



Healthcare Epidemiology

Hunter Ratliff, MD, MPH
09/03/2026

I have no conflict of interest in relation to this presentation

These fictionalized composite cases are heavily based on real epidemiological principles, historical outbreaks, and my own clinical experiences, but no actual patient cases, true outbreaks, or other identifying information are presented here. Views & opinions are my own



What do I do?

—



Infectious Disease Physician

The "Patient": One person at a time

The goal: Diagnose & cure

I am the **consultant other doctors call** when a patient has a rare, stubborn, or **complex infection(s)**

Can be anything from mysterious fevers & tropical diseases to severe infections (of the heart, brain, bones, bloodstream)



Healthcare Epidemiologist

The "Patient": Entire hospital (1,000+ patients & staff)

The Goal: Prevent and protect

I use **public health principles** to **stop infections from spreading** within the **healthcare system**

Often these are healthcare-associated infections, but also involves measles, TB, respiratory virus, diarrheal illnesses



And I do a little bit of teaching
(including right now!)



Infectious Disease Physician

Diagnose & treat one patient



Healthcare Epidemiologist

Prevent & protect entire hospital

Myth: I spend my time in a lab

- Most of the time is interviewing and **examining patients at the bedside**
- We have excellent microbiology techs that are far better than me in the lab

Myth: It's a lot of spreadsheets

- There are *some* spreadsheets, but *that's the easy part*
- The fun (and hard) part is translating the data & **evidence into policy** → changing behavior

Fact: Most of both jobs are lots of talking to people, synthesizing data, & **making shared decisions** based off my findings

Asking strangers **fun questions**:

- Sex, drugs, & rock & roll
- Pets, outdoor activities
- Travel, hobbies/work
- Cut down any trees recently?



How long should we use the antibiotics? (for **super-bugs**)

Am I worried about TB enough to keep a **patient in isolation**?

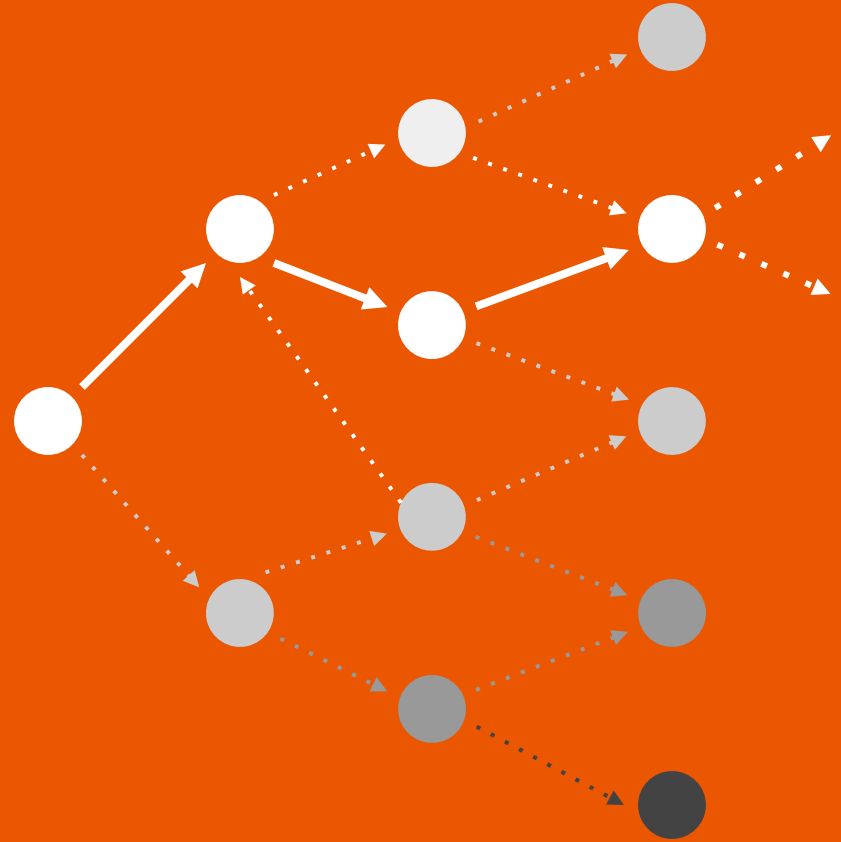


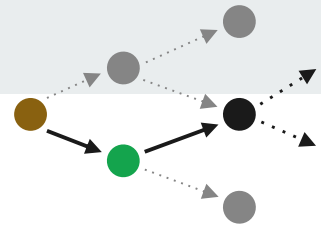
How do we **safely do construction** on the **transplant unit** without exposing patients? Or do we need to shut it down?



How I got here

Spoiler alert:
Luck chance
was involved





My path here: Undergrad



Somehow selected **biochemistry** as my major, of which I recall very little of now, unlike...

Minor #1: Started as **computer science**

(this was a decade before ChatGPT)

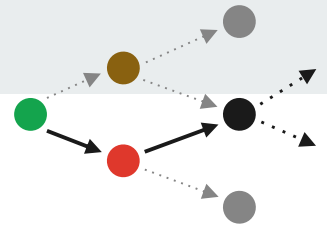
- Really liked the **data science** aspect
- Dropped this minor to focus on **social sciences**

Minor #2: **Psychology** → **sociology**

- **Sociology Of Health** introduced me to the "**public health lens**"

Applied to medical school

- Wanted to do **psychiatry**
- Backup plan was grad school (MPH or biostatistics)



My path here: Med school / MPH

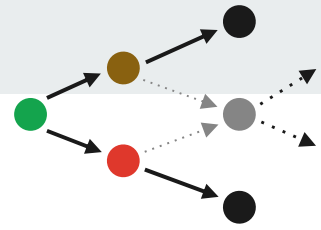
Initially wanted to do **psychiatry**
Microbiology was one of my *least*
favorite portions of med school

Fell in love with the **clinical aspect**
of **infectious diseases**
Very similar detective work to
public health

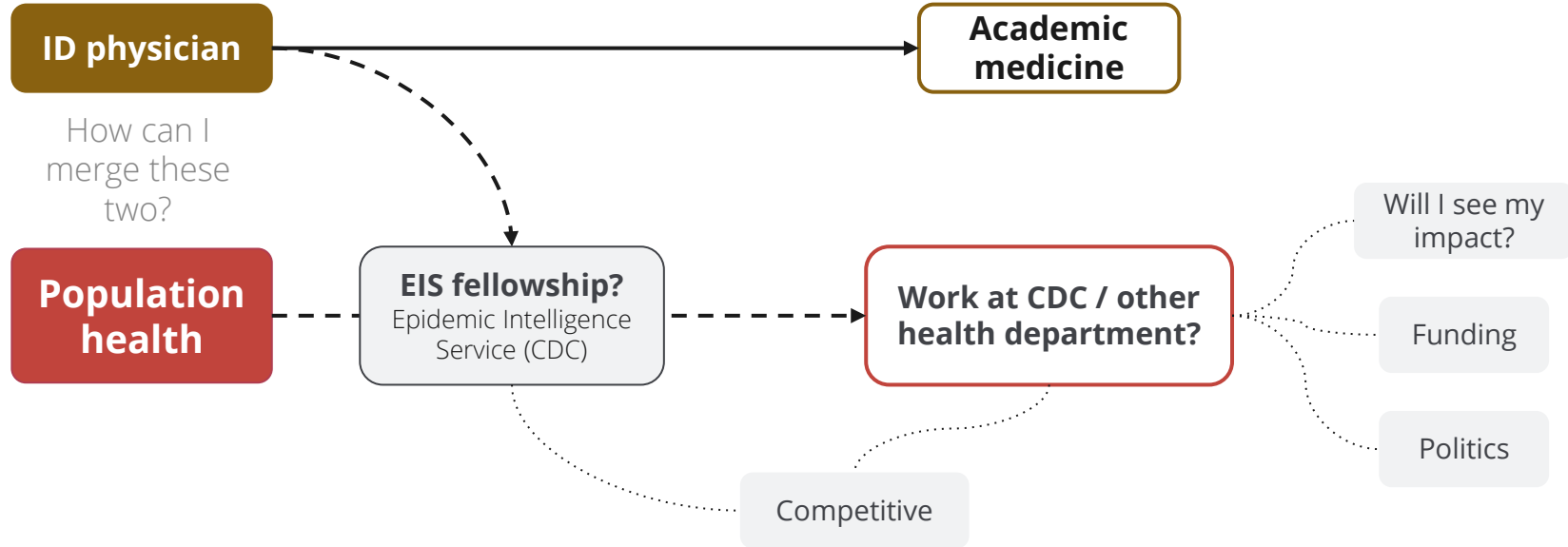
-- AND --

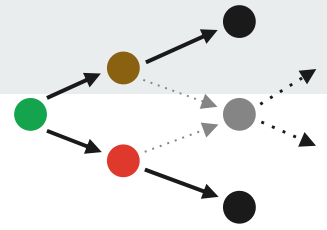
Had enough interest in **public health**
sphere to do a **MPH** too
But: I wanted to do chronic disease
&/or **addiction epidemiology**

Started my **MPH**...
...in the **Fall of** (COVID-)19...

