	36 (0)	36 (—)
Norovirus	13 (3)	542 (2)	36 (6–140)
Chemical	**22 (4)**	**1,028 (4)**	**17.5 (2–665)**
Excess chlorine, disinfection by-product, or altered pool chemistry	22 (4)	1028 (4)	17.5 (2–665)
Unidentified	**108 (22)**	**1,738 (6)**	**7.5 (2–280)**

Abbreviation: MRSA = methicillin-resistant *Staphylococcus aureus*.

* Not applicable because only one outbreak was nationally reported for that etiology.

Vulnerabilities

- Cryptosporidium – extremely chlorine-tolerant
- Legionella & Pseudomonas – persist in biofilm → protected from inactivation, amplify when disinfectant concentrations aren't adequate & when water temperature is warm (25-42C)



https://www.trythisteaching.com/2015/04/glass-half-full-or-half-empty/

Wastewater surveillance, a brief history

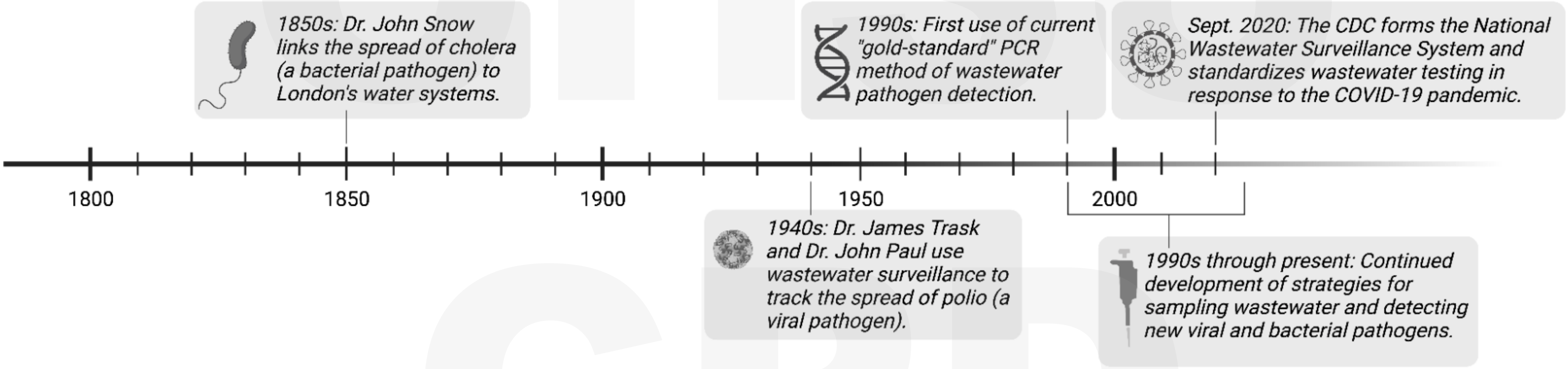


Figure 1. Timeline of advances in wastewater surveillance. *Using wastewater to monitor disease dates back to the 1850s, but modern methods were not developed until the 1990s. The COVID-19 pandemic brought wastewater surveillance to the public eye, and the CDC formed a national surveillance system in 2020.*

https://sitn.hms.harvard.edu/flash/2023/something-in-the-sewage-what-watching-our-wastewater-can-tell-us-about-infectious-diseases/

