

NOTE: YAY! You're done with checking my test! ,Check the open ended answers with leniency, other relevant answers may still apply. Remember, there are some things I did not cover on this test such as:

- R0
- nominal/ordinal/ratio scale variables
- HALE and DALY
- Standardization
- Immunity
- Types of prevention

Etc.. So keep studying!!

#### Background:

Legionella is a genus of over 60 species of gram negative intracellular bacteria. In endemic areas, legionella are found in low concentrations in most freshwater sources like lakes, rivers, and sewers. In their natural habitat, legionella live inside bacteria eating amoeba and protozoa. All species are considered pathogenic, but Legionella pneumophila is the most common disease causing agent. Legionella spreads through aerosolized droplets and multiply inside alveolar macrophages in the body. They are capable of causing a severe pneumonia known as Legionnaires' disease and a less severe form called pontiac fever. Legionnaires disease has an incubation of 2-10 days. Symptoms always include fever, myalgia and pneumonia and commonly include shortness of breath, headache, confusion, nausea, diarrhea. Hospitalization is common in cases of Legionnaires' disease and the mortality rate is around 10 percent. However, only around 5% of those exposed actually develop the infection. Pontiac fever is theorized to be a reaction to Legionella endotoxins and occurs 24-72 hours after exposure. Though cases lack pneumonia, they still retain symptoms of fever and myalgia. Pontiac fever is self limiting to slightly less than a week. Some risk factors of Legionnaires' disease are:

- Age  $\geq$ 50 years
- Smoking (current or historical)
- Chronic lung disease (such as emphysema or COPD)
- Immune system disorders due to disease or medication
- Systemic malignancy
- Underlying illness such as diabetes, renal failure, or hepatic failure
- Recent travel with an overnight stay outside of the home, including stay in a healthcare facility
- Exposure to hot tubs
- Travel to hospital, nursing home or cruise within the last 10 days

Legionella is treated with with antibiotics but they must have high intracellular penetration. The incidence of legionella is increasing, with about 1.8 cases per 100,000 pop reported in 2016. However, many epidemiologists believe Legionnaires' disease is underreported.

1. Define and provide 2 examples of a chronic and acute disease (6pts)

Grading: definition, and both examples are each worth 1 point.

Chronic: long running medical syndrome quickly that develops slowly. Has to last longer months than 3 months

Acute: a disease with sudden onset and worsening symptoms lasting less than 3

Ex: Arthritis, Atherosclerosis, diabetes epilepsy

Ex: common cold, influenza, asthma attack, heart attack

2. According to your definitions, what is pontiac fever? (1pt)

- a. acute
- b. chronic

3. According to your definitions, what is legionnaires' disease? (1pt)

- a. acute
- b. chronic

4. List the steps in the chain of transmission (6 pts)

Grading: each step is 1 point

1. agent
2. Reservoir
3. Exit portal
4. Mode of transmission
5. Entry portal
6. Susceptible host

5. Acanthamoeba, an ubiquitous freshwater bacterivore differs little on the cellular level with mammalian cells. Acanthamoeba are commonly found with legionella like endosymbionts. Bacteria isolated from Acanthamoeba are often associated with higher efficacy in invading human tissue and resistance to antibiotics. What would Acanthamoeba be to legionella? Explain why (4 pts)

Grading: multiple choice is 2 points, explanation is 2

- a. A reservoir
- b. A biological vector (Acanthamoeba does not spread the disease to humans)
- c. A mechanical vector
- d. A host (remember this is in relation to humans)

Without Acanthamoeba and other amoeba/protozoa, there is nowhere for legionella to grow in the wild, as they can't survive extracellularly. However these organisms don't directly interact with humans so they cannot be vectors.

TB1: Acanthamoeba is also a human pathogen, List some diseases it causes, symptoms or risk factors (up to 6 points)

Each symptom, disease name or risk factor is 1 point but they have to be correlated correctly (EX: GAE is not associated with wearing contact lenses)

Acanthamoeba keratitis ( blindness, eye irritation) associated with contact lens wearers, granulomatous amoebic encephalitis (GAE) (headaches, seizures,death) associated with immunodeficiency

6. Droplets of legionella are around (1pt)
- a. 100-10  $\mu\text{m}$  (too big to get deep in the lungs but still droplet)
  - b. 10-5  $\mu\text{m}$  (smallest while still considered droplets)
  - c. Less than 5  $\mu\text{m}$  (considered airborne)

NOTE: irl legionella can spread in droplets 2.5-10  $\mu\text{m}$

#### Pneumonia outbreak at [REDACTED]

It is July 12th, 2014, the dog days of summer, your family is on vacation in Singapore but you're stuck working at your local health office in the sleepy town of [REDACTED], population . You receive a call."we would like to report a case of Legionnaires' disease" says hospital clerk."Ok" you say, "tell me about the case". The hospital clerk happily obliged. "3 days ago, a 17 year old hispanic male was admitted to our hospital. The patient was brought in by his mother after he experienced coughing and a fever of 39.7 degrees celsius. His mother said that he started complaining of chest pains on the 9th. When we performed a radiograph on him, we found he had pneumonia. He was attending the summer school at [REDACTED] high school. We issued a culture , but the results are not yet conclusive. However, the urine antigen test we performed turned out positive.The patient is still in our ICU, receiving treatment." "keep us updated you say, we'll give you [DATA EXPUNGED] in return" you say. You put down your phone, surprised, immediately your mind begins to race.

