Emerging Infections, Outbreak Investigations, and the Role of Public Health

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Fall 2022

Objectives

- Describe legal framework for disease surveillance, investigation, and response
- Review outbreak surveillance data and trends over time
- Discuss emerging infections & specific healthcare-associated pathogens
- Discuss role of Public Health in infection prevention and outbreak response
- Describe the 10 steps of an outbreak investigation

Legal Framework

Public Health: Legal Framework

- Public Health Laws and Rules:
  - General Statutes
  - NC Administrative Code rules
- Health Director's Authority (State & Local)
  - Surveillance
  - Investigation
  - Control Measures

Public Health Law

General Statutes §130A-144: Investigation and Control Measures

(a) The **local health director shall investigate**… cases of communicable diseases and communicable conditions reported to the local health director

(b) Physicians, persons in charge of medical facilities or laboratories, and other persons shall… **permit a local health director or the State Health Director to examine, review, and obtain a copy of medical or other records…**

(d) The **attending physician shall give control measures**… to a patient with a communicable disease or communicable condition and to patients reasonably suspected of being infected or exposed to such a disease or condition.

(e) The **local health director shall ensure that control measures**… have been given to **prevent the spread** of all **reportable communicable diseases** or **communicable conditions** and **any other communicable disease or communicable condition that represents a significant threat to the public health.**

(f) All **persons shall comply with control measures**, including submission to examinations and tests…

Public Health Law

10A NCAC 41A .0103: Duties of local health director: report communicable diseases

(a) Upon receipt of a report of a communicable disease or condition… the **local health director** shall:

(1) immediately **investigate** the circumstances… [to] include the collection and submission for laboratory examination of specimens necessary to assist in the diagnosis and indicate the duration of control measures;

(2) determine what **control measures** have been given and ensure that proper control measures… have been given and are being complied with;

(c) Whenever an **outbreak of a disease or condition** occurs which is not required to be reported… but **which represents a significant threat to the public health**, the local health director shall give appropriate control measures… and **inform the Division of Public Health**

Public Health Law

10A NCAC 41A .0101: Reportable diseases and conditions

- **80+ reportable diseases and conditions**
  - Timeline of reporting varies between immediately and within 7 days
- **Laboratory** reporting requirements

Public Health Law

- **10A NCAC 41A .0106**
  - Infection Prevention – Reporting of Healthcare Associated Infections
- **10A NCAC 41A .0206**
  - Infection Prevention – Health Care Settings, 1992
- **10A NCAC 41A .0201**
  - General Control Measures
- **10A NCAC 41A .0202 - .0205**
  - Control Measures for HIV, Hepatitis B, STDs, TB

Role of Public Health

SHARPPS *Surveillance for Healthcare Associated & Resistant Pathogens Patient Safety Program*

Mission

To work in partnerships to prevent, detect, and respond to events and outbreaks of healthcare-associated and antimicrobial-resistant infections in North Carolina.

SHARPPS *Surveillance for Healthcare Associated & Resistant Pathogens Patient Safety Program*

Surveillance, Investigation & Response	Prevention, Education & Training	Monitoring & Evaluation	Communication
HAI reporting to NHSN	Antimicrobial resistance & stewardship	Data validation	HAI data reports
MDRO surveillance	Infection Control, Assessment & Response (ICAR)	Data analysis	Newsletters
DHSR infection prevention breach reporting	Drug diversion	Identification, evaluation of aberrant data	Webinar updates
Outbreak & exposure management	Partnerships		Tabletops

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When Should Public Health Be Called?

- HAI reporting questions (i.e., NHSN)
- Reportable diseases / conditions (10A NCAC 41A .0101)
  - https://epi.dph.ncdhhs.gov/cd/report.html (Form 2124)
- When **any** disease is above normal baseline (i.e., an "outbreak")
- Report suspected infection prevention breach

What Happens When Public Health is Called?

- Data Review
- Clinical Investigation
- Environmental Investigation
- Control Measures
- Communication (Patients/Staff/Families/Public)
- Laboratory Support

Outbreak Assistance

We can assist with:

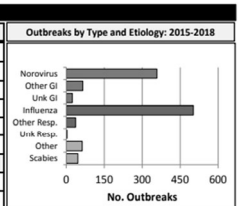
- Determining if it is an outbreak
- Guidance, tools, and onsite support
- Facilitating and coordinating calls with partners
- Written recommendations

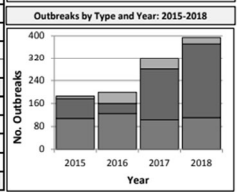
Outbreak Summary

2015-2018 Outbreak Summary

TYPE AND ETIOLOGY

Type	Etiology	2015	2016	2017	2018	Total	%
Gastrointestinal (GI) Causes							
41%	Norovirus	78	95	88	97	358	80%
	Salmonella	4	2	4	5	15	3%
	Shigella	11	11	4	1	27	6%
	Other GI	11	3	3	6	23	5%
	Unknown	4	14	4	2	24	5%
	Total	**108**	**125**	**103**	**111**	**447**	
Respiratory Causes							
49%	Influenza	66	25	165	246	502	93%
	Pertussis	1	2	8	7	18	3%
	Legionella	0	2	3	0	5	1%
	Other Respiratory	2	3	2	7	14	3%
	Unknown	0	3	0	0	3	1%
	Total	**69**	**35**	**178**	**260**	**542**	
Other Causes							
10%	Other	6	19	22	16	63	58%
	Scabies	2	20	17	7	46	42%
	Total	**8**	**39**	**39**	**23**	**109**	
Total Outbreaks		**185**	**199**	**320**	**394**	**1098**	





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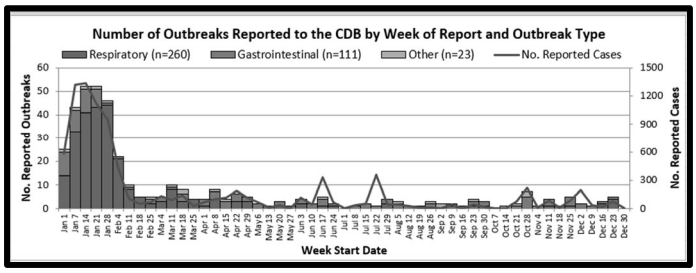