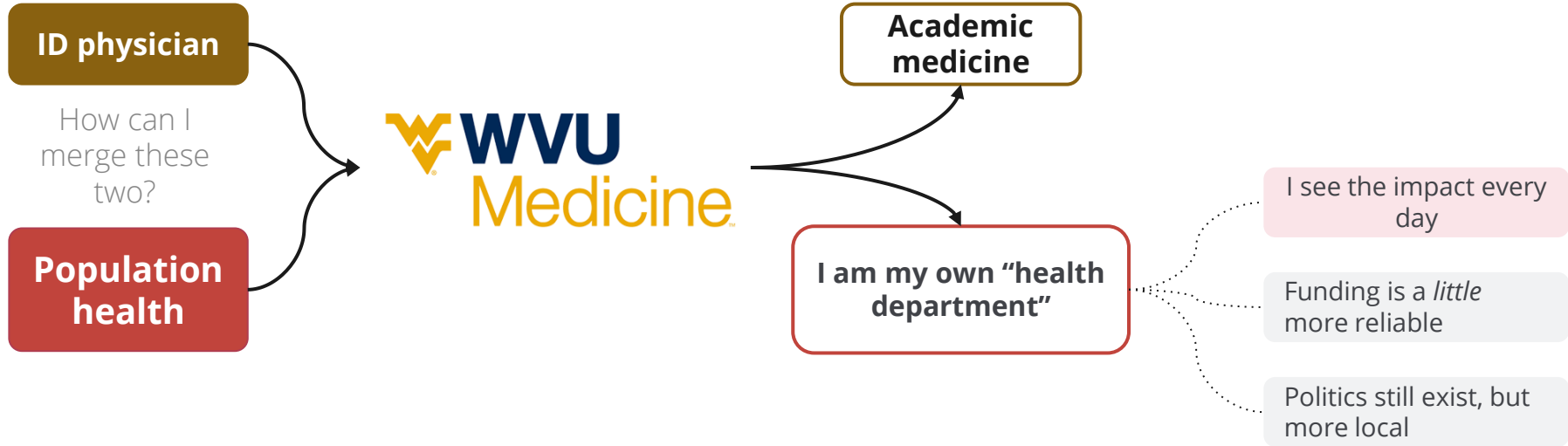


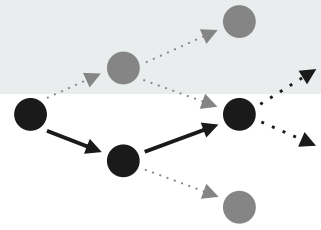
My path here: After school





My path here: After school





My path here: The role of luck

Admissions Lottery

Acceptance to medical school involves a large degree of chance

There are other paths besides being a physician

An admissions decision is *not a measure of your worth*

Plan B

My path is the most technically difficult.
Consider NP, PA, MHA, MBA, PhD etc

Right **Mentors**

If my wife didn't have to re-apply to residency, I wouldn't have ended up here

I did not know healthcare epidemiology was a thing until I came here

MD Safety Net

Being a **healthcare provider** provides **immense job security** (especially MD/DO)

Public health is highly rewarding, but notoriously underfunded

If doing a standalone MPH

Pair a *MPH with something else* (nursing, data science, administration) gives **job security** and makes you a *far better candidate*

Systemic Privilege

Per Executive Order No. 3-25, you'll have to take some **sociology classes** to see what I mean 😊

See: "Social Determinants of Health"

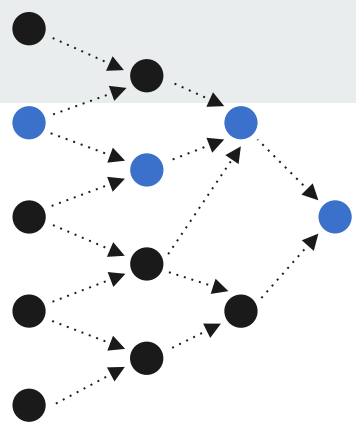
My path here: The role of luck

Born as a human (hard to get a job if not human)

- After discovery of antibiotics
- Sanitation, vaccines
- Democracy
- Economically developed country
 - Good taxpayer funded K-12

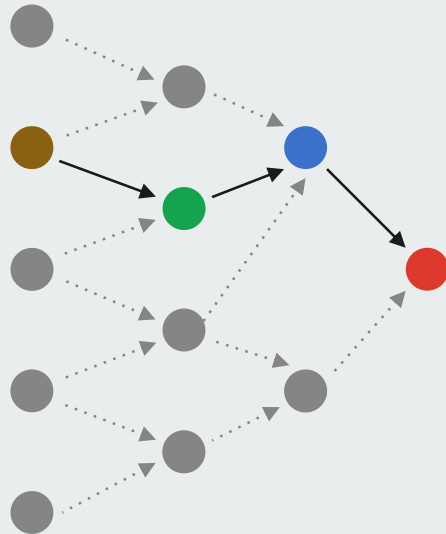


Past performance is no guarantee of future societal progress. Institutions, infrastructure, and public goods subject to change (if we all don't put in the effort)





How can you get here?



There are **multiple paths**

- MD+MPH paired with infectious diseases was my path
- But I had no idea *that* would be *my* path

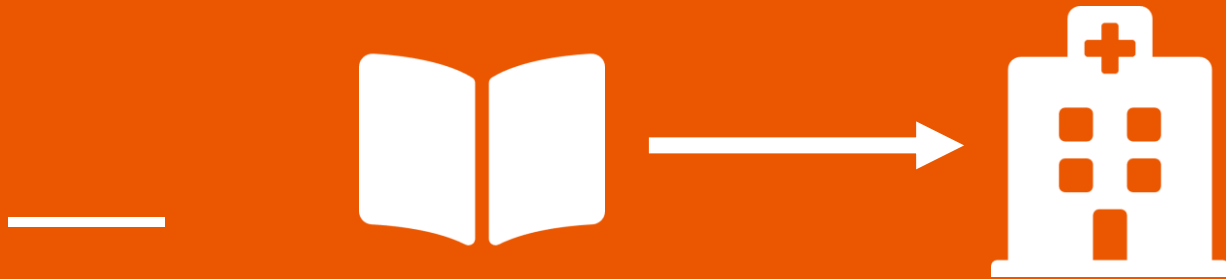
MPH is *probably* a good idea

- Pair it with something else (does not have to be MD)
- Be strategic, but open minded (would have not guessed I would love ID as much as I do)

Learn about the field & develop mentors!