7. Please fill out the case report (the case report is attached next to the test files) (10 points)
- <https://www.cdc.gov/legionella/downloads/case-report-form.pdf>

Patient's Name: N/a Telephone Number: N/a Hospital: N/a  
LAST / FIRST / MI  
 Address: N/a Patient Chart No.: 1/a  
NUMBER / STREET / APT NO. / CITY / STATE ZIP CODE  
PATIENT IDENTIFIER INFORMATION IS NOT TRANSMITTED TO CDC

Form Approved OMB No. 0920-0728



CDC • National Center for Immunization and Respiratory Diseases

**LEGIONELLOSIS CASE REPORT**  
 (DISEASE CAUSED BY ANY LEGIONELLA SPECIES)



Department of Health & Human Services  
 Centers for Disease Control and Prevention (CDC), Atlanta, Georgia, 30329-4027  
<http://www.cdc.gov/legionella/index.htm>

Case No.:        
(CDC use only)

1. State Health Dept. Case No.: \_\_\_\_\_ 2. Reporting State: MA 3. County of Residence: USA 4. State of Residence: MA 5. Occupation: student

6a. Date of Birth:       6b. Age:   7. Sex: 1  Male 2  Female 8. Ethnicity: 1  Hispanic/Latino 2  Not Hispanic/Latino 9. Race: (check all that apply) 1  Black or African American 2  American Indian/Alaska Native 3  Asian 4  Native Hawaiian or Other Pacific Islander 5  White 6  Unknown

10. Diagnosis: (check one) 1  Legionnaires' Disease (pneumonia, clinical or X-ray diagnosed) 2  Pontiac Fever (fever and myalgia without pneumonia) 3  Other (e.g., endocarditis, wound infection): \_\_\_\_\_ 11. Date of symptom onset of legionellosis:       12. Date of first report to public health at any level:

13. Was the patient hospitalized during treatment for legionellosis? 1  Yes 2  No 3  Unknown If yes, date of admission:       Hospital name: N/a City, State: [REDACTED], N/a 14. Outcome of illness: 1  Survived 2  Died 3  Still ill 4  Unknown

15. In the 10 days before onset, did the patient spend any nights away from home (excluding healthcare settings)? (check one) 1  Yes\* 2  No 3  Unknown If yes, please complete the following table.

ACCOMMODATION NAME	ADDRESS	CITY	STATE	ZIP	COUNTRY	ROOM NUMBER	DATES OF STAY	
							ARRIVAL	DEPARTURE
[REDACTED] high	N/a	[REDACTED]						

\*If yes, was this case reported to CDC at [travellegionella@cdc.gov](mailto:travellegionella@cdc.gov)? 1  Yes 2  No 3  Unknown

16. In the 10 days before onset, did the patient get in or spend time near a whirlpool spa (i.e., hot tub)? (check one) 1  Yes 2  No 3  Unknown If yes, describe where: \_\_\_\_\_ If yes, list dates: \_\_\_\_\_

17. In the 10 days before onset, did the patient use a nebulizer, CPAP, BiPAP or any other respiratory therapy equipment for the treatment of sleep apnea, COPD, asthma or for any other reason? (check one) 1  Yes 2  No 3  Unknown If yes, does this device use a humidifier? 1  Yes 2  No 3  Unknown If yes, what type of water is used in the device? (check all that apply) 1  Sterile 2  Distilled 3  Bottled 4  Tap 5  Other 6  Unknown

18. In the 10 days before onset, did the patient visit or stay in a healthcare setting (e.g., hospital, long term care/rehab/skilled nursing facility, clinic)? (check one) 1  Yes 2  No 3  Unknown If yes, please complete the following table.

TYPE OF HEALTHCARE SETTING / FACILITY (CHECK ONE)	TYPE OF EXPOSURE (CHECK ONE)	NAME OF FACILITY	IS THIS FACILITY ALSO A TRANSPLANT CENTER?	REASON FOR VISIT	CITY	STATE	DATE OF VISIT / ADMISSION	
							START DATE	END DATE
1 <input type="checkbox"/> Hospital 2 <input type="checkbox"/> Long term care 3 <input type="checkbox"/> Clinic 4 <input type="checkbox"/> Other _____	1 <input type="checkbox"/> Inpatient 2 <input type="checkbox"/> Outpatient 3 <input type="checkbox"/> Visitor or volunteer 4 <input type="checkbox"/> Employee		1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unknown					
1 <input type="checkbox"/> Hospital 2 <input type="checkbox"/> Long term care 3 <input type="checkbox"/> Clinic 4 <input type="checkbox"/> Other _____	1 <input type="checkbox"/> Inpatient 2 <input type="checkbox"/> Outpatient 3 <input type="checkbox"/> Visitor or volunteer 4 <input type="checkbox"/> Employee		1 <input type="checkbox"/> Yes 2 <input type="checkbox"/> No 3 <input type="checkbox"/> Unknown					