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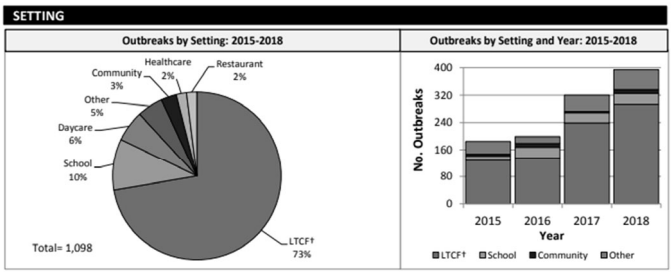
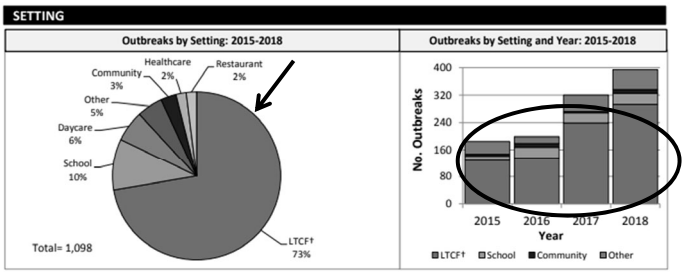


†Long-term care facility (LTCF) includes nursing homes, adult care homes, and assisted living facilities

NC Communicable Disease Branch - http://epi.publichealth.nc.gov/cd

2015-2018 Outbreak Summary



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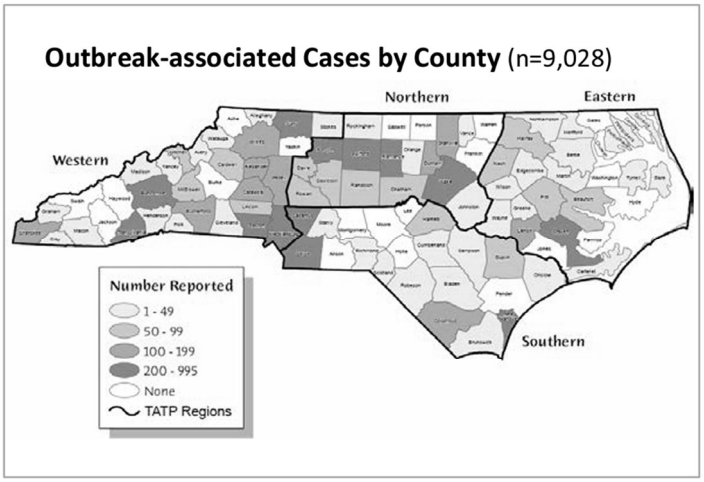


*2018 data

2019-2021 Outbreak Summary

2019:

- 347 outbreaks reported
  - 9,028 outbreak-associated cases identified

2020 (excluding COVID):

- 214 outbreaks reported
  - >2,800 outbreak-associated cases identified

2021 (excluding COVID):

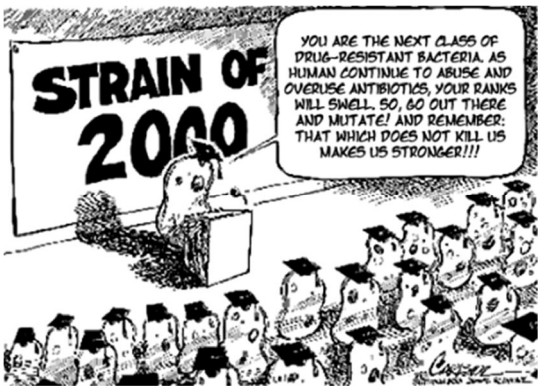
- 88 outbreaks reported
  - >1,200 outbreak-associated cases identified

Decrease in number of outbreaks during COVID is primarily due to fewer influenza and norovirus outbreaks in LTCFs

Emerging Infections & Outbreak Response

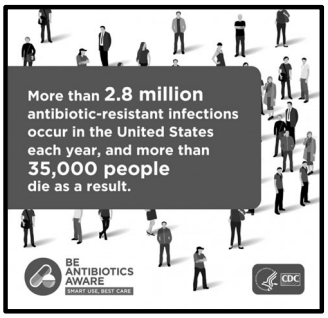
Multidrug-Resistant Organisms (MDROs)

Multidrug-Resistant Organisms (MDROs)



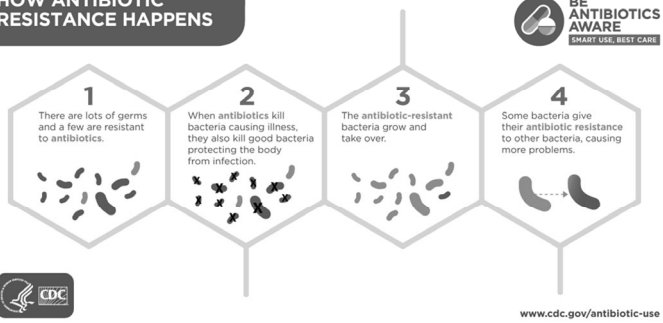
Significance of MDROs

- MDROs are pathogens that are resistant to one or more classes of antimicrobial treatment
- Affect vulnerable patient populations
- Are easily transmitted in and between healthcare/congregate care settings
- Difficult to treat and may require more toxic antibiotics
- Improper treatment → some organisms may produce another enzyme that makes it easier to transmit resistance
- Increase in mortality, healthcare costs, length of stays
- Estimates of economic costs vary, up to $20 BILLION in direct healthcare costs



https://www.cdc.gov/antibiotic-use/community/about/antibiotic-resistance-faqs.html

HOW ANTIBIOTIC RESISTANCE HAPPENS



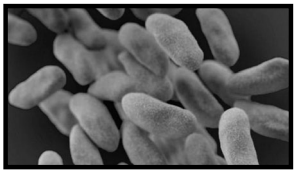
source

Extended-Spectrum Beta-Lactamases (ESBLs)

- Beta-lactamase → Enzyme produced by Gram-negative bacteria
  - Resistant to third-generation cephalosporins and monobactams
- Endemic in United States
  - Can be community acquired
- Spread via direct and indirect contact with colonized/infected patients and contaminated environmental surfaces.