Wastewater surveillance, circa 2025

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

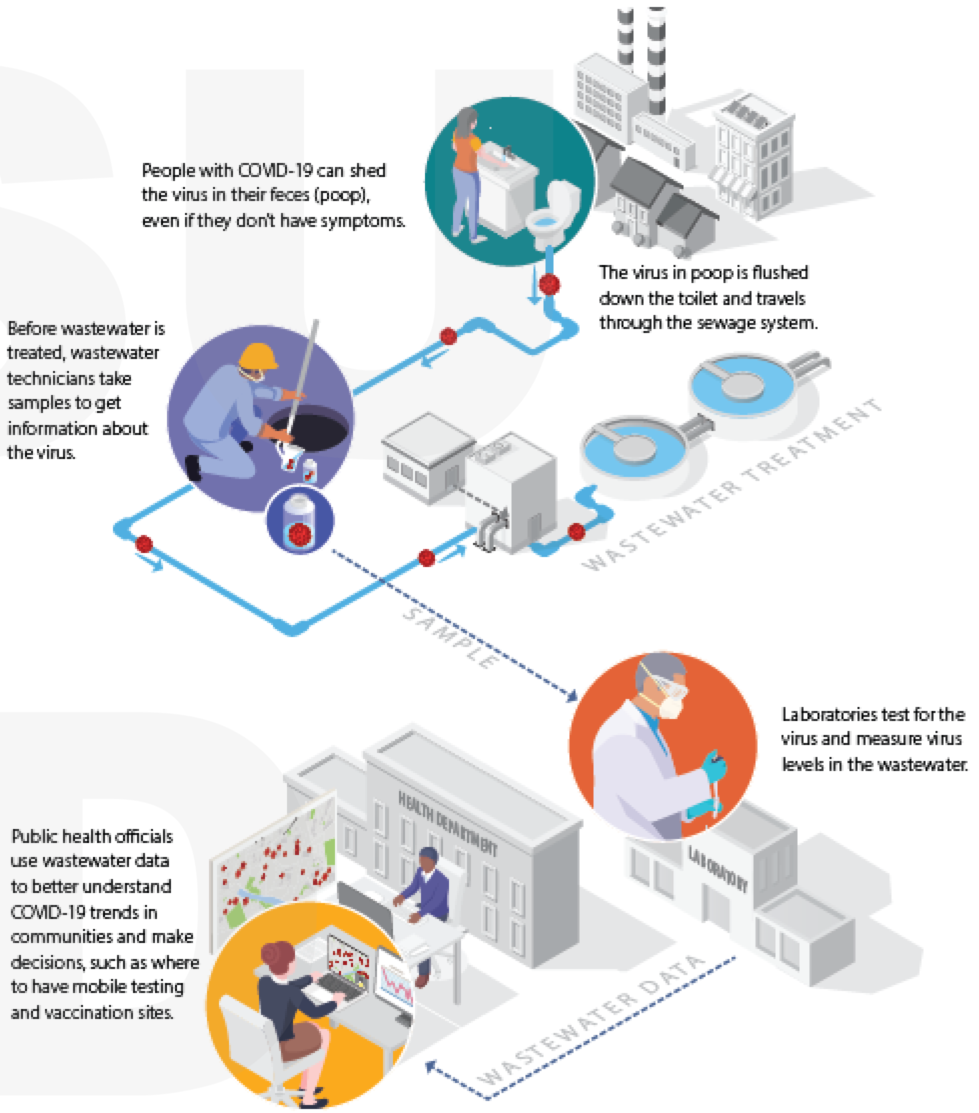
National Wastewater Surveillance System (NWSS)

Wastewater monitoring is a valuable, efficient, and robust tool that public health officials can use to guide public health decision making across the nation.

NATIONAL™ WASTEWATER SURVEILLANCE SYSTEM

CDC's National Wastewater Surveillance System (NWSS) provides the public health infrastructure to monitor infectious diseases through wastewater across the country. Wastewater monitoring data can help local public health agencies identify outbreak trends early, direct prevention efforts to where they are most needed, and provide additional insight into disease spread that complements other public health surveillance data. Health departments, community leaders, and individuals can use wastewater monitoring data to make decisions about how best to protect their community.

Number of Wastewater Sampling Sites Reporting to NWSS in the Last Two Months	Estimated U.S. Population Covered by NWSS	Explore Wastewater Data
1,551	151,000,000 (45.0%)	COVID-19 Influenza A Avian Influenza A(H5) RSV Mpox



site accessed 2.7.2025

https://www.cdc.gov/nwss/about.html

Wastewater COVID-19 National and Regional Trends

COVID-19 Wastewater Monitoring in the U.S.

Print

LOW

Nationally, the wastewater viral activity level for COVID-19 is currently **low**.

