Investigating a Healthcare Associated Infection Outbreak

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Objectives

- Define an outbreak
- Describe epidemiologic and lab methods for investigating outbreaks in healthcare settings
- Discuss effective strategies to manage and control an outbreak of healthcare-associated infections

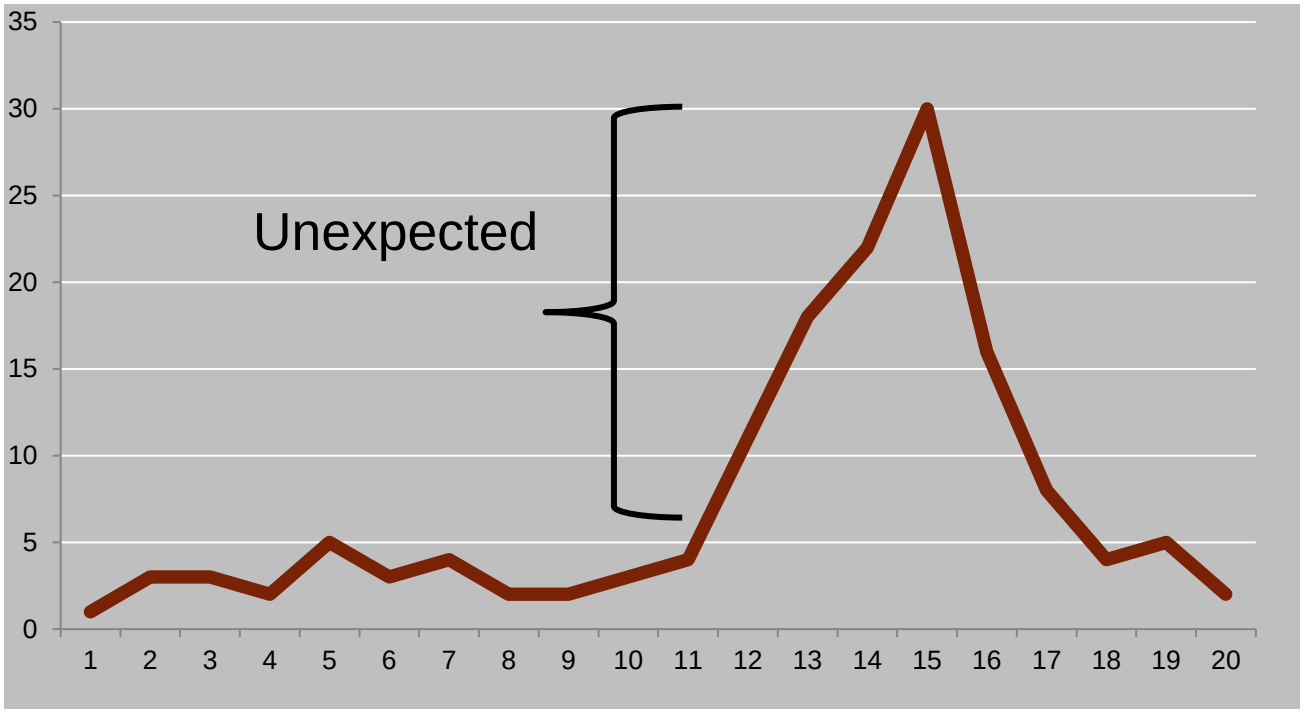
Major Public Health Challenge

- Healthcare Associated Infection(HAI) outbreaks remain a major detriment to patient care and patient safety in both public and private sector
- Can have massive financial and public relations impacts on healthcare facilities
- Reported often but not always systematically investigated
- Lack of policy/guidelines for HAI outbreak detection and response

What is an outbreak?

What is an outbreak?

- The occurrence of more cases of a disease than expected for a particular place and time



“Outbreaks” vs. “Clusters”

- Sometimes small outbreaks are referred to as clusters
- Functionally, there is no difference since they are both problems and both need to be investigated and controlled

Identifying a potential outbreak

- Review of surveillance data
- Clinician reports of unusual diagnoses
- Reports from the public
- Media

Example: Outbreak of *Burkholderia cepacia*

- In 2018, a medical microbiologist working in a mid-sized teaching hospital while reviewing the monthly data noticed a cluster of 21 patients with *Burkholderia cepacia* infections
- All infections occurred in the 16-bed surgical intensive care unit
- All of the isolates were highly resistant, and reported to be resistant to colistin

CLSI- M100- 2021

Organism \ Antimicrobial Agent	Ampicillin, Amoxicillin	Piperacillin	Ticarcillin	Ampicillin-sulbactam	Amoxicillin- clavulanate	Piperacillin-tazobactam	Cefotaxime	Ceftriaxone	Ceftazidime	Cefepime	Aztreonam	Imipenem	Meropenem	Ertapenem	Polymyxin B Colistin	Aminoglycosides	Tetracyclines/ Tigecycline	Trimethoprim	Trimethoprim-sulfamethoxazole	Chloramphenicol	Fosfomycin
Acinetobacter baumannii/ Acinetobacter calcoaceticus complex	R				R						R			R				R		R	R
Burkholderia cepacia complex[a]	R	R	R	R	R	a	a	a		a	a	a		R	R	a		a			R
Pseudomonas aeruginosa	R			R	R		R	R						R			R	R	R	R	
Stenotrophomonas maltophilia	R	R	R	R	R	R	R	R			R	R	R	R		R	b	R			R

Abbreviation: MIC, minimal inhibitory concentration; R, resistant.

Footnotes

a. *B. cepacia* complex isolates have chromosomal genes that must undergo mutational changes before expressing resistance. It is not known how often these mutations occur during growth. Intrinsic resistance implies the presence of resistance mechanisms in natural or wild-type strains that result in phenotypic resistance for all or nearly all strains. Environmental *B. cepacia* complex strains lacking mutations do not express resistance mechanisms, resulting in low MICs to many antimicrobial agents, whereas clinical strains that express resistance genes, such as those from cystic fibrosis patients, have high MIC values to these same antimicrobial agents. There is insufficient clinical evidence to confirm whether strains that test susceptible *in vitro*, despite the presence of resistance mechanisms, will respond *in vivo*. Therefore, intrinsic resistance to the footnoted antibiotics (listed as resistant in previous editions of M100) cannot be confirmed.