Carbapenem-Resistant Enterobacterales (CRE)

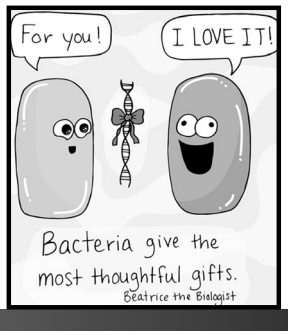
- First recognized in US in 2001
- Enterobacterales = gut bacteria
  - *Klebsiella* spp.
  - *E. Coli*
  - *Enterobacter* spp.
- Resistant to nearly all antibiotics



- Many ways to be resistant
  - Carbapenemase-producing CRE (CP CRE)
    - Klebsiella pneumoniae carbapenemase (KPC)
    - New Delhi metallo-β-lactamase (NDM)
    - Verona integron encoded metallo-β-lactamase (VIM)
    - Imipenemase metallo-β-lactamase (IMP)
    - Oxacillinase-48 (OXA-48)

Significance of Carbapenemase-producing CRE

- "Urgent public health threat" – CDC
- Highly resistant
- Mobile resistance elements
- >9,000 healthcare-associated infections each year
- Up to 50% mortality

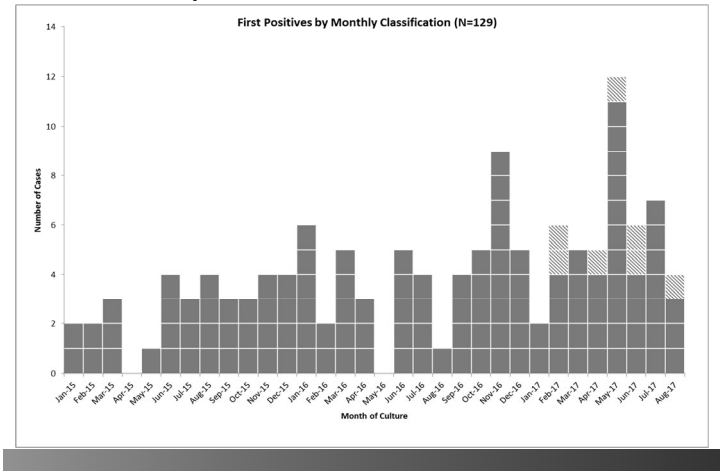


Investigation

- Notified by LHD on April 21, 2017 (a Friday!)
  - Increase in the number infections caused by ESBL-producing organisms among patients admitted to local hospital between October 16, 2016 and April 13 2017
- Majority of cases were residents of three long-term care facilities (LTCFs)
- Coordinated an investigation to **assess infection prevention practices among these LTCFs and prevent further intra- and inter- facility spread of disease**

- 4 cases were discussed on Friday but > 40 positive labs were waiting for us on Monday morning!

New onset ~~ESBL and CRE cases among~~ local hospital ~~ED visits and admissions~~

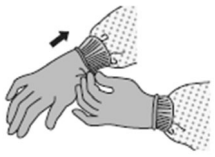


Outbreak Case Definition

Identification of new* CRE or ESBL infection or colonization in a resident of county D County with a specimen collection date on or after October 1, 2016.

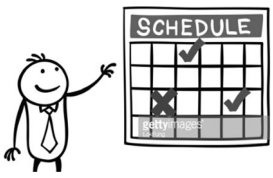
*Different organisms/species/carbapenemases identified in a single resident counted as separate events from other organisms/species/carbapenemases

Initial Control Measures



Gown and gloves

Hand hygiene



Prevent opportunities for transmission

Site Visit

Investigate to stop transmission & prevent future outbreaks

Major Findings

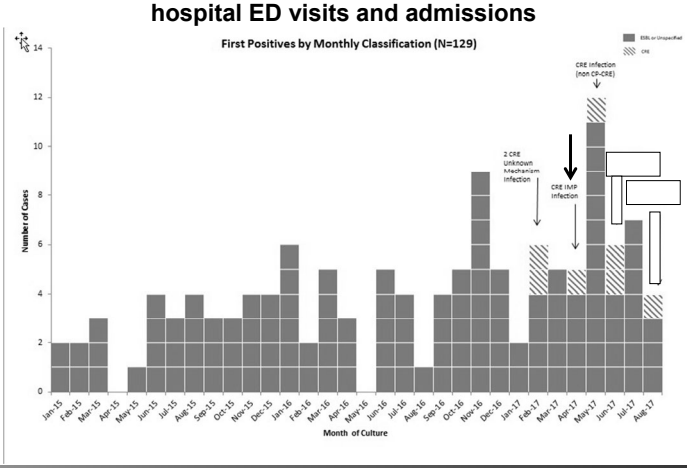
- **Hand hygiene:** inconsistent ✖
- **Wound care:** reusing scissors, interruptions in flow from clean to dirty ✖
- **OT/PT:** contact precautions not adequately maintained, lack of dedicated equipment ✖
- **Contact precautions:** implemented to varying degrees ✖
- **Lack of inter-facility notification** ✖
- **Outdated policies** ✖

Site Visit: Control Measures

1. Staff education
2. Laboratory notification
3. Cohort infected residents
4. Contact precautions for colonized and infected individuals at higher risk for transmission
5. Hand hygiene
6. Environmental cleaning
7. Communicate CRE status to transferring and receiving facilities
8. Review infection prevention policies and procedures
9. Antimicrobial stewardship

CRE alert

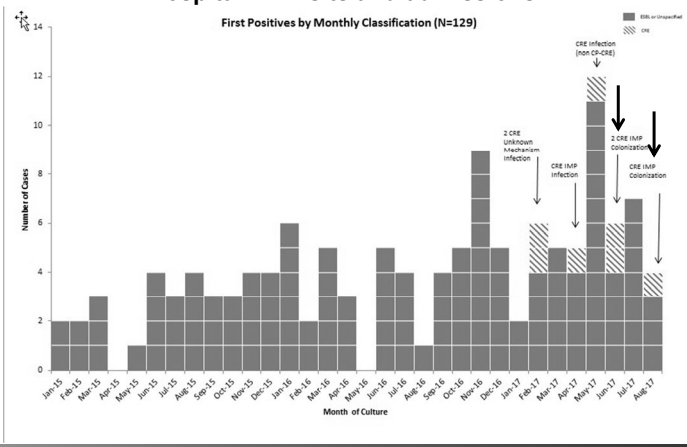
New onset ESBL and CRE cases among local hospital ED visits and admissions