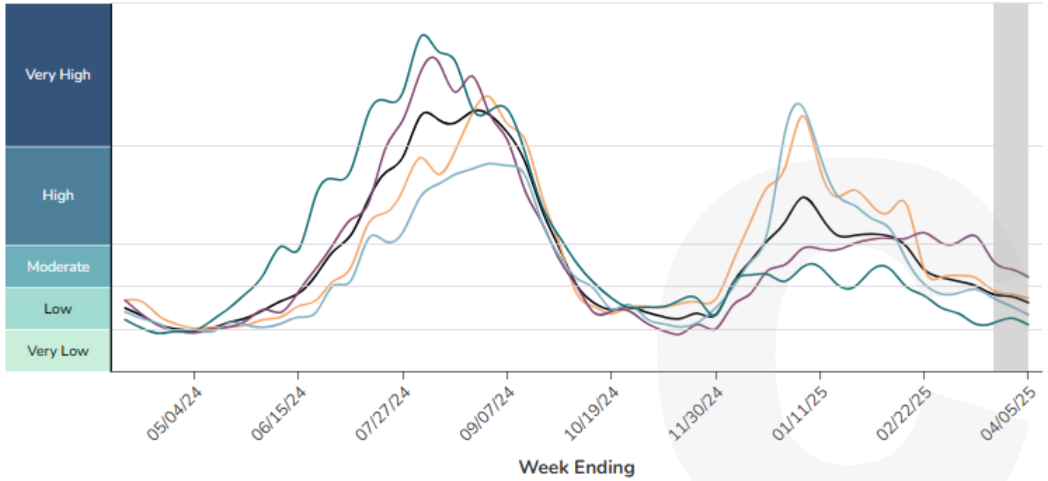
Region with the highest wastewater viral activity level for COVID-19:
South

See individual state and territory trends.

Wastewater data are updated every Friday with the previous week's data, which allows for data to be reviewed for accuracy.

This chart shows national and regional trends of wastewater viral activity levels of SARS-COV-2 (the virus that causes COVID-19).

1 Year



Select a geography to add or remove it from the visualization.

National · Midwest · South · Northeast · West

COVID-19 Current Wastewater Viral Activity Levels Map

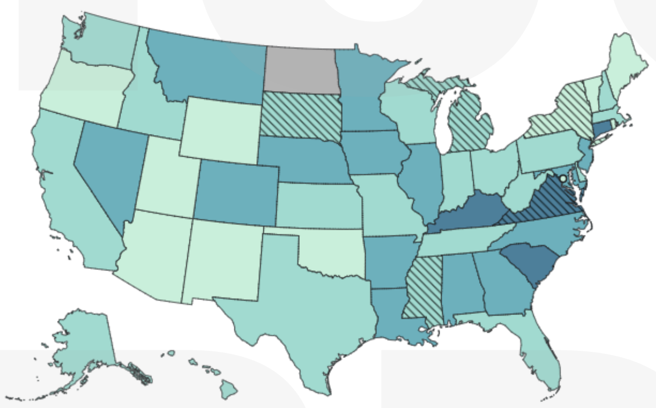
COVID-19 Wastewater Monitoring in the U.S.

Print

This interactive map shows the current wastewater viral activity level of SARS-CoV-2 (the virus that causes COVID-19) for each state or territory.

Wastewater data are updated every Friday with the previous week's data, which allows for data to be reviewed for accuracy. Data may change as more reports are received.

Time Period: March 30, 2025 - April 05, 2025



U.S. Territories

GU VI

SARS-CoV-2 Wastewater Viral Activity Levels

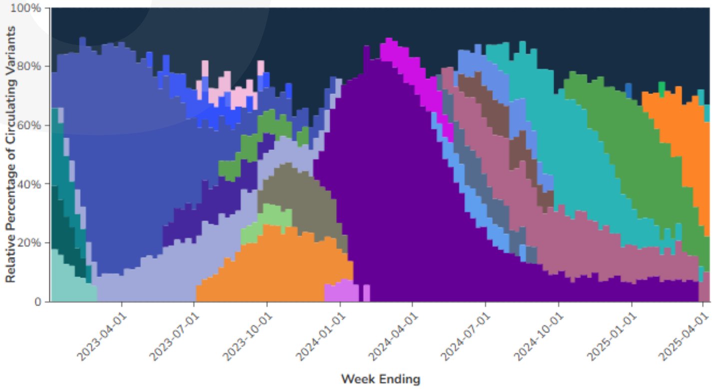
Select a level to add or remove from map.