Clinical Laboratory Standards Institute (CLSI), Performance Standards for Antimicrobial Susceptibility M100, 31 Edition 2021, *Page 243*

When should you investigate?

- Some are easy:
  - Unusual or important organisms
    - *Elizabethkingia meningoseptica*, *Ralstonia, B. cepacia*

- Some are not:
  - 50% increase in SSIs for one quarter?
  - Doubling of MRSA BSIs for one month?
  - Doubling CREs in UTIs for one month?

Why investigate HAI outbreaks?

- Identify the cause of the outbreak
- Control the outbreak
- Prevent similar outbreaks in the future
- Provide new research and insight
- Evaluate existing prevention strategies
- Address public concerns
- Minimize economic and social disruptions

Should you investigate?

Depends on:

- Severity of illness
- Potential for spread
- Political considerations
- Public relations
- Resource availability
- Availability of prevention and control measures

Burkholderia cepacia

- An important cause of mortality and morbidity in hospitalized patients because of high intrinsic antibiotic resistance
- potential to grow in hospital surroundings (e.g., taps, sinks, irrigation solutions, intravenous fluids, antibiotic and antiseptic solutions)
- Needs to be correctly identified as it has contrasting susceptibility pattern to P. aeruginosa
- Present in biofilms, can be difficult to isolate from the environment

Picture credit HAI Surveillance Network AIIMS-ICMR

Conducting an HAI Outbreak Investigation

Essential investigation components

1. Verification of diagnosis & Confirmation of outbreak existence
2. Inform key stakeholders about the investigation
3. Construct a case definition
4. Identifying and count the number of cases and collect information
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10. Follow- up and Communicate results (staff, officials, public)

One thing to remember…

- Outbreak investigations are neither linear nor orderly
- Multiple steps happen simultaneously
- Steps often have to be repeated several times

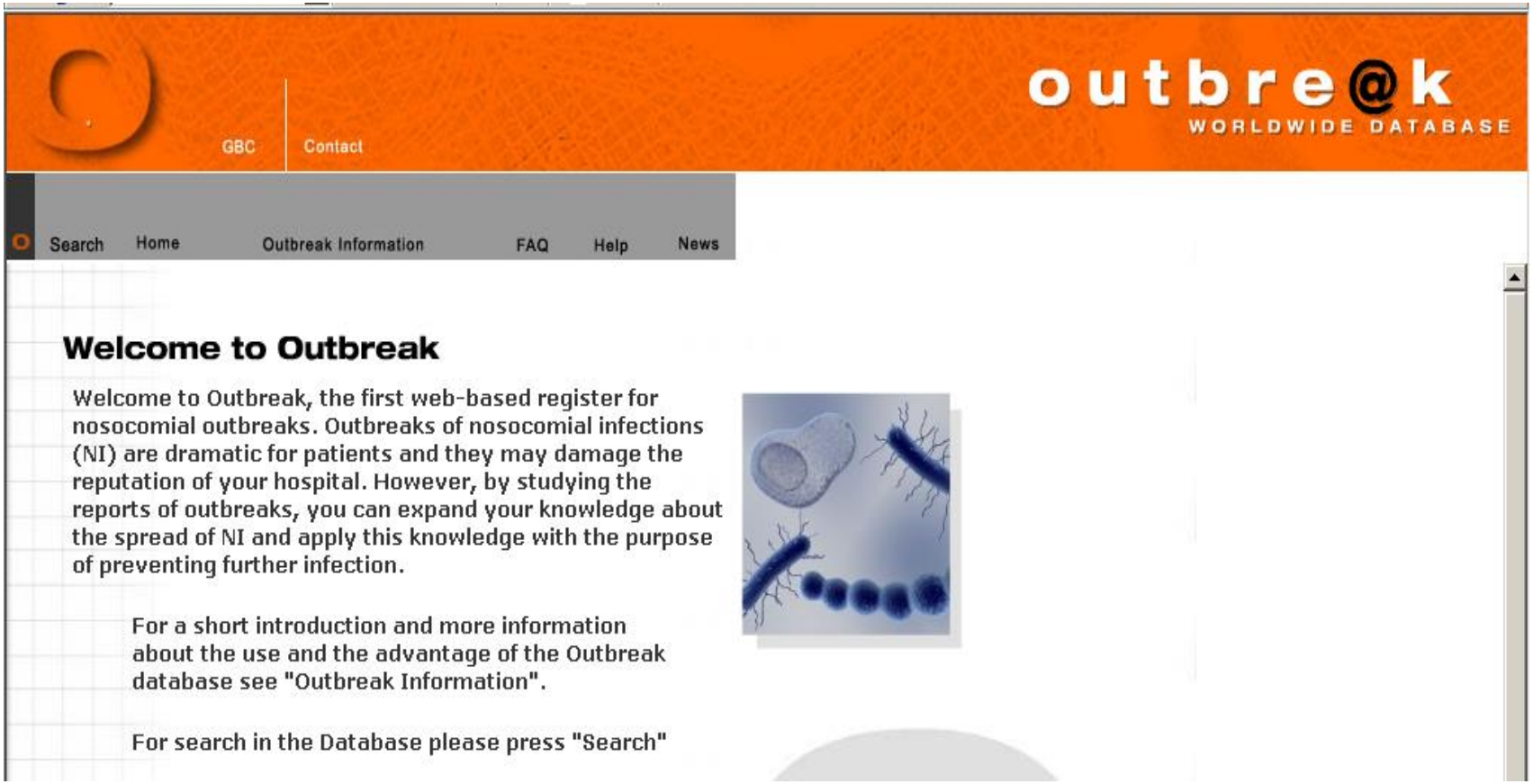
Before you begin

- Talk to the lab and ask them to save ALL isolates that might be part of the outbreak!