Public reporting burden of this collection of information is estimated to average 20 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to CDC, Project Clearance Office, 1600 Clifton Road, NE, Atlanta, GA 30333, ATTN: PRA (0920-0006). Do not send the completed form to this address. While your response is voluntary your cooperation is necessary for the understanding and control of this disease.

State Health Dept. Case No.: \_\_\_\_\_

19. Was this case associated with a healthcare exposure; (check one)

1 **Definitely:** Patient was hospitalized or a resident of a long term care facility for the entire 10 days prior to onset

2 **No:** No exposure to a healthcare facility in the 10 days prior to onset

3 **Possibly:** Patient had exposure to a healthcare facility for a portion of the 10 days prior to onset

4 **Other (specify)** \_\_\_\_\_

5 **Unknown**

20. In the 10 days before onset, did the patient visit or stay in an assisted living facility or senior living facility? (check one)  1 Yes  2 No  3 Unknown

TYPE OF FACILITY	TYPE OF EXPOSURE	NAME OF FACILITY	CITY	STATE	DATE OF VISIT	
					START DATE	END DATE
<input type="checkbox"/> 1 Assisted Living	<input type="checkbox"/> 1 Resident <input type="checkbox"/> 2 Visitor or Volunteer <input type="checkbox"/> 3 Employee					
<input type="checkbox"/> 2 Senior Living (includes retirement homes <i>et cetera</i> ) skilled nursing or personal care)	<input type="checkbox"/> 1 Resident <input type="checkbox"/> 2 Visitor or Volunteer <input type="checkbox"/> 3 Employee					

21. Was this case associated with a known outbreak or possible cluster? (check one)  1 Yes  2 No  3 Unknown

If yes, specify name of facility, city, and state of outbreak: REDACTED high, [REDACTED], NJ

PLEASE CHECK ALL METHODS OF DIAGNOSIS WHICH APPLY:

CONFIRMED CASE	SUSPECT CASE
<p><input checked="" type="checkbox"/> 1 <b>Urine Antigen Positive:</b> If yes.</p> <p>Date Collected: <input type="text" value="6"/> <input type="text" value="11"/> <input type="text" value="2018"/> Mo. Day Year</p> <p><input type="checkbox"/> 2 <b>Culture Positive:</b> If yield.</p> <p>Date Collected: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Mo. Day Year</p> <p>Site: <input type="checkbox"/> 1 lung biopsy <input type="checkbox"/> 2 respiratory secretions (e.g., sputum, BAL) <input type="checkbox"/> 3 pleural fluid</p> <p><input type="checkbox"/> 4 blood <input type="checkbox"/> 5 other (specify) _____</p> <p>Species: _____ Serogroup: _____</p> <p><input type="checkbox"/> 3 <b>Fourfold rise in antibody titer to Legionella pneumophila serogroup 1:</b> If yield.</p> <p>Initial (acute) titer: _____ Date Collected: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Mo. Day Year</p> <p>Convalescent titer: _____ Date Collected: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Mo. Day Year</p>	<p><input type="checkbox"/> 4 <b>Fourfold rise in antibody titer OTHER THAN Legionella pneumophila serogroup 1 or to multiple species or serogroups of Legionella using pooled antigen:</b> If yes.</p> <p>Initial (acute) titer: _____ Date Collected: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Mo. Day Year</p> <p>Convalescent titer: _____ Date Collected: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Mo. Day Year</p> <p>Species: _____ Serogroup: _____</p> <p><input type="checkbox"/> 5 <b>Direct Fluorescent Antibody (DFA) or Immunohistochemistry (IHC) Positive:</b> If yes.</p> <p>Date Collected: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Mo. Day Year</p> <p>Site: <input type="checkbox"/> 1 lung biopsy <input type="checkbox"/> 2 respiratory secretions (e.g., sputum, BAL) <input type="checkbox"/> 3 pleural fluid</p> <p><input type="checkbox"/> 4 blood <input type="checkbox"/> 5 other (specify) _____</p> <p>Species: _____ Serogroup: _____</p> <p><input type="checkbox"/> 6 <b>Nucleic Acid Assay (e.g., PCR):</b> If yes.</p> <p>Date Collected: <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> Mo. Day Year</p> <p>Site: <input type="checkbox"/> 1 lung biopsy <input type="checkbox"/> 2 respiratory secretions (e.g., sputum, BAL) <input type="checkbox"/> 3 pleural fluid</p> <p><input type="checkbox"/> 4 blood <input type="checkbox"/> 5 other (specify) _____</p> <p>Species: _____ Serogroup: _____</p>