Very High · High · Moderate · Low · Very Low · No Data · *Limited Coverage

Predominant Variant

LP.8.1

All lineages not enumerated in this graphic are aggregated with their parent lineages, based on Pango statement of nomenclature rules.



Select a variant to add or remove it from the visualization.

BA.2 · BA.2.86 · BA.5 · BQ.1 · BQ.1.1 · EG.5 · FL.1.5.1 · HK.3 · HV.1 · JN.1 · XBB · XBB.1.16 · XBB.1.16.1 · XBB.1.16.6 · XBB.1.5 · XBB.1.5.1 · XBB.1.5.59 · XBB.1.9.1 · XBB.1.9.2 · XBB.2.3 · JN.1.11.1 · JN.1.7 · JN.1.8.1 · KP.2 · KP.1.1 · KP.3 · LB.1 · KP.2.3 · KP.3.1.1 · XEC · MC.1 · MC.19 · LB.1.3.1 · LP.8.1 · XEC.4 · MC.10.1 · KP.1.1.3 · Other

Data from the most recent weeks may be incomplete due to delays in data reporting. These data sets are subject to change.

Data last updated 2025-04-10

site accessed 4.16.2025

https://www.cdc.gov/nwss/rv/COVID19-nationaltrend.html

Contact Us

Updated weekly. Data current as of 4/16/2025

Oregon Respiratory Viral Pathogen Wastewater Monitoring Dashboard

OHA is working with Oregon State University to collect and test samples of wastewa
three respiratory viral pathogens: SARS-CoV-2, influenza, and respiratory syncytial v
are collected 1-2 times weekly from community wastewater treatment centers arou
Samples are tested year-round for SARS-CoV-2 and influenza and during the respirat
1–April 30) for RSV. Viral levels are shown with statewide test percent positivity for
diseases. Wastewater monitoring can be used to detect trends in community spread
CoV-2 variants and influenza subtypes at the community-level.

Select a pathogen below or go to the **methods** page for more on how we collect our d

SARS-CoV-2 | Influenza | RSV | Me

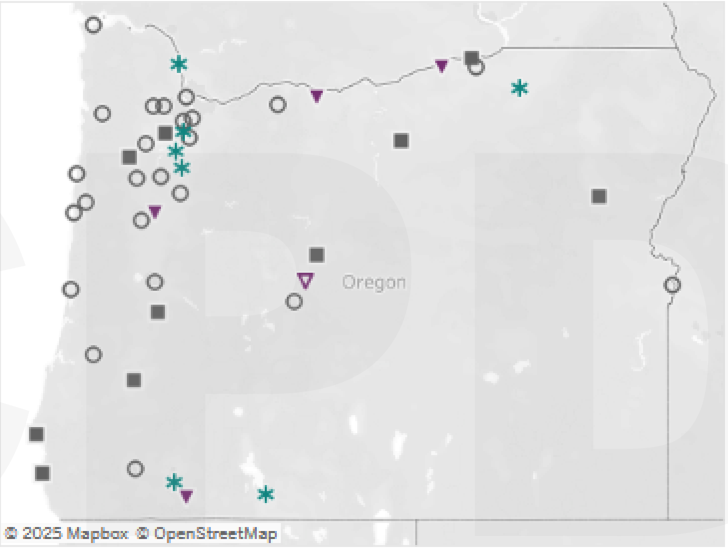
39% of Oregon community wastewater treatment centers were **positive** for influenza on the most recent sample

61% of Oregon community wastewater treatment centers were **non-detectable** for influenza on the most recent sample

Proportion of reporting community wastewater treatment centers by most recent **influenza trend category**

Sustained increase: 0%	Increase: 0%	Plateau: 58%	Decrease: 8%	Sustained decrease: 33%	Sporadic detections	Discontinued
▲	△	✱	▽	▼	○	■

Map of community wastewater treatment centers in Oregon by most recent **influenza trend**



Select one or more influenza trend categories to filter the map. The list of community wastewater treatment center locations will update based on the trend category selection.