Literature review

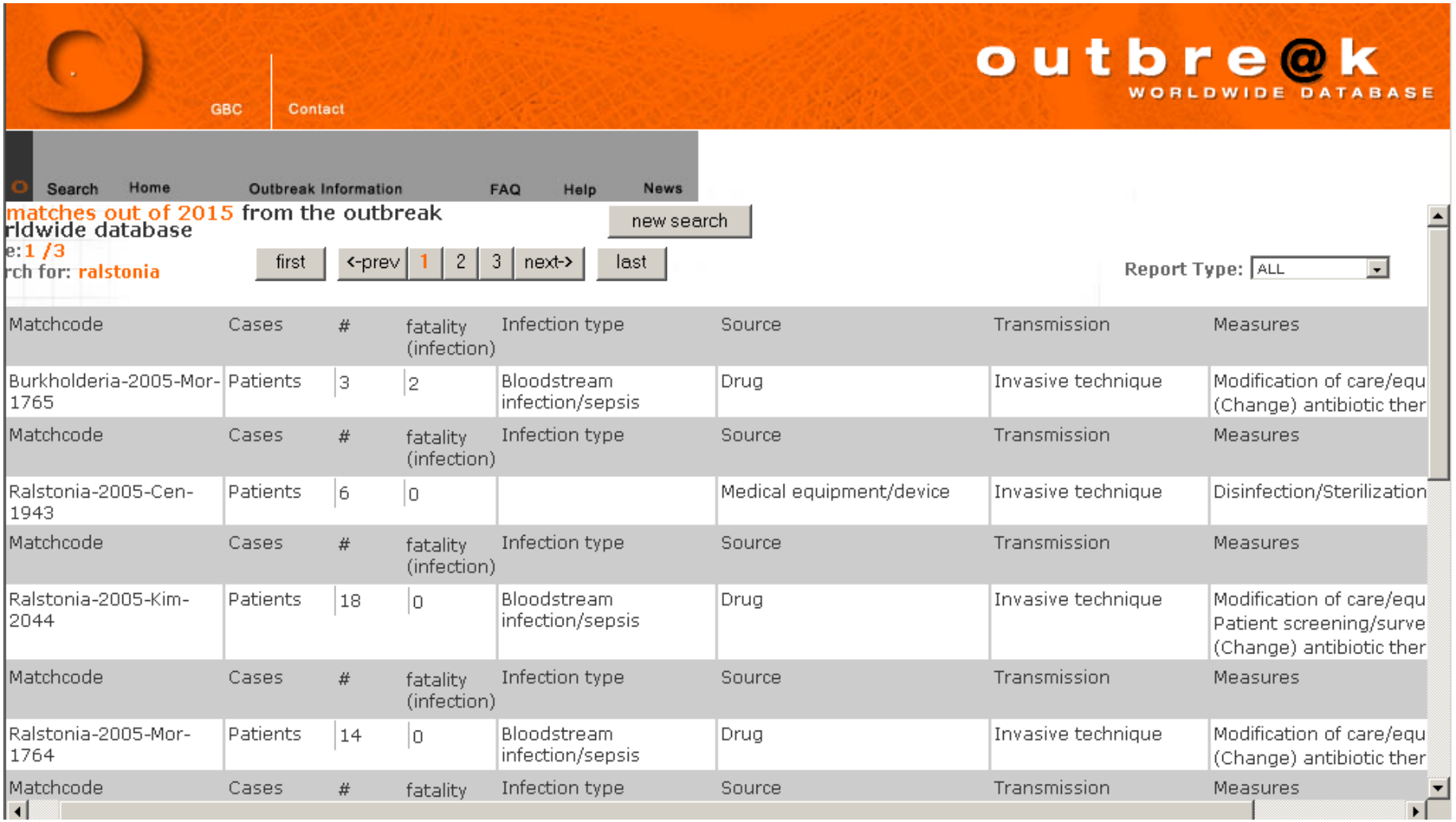
- Is an important place to start
- There are LOTS of published outbreak investigations- more than 50,000
- You will get good leads both on where and how to start your investigation

A great resource



http://www.outbreak-database.com/Home.aspx

They already did the hard work!



outbre@k WORLDWIDE DATABASE

GBC | Contact

Search | Home | Outbreak Information | FAQ | Help | News

matches out of 2015 from the outbreak
rldwide database
e: 1 /3
rch for: ralstonia

new search

first | <-prev | 1 | 2 | 3 | next-> | last

Report Type: ALL

Matchcode	Cases	#	fatality (infection)	Infection type	Source	Transmission	Measures
Burkholderia-2005-Mor-1765	Patients	3	2	Bloodstream infection/sepsis	Drug	Invasive technique	Modification of care/equ (Change) antibiotic ther
Matchcode	Cases	#	fatality (infection)	Infection type	Source	Transmission	Measures
Ralstonia-2005-Cen-1943	Patients	6	0		Medical equipment/device	Invasive technique	Disinfection/Sterilization
Matchcode	Cases	#	fatality (infection)	Infection type	Source	Transmission	Measures
Ralstonia-2005-Kim-2044	Patients	18	0	Bloodstream infection/sepsis	Drug	Invasive technique	Modification of care/equ Patient screening/surve (Change) antibiotic ther
Matchcode	Cases	#	fatality (infection)	Infection type	Source	Transmission	Measures
Ralstonia-2005-Mor-1764	Patients	14	0	Bloodstream infection/sepsis	Drug	Invasive technique	Modification of care/equ (Change) antibiotic ther
Matchcode	Cases	#	fatality	Infection type	Source	Transmission	Measures

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Verify the diagnosis

Evaluate the clues:

- ✓Signs and symptoms
- ✓Laboratory findings
- ✓Duration of symptoms
- ✓Suspected exposure
- ✓Suspected virus, bacteria, or toxin
- ✓Hospital onset

Laboratory confirmation

- Most definitive method for verifying diagnosis
- May help define the incubation period
- Interpret negative results with caution:
  - Organism may not have been tested
  - Specimens collected too late in illness
  - Mishandling of specimen

Look for an increase in case reports

- Review the reports and data
- Confirm that cases are the same disease
- Confirm that the number of cases exceeds the normal
- Confirm healthcare onset

“Outbreak” vs. “Pseudo-outbreak”

- “Outbreak” – generally, an increase in clinical disease or clinically relevant cultures
- “Pseudo-outbreak” – generally, an increase in reports or positive cultures without evidence of disease
- May be a surveillance artifact due to:
  - New definitions
  - New practitioners
  - New area or population surveyed
  - New lab tests or change in testing frequency

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Inform key partners

- Facility staff
  - ✓ Infection control staff
  - ✓ Administration
- Laboratory staff
  - ✓ Save ALL isolates
- Local and national public officials as appropriate

Constraints of outbreak investigations

- Urgency to find source and prevent cases
- Pressure for rapid conclusion
- Limited human or environmental samples for testing
- For analytic studies, statistical power often limited
- Media reports may bias interviewees
- Pressures because of legal liability