- The **Society for Healthcare Epidemiology of America** (SHEA) is a great resource for healthcare epidemiology

Practical Disease Transmission





Case #1

Case 1: The scenario

A **5-year-old unvaccinated child** returns from international travel and develops a **fever**, **cough**, **red eyes**, and a **rash**

The parents take them to your hospital's packed **pediatric urgent care**. The child sits in the **waiting room** for **45 minutes**, is seen in **Exam Room 3**, and gets discharged home

The next day, the **state health department** calls you: the child's swab came back positive for **measles**

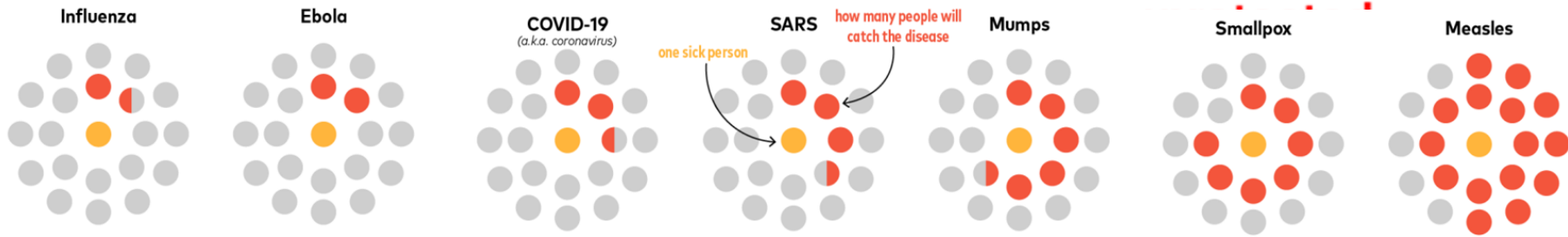
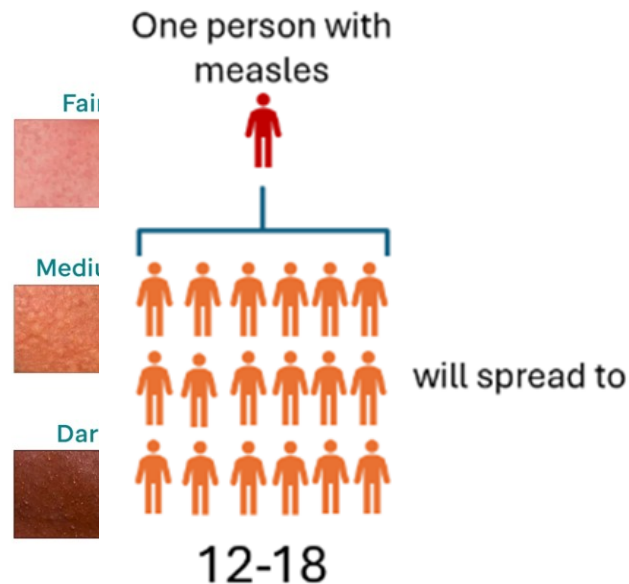


Case 1: The virus

Measles is one of the **most contagious diseases** that infects humans (R_0 around **15**)

R_0 naught (R_0) is the average number of people who will catch a disease from **one single infected person** (in a totally non-immune group)

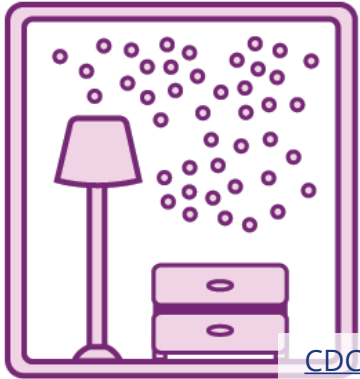
- $R_0 < 1$ → Disease slowly fades away
- $R_0 = 1$ → Stays stable (influenza is 1-2)
- $R_0 > 1$ → Can become widespread → epidemic





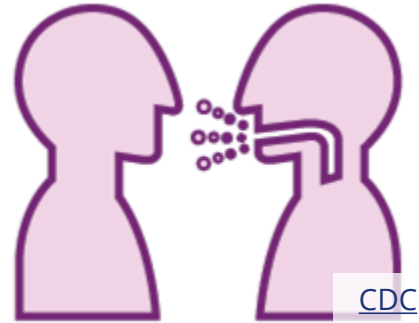
Case 1: Transmission in the air

Measles is spread via **coughing and sneezing**



Measles is unique in that the virus can **survive in the air** for up to **two hours**

- Referred to as “**airborne**” **transmission** (also the case for tuberculosis [TB] and varicella [chickenpox/shingles])



Case 1: Transmission in the air

Measles is spread via **coughing and sneezing**



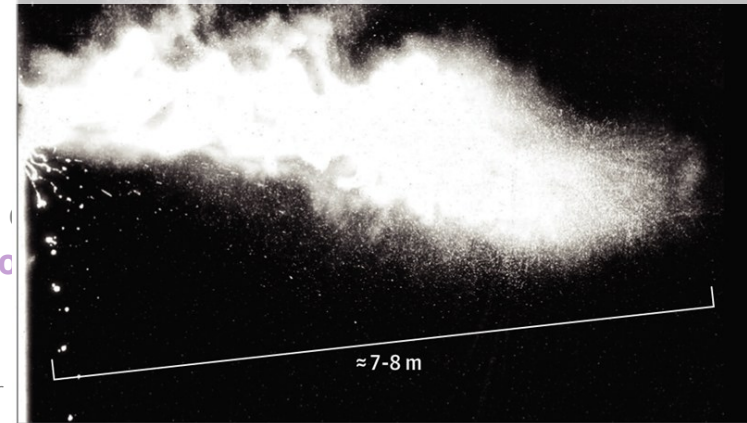
Measles is unique in that the virus can **survive in the air** for up to **two hours**

- Referred to as **"airborne" transmission** (also the case for tuberculosis [TB] and varicella [chickenpox/shingles])
- Compared with **"droplet"** (for most other respiratory infections)

Droplet ("cannonballs")
Large respiratory drops ($>5\text{ }\mu\text{m}$)
Heavier → fall to the floor w/in 6 ft

Airborne ("floaters")
Tiny droplet nuclei (less than $5\text{ }\mu\text{m}$)
Evaporate → stay in the air

Turbulent Gas Cloud From a Human Sneeze
([Bourouiba, 2020](#))