Influenza trend categories

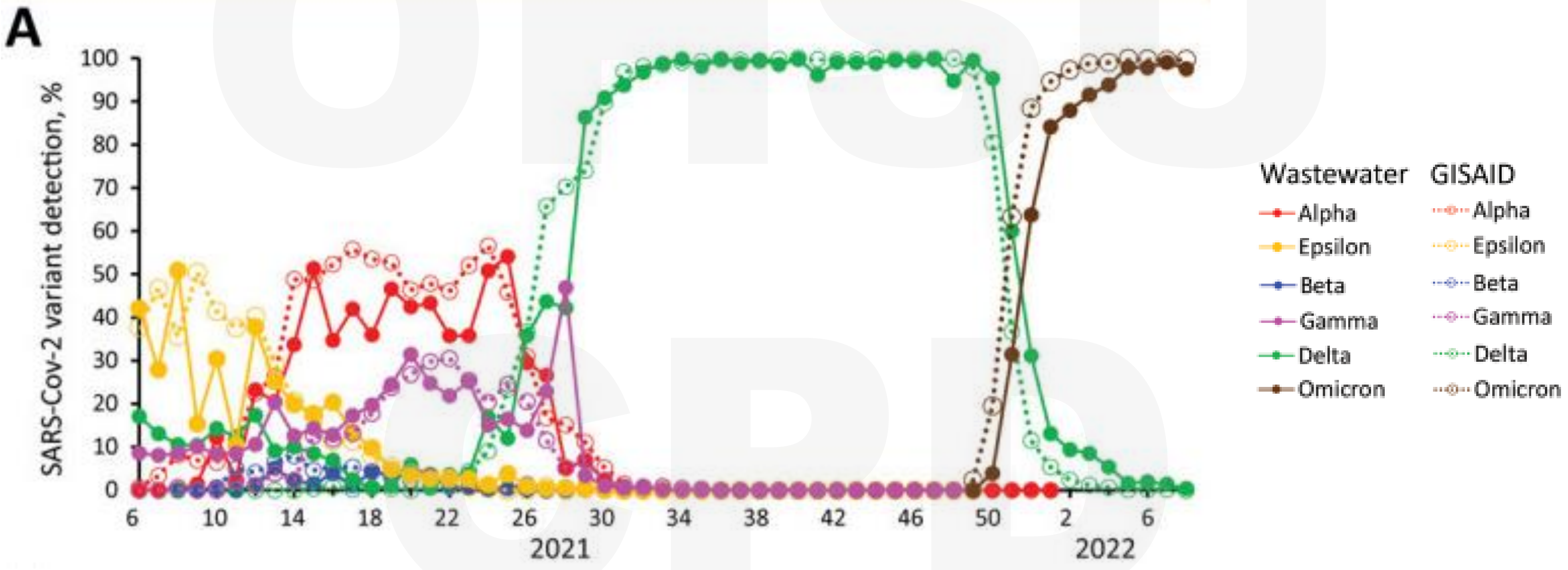
- ☑ (All)
- ☑ Plateau
- ☑ Decrease
- ☑ Sustained Decrease
- ☑ Sporadic Detections
- ☑ Discontinued

Locations

- ◉ (All)
- ○ Albany
- ○ Ashland
- ○ Astoria
- ○ Baker City
- ○ Bend
- ○ Boardman
- ○ Canby
- ○ Condon
- ○ Corvallis
- ○ Cottage Grove
- ○ Dallas
- ○ Durham

https://public.tableau.com/app/profile/oregon.public.health.division.acute.and.communicable.disease.pre/viz/OregonsRVPWastewaterMonitoring/Mainpage