<p>Interviewer's Name: <u>E. Gorgonis</u></p> <p>Affiliation: _____</p> <p>Telephone No.: <u>696-969-6969</u></p>	<p>State Health Dept. Official who reviewed this report: <u>E. Gorgonis</u></p> <p>Title: <u>N/A</u></p> <p>Telephone No.: <u>777-777-7777</u></p>	<p>Local Health Dept. Please submit this document to: State/DHD/SSS via your CD clerk</p> <p>State Health Dept. Return completed form to: Respiratory Diseases Branch, Mailstop C25 Office of Infectious Diseases Centers for Disease Control and Prevention 1600 Clifton Rd. NE, Atlanta, GA 30329</p>
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Grading: each error is -1 point, things like omitting info or making it up constitute an error

8. According to the case report, is this patient a probable or **confirmed** case? (1 point)

9. Please define both terms (2 points for each)

**Probable:** case with most clinical symptoms and determinants but usually without laboratory confirmation

**Confirmed:** A case with both clinical symptoms and determinants AND laboratory testing

**Confirmed:**

10. Define sensitivity (2pts)

The true positive rate, or true positives divided by all positives (or true positives over false negatives) or  $TP/(TP+FN)$  or  $a/(a+c)$  but if you use abcd then you MUST include a labeled 2x2 table

11. If the urine antigen test for legionella has a 73.2% sensitivity rate, how many false negatives would you expect to find in a sample of 829 cases results? Show work (3pts)

Handwritten work for question 11:

$$\frac{73.2}{100} = \frac{tp}{829(tp+fn)}$$

$$tp = 606$$

$$829 - 606 = 223$$

223 (or 224)

12. Using the above information, find the PPV, if possible. (3pts)

Impossible, you would need to know the number of false positives

13. What type of error would be a false negative be? (2pts)

Type II

The CDC prefers 2 methods to diagnose legionella: culture or a urinary antigen test, Here are some pros and cons to these tests:

Culture:

+

-

Can detect all serotypes and species of legionella  
Slightly higher specificity  
Can be taken anywhere

Takes longer to get a confirmation  
Lower sensitivity  
More expensive

Urinary test:

+

-

Cheaper  
Quicker  
Higher sensitivity

only detects legionella pneumophila serogroup 1  
slightly lower specificity

For questions 14-19 (1pt each), say which test would be better to use

14. An immunocompromised patient who already has all the clinical symptoms of Legionnaires' disease, including pneumonia

urinary

15. A patient reporting symptoms of Legionnaires' disease without a immediately identifiable cause of infection

Culture (to try to find source)

16. Someone who insists he or must have gotten Legionnaires' disease because he or she visited a place where an outbreak occurred.

Urinary or none

17. An air conditioning cooling tower suspected to have caused an outbreak of legionella



### Culture (ACs don't pee)

18. A patient that tested positive in paired serology (another diagnostic test) who you want to compare to other patients and environments.

### culture

19. An elderly person who attends a nursing home which recently had an outbreak of Legionella pneumophila serotype 1 and who has been complaining of coughing.

### urinary

20. According to the above information, would this be considered an outbreak? List 2 reasons why or why not. (5pts)

No

1. We don't know the baseline of legionnaires' disease in this region and there cannot tell if this is an abnormal increase
2. 1 case is never enough to say if something is an outbreak or not
3. Legionnaires' disease causes 9-15% or pneumonia cases anyways

21. Define active and passive surveillance and provide an example (6pts):

Grading: definitions are 2 points and examples are 1

Active: surveillance where those who maintain the surveillance initiate reporting. Often incentivised. Occurs during an outbreak investigation.

Ex: epidemiologists interviewing those who were exposed to a chemical accident

Passive: Doctors report relevant cases when they come up. Does not provide incentives. Occurs all the time and is used to detect outbreaks.

Ex: doctor reporting a patient who developed a rare form of cancer

TB2: define either sentinel, public health or syndromic surveillance and provide an example (up to 3 pts, ONLY DO 1)

Grading: same as above

Sentinel: employing a select sample of health care locations to specifically gather information

Ex: employing a specific hospital network to estimate the number of cases of a common cancer in the region

Public health: The constant collection of public health data required to perform basic public health

Ex: the census asks questions on alcoholism, smoking etc.

Syndromic: collecting public health related information to detect or anticipate outbreaks

Ex: using school absentee logs to detect when the flu outbreak hits a school

22. The hospital themselves reported the first case, is this active or passive surveillance?

23. By offering [DATA EXPUNGED] what have you done to the mode of surveillance?

Made it active by directing and providing incentives

24. What type of surveillance, active or passive is more likely to underreport cases and why? (3pts)

Passive because there is less effort (per se) being put into identifying cases.