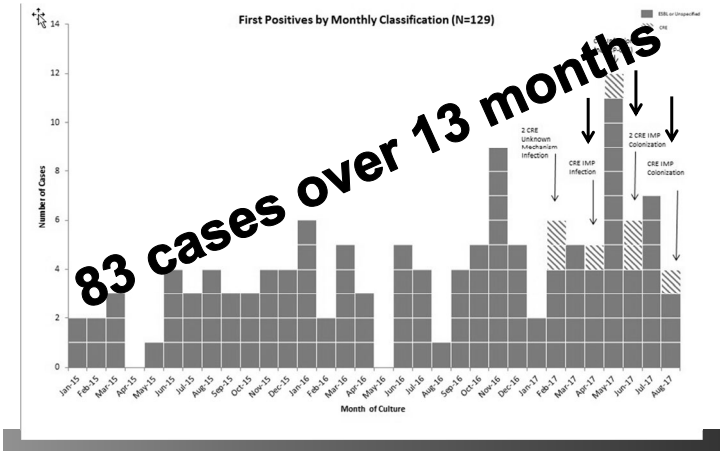
IMP outbreak case definition

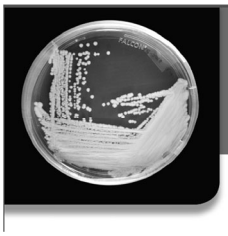
- Confirmed: CRE infection or colonization in a resident of North Carolina with laboratory confirmation of imipenemase metallo-β-lactamase (IMP) production by a CDC-recognized test.
- Probable: A resident of North Carolina with CRE infection or colonization with a positive phenotypic test for carbapenemase production (e.g, metallo-β-lactamase test, modified Hodge test, Carba NP, Carbapenem Inactivation Method (CIM), or modified CIM (mCIM)).

New onset ESBL and CRE cases among local hospital ED visits and admissions



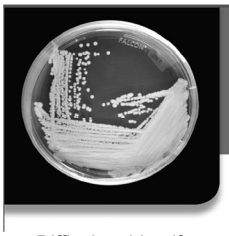
New onset ESBL and CRE cases among local hospital ED visits and admissions October 22, 2016–November 30, 2017 (n=83*)





Candida auris:
A drug-resistant germ that spreads in healthcare facilities

Candida auris (also called *C. auris)* is a fungus that causes serious infections. Patients with *C. auris* infection, their family members and other close contacts, public health officials, laboratory staff, and healthcare workers can all help stop it from spreading.



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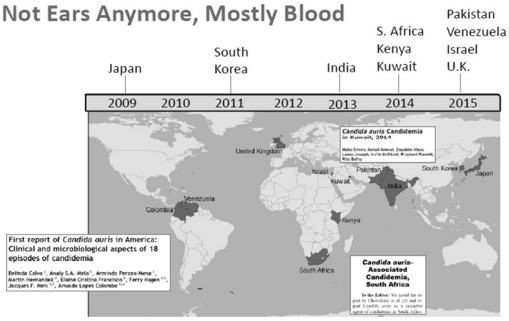
- Difficult to identify
- Global health threat
- Invasive infections
- ~ 60% mortality
- Environmental persistence
- Easily transmissible in the healthcare setting

Candida auris

Rapid Emergence Since 2009
Not Ears Anymore, Mostly Blood

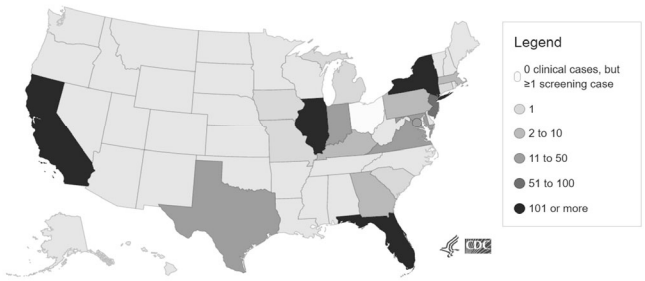


Candida auris

Countries from which *Candida auris* cases have been reported, as of February 15, 2021
This map is no longer being updated given how widespread *C. auris* has become.

United States

Reported clinical cases of *Candida auris*, July 1, 2020-June 30, 2021



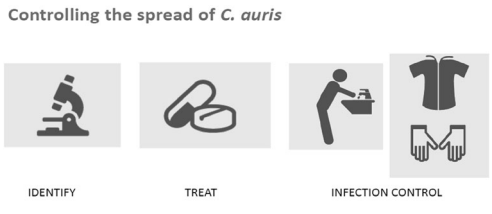
North Carolina

5 clinical cases of *C. auris* to date:
-2 linked to LTCF outbreaks in other states
-3 linked to international hospitalizations

Added to NC Reportable Conditions list – October 1, 2018

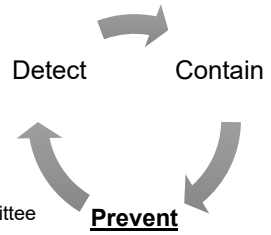
Infection Prevention

- Private room, contact precautions
- Adherence to hand hygiene
- Clean with EPA approved disinfectant effective against *C. difficile* spores
- Screen contacts

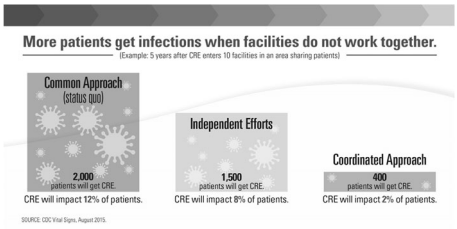


Responding to MDROs

- Detect MDROs
  - Increased awareness and testing
  - ARLN
  - Nationally notifiable
- Ensure rapid response & containment
  - Prevent transmission
  - Inter-facility communication
- Stewardship efforts
  - Antimicrobial resistance subcommittee
  - Get Smart Campaign
  - STAR Partners
- Education
  - Collaborative effort (SPICE, DPH, LHD)



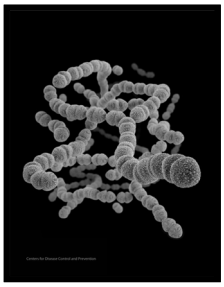
Responding to MDROs



Group A *Streptococcus* (GAS)

Group A *Streptococcus* (GAS)

- A group of gram-positive bacteria
- Spherical shape and divide by fission, but remain attached and grow in beadlike chains
- Commonly found in the throat and on the skin
- Illness varies depending on site of infection



LTCF Mortality Risks

- Between 1,100 and 1,600 people *die* as a result of invasive GAS disease annually in the US
- LTCF residents 1.5 times more likely to die from invasive GAS infections than the average population
- 10-15% of LTCF residents who acquire a GAS infection will die.

