UK Health Security Agency

HPT Modular Programme: Outbreak Management & Epidemiological methods

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UK Health Security Agency

Outline

1. Define and Identify Outbreaks – Katy Town
2. Role of UKHSA Health Protection Teams in Outbreak Management – Suzi Coles
3. Outbreak analyses – Adrian Wensley

Define and Identify Outbreaks

What is an outbreak?

Increase in cases or a change in the pattern of a particular disease/infection/illness more than expected in:

- A specific period (**Time**)
- A group of people (**Person**)
- A specific area or setting (**Place**)

Why do we want to identify & investigate outbreaks?

- Identify the source of infection
- Stop further spread
- Implement control measures
- Prevent future outbreaks

What is an outbreak?

- More cases or a change in the pattern of a particular disease or strain than **expected** in:
  - A specific period (**Time**)
  - A group of people (**Person**)
  - A specific area or setting (**Place**)

How do we know what is expected?

Identifying outbreaks

- Surveillance systems
- Notification from partner organisations

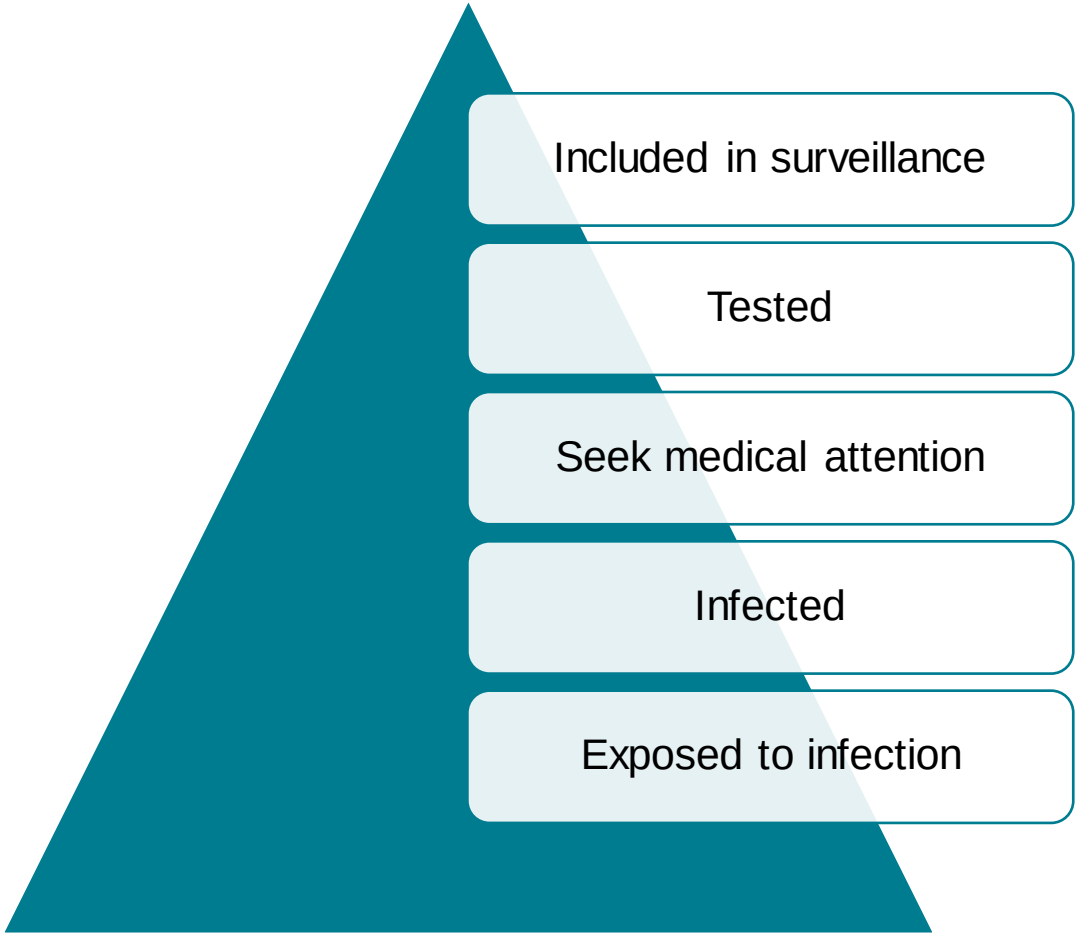
Who may notify us of an outbreak?