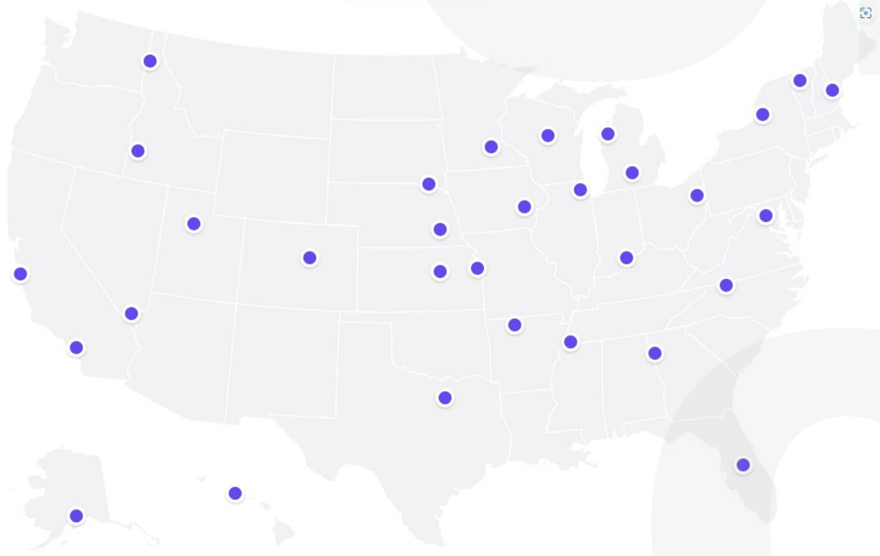
Correlation between clinical and wastewater SARS-CoV-2 genomic surveillance, Oregon, USA