25. Why would you want to investigate this? Give 3 reasons (3pts):

1. The outbreak may still be ongoing
2. Legionnaires' disease is a dangerous disease
3. Protect those with frail bodies
4. Assure the public
5. Learn more about the disease and how it spreads

Your team decides to investigate further. You make calls to arrange an investigation. Soon, your assistant returns with some papers. "Sir, I have bad news. Hospitals reported 9 more cases of Legionnaires disease and 11 cases of Pontiac fever, additional reports might still be coming in, All cases seem to have occurred at [REDACTED] high school".

26. Which step of an outbreak investigation are you on now? (1pt)

Prepare for fieldwork

27. After 5 more steps, which step would you be on? (2 pts)

Develop hypothesis

28. Is a general or specific case definition better right now? Please explain why (3pts)

General as you are just starting out the investigation and therefore want all possible cases

Cases of Legionnaires' Disease

Case #	Date of onset	myalgia	coughing	Diarrhea	fever	gender	age	occupation	culture
1	7/9	y	y	n	y	m	17	student	+
2	7/9	y	y	y	y	f	15	student	+
3	7/10	y	y	n	y	f	39	teacher	+
4	7/10	y	y	n	y	m	73	Substitute teacher	-
5	7/10	y	n	y	y	m	25	Teaching assistant	+
6	7/11	y	y	y	y	m	56	School counselor	+
7	7/11	y	y	n	y	m	56	administrator	+
8	7/11	y	y	n	y	f	45	SRO	+
9	7/12	y	y	y	y	m	61	teacher	+
10	7/13	y	y	y	y	f	14	Student	-



Cases of pontiac fever

Case #	Date of onset	head ache	Muscle aches	Diarrhea	fever	gender	age	occupatio n	+
1	7/8	y	n	n	y	m	43	teacher	+
2	7/9	y	y	n	y	m	29	Teaching assistant	+
3	7/10	y	y	n	y	f	17	student	+
4	7/10	n	y	n	y	f	15	student	+
5	7/11	y	y	n	y	f	38	administra tor	+
6	7/11	n	n	n	y	f	35	teacher	+
7	7/11	n	n	n	n	m	18	student	+
8	7/11	n	n	n	y	f	60	administra tor	+
9	7/12	y	n	n	n	m	16	student	+
10	7/12	y	y	y	y	m	15	student	+
11	7/13	y	y	n	y	f	17	student	+

New cases of Legionnaires disease and pontiac fever

	2010	2011	2012	2013 (current)
Legionnaires disease	8	0	1	10
pontiac fever	9	1	2	11

Census data of the town of [REDACTED] (in 100,000)

\* In the year of 2011, the town of [REDACTED] was split in two to deal with the booming population

	2010	2011	2012	2013
population	1.1	0.4		0.47

29. What are the 4 components of a case definition (4pts)?

Time, place, person and clinical features

30. What are the 3 components of the epi triad? (3pts)

1. agent
2. host
3. environment

31. What are the 3 components of the *descriptive* epi triad? (3pts)

1. time
2. place
3. person

32. What part of the descriptive epi triad would column 2 of the graph be? (1pt)

time

33. What part of the descriptive epi triad would column 9 of the graph be? (1pt)

person

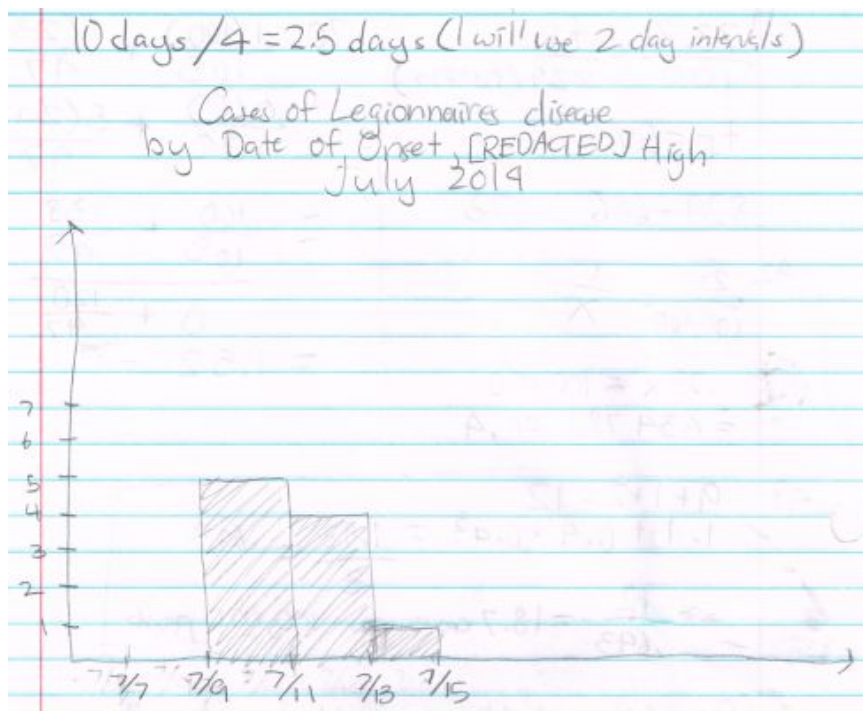
34. Based on your current knowledge, write a case definition for this outbreak (use Legionnaires' disease): (6 pts)