- Environmental health officers
- GPs/hospital doctors
- Infection control teams
- Microbiologists
- Community nurses
- General public
- Schools
- Media

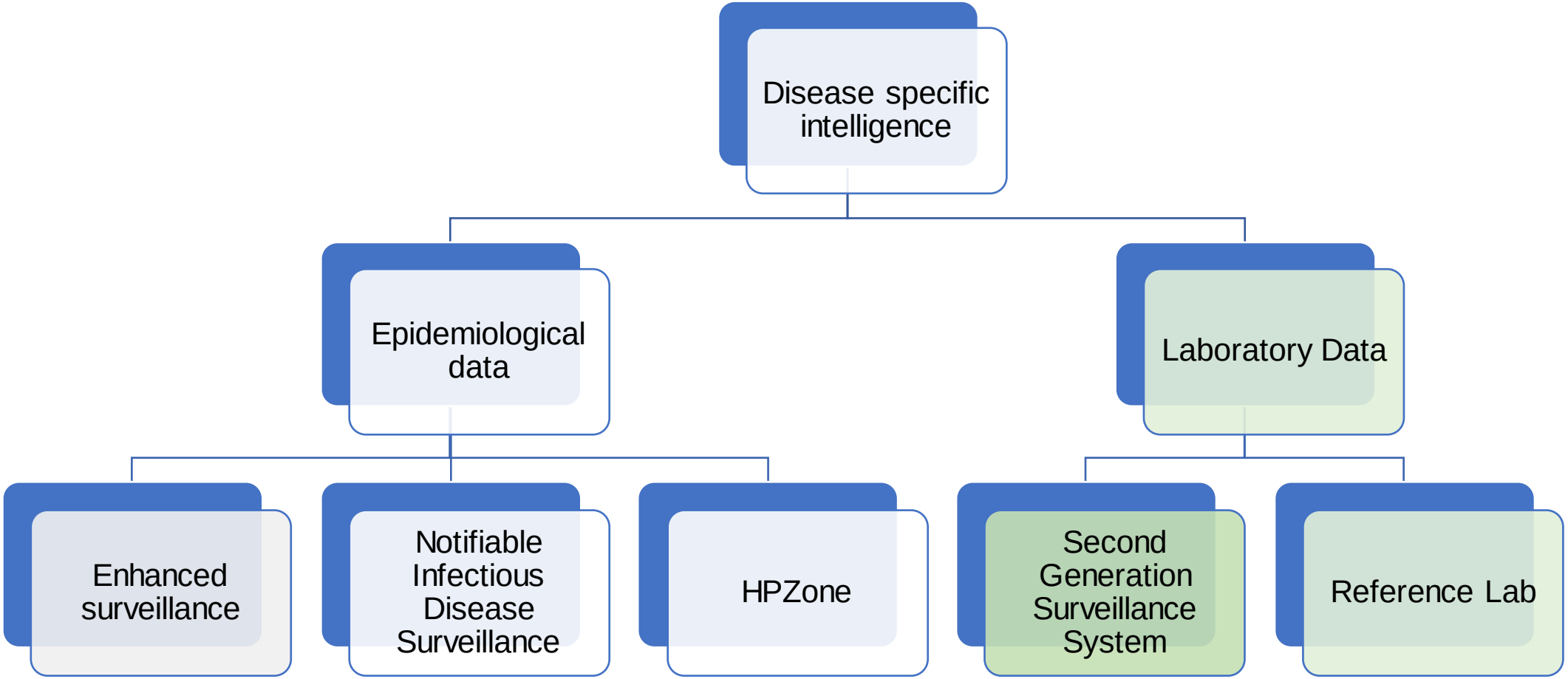
Identifying outbreaks

- Surveillance systems
  - National
  - Indicator-based
  - Universal
  - Mandatory
  - Weekly
  - Local
  - Event-based
  - Sentinel
  - Voluntary
  - Annually