Airborne



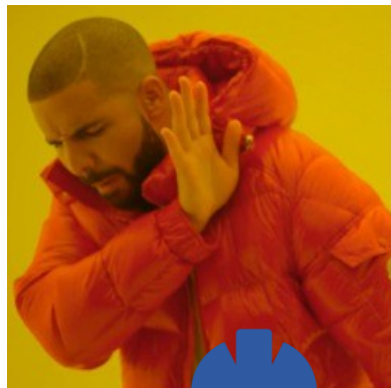
Droplet

VS





Case 1: Speaking of ventilation

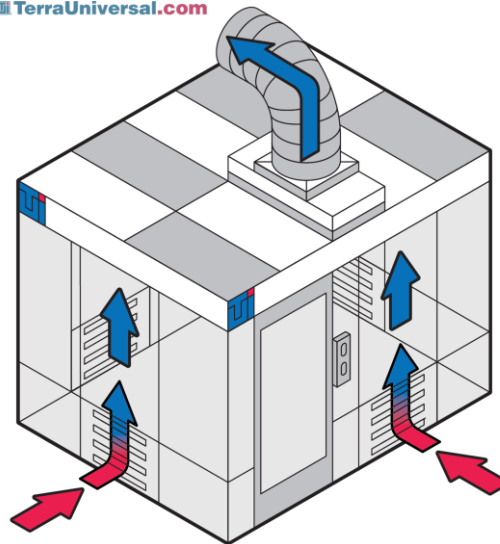


Positive
pressure



Negative
pressure

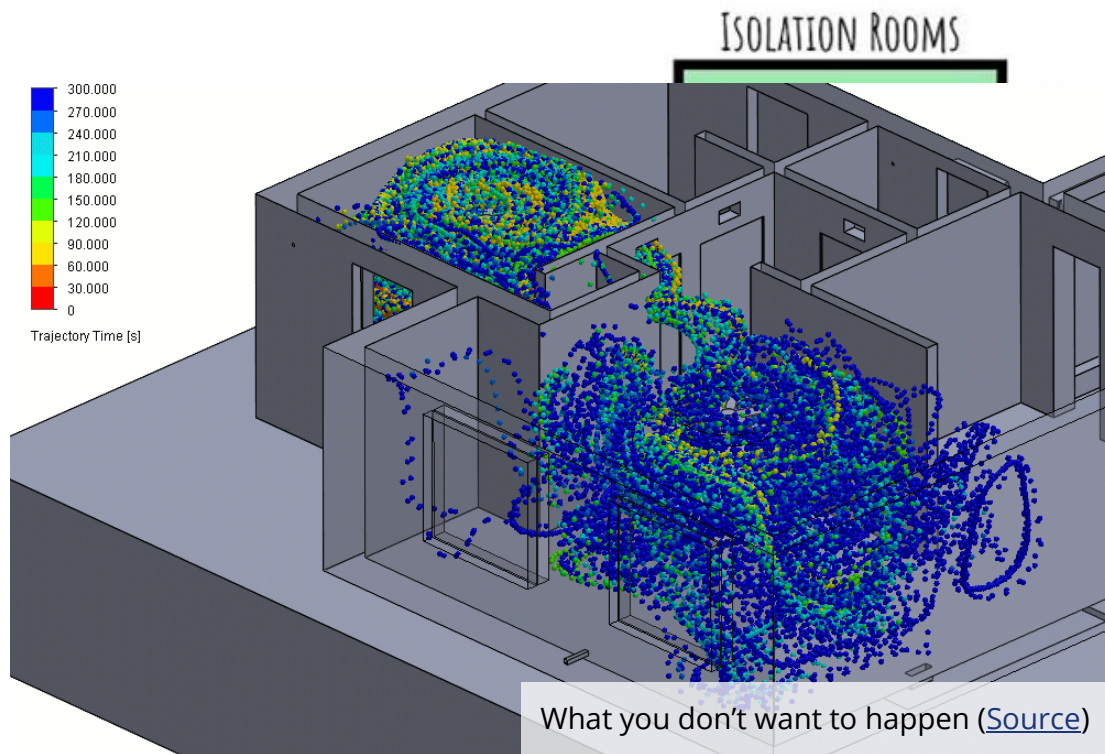
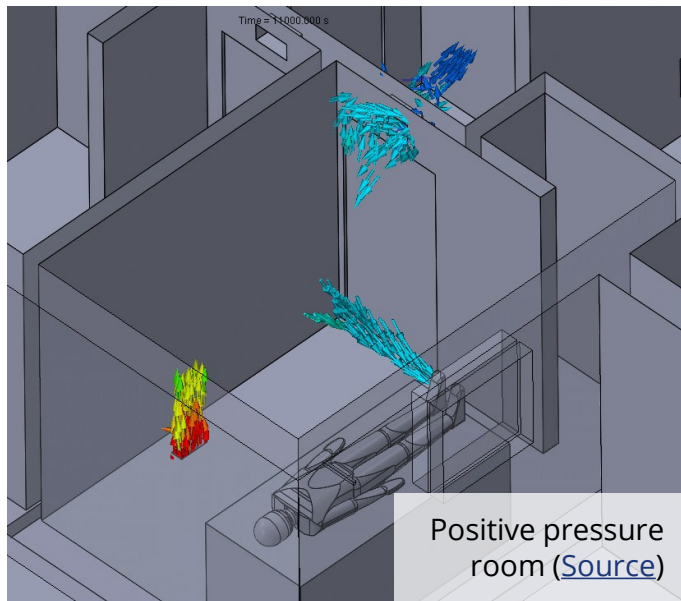
TerraUniversal.com



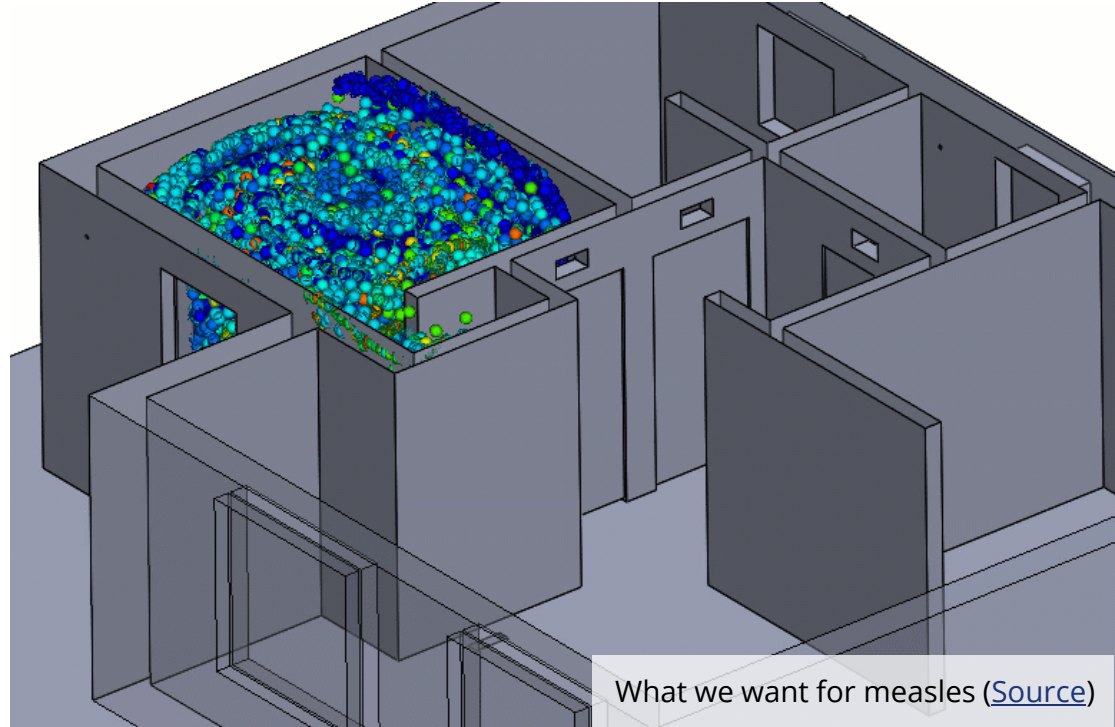
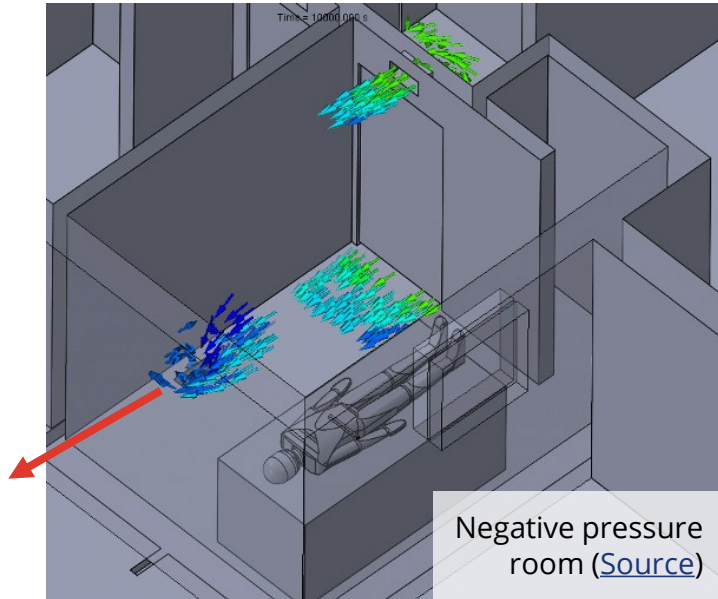
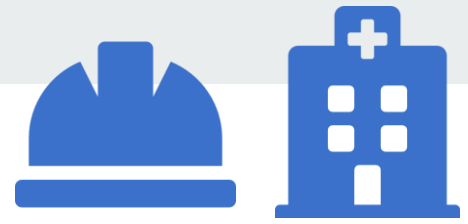
Negative pressure rooms prevent air from escaping into the hallway ([Source](#))



Case 1: **Positive** pressure room (**bad** for measles)



Case 1: Negative pressure room (good)