GAS Outbreak, 2017

- January 2017
  - 2 Facilities in County X, North Carolina
  - 'Sister' facilities, owned by the same company

GAS Outbreak, 2017

- Case definition:

  New GAS infection or colonization identified by culture in a resident or symptomatic staff member of facility A or facility B with a specimen collection date on or after December 1, 2016

Public Health Response

- Retrospective chart review
- Survey healthcare workers for GAS symptoms
- Culture close contacts
- 4 months active surveillance
- Site visit to assess infection control

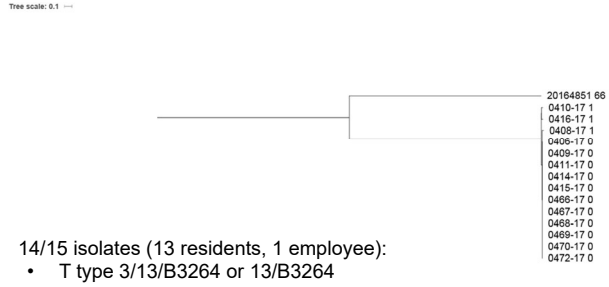
Site Visit Findings: Infection Risk Factors

- Increased staff contact linked to illness
  - Significant nursing needs
  - Non-intact skin/wound care
  - Immobility/bed baths
- Link to inadequate infection control
  - Poor hand hygiene
  - Staff working while sick

Whole Genome Sequencing, GAS

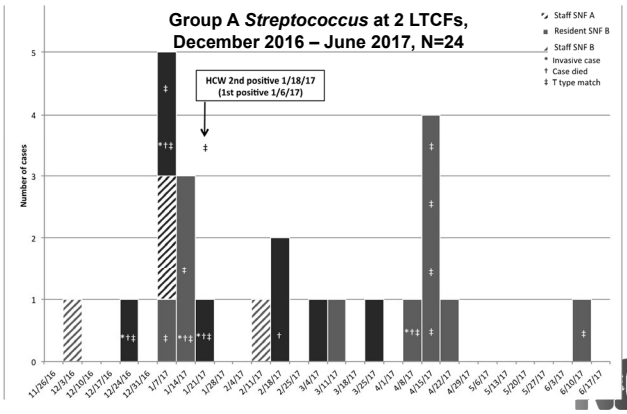
- Submitted isolates from 15 (14 residents & 1 employee) of 24 cases to CDC to determine strain relatedness
  - Serologic and molecular typing, whole genome sequencing

Whole Genome Sequencing, GAS



- 14/15 isolates (13 residents, 1 employee):
  - T type 3/13/B3264 or 13/B3264
  - All *emm* type 89
- WGS: closely related, maximum difference of 3 single nucleotide polymorphisms between sequences

GAS Epi Curve, December 2016 – June 2017



Summary

- 24 Cases
  - **Facility A:** 10 cases (8 residents, 2 employees)
  - **Facility B:** 14 cases (12 residents, 2 employees)
- 6 residents died (case fatality rate=25%)
- Epi, laboratory, site assessments:
  - Substantial infection prevention gaps
  - Support conclusion that these are related outbreaks
  - Shared employee link between facilities, but not source

Legionellosis

Legionellosis

- Caused by inhalation of *Legionella pneumophilia*
- Transmission: Inhalation of aerosolized water
- Two manifestations

	Legionnaires' disease	Pontiac Fever
Incubation period	2–14 days	5–72 hours
Symptoms	Non-productive cough and **pneumonia**	Self-limited febrile illness; no pneumonia
Resolution	Typically requires antibiotics; ~15% case-fatality rate	Spontaneous recovery in 2–5 days

- Risk factors
  - >50 years old, smokers, compromised immune systems

Incidence of legionellosis has been increasing in the US and North Carolina

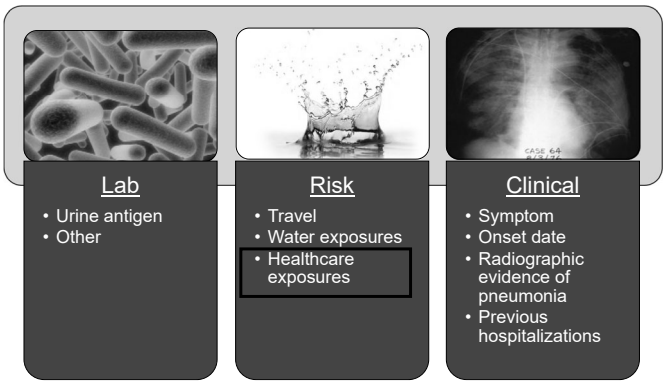
Investigation Steps

Lab
- Urine antigen
- Other

Risk
- Travel
- Water exposures
- Healthcare exposures

Clinical
- Symptom
- Onset date
- Radiographic evidence of pneumonia
- Previous hospitalizations

Investigation Steps



Lab
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- Previous hospitalizations

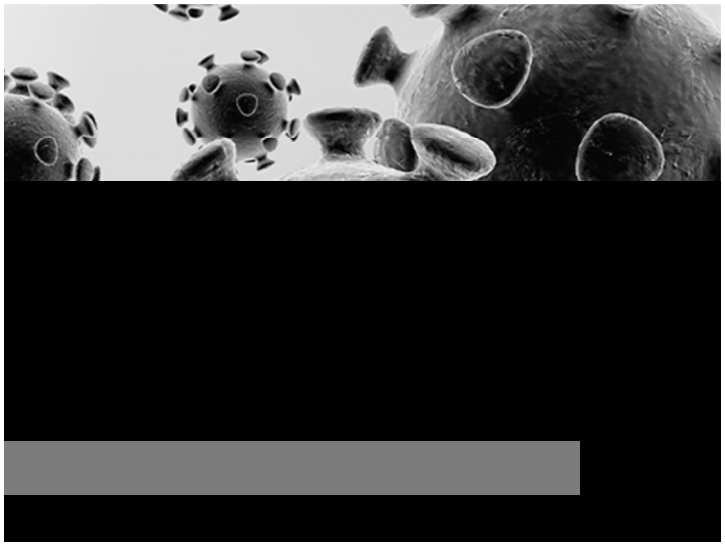
The most important question…

Was the patient in the healthcare facility during the 14 days before symptom onset?