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Case definition

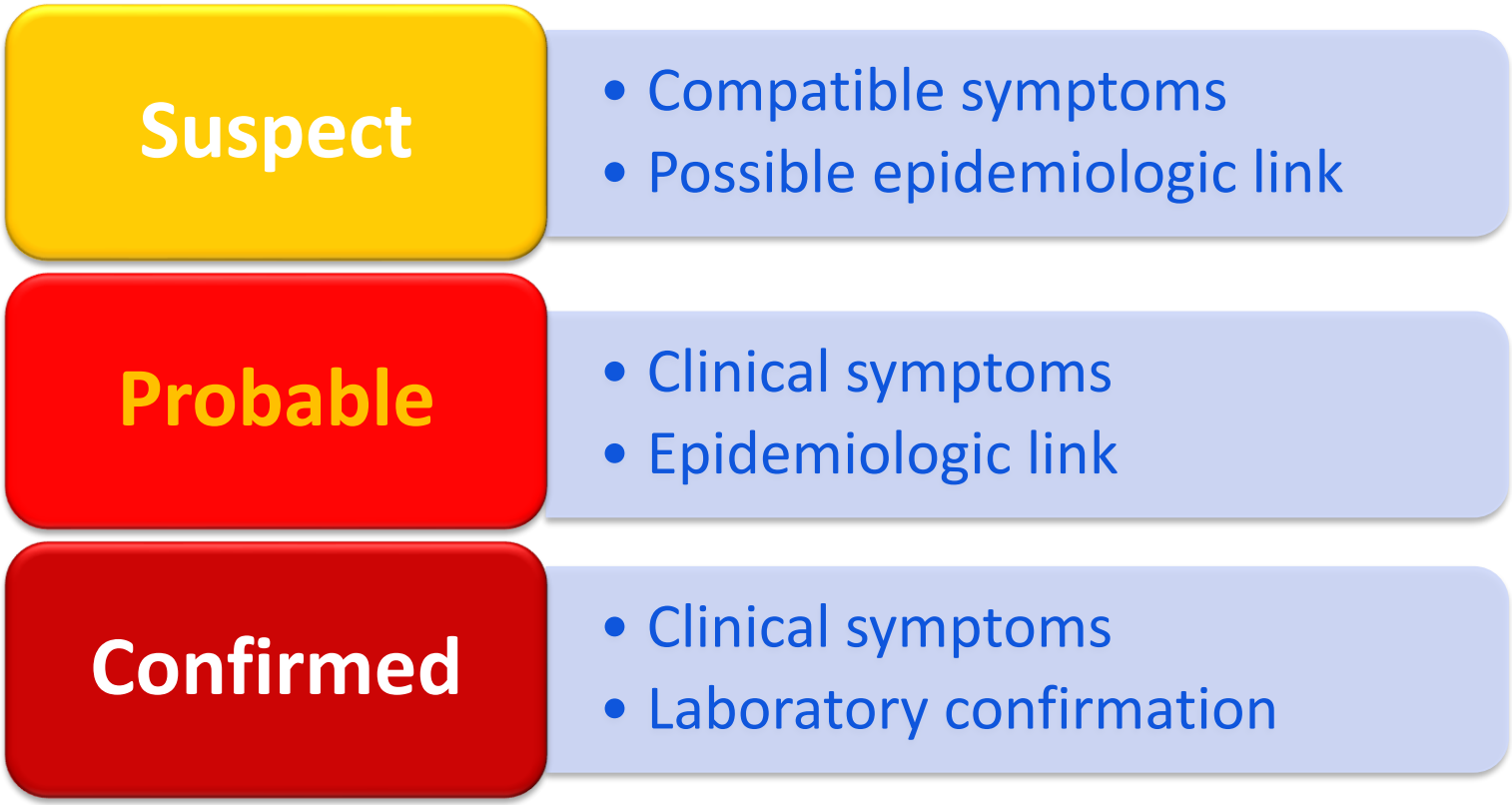
- Elements of a case definition
  - Clinical criteria (signs and symptoms)
  - Person, place, and time criteria
  - Laboratory tests

- How narrow to make it depends on the pathogen and setting
  - Narrow enough to focus efforts
  - Broad enough to catch most possible cases

Case definition may vary based on setting

- Based on etiologic agent
  - If known, include in case definition
  - Allows study of either/both infected and colonized patients
  - Vary the specificity of the definition to suit the cluster/outbreak
- Based on signs and symptoms of infection
  - Allows investigation of outbreaks caused by numerous organisms
- Definition may change as investigation proceeds

Case definition classification levels



Case definition examples

A patient who developed a surgical site infection after undergoing shoulder surgery at Hospital A between December 31,2012 and January 1, 2013

Any patient who developed ***Burkholderia cepaciae*** bloodstream infection in the surgical intensive care unit between October 1 2017 and December 31 , 2018

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Active case finding

- Many outbreaks first recognized by healthcare personnel
- Active case finding requires casting a wide net at the beginning of the investigation
- Helps provides more information about the outbreak and define the exposed population

How do you find cases?

- Microbiology data
- Infection control or surveillance records
- Discussions with clinicians
- Medical records
- Operative notes
- Pathology reports
- Pharmacy records
- Radiology reports
- Central service/supply records
- Occupational health records
- Hospital billing records
- Purchasing Records
- Log Books

In our *Burkholderia cepacia scenario…*

- Obtained monthly *Burkholderia cepacia* line list report with AST from laboratory from October 2017 to December 2018
- Searched for all cultures that met the definition for *Burkholderia cepacia BSIs*
- Identified all patients with initial culture 48 hours after hospital admission

Case finding challenges

- Finding cases when you can't rely on microbiology is very tough and requires a lot more effort in chart review
  - requiring a microbiology link makes case finding easier, BUT may miss cases (example: influenza positive versus influenza like illness)

- In some instances, there may be cases with sub-clinical infections or cases that are only colonized with the organism
  - Will surveillance cultures help find unknown cases?
  - Is it worth the extra time and money?

How hard should I look?