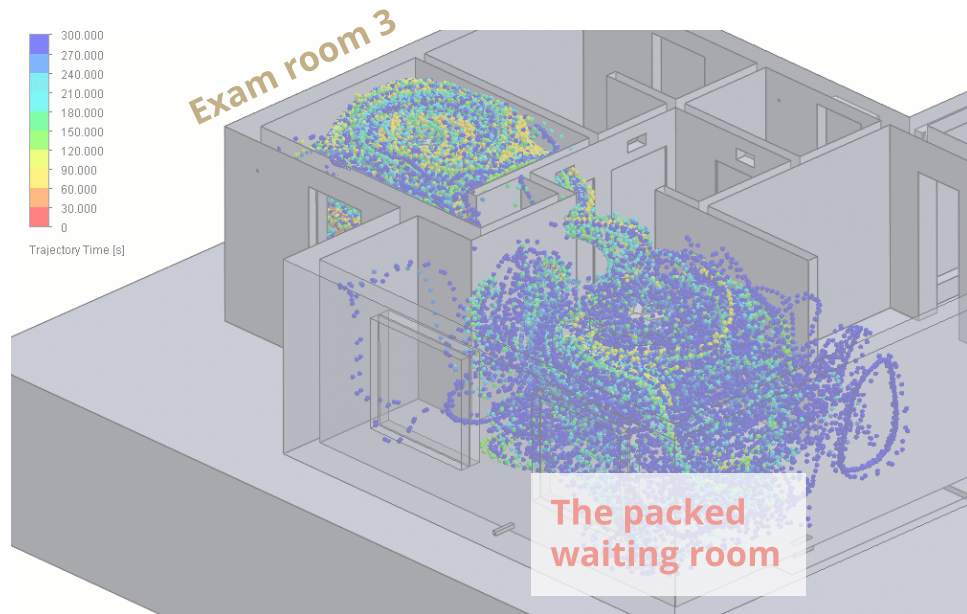


Case 1: Back to the case

I now **need to identify every single** patient, visitor, and staff member who:

- Shared the **waiting room** with them*
- Were in the **exam room** after them*
- **Cared for** the child
- **Cleaned** the exam room*
- Checked them in

(*) Since measles hangs out in the air for 2 hours, this could extend to the **2 hours after they left** (if we didn't cycle the air)



The child sits in the **waiting room** for **45 minutes**, is seen in **Exam Room 3**, and gets discharged home

Case 1: Back to the case

I now **need to identify every single** patient, visitor, and staff member who:

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- **Cared for** the child
- **Cleaned** the exam room*
- Checked them in

Contact tracing: The process of **identifying and notifying people** who may have been exposed to an infectious disease

For measles, you have 72 hours to get them post-exposure prophylaxis

Fortunately, the **electronic medical record (EMR)** is **incredibly helpful** here

Not real patient data

Not real patient data
This is simulated data, but it looks the same in real life (except the number of exposures would be much higher)

Event Details

08/22/26 0000

0000

0000

Refresh Views Settings Export Trace Patient Trace Caregiver Open Chart Help

From: 8/22/2026 To: 8/29/2026 Minimum patient exposure in hours: Outpatient exposure window in hours: Run

Accumulate exposures within (days):

Patient Exposures (244) Caregiver Exposures (3) Transport/EVS Exposures (0) Additional Details Select All

Trace Selected Caregiver

Caregiver Name	Primary Phone	Treatment Team Relation	Login Departments During Exposure	Contact Source
Urgent, Jim, MD		Attending Provider		Treatment Team

1315 ED Tracking End (EMERGENCY MED-RUBY)

Measles: What I spend most of my time on

- **Outbreak investigations**, especially with measles, are fortunately pretty **rare**
- More of my time is spent **planning for these situations** and **developing / evaluating our policies**



Healthcare Epidemiologist

Use **public health principles** to **prevent** and stop **infections from spreading** within the hospital

Case #2

Case 2: The scenario

You receive a call from your transplant infectious disease colleague who says over the **past three weeks**, she's noticed **two cases** of **bone marrow transplant** patients who have developed a **rare mold infection** (*Aspergillus*) in their **lungs**

You know that *Aspergillus*

Is *everywhere* in the environment

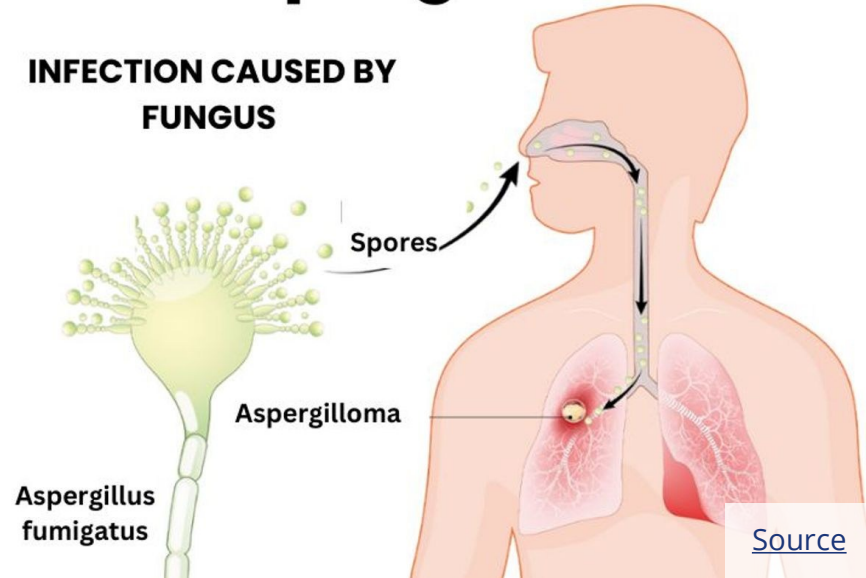
- Lives in soil and rotting leaves
- Spread by spores

Should not be inside a sterile transplant unit

Mainly infects people without immune systems (cancer, transplant, HIV off of meds)

Aspergillosis

INFECTION CAUSED BY
FUNGUS



[Source](#)

Is this a breakout?



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Case 2: Is this an outbreak?

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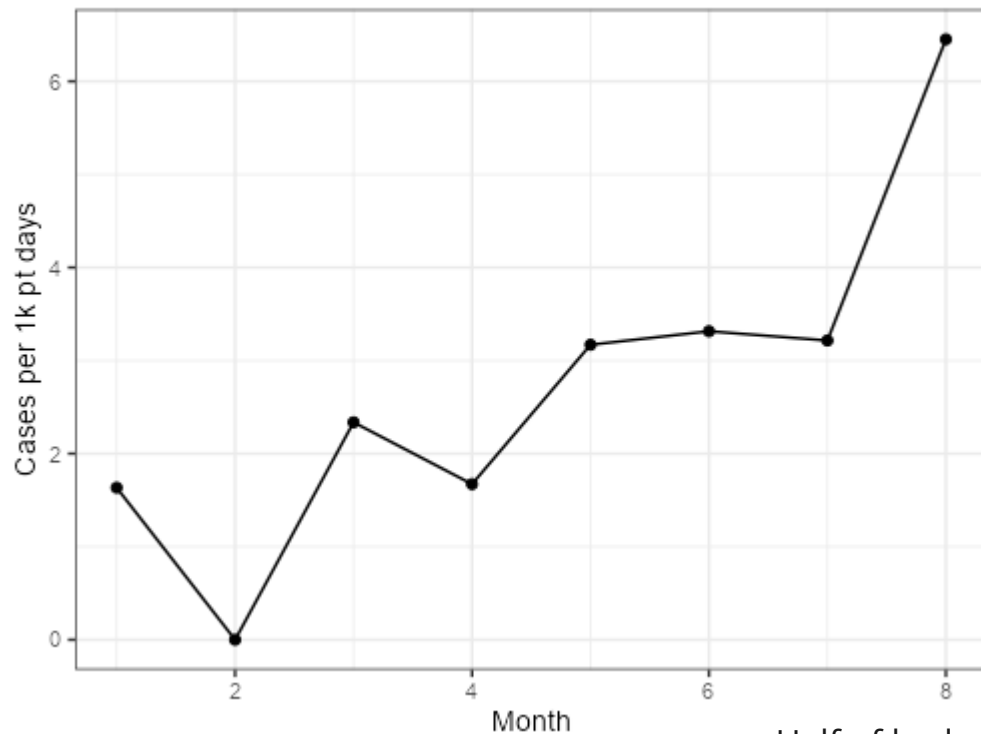
Should not be inside a sterile transplant unit

Mainly infects people without immune systems (cancer, transplant, HIV off of meds)

Month	Cases
January	1
February	0
March	1
April	1
May	2
June	3
July	3
August	2

Case 2: Is this an outbreak?