A person showing fever, myalgia and coughing and who tested positive for the culture or urinary analysis test and who attended [REDACTED] high school after the date of 7/9/18

35. What are the first and second graphs called? (2pts)

Line listing

36. Please construct an epi curve for cases of Legionnaires' disease. Label the axes and the title. (10pts)



37. Define an epi curve (2pts)

A visual display of the onset of cases in an outbreak. Cases are displayed as a histogram with the y axis being the number of cases and the x axis being the date.

38. What type of epicurve is this? (2pts)

Point source

39. What does this type of epi curve tell you about the exposure period of the outbreak? (4pts)

All cases of legionella could have occurred due to 1 single exposure

40. What do the cases of pontiac fever tell you about the outbreak? (4pts)

Contrary to legionnaires' disease, the source of infection is still ongoing as pontiac fever has a shorter incubation period

41. Calculate the incidence of Pontiac fever in 2010 (per 100,000 people) (2pts)

$9/1,100,000 * 100,000 = 8.18$  cases per 100,000 people

42. If the incidence of Legionnaires disease in 2012 was 2.3 per 100,000 people, what was the population at the time in 100,000s? Round to the nearest hundredth. (3 pts)

$(2.3/100,000)=(1/x)= 43478, 43478/100,000 = .43$  per 100,000

43. What is the period prevalence of Pontiac fever between 2010-2012 (3pts)

43.  $9 + 1 + 2 = 12$   
 $1.1 + 0.4 + 0.43 = 1.93$   
 $\frac{12}{.643} = 18.7$  cases per 100,000 people

12/.643 +18.7 cases per 100,000 people

As you gaze over your results, you see the majority of the outbreak seems concentrated at [REDACTED] high. You order an investigation quickly. You need to hire some people:

To the left are the positions you need. To the right are the people you are considering hiring or recruiting. Match the candidates to their jobs:

person		role
44. sanitarian	C	A. interviews cases and provides first aid
45. School officials	B	B.Tells of the general school layout and student activities
46. janitor	E	C.informs and enforces relevant health related legislation
47. Lab technician	F	D. informs the public of necessary health measures
48. nurse	A	E. has extensive knowledge of cleanliness in the school
49. reporter	D	F.Cultures and performs diagnostic tests
		G. provides medication to cases

After a long day of calling and hiring, you dive to your empty apartment and slump down on the couch. You see that your wife has sent pictures from their vacation in Singapore. As you scroll through the photos you absentmindedly turn on the tv to your favorite channel. Instead, you are met with the blare of a news jingle, "Deadly outbreak of Legionella at [REDACTED] high school, are health officials doing enough!?!?" says the news anchor with too much hairspray in her hair. You audibly groan.

50. What are 2 benefits of widespread news coverage of an outbreak?

1. More resources (funding) allocated to your investigation
2. People more likely to report cases

51. What are 2 disadvantages of widespread news coverage of an outbreak?

1. Public hysteria can seriously confuse studies
2. Influx of irrelevant information

The next morning, you arrive bright and early to the school. The school Principal, Dr. Vasich, greets you. "I promise to do everything I can to aid in your investigation. He says as sweat forms on his brow." "Tell me about your school, you say". "[REDACTED] high school is one of the biggest high schools in the region." Vasich begins. "As such it is the perfect campus for summer school. Students from schools across the county come here to attend our prestigious summer school which began on Monday July 7th. Before then the school had been closed down for repairs. [REDACTED] high has a North and East campus. Each campus has separate amenities like plumbing, air conditioning and electricity though they all come from a single underground pipe. The east campus has been used extensively for summer school while our sports teams have also been utilizing the north. Teachers usually go between the buildings to relax at the several teachers lounges we have scattered through the building. he finishes. "Thank you" you say

At this point you are considering closing the school

52. What are 2 benefits of closing the school? (2pts)

1. No more exposure to the agent
2. More freedom to investigate the campus
3. Seen as sign that worries are being addressed

53. What are 2 disadvantages of closing the schools?

1. Hysteria
2. Harder to contact cases and controls
3. Disrupts productivity

A day later your assistant briefs you on the current status of the outbreak. "After narrowing our reach to the school we've sent out a custom questionnaire to everyone attending the school." she says. "There have been 2 additional cases of Legionnaires' disease and we've discovered 117 probable cases of Pontiac fever. Parents of those hospitalized filled out the cases forms to the best of their ability". I'm happy to say that we only have 2 non responses! Next up is the sanitarian "I've reviewed the school and found many unsanitary

places.” he says, straightening his glasses “First, there are stagnant pools in the greenhouse that the biology teachers use for breeding fish, secondly there is an open fountain in the school’s atrium that students used to toss coins into but is now scummy with biofilms, there is also a hot tub in the north teacher’s lounge which the janitor has told me is not regularly emptied.” his look of disdain at the school shines clearly through his forced neutrality. “Tomorrow I’m going with the janitor to take samples and start an environmental investigation”.