Create a timeline:
- When was the patient admitted to the facility?
- When did symptoms start?
- Where did the patient go during the 14 days before symptom onset?

Healthcare-associated legionellosis

- Definite healthcare-associated case
  - Confirmed case of legionellosis in a person who has spent ≥10 days **continuously** in a healthcare facility during the 14 days before illness onset
- Possible healthcare-associated case
  - Confirmed case of legionellosis in a person who has spent **part but not all** of the 14 days before illness onset in a healthcare facility



NC Public Health Actions

- **Contact tracing**
- **Develop, disseminate guidance**
- **Rule change to require reporting**
- **Develop and implement control measures**
- **Develop laboratory testing capacity**
- **Vaccine planning, distribution**

Partnerships

Other responses of interest

Other responses of interest

- TB in a NICU
- Multidrug Resistant Acinetobacter
- Scabies in long-term care facilities
- Acute Hepatitis B (orthopedic clinic)
- Potential Hepatitis B transmission in dialysis facility & plasma donation center
- Drug diversion among healthcare providers
- Peritonitis among patients receiving peritoneal dialysis
- Enterovirus in a NICU
- Legionellosis associated with a fair
- National responses:
  - Non-tuberculous mycobacterium (NTM) and heater-cooler units
  - *B. cepacia* and liquid docusate
  - Ebola virus disease

10 Steps of an Outbreak Investigation

Reasons to Investigate an Outbreak

- Identify, describe the source
- Describe new diseases / learn more about known diseases
- Identify populations at risk
- Evaluate existing prevention strategies
  - e.g., immunization requirement
- Opportunity to educate public about disease prevention
- Address public concern
- Develop strategies to prevent future outbreaks
- Fulfill legal obligation and duty to care for the public
- End the outbreak!

Principles of Outbreak Investigations

- Be systematic
  - Follow the same steps for every type of outbreak
  - Write down case definitions
  - Ask the same questions of everybody
- Stop often to re-assess what you know
  - Line list and epidemic curve provide valuable information
  - Consider control measures to be applied
- Coordinate with partners

Steps of an Outbreak Investigation

- These steps may occur simultaneously - or be repeated as new information is received

What is an Outbreak?

- Anything above what is normally seen for any given time period
- If you aren't sure, call us!
- In a facility setting, an outbreak is generally defined as two or more individuals with the same illness
- Two or more 'epi-linked' cases
  - **Caveat to this rule:**
    - One case of certain diseases = Outbreak
    - Disease not normally seen (Avian Flu, SARS, Ebola)

Verify the Diagnosis

- Review medical records, laboratory reports
- Talk with patients
- Request additional testing if needed
- Consult with local health department, communicable disease branch, state public health lab

What is a Case Definition?

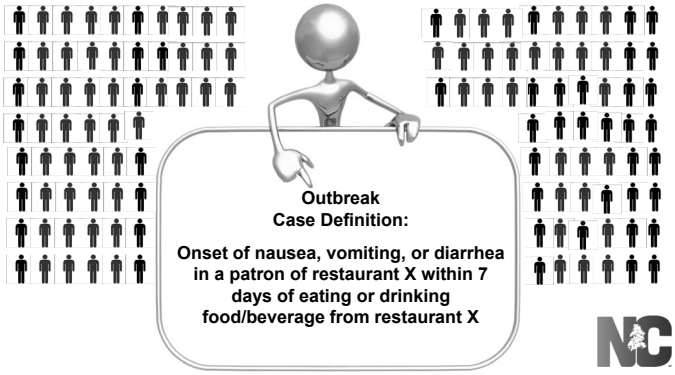
- Allows a simple, uniform way to identify cases
- "Standardizes" the investigation
- Is specific to the outbreak

Case Definition

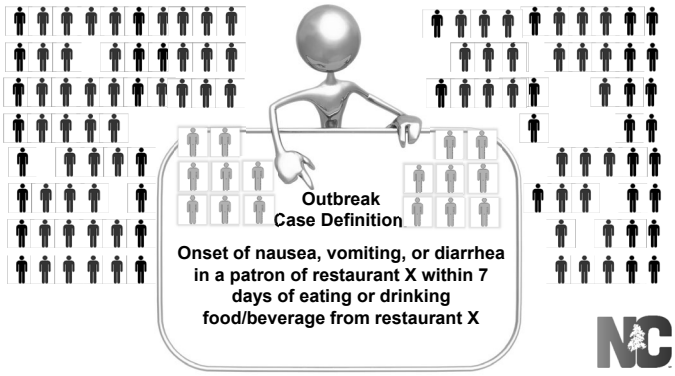
- 3 components:
  - Person..... Type of illness, characteristics (e.g., "a person with...")
  - Place..... Location of suspected exposure
  - Time..... When exposure or illness occurred

Outbreak Case Definition

Outbreak Case Definition



Outbreak Case Definition



Descriptive Epidemiology

- What and why?
  - Provides systematic method
  - Characterize, or describe what has occurred
  - Person, place, time
- Components
  - Line list
  - Epi curve
  - Others, but we will focus on line list and epi-curve

Descriptive Epidemiology

- Person
- Place

} Line List

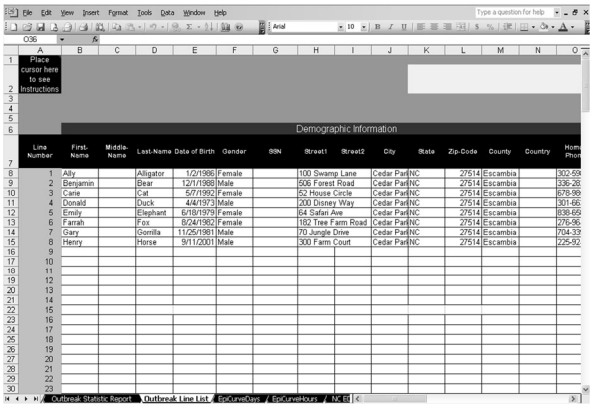
- Time

} Epidemic curve ('Epi curve')