Rate of Aspergillus cases, per 1000 patient days

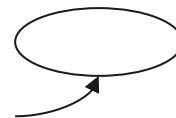


Seasonal trends: It's common for mold cases to spike in the humid summer months (outside of the hospital)

Construction: hospital walls and ceilings are **full of dust** → when you move that dust, it becomes airborne

Month	Cases
January	1
February	0
March	1
April	1
May	2
June	3
July	3
August	2

Half of beds **closed for renovations**



Case 2: The epi investigation

Since you know **construction** is going on near the unit, I'd skip the crunching the numbers. Instead, you grab the **infection preventionist** who is in **charge of construction**, take the elevator up from your office, and **physically walk around the hospital**

What are we looking for?

The barrier: Is the construction zone sealed?

The airflow: Which way is the wind blowing?

- ✓ Is the plastic barrier intact?
- ✓ Is the zipper all the way zipped?
- ✓ Are ceiling tiles fully in place?
- ✓ Is the workspace negative pressure?



(Source)



Case 2: The epi investigation

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What are we looking for?

The barrier: Is the construction zone sealed?

The airflow: Which way is the wind blowing?

The humans: How are workers and trash moving?

- ✗ Workers **prop door wide open** (to make it easier to haul materials)
- ✗ **No sticky mat** for cleaning dust off boots
- ✗ Transporting **materials uncovered** in patient facing spaces (hallway)





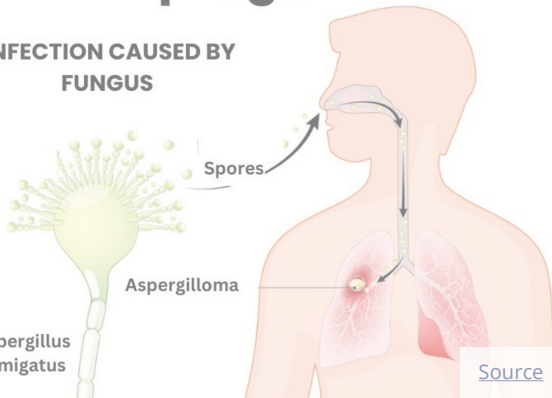
Case 2: Transmission isn't always textbook

Even if mold infections (like *Aspergillus*) are “transmitted” through **inhalation**, preventing infections (in healthcare and beyond) often comes down to **human factors** (often *far removed from the actual patient*)

Much of my job is **talking to people**, synthesizing data, & making shared decisions based off my findings (**including construction signs in Spanish**)

Aspergillosis

INFECTION CAUSED BY
FUNGUS



[Source](#)



AI generated
Nano Banana Pro / Gemini 3

Case #3

Case 3: The scenerio

On a Friday evening, you get an email from the hospital CEO

- She has been looking at the quarterly safety dashboard
- Hospital-wide **C. diff rates are in the red** (higher than expected)



Case 3: The scenerio

On a Friday evening, you get an email from the hospital CEO

- She has been looking at the quarterly safety dashboard
- Hospital-wide **C. diff rates are in the red** (higher than expected)

The bacteria

Clostridioides difficile (**C diff**) causes severe, sometimes fatal diarrhea

The Reservoir

(Asymptomatic Carriers)

Many people have C. diff in their guts right now doing zero harm

It only becomes a problem when antibiotics wipe out the "good" gut flora, allowing **C. diff to overgrow**

The spores

C. diff poops out spores. These spores are not killed by hand sanitizer or routine disinfectants

Only way to kill it is **bleach**, or **washing hands** with soap & water (goes down the drain)

Prevention

Wear **gown & gloves**

Wash hands with soap & water

Avoid antibiotics (when able)

Case 3: What are HAIs?

On a Friday evening, you get an email from the hospital CEO

- She has been looking at the quarterly safety dashboard
- Hospital-wide **C. diff rates are in the red** (higher than



I am my own "health department"

I see the impact every day

Funding is a *little* more reliable

Politics still exist, but more local

The cost of HAIs

- The government incentivizes hospitals to **prevent healthcare associated infections** (HAIs)
- High rates of HAIs (like C diff) can cost a hospital tons of money
 - Nobody likes to talk about money in healthcare
 - But these can result in funding cuts to important programs

Where do I start?



Mentimeter

- A. Walk blindly around the hospital?
- B. Blame the doctors?
- C. Ignore it and hope it goes away?
- D. Look at the data?

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Case 3: I can't be everywhere at once

unit	Had C diff	No C diff
Maternity	2	650
ICU	10	800
4-West	21	600

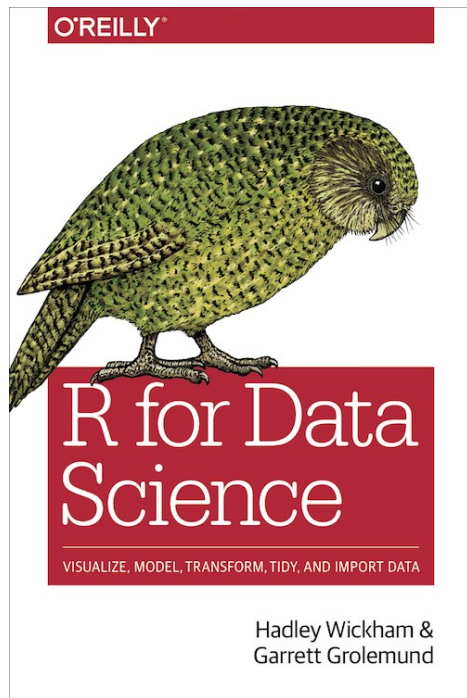
	Disease (Case)	No Disease (Control)
Exposed	A	B
Unexposed	C	D

Odds that a case
was exposed (A/C)

$$\text{OR} = \frac{\text{Odds that a case was exposed (A/C)}}{\text{Odds that a control was exposed (B/D)}}$$

Odds that a control
was exposed (B/D)

```
glm(c_diff_logical ~ is_unit, data = df, family = "binomial") %>%  
  broom::tidy(exponentiate = T, conf.int=T) |
```



Case 3: What's wrong with 4-West?

Besides not being a real unit in my hospital

On review of the cases in the past 3 months:

- Does not look like they occurred on similar dates
- No clear shared risk factors (e.g. coming from the same skilled nursing facility before admission)

But the manager for 4-West does point out...

	odds_ratio	95% CI
Maternity	0.206	0.034–0.661 (p=0.03)
ICU	0.931	0.444–1.76 (p=0.838)
4-West	3.5	2.02–5.91 (p<0.001)