- Remember, goal of investigation is to stop the outbreak, not necessarily to uncover every case

- More exhaustive case findings efforts may not be needed up front, but might become important if you can't get things under control quickly

Data collection

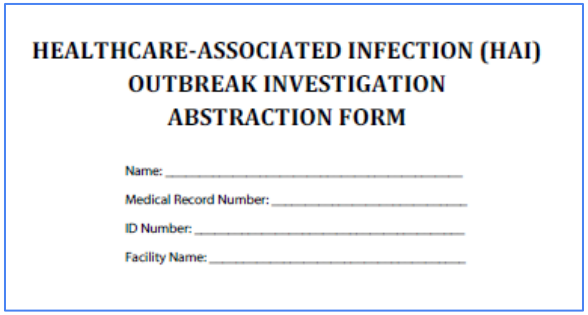
- Identifying information
- Demographic facts
- Clinical information
- Risk factor information
- **All identifying information should be confidential**

Questionnaire may include potential risk factors or exposures

- Medications
- Procedures
- Dates of admission and discharge
- Consultants
- Facility locations or units
- Health care providers
- Host factors (age, gender, immunity)

Case abstraction form

- Systematic collection of case-patient information
- Abstracts data from patient chart and laboratory, radiology
- Designed specifically for investigation to describe cases and potential risk factors depending on type of infection



HEALTHCARE-ASSOCIATED INFECTION (HAI)
OUTBREAK INVESTIGATION
ABSTRACTION FORM

Name: _____

Medical Record Number: _____

ID Number: _____

Facility Name: _____

http://www.cdc.gov/hai/outbreaks/outbreaktoolkit.html

Case abstraction form

8

9

Clinical History

History of Present Illness (Give a brief summary of the patient's illness and include any other relevant information not otherwise collected on this form):

Past Medical History:

- ☐ Chronic Lung Disease
- ☐ Coronary Artery Disease
- ☐ Congestive Heart Failure (EF_____)
- ☐ Diabetes (AIC_____)
- ☐ Peripheral Vascular Disease
- ☐ Gastrointestinal disease/bleeding
- ☐ Liver Disease/Cirrhosis
- ☐ Chronic kidney disease (creatinine _____)
  - ☐ Dialysis Dependent
- ☐ HIV/AIDS (CD4 _____)
- ☐ Major Trauma (30d PTA)
- ☐ Previous Surgery (30d PTA)
- ☐ Obesity
- ☐ Malignancy (type_____)
- ☐ Cerebrovascular Disease
- ☐ Hypertension
- ☐ Other _____
- ☐ Other _____
- ☐ Other Immunosuppression (specify: _____)

22

23

Mechanical Ventilation (7 days prior to end of abstraction period)		
Type: (Endotracheal, Tracheostomy)	Start Date	End Date
CPAP/BiPAP: ☐ Yes ☐ No	Start Date: ____/____/____	End Date: ____/____/____

24. Devices: -Complete the following table if patient had contact with the listed devices. If a device is not listed, write it in the "Other" box. Abstractor should record the site, date inserted, and date removed.

24

Devices (7 days prior to end of abstraction period)			
Device	Site	Date Inserted	Date Removed
☐ Central Venous Catheter			
☐ Central Venous Catheter			
☐ Central Venous Catheter			
☐ Condom Catheter			
☐ Foley Catheter			
Feeding Tube: ☐ Nasogastric /Nasoduodenal ☐ PEG/PEJ (stomach)			
☐ Other			

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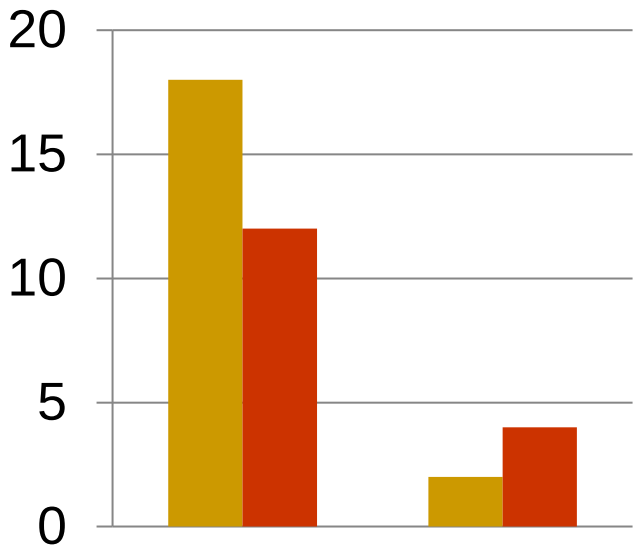
Descriptive epidemiology

- Who is at risk?
  - Describe data by person, place, time
- Characterizes the outbreak
- Identifies the population at risk
- Provides clues about the agent, source, or mode of transmission
- Provides information to begin control measures
- Familiarizes the investigator with the data

Options for describing the data

- Line listing
  - Collect key demographic, clinical, and exposure information
- Graphs
  - Bar graphs
  - Histograms
- Maps/ plots