Other limitations



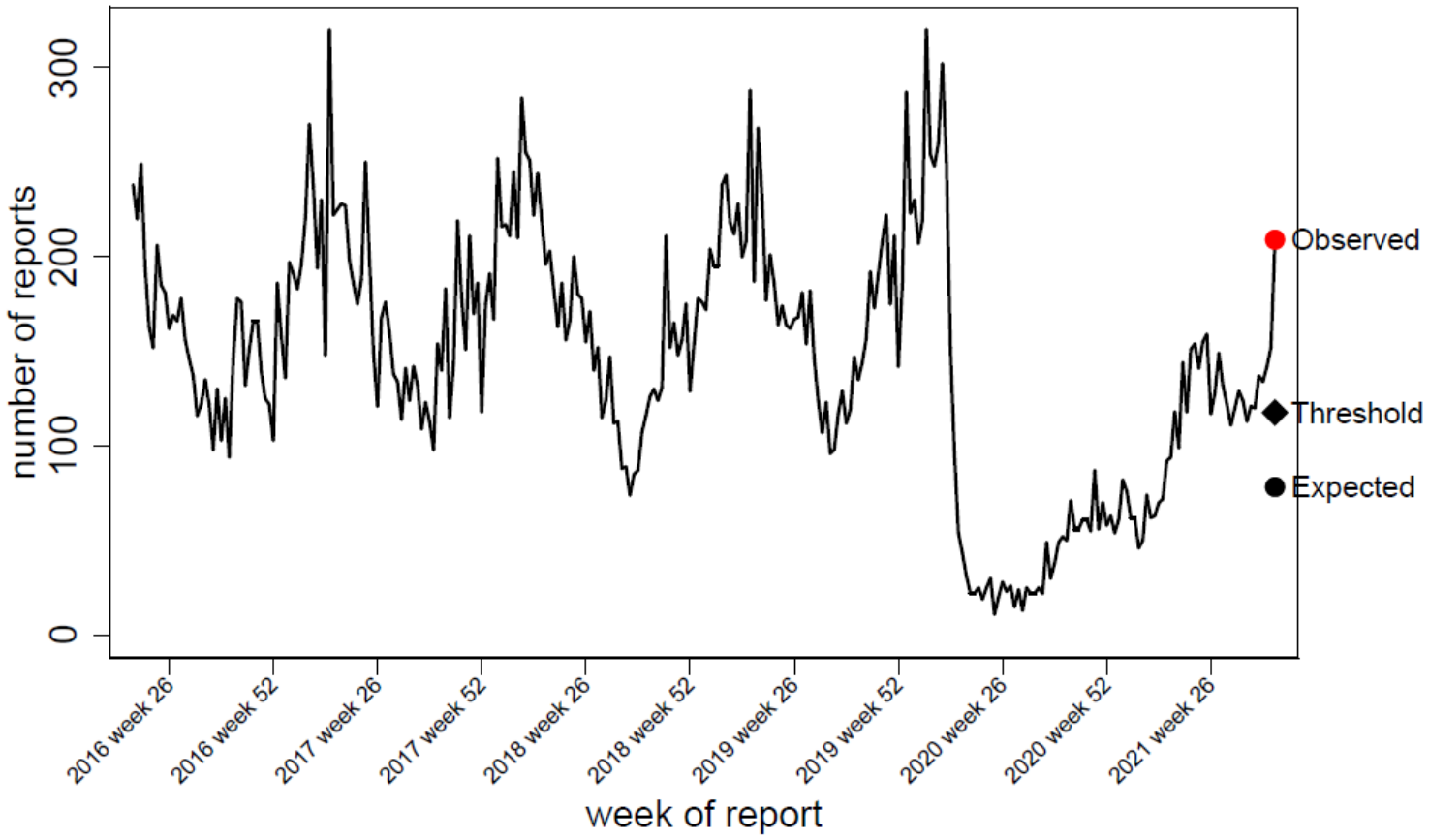
Standard surveillance data sources



Identifying outbreaks from surveillance data

- Compare the current number of cases with the number from a comparable period in the past
- Estimate using statistical techniques
- Estimate from other regions/national data