Line List

- Method to systematically record information
- Simple to review, update, summarize
- Each row represents data for a single 'case'
- Information to include:
  - Identifying information
  - Demographics
  - Clinical
  - Exposure/risk factor
- Paper or electronic

Example – Line List



Place cursor here to see Instructions

Demographic Information

Line Number	First. Name	Middle. Name	Last-Name	Date of Birth	Gender	SSN	Street1	Street2	City	State	Zip-Code	County	Country	Hom Phon
1	Ally		Alligator	1/2/1986	Female		100 Swamp Lane		Cedar Park	NC	27514	Escambia		302-69
2	Benjamin		Bear	12/1/1988	Male		506 Forest Road		Cedar Park	NC	27514	Escambia		336-28
3	Cane		Cat	5/7/1992	Female		52 House Circle		Cedar Park	NC	27514	Escambia		678-99
4	Donald		Duck	4/4/1973	Male		200 Disney Way		Cedar Park	NC	27514	Escambia		301-66
5	Emily		Elephant	6/18/1979	Female		64 Safari Ave		Cedar Park	NC	27514	Escambia		838-66
6	Farrah		Fox	8/24/1982	Female		182 Tree Farm Road		Cedar Park	NC	27514	Escambia		276-96
7	Gary		Gorrilla	11/25/1981	Male		70 Jungle Drive		Cedar Park	NC	27514	Escambia		704-33
8	Henry		Horse	9/11/2001	Male		300 Farm Court		Cedar Park	NC	27514	Escambia		225-92

Outbreak Statistic Report | Outbreak Line List | EpiCurveDays | EpiCurveHours | NC EI

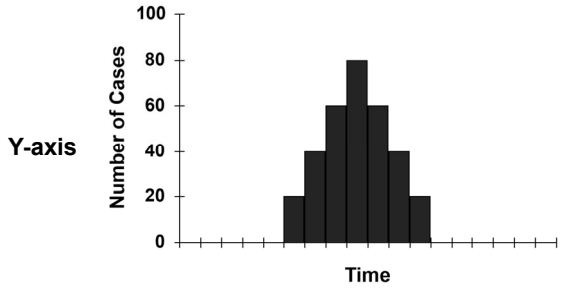
Epidemic 'Epi' Curve

- Visual representation of
  - Ill persons (cases) over time
  - Magnitude of outbreak
  - Number of cases on the vertical (y) axis
  - Time period (or date of illness onset) on the horizontal (x) axis
  - Type of outbreak
    - Point source
    - Propagated (person-to-person)

Epi Curves

- Point source
  - Sharp upward slope and a gradual downward slope
  - Common source outbreak
  - Period of exposure is brief
  - Cases occur within one incubation period

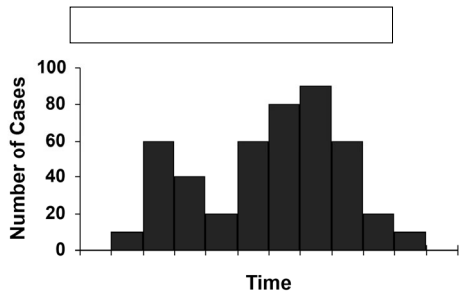
Example Epi Curve – Point Source Outbreak



Epi Curves

- Propagated (person-to-person)
  - Progressively taller peaks, an incubation period apart
  - Person to person transmission
  - May last a long time
  - May have multiple waves

Example Epi Curve – Person to Person Outbreak (Propagated)



What are Hypotheses?

- Statements which help us describe why and how the outbreak occurred (i.e., educated guess)
- How do you generate hypotheses?
  - Review the existing body of knowledge
  - Examine line list, epi-curve
  - Conduct open-ended interviews with few case-patients

Evaluating the Hypotheses

- Two methods:
  - Compare hypothesis with established facts
  - Perform additional studies (e.g., analytic)
    - Cohort or case-control
    - Assess exposures equally among ill and non-ill persons

Control Measures

- When should control measures be implemented *immediately?*
  - Source is known
  - Continued risk of either exposing others or being exposed (e.g., HCW diverting injectable drugs)
- Control measures:
  - Are applied as soon as possible
  - May change during investigation

Communicate Findings

- Oral
  - Internally with team
  - Externally to public, media, health care providers
- Written
  - Daily updates (e.g., Situation Reports)
  - Final outbreak report

Maintain Surveillance

- Evaluate / document effectiveness of control measures
- To ensure outbreak is over
- To ensure secondary outbreak is not occurring
- Maintain surveillance for 2 average incubation periods following the last date of illness onset

Conclusions

- Epidemiologic investigations essential component of public health, present opportunities to:
  - Characterize diseases
  - Identify populations at risk
  - Evaluate programs, policies, or existing prevention strategies
  - Train public health staff
  - Educate the public
  - Fulfill legal obligations and duty of care for the public
- 10 steps provide systematic framework necessary to investigate any outbreak

Resources

- **MDROs**
  - Management of Multidrug Resistant Organisms in Healthcare Settings, 2006 https://www.cdc.gov/hicpac/mdro/mdro_toc.html
  - CDC Facility Guidance for Control of CRE, *November 2015 Update* https://www.cdc.gov/hai/pdfs/cre/CRE-guidance-508.pdf
  - CDC Interim Guidance for a Public Health Response to Contain Novel or Targeted MDROs https://www.cdc.gov/hai/pdfs/containment/Health-Response-Contain-MDRO-H.pdf
  - NC DPH CRE information for Long-Term Care Facilities http://epi.publichealth.nc.gov/cd/hai/docs/CREinfoLTCfacilities.pdf
- **Exposure Investigations**
  - NC ADMINISTRATIVE CODE, TITLE 10A, SUBCHAPTER 41Ahttps://www.cdc.gov/niosh/topics/bbp/guidelines.html
- **Injection Safety**
  - One and Only Campaign http://www.oneandonlycampaign.org/partner/north-carolina
- **Antimicrobial Stewardship**
  - Be Antibiotics Aware Campaign https://epi.publichealth.nc.gov/cd/antibiotics/campaign.html
  - NC DPH Antimicrobial Stewardship https://epi.publichealth.nc.gov/cd/antibiotics/stewardship.html
  - NC DPH STAR Partners https://epi.publichealth.nc.gov/cd/antibiotics/star_partners.html

Questions?