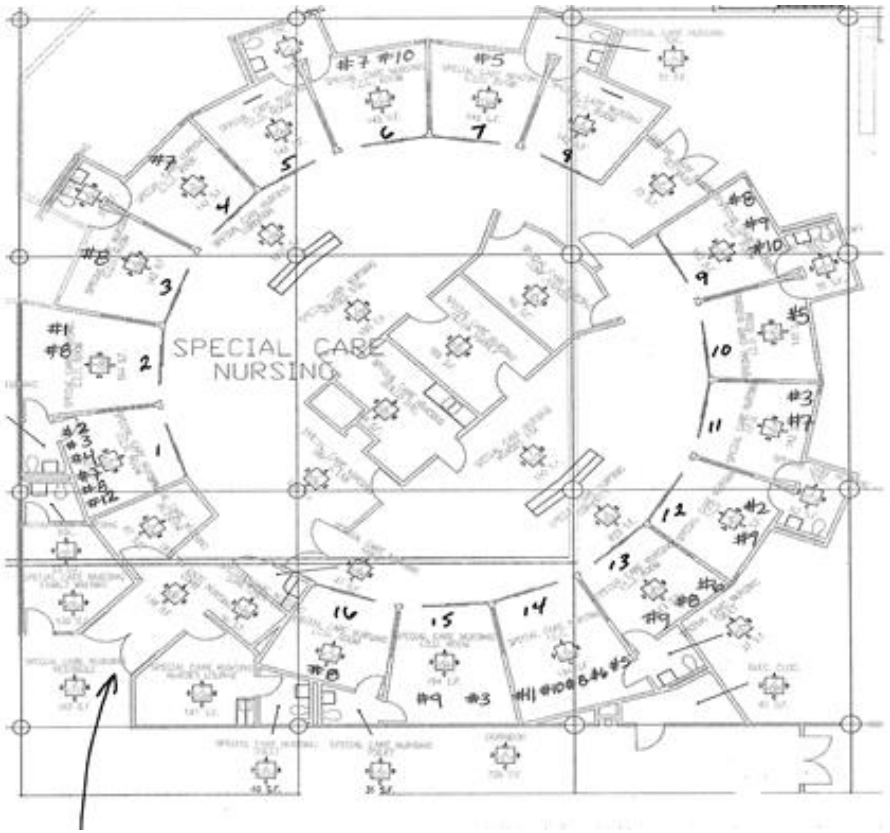


Linelist

- Created from case data
  - Each row is a case
  - Each column is a variable of interest:
    - Signs and symptoms, onset date – is this an outbreak?
    - Medications, intravenous solutions
    - Invasive procedures, surgery
    - Consults, staff contact
    - Host factors (e.g. age, underlying disease?)
    - Lab results
- **Arguably the single most important part of the investigation since it drives all the investigation efforts!**

Describe the data by “place”

- ICU room layout with room numbers and case-patient locations, Hospital A

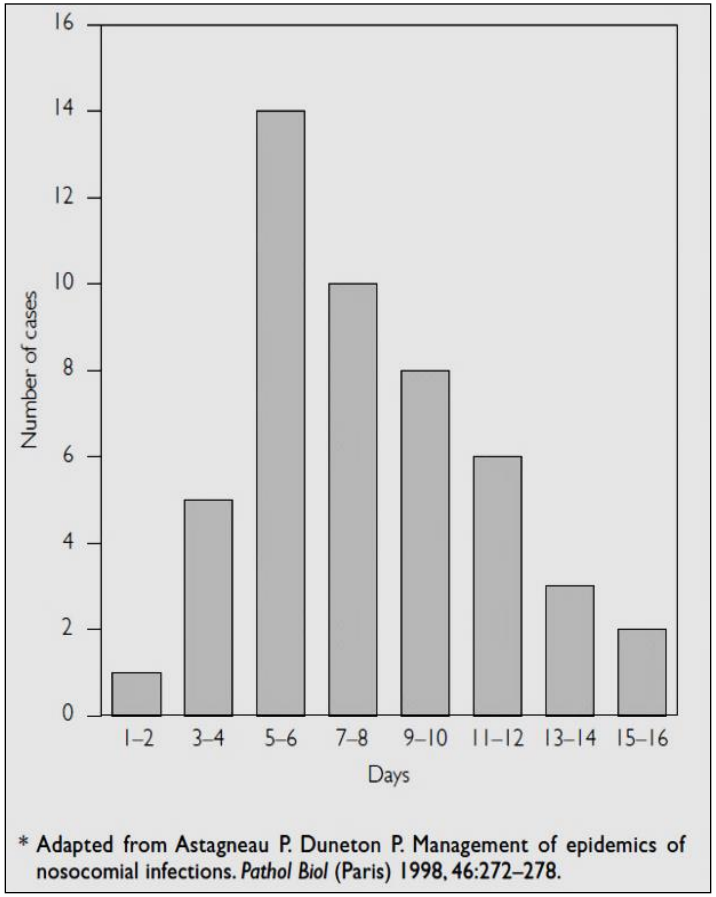


Describe the data by “time” -- Epidemic curve

- An epidemic curve is a graphical display of the number of incident cases in an outbreak, plotted over time
  - Y-axis: Number of cases of illness
  - X-axis: Date or time of illness onset
  - Unit of time often based on incubation period
- Provides important information:
  - Show the magnitude of the outbreak
  - Show the time trend of the outbreak
  - Can help define the incubation period or exposure period
  - Show the pattern of spread
  - Highlight outliers

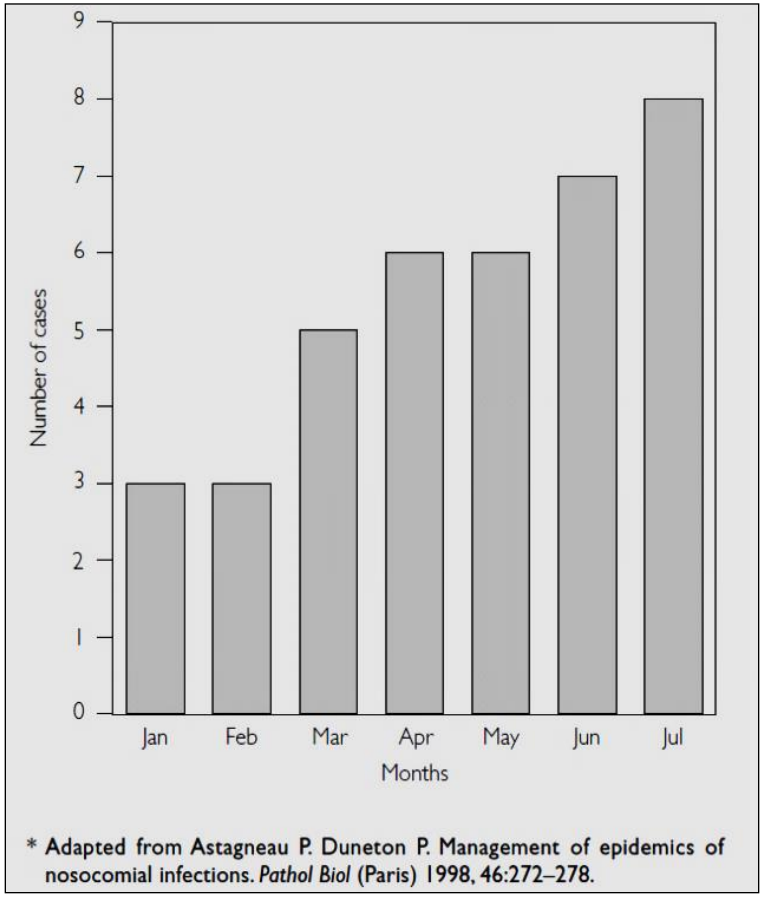
Interpreting the epidemic curve

Single Point Source



* Adapted from Astagneau P. Duneton P. Management of epidemics of nosocomial infections. *Pathol Biol* (Paris) 1998, 46:272–278.