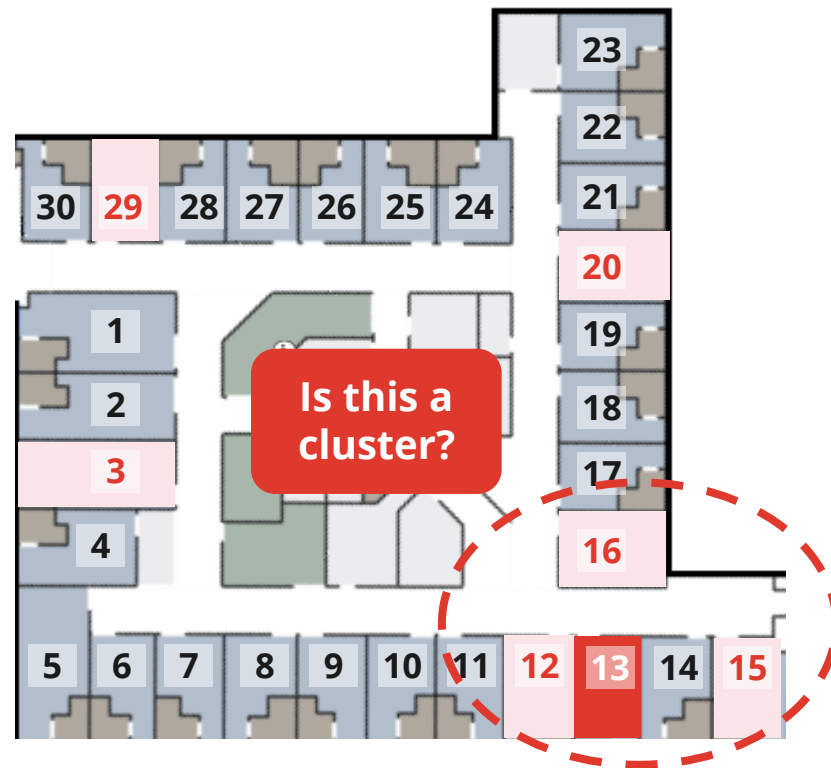


Case 3: What's wrong with 4-West?

Cases over the past month:

Location	C diff cases
Bed 3	1
Bed 12	1
Bed 13	2
Bed 15	1
Bed 16	1
Bed 20	1
Bed 29	1

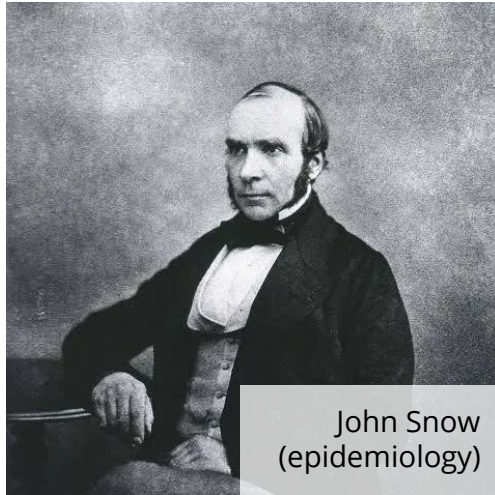
Fun fact: We actually don't have a "room 13"



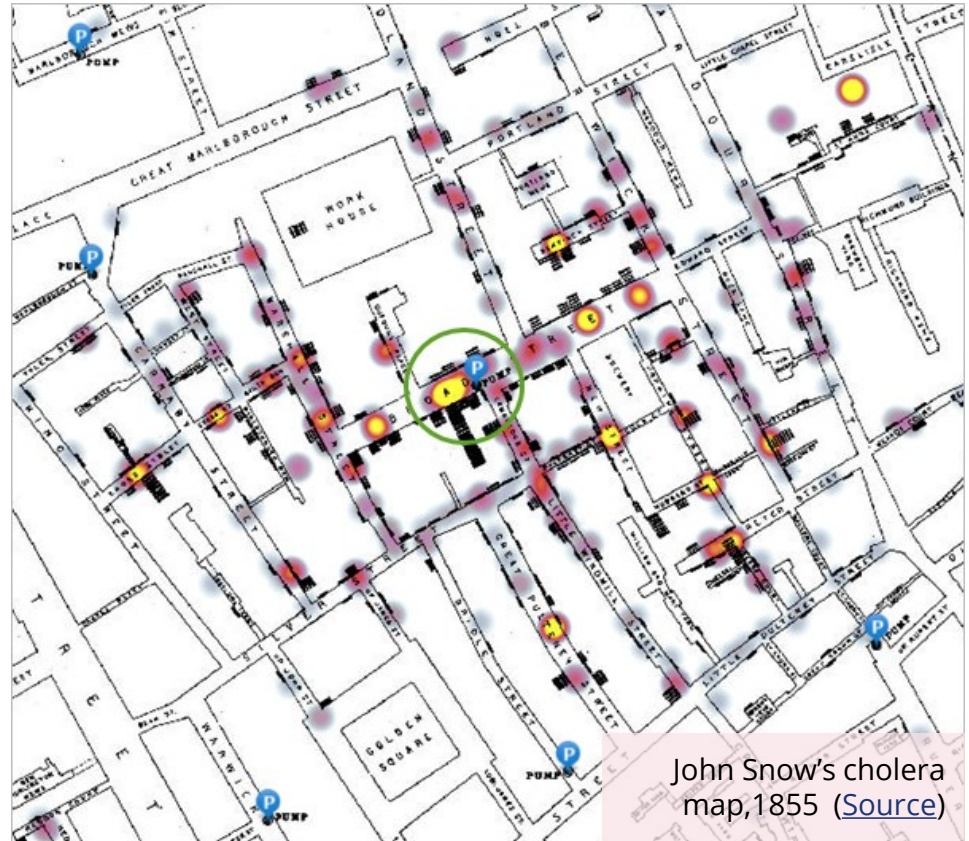
Case 3: John Snow



John Snow
(Game of Thrones)



John Snow
(epidemiology)



John Snow's cholera
map, 1855 ([Source](#))

Case 3: Doing some observations

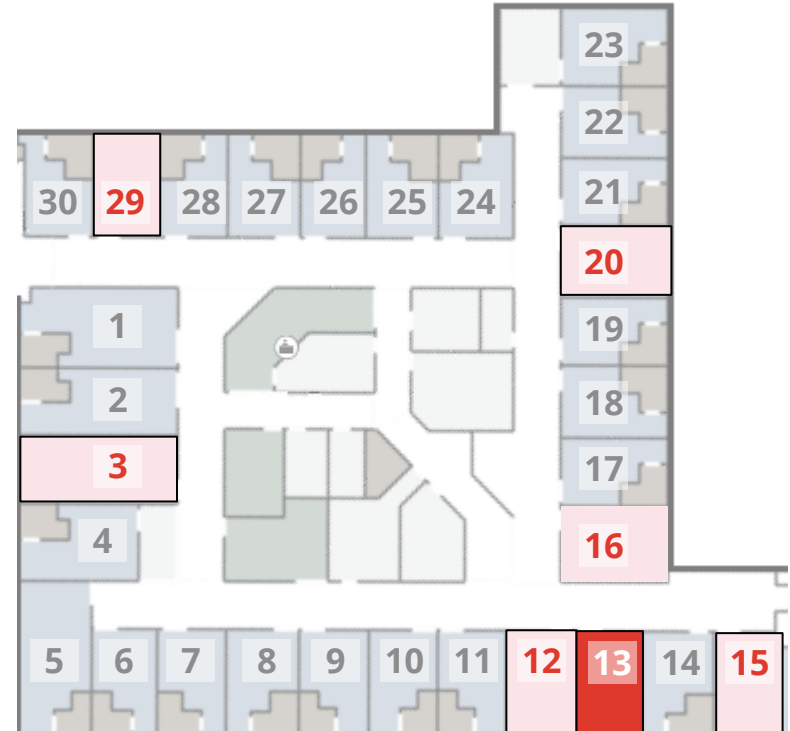
Shared medical equipment?

- Are there things going from room-to-room?
(stethoscopes, heart monitors, glucose machines)
- How are they cleaned? **Bleach** vs alcohol wipes

The spores

These spores are not killed by routine disinfectants (alcohol wipes)

Only way to kill it is **bleach**



Case 3: Doing some observations

Shared medical equipment?

Personal protective equipment?

- Are there gowns & gloves?
- Are people actually using them?