Comments!

NCHAI@DHHS.NC.GOV

Case Study

Oswego – An Outbreak of Gastrointestinal Illness following a Church Supper

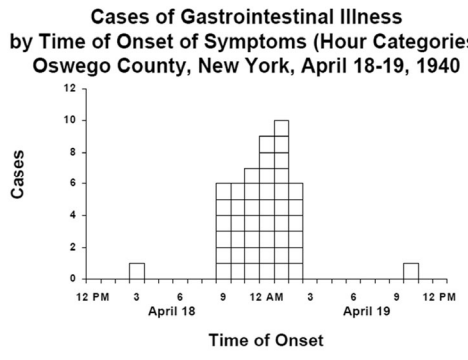
◈

Case Study No. 401-303

Centers for Disease Control and Prevention

Epidemiology Program Office

107



Incubation Period

ID	AGE	SEX	TIME OF MEAL	ILL	DATE OF ONSET	TIME OF ONSET	INCUBATION PERIOD
6	63	F	7:30pm	Y	4/18	10:30pm	3
7	70	M	7:30pm	Y	4/18	10:30pm	3
9	15	F	10:00pm	Y	4/19	1:00am	3
21	13	F	10:00pm	Y	4/19	1:00am	3
27	15	F	10:00pm	Y	4/19	1:00am	3
32	15	M	10:00pm	Y	4/19	1:00am	3
33	50	F	10:00pm	Y	4/19	1:00am	3
39	16	F	10:00pm	Y	4/19	1:00am	3
58	12	F	10:00pm	Y	4/19	1:00am	3
65	17	F	10:00pm	Y	4/19	1:00am	3
10	33	F	7:00pm	Y	4/18	11:00pm	4
52	8	M	11:00am	Y	4/18	3:00pm	4
60	53	F	7:30pm	Y	4/18	11:30pm	4
2	52	F	8:00pm	Y	4/19	12:30am	4.5
72	18	F	7:30pm	Y	4/19	12:00am	4.5
71	60	M	7:30pm	Y	4/19	1:00am	5.5
3	65	M	6:30pm	Y	4/19	12:30am	6
4	59	F	6:30pm	Y	4/19	12:30am	6
48	20	F	7:00pm	Y	4/19	1:00am	6
8	40	F	7:30pm	Y	4/19	2:00am	6.5
14	10	M	7:30pm	Y	4/19	2:00am	6.5
59	44	F	7:30pm	Y	4/19	2:30am	7

Incubation Period – Median

ID	AGE	SEX	TIME OF MEAL	ILL	DATE OF ONSET	TIME OF ONSET	INCUBATION PERIOD
6	63	F	7:30pm	Y	4/18	10:30pm	3
7	70	M	7:30pm	Y	4/18	10:30pm	3
9	15	F	10:00pm	Y	4/19	1:00am	3
21	13	F	10:00pm	Y	4/19	1:00am	3
27	15	F	10:00pm	Y	4/19	1:00am	3
32	15	M	10:00pm	Y	4/19	1:00am	3
33	50	F	10:00pm	Y	4/19	1:00am	3
39	16	F	10:00pm	Y	4/19	1:00am	3
58	12	F	10:00pm	Y	4/19	1:00am	3
65	17	F	10:00pm	Y	4/19	1:00am	3
10	33	F	7:00pm	Y	4/18	11:00pm	4
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2	52	F	8:00pm	Y	4/19	12:30am	4.5
72	18	F	7:30pm	Y	4/19	12:00am	4.5
71	60	M	7:30pm	Y	4/19	1:00am	5.5
3	65	M	6:30pm	Y	4/19	12:30am	6
4	59	F	6:30pm	Y	4/19	12:30am	6
48	20	F	7:00pm	Y	4/19	1:00am	6
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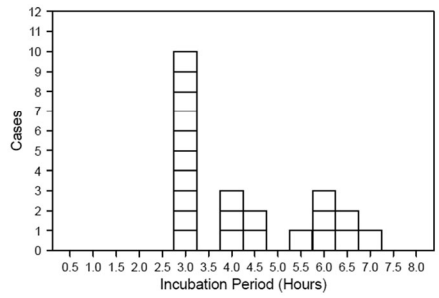
Cases of Gastrointestinal Illness
by Incubation Period in Hours
Oswego County, New York; April 18-19, 1940



Food Items Served	Number of persons who ATE specified food				Number of persons did NOT eat specified food				Attack Rate Ratio
	Ill	Not Ill	Total	Percent Ill (Attack rate)	Ill	Not Ill	Total	Percent Ill (Attack rate)	
Baked ham	29	17	46	63%	17	12	29	59%	1.1
Spinach	26	17	43	60%	20	12	32	62%	1.0
Mashed potato*	23	14	37	62%	23	14	37	62%	1.0
Cabbage salad	18	10	28	64%	28	19	47	60%	1.1
Jello	16	7	23	70%	30	22	52	58%	1.2
Rolls	21	16	37	57%	25	13	38	66%	0.8
Brown bread	18	9	27	67%	28	20	48	58%	1.0
Milk	2	2	4	50%	44	27	71	62%	0.8
Coffee	19	12	31	61%	27	17	44	61%	1.0
Water	13	11	24	54%	33	18	51	65%	0.8
Cakes	27	13	40	67%	19	16	35	54%	1.3
Ice cream, vanilla	43	11	54	80%	3	18	21	14%	5.7
Ice cream, chocolate*	25	22	47	53%	20	7	27	74%	0.7
Fruit salad	4	2	6	67%	42	27	69	61%	1.1

* Excludes 1 person with indefinite history of consumption of that food.

1. Food with highest attack rate among consumers: vanilla ice cream (80%)
2. Food with lowest attack rate among non-consumers: vanilla ice cream (14%)
3. Proportion of cases exposed to vanilla ice cream: 43/46 = 93%.

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Measures of Association

Odds ratio, Risk ratio, Rate ratio

1=null

<1=less likely | **>1=more likely**

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