Common Continuous Source



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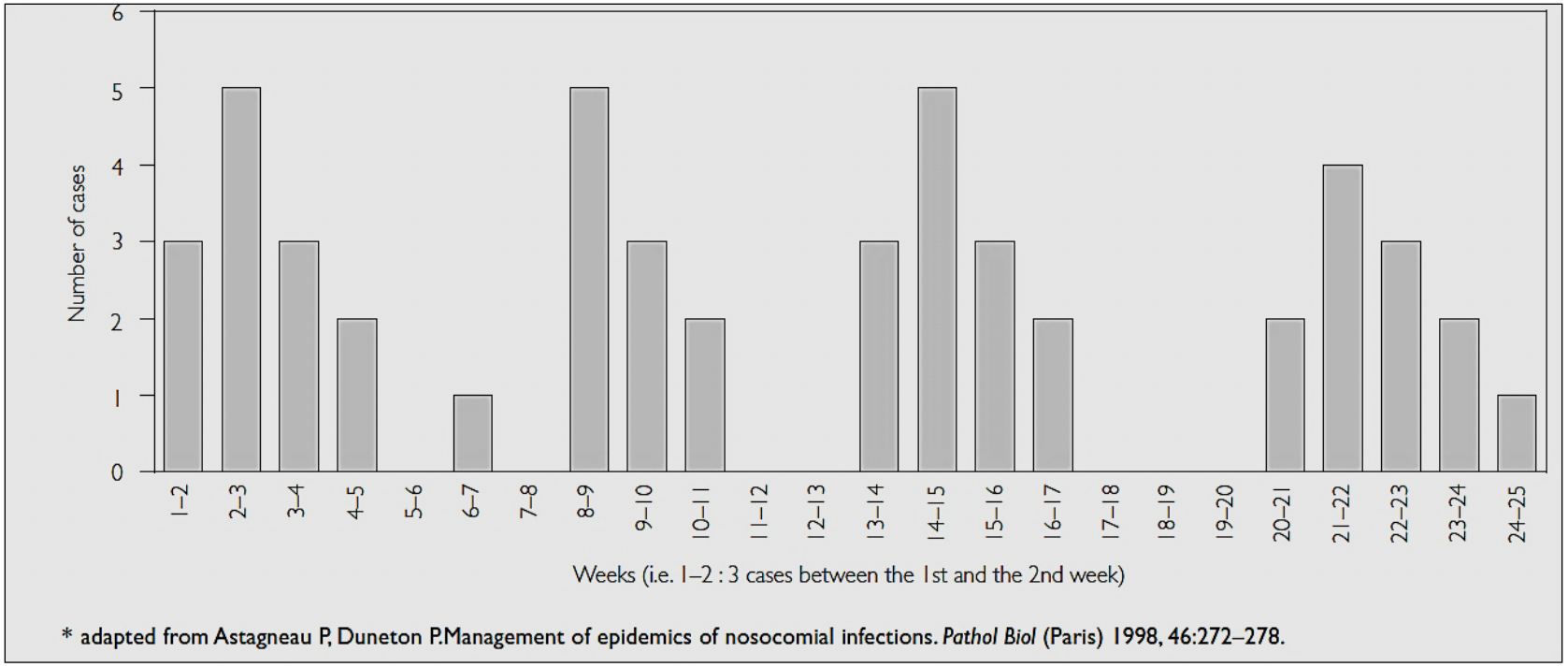
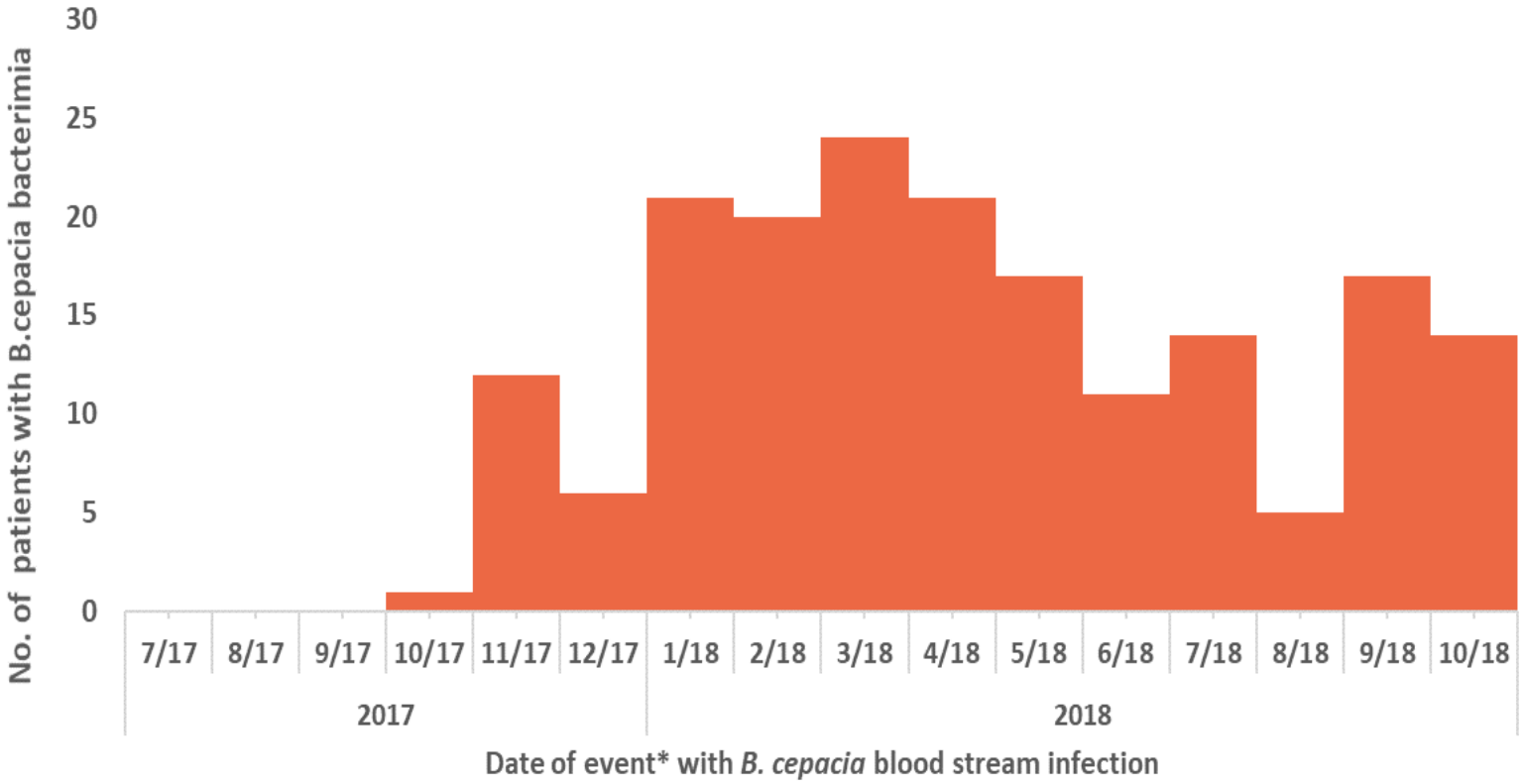
Interpreting the epidemic curve