54. Why would a custom questionnaire be more beneficial than a general form? List 2 reasons (2pts)

1. More specific questions allow you to better get information
2. Can include factors specific to the outbreak and exclude irrelevant information

55. Why would Pontiac fever likely be underreported as seen above? (3pts)

Pontiac fever is often not very severe and self limiting. People with it may not even realize they are specifically sick from legionella

Here are a list of the risk factors your assistant included on the questionnaire:

- Attended class in the east campus
- Attended class in the north campus
- Ate lunch in the atrium (has an uncovered bird bath)
- Had class in the greenhouse (uncovered fish breeding pools)
- Bathed in the hot tub (teachers only)
- Visited a hospital within the last 10 days
- Washed themselves in the river (sports teams)

55. Please write a hypothesis supporting eating lunch in the atrium as the cause of the outbreak. (4pts)

If someone ate lunch in the Atrium they have a higher chance of contracting legionnaires’ disease because the source of infection was the covered fountain held in the atrium.

56. Please write a null hypothesis for washing themselves in the river being the cause of the outbreak . (4pts)

If someone washed themselves in the river they are no more likely to contract legionnaires’ disease because the source of infection was not the river.

Cases of Legionnaires’ disease at REDACTED high by exposure

	Sick	Not sick	total
Attended east building	10	116	126
Attended north building	3	34	37
Exposed to covered atrium fountain	10	69	79

Entered the greenhouse	1	11	12
Visited a hospital within the last 10 days	1	16	17
Bathed in river	3	23	26
Visited hot tub	7	23	30

Note: [REDACTED] high has 153 students in total, there are 12 total cases of Legionnaires' disease.

57. Please define and provide the pros and cons of a case control study (5pts):

A study design where you look at a sick and healthy group and hunt for causes by comparing

+	-
Often cheaper	Affected by selection bias
Good for rare diseases or diseases with long incubation times	Cannot get the true risk ratio but only an approximation

57. Please define and provide the pros and cons of a cohort study (5pts):

A study design where you look at an exposed and unexposed group and hunt for causes by comparing them

+	-
Can track the range of diseases caused by a single exposure	Takes lots of time and money (usually)
Clear temporality	Can only track initial exposures

58. For this case which study design would you choose and why? Provide 2 reasons (6 pts):

Retrospective cohort

We're dealing with a relatively contained, well defined population.

59. For this study, how would you measure association? (1pt)

- a. Odds ratio
- b. Fisher's exact test
- c. ANOVA
- d. Relative risk

60. Calculate the risk associated with visiting the greenhouse (show work) (3pts):



60. sick not sick 12-1=11

exposed	1	11	141-11=130
no	11	130	

$$\frac{\left(\frac{1}{12}\right)}{\left(\frac{11}{141}\right)} = 1.07$$

1.07

61. Calculate the attributable risk of eating in the atrium (show work) (3pts):

61. sick not sick

exposed	10	69
no	2	72

$$\left(\frac{10}{79}\right) - \left(\frac{2}{74}\right) = .10$$

0.10

62. List the top 3 risks most likely to have caused the disease:

1. Attending the east building
2. Eating in the atrium
3. Going into the hot tub.

63. Please calculate the chi square values for those 3 (with Yates correction) (show work) (12 pts)

	Outcome 1	Outcome 2	Total
Group 1	10	116	126
Group 2	2	25	27
Total	12	141	153

Chi-square with Yates correction

Chi squared equals 0.009 with 1 degrees of freedom.  
 The two-tailed P value equals 0.9261  
 The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.

[Learn how to interpret the P value.](#)

1.

east building

attending

	Outcome 1	Outcome 2	Total
Group 1	10	69	79
Group 2	2	72	74
Total	12	141	153

Chi-square with Yates correction

Chi squared equals 3.953 with 1 degrees of freedom.  
The two-tailed P value equals 0.0468  
The association between rows (groups) and columns (outcomes) is considered to be statistically significant.

[Learn how to interpret the P value.](#)

2. eating in the fountain

	Outcome 1	Outcome 2	Total
Group 1	7	23	30
Group 2	5	118	123
Total	12	141	153

Chi-square with Yates correction

Chi squared equals 9.866 with 1 degrees of freedom.  
The two-tailed P value equals 0.0017  
The association between rows (groups) and columns (outcomes) is considered to be very statistically significant.