The spores

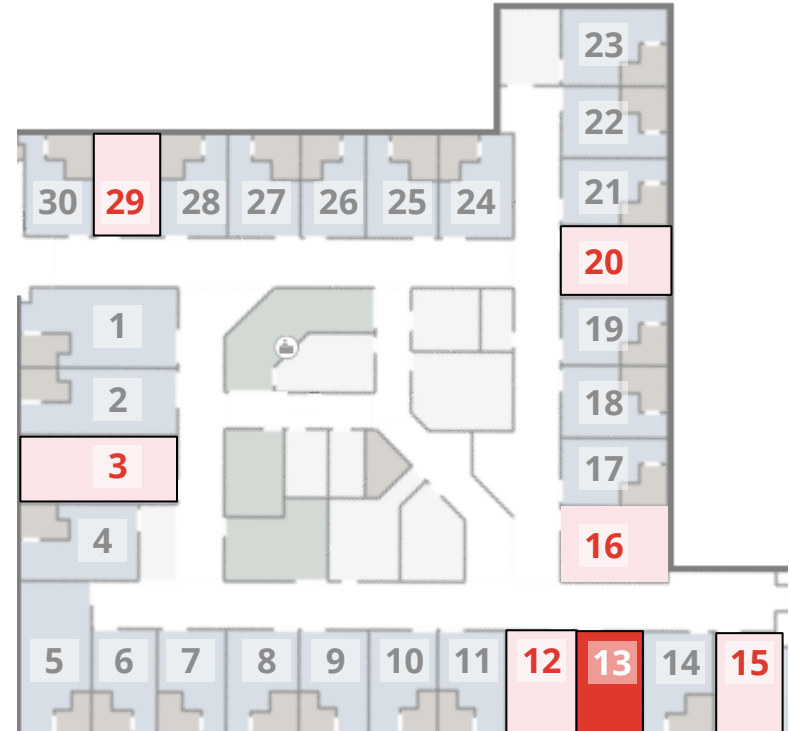
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Only way to kill it is **bleach**

Transmission

Wear **gown & gloves**

Wash hands with soap & water



Case 3: Doing some observations

Shared medical equipment?

Personal protective equipment?

Wash your hands!!! (you work in a hospital)

- How often do staff fully wash their hands?
- **Where are the sinks** located?

The spores

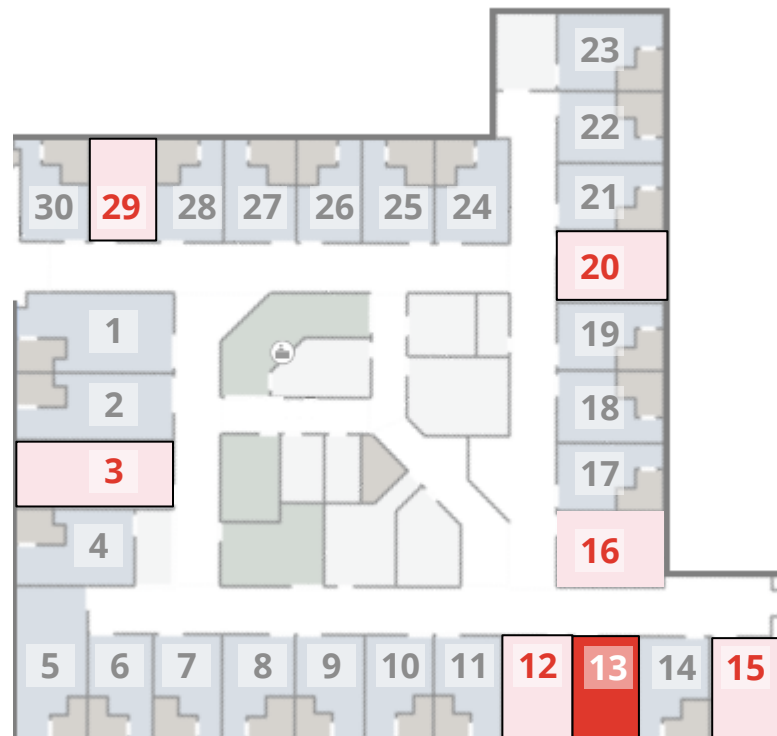
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Wear **gown & gloves**

Wash hands with soap & water

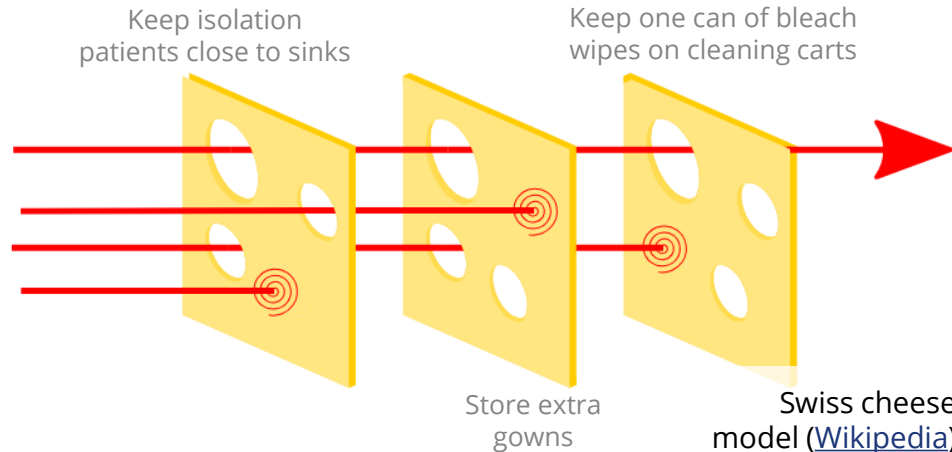




Case 3: Human factors & safety culture

Swiss cheese model

- Complex human systems (slices) will have failures (holes)
- We *stack them* to **prevent** the holes from **lining up**



Human factors engineering

Designing a system that **accounts for** human psychology and fatigue

If a nurse has to walk to the other side of the unit to find a gown, it's the system that is failing the patient

Case 3: Teamwork



Individual healthcare workers can do their part, but **it takes a village** to prevent the spread of infections in healthcare

Nursing leadership

Prioritizing the rooms that are **close to the sink** for C diff patients is far easier than building new sinks

Environmental services (EVS)

Keep the patient rooms and **shared, high touch surfaces** (e.g. computers) clean

These folks probably do more to prevent infections than I ever could

Facilities & architecture

Designing hospitals with infection prevention in mind

Government

Regulatory agencies to keep the **incentives aligned**

Healthcare economics might also be a good course to take

Learning points & take aways

Healthcare Epidemiology



What **my friends** think I do



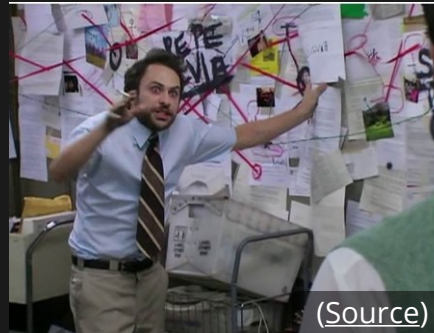
What **society** thinks I do



What **other doctors** think I do



What **administrators** think I do

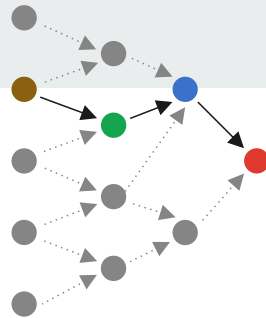


What **I** think I do



What I **actually** do

Questions?



- **Human behavior is “a vector” too:** The core of transmission is still what the textbook says (droplet, bloodborne, fomite, sexual), but human behavior twists these definitions in unique ways
- **Internalize the fundamentals:** The real world is messy, but you can *begin* to decipher it with the principles of basic public health (and don't forget the denominator)
- **Data can identify the problem, but cannot solve it:** I got into this because of the data, but my passion comes from the “boots-on-the-ground” and multidisciplinary aspect (but the data is still really fun)
- **Embrace the non-linear path:** You don't have to have it all figured out (I sure don't). Talk to mentors, pair your degree strategically, and be open minded (and don't let setbacks derail your public health impact)

Slides available on hunteratliff1.com/talk/

Use of AI

Claude 5, Gemini 3.1 Pro - Case design, text generation
Nano Banana 2 & Pro - Image generation
Google Slides - Visual design