Intermittent source infection



* adapted from Astagneau P, Duneton P. Management of epidemics of nosocomial infections. *Pathol Biol* (Paris) 1998, 46:272–278.

Distribution of *B. cepacia* BSIs in the surgical ICU, Hospital C, October 1, 2017- December 31, 2018



- **183 patients met the case definition between Oct 2017 – Oct 2018**
- **At least 144 (79%) were in SICU at time of infection**

Outliers

- An early case or a late case
- May represent unrelated incident
- Worth examining carefully
- May point directly to the source

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Clinical observations

- Who and what to observe is generally driven by the line list

- Observations can include
  - Medication preparation
  - Vascular access care
  - Hand hygiene practices
  - Adherence to isolation precautions
  - Surgical practices
  - Respiratory care practices

- Initial observations can be very informative and help facilitate creation of a standard observation tool, if needed

Ask lots of questions to lots of people!

- Do you always do it that way?
- Have you seen other people do it differently?
- What are the challenges with maintaining good techniques?
- What do you think is causing the outbreak?
- What procedures or medications might I be missing because they are not in the chart or done infrequently?

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What is a hypothesis?

- An educated guess about an association between an exposure and outcome
- Usually generated based on your descriptive data (linelist) and observations of infection control and patient care activities
- Comparing hypotheses with established facts
  - Laboratory evidence
  - Clinical evidence
  - Environmental evidence
  - Epidemiologic evidence

B. cepacia example: hypothesis generation

- ***B cepacia*** was transmitted in two units primarily in SICU in Hospital C because of antiseptic mouth wash and of poor cleaning and disinfection practices of high-touch surfaces and patient care equipment

Analytic study

- Hypotheses can be tested in an analytic study, such as a case-control study that compares exposures among case patients to hospital-matched controls
- In many cases, a study is “icing on the cake”, but not necessary to control the outbreak
- Can be helpful in guiding more investigation when source remains unclear or to support a hypothesis

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Environmental sampling

- Can be a powerful and definitive aspect of an investigation
- But can also be expensive, misleading and frustrating
  - Does a negative culture mean the bug was never there or just is not there right now?
  - Did we culture the right things?

Environmental cultures: other challenges

- Methodologies can be tricky and might not be the standard methods used in clinical labs
- Some environmental pathogens have adapted to low nutrition environments and need special media to grow
  - Some sample results in overgrowth of other pathogens
  - Some samples require neutralization steps to get rid of disinfectants
- Even using the best methods, the yield can still be low
  - Limited yield in getting the bacteria off the surface onto the swab
  - Limited yield getting the bacteria off the swab into the media

Environmental cultures: suggestions

- ***Remember: the environment is big; the swab is small!***
- Culture *after* you have data from the line list and observations
- Talk with the lab about optimal methods
- Culture only things that are likely routes of transmission (high-touch surfaces!)
- Culture what makes sense for the organisms (e.g., *Burkholderia* – fluids, water systems etc VRE- objects/surfaces)

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9. **Implement control measures**
10. Communicate results (staff, officials, public)

Implementing control measures

- Ultimately, primary goal is to stop transmission, not necessarily to find the source

- It’s okay to implement a variety of control measures targeting various possibilities based on initial observations

Examples of control measures

- Reinforce hand hygiene
- Establish barrier between infected/colonized patients and non-infected/ colonized patients
- Environmental controls
  - Enhanced cleaning
  - Review disinfection of environment, equipment
  - Remove suspected common source(s)
    - Multi-dose medications, antiseptics, etc.
- Restrict use of antibiotics to which organism is resistant
- Close unit to new admissions

Follow-up or “definitive” investigation

- Refine the case definition based on the initial findings – make it as focused as possible to detect real cases
- Continue surveillance efforts based on refined case definition
- Continue to review control measures
  - Compliance
  - Do they need to be modified?

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11. **Follow up & Communicate results (staff, officials, public)**

Communicate findings

- During the investigation
  - Among team members
  - To the public
  - To health professionals
  - To public health officials/ policy makers
- At the end of the investigation
  - Oral briefing
  - Written report

Conclusions

- Outbreaks are sentinel events that help us understand and confront emerging challenges in healthcare

- They can play an important role in making recommendations that improve overall patient care and provide important opportunities for education

Acknowledgement

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SKIMS, Srinagar

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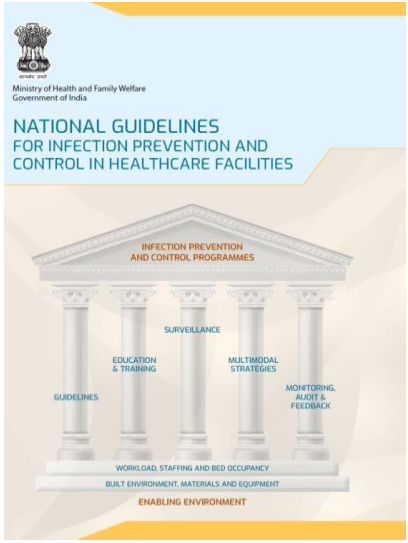
Additional reading

- **National Guidelines for Infection Prevention and Control in Healthcare Facilities, March 2020**
  - Management of HAI outbreaks Page 152



- **Outbreak Investigation Module**
  - Developed by the **World Health Organization,** the **US Centers for Disease Control and Prevention,** and **the University of Washington Global Health E-Learning Program**

1. Untitled-3 (mohfw.gov.in)
2. https://ipc.ghelearning.org/

Thank you!

For more information, contact CDC Staff
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