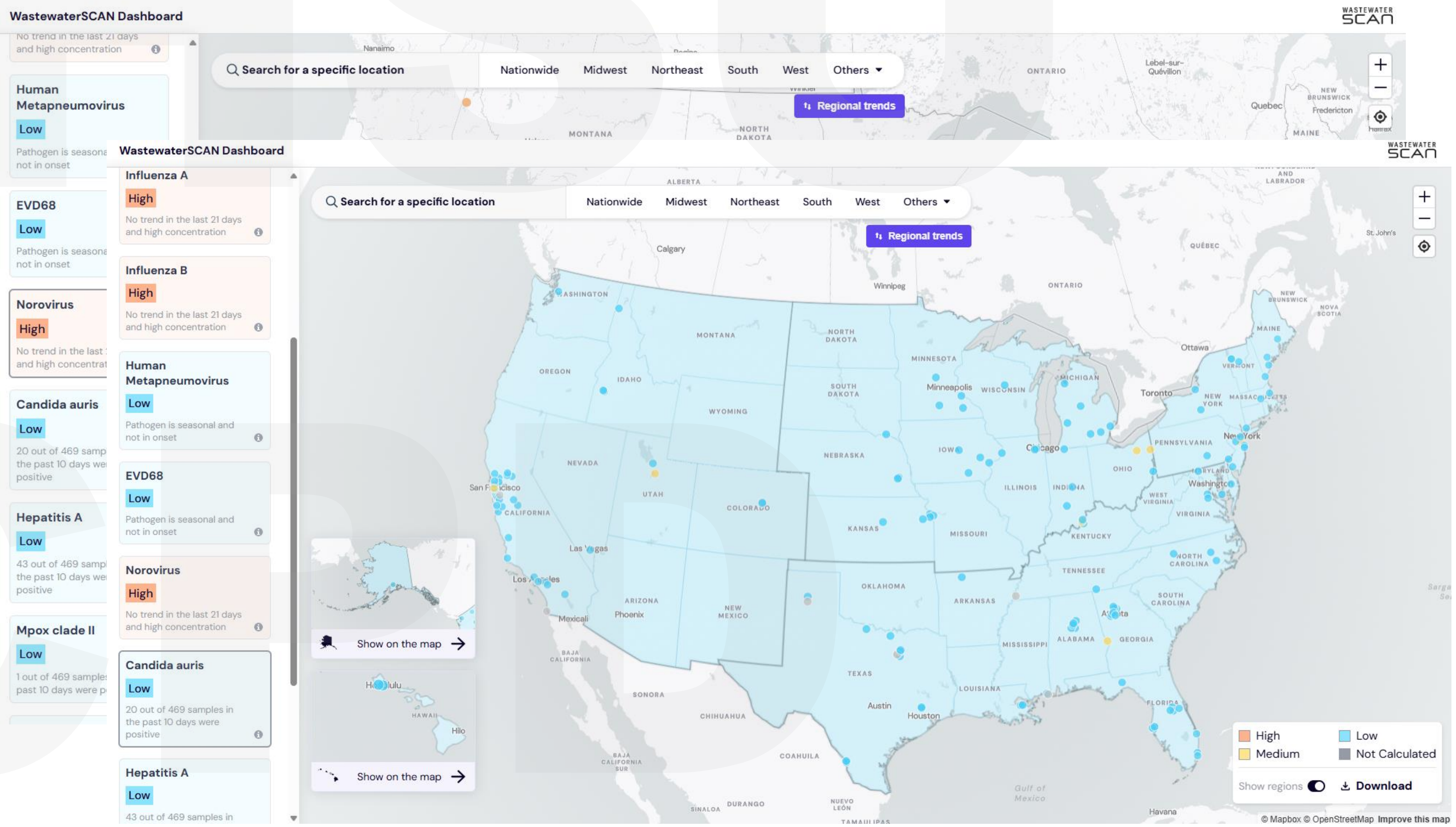


Kaya D,…Sutton M, et al. *Emerg Infect Dis* 2022

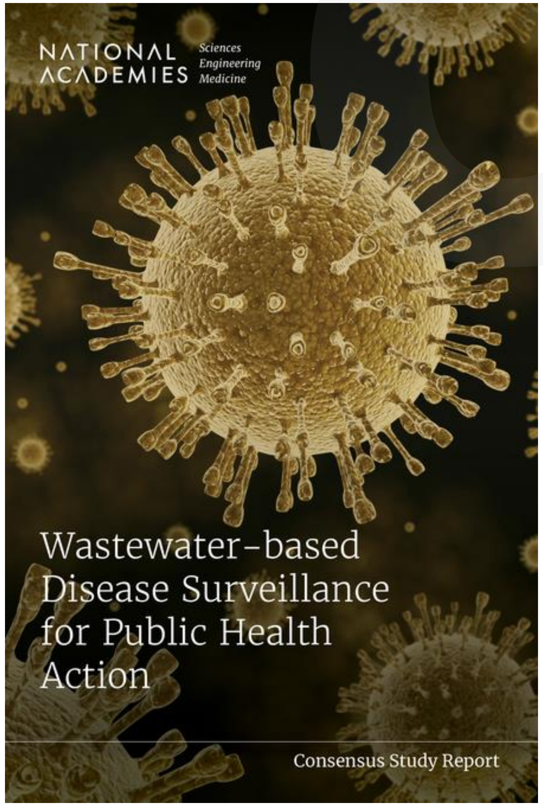
Gratitude to Melissa Sutton, OHA

Wastewater surveillance - potential





Wastewater surveillance – opportunities, shortcomings, and potential applications



Advantages:

- Does not require direct patient contact or invasive procedures
- Can be applied to communities and/or diseases, even if people are not presenting to healthcare for diagnosis
- Can provide lead time to community surge

However, 20% of US households, including many tribal and rural communities, are not connected to a sewer line.

Vision for a national wastewater surveillance system

"When evaluating potential targets for future wastewater surveillance, CDC should consider three criteria: (1) public health significance of the threat, (2) analytical feasibility for wastewater surveillance, and (3) usefulness of community-level wastewater surveillance data to inform public health action."

2023, National Academies of Sciences, Engineering, and Medicine
https://nap.nationalacademies.org/catalog/26767/wastewater-based-disease-surveillance-for-public-health-action

Journal of Medical Virology

WILEY

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MEDICAL VIROLOGY

SHORT COMMUNICATION OPEN ACCESS

Detection of Measles Virus Genotype D8 in Wastewater of the Brussels Capital Region, Belgium

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Keywords: genotyping | measles virus | public health | wastewater based epidemiology

ABSTRACT

We analyzed wastewater from Belgian treatment plants to look for measles virus. Genotype D8 was identified in Brussels North samples, matching sequences from 15 regional measles cases. Finding measles virus in wastewater can suggest undetected virus transmission. Wastewater surveillance is a valuable tool for identifying viral circulation and supporting public health interventions against outbreaks.

Summary

- There are local/regional, institutional, and population-based variations in risk for waterborne infection.
- The threat and impact of waterborne infection is typically proportional to host vulnerability.
- Prevention of waterborne infection relies on protocols and processes to mitigate risk.
- Wastewater surveillance for infectious diseases is an evolving epidemiologic tool.