[Learn how to interpret the P value.](#)

3. going to the hot tub

### Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of $\chi^2$								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21

64. Using the above p value table, please determine if the chi square values you calculated above are statistically significant (use 95%) (3pts)

1. no
2. yes
3. yes

What does this mean? (4pts)

For 1. Even though there is a difference, it is possible due to random chance. For numbers 2 and 3, it is extremely unlikely that the differences observed were due to chance

65 The health data gathered in your investigation was from a voluntary survey. What bias may this have caused? (3pts)

**Volunteer bias**

66. This type of bias has a tendency to \_\_\_\_\_ estimate incidence. (2 pts)

- a. **Over**
- b. under

67. Though the hot tub showed the highest risk, you don't trust the results completely. Why so? (3pts)

- a. Selection bias
- b. Confirmation bias
- c. Congruence bias
- d. Confounding**
- e. Recall bias

68. Explain your reasoning:

**Only teachers were allowed in the hot tub. This introduces a new variable-age**

69. You decide to do something about this and separate those who visited the hot tub above age 55 and above with those under 55

<50 yrs

≥ 50 yrs

	Case	control		Case	control
Entered hot tub	1	5	Entered hot tub	6	18
Did not enter hot tub	0	100	Did not enter hot tub	5	18

70. Now calculate the mantel haenszel test for you risk entry (show work) (4pts)

**1.53**

$$\begin{aligned} 70. & \frac{1(100)}{5 \cdot 100} + \frac{6(18)}{18 \cdot 5} \\ & \frac{0.6}{100} + \frac{5(24)}{47} \\ & = \frac{100}{100} + \frac{120}{47} \\ & = 0 + \frac{120}{47} \\ & = 1.52 \end{aligned}$$

71. What seems to be the cause of the outbreak?

The contaminated fountain in the atrium of the school

72. Provide 3 reasons why you believe so (use Hill's criteria) (6pts)

1. Temporality- students were exposed to the fountain (7/7/17) before developing the disease (7/9)
2. Strength of association: eating in the fountain has the highest relative risk of contracting legionnaires' disease
3. Biological plausibility: legionella is known to be able to grow in uncovered fountains

74. List Hill's criteria (4pts):

- Temporality
- Biologic gradient
- Consistency
- Considerations of alternate hypotheses
- Experimental evidence
- Specificity
- Biological plausibility
- coherence

While you have been investigating the outbreak, the lab tech has fervently been culturing samples that you collected from around the school. Soon he calls you back with results "we've completed our environmental study" he says, I'll fax you the results!

75. When the lab tech was culturing the bacteria, what step of Koch's postulates would he be on? (2pts)

Step 2

76. List Koch's postulates:

1. Isolate a pathogen
2. Culture the pathogen
3. Reintroduce the pathogen to a susceptible host and observe that it causes disease
4. Reisolate the pathogen and find that it is the same

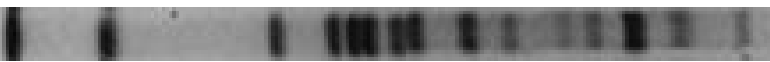
Results from the Lab



Lake strain



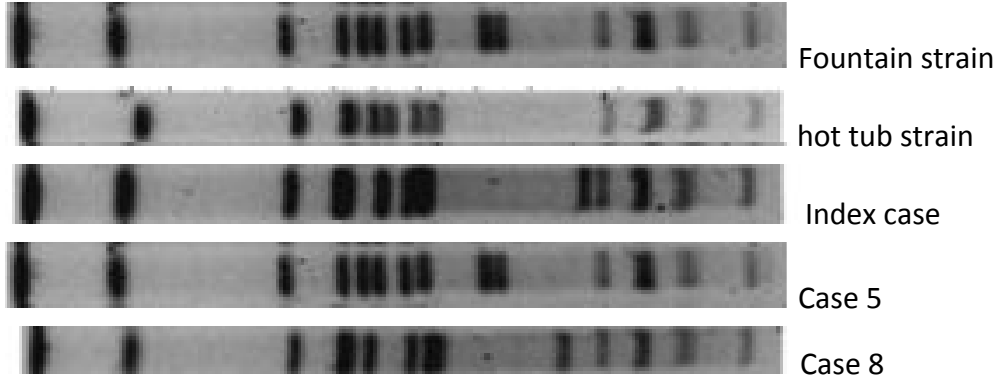
Hospital strain



Sewer strain



river strain



TB3. What is this technique called and what is its purpose? (4pts)

PFGE (Pulsed-Field Gel Electrophoresis). It is used to identify and compare the genetic fingerprints of organisms.

77. Do the lab results support or contradict your investigation? Explain. (3 pts)

Yes- the clinical isolates match the legionella isolate found in the fountain

78. What strain looks like to me the original strain that contaminated the fountain? (2pts)

- a. Lake
- b. Hospital
- c. sewer

79. List up to 5 control methods to deal with the outbreak

1. Chlorinate the fountain
2. Replace the water feature
3. Temperature sterilize the fountain
4. Routinely clean the fountain
5. Have education programs against legionella
6. Regularly inspect water features for dangerous legionella concentrations

Finally the investigation concludes, you smile. Helping save people's lives is so great, you think. It's days like this that you're proud to be an epidemiologist.

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