Exceedance reports



Data removed from real context for training purposes

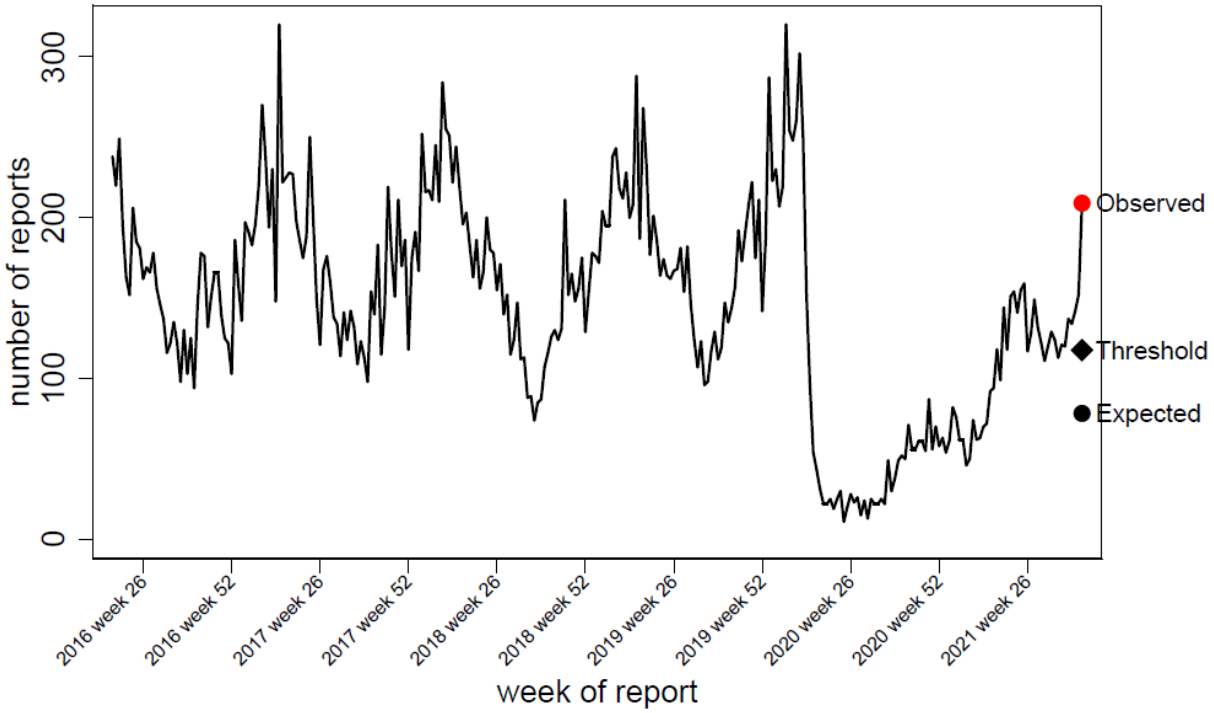
Interpreting exceedances & notifications

- Changes in local reporting or testing procedures
- Increased reporting due to heightened local or national awareness
- Sudden changes in population size
- Surveillance system technical error
- Diagnostic error
- Corrected once more information available

- Outbreak!

Example 1

- Weekly automated exceedance report from national laboratory data flags an increase above the threshold for the number of diagnoses of infection A
- Report covers all of Y&H



Time

Person

Place

Data removed from real context for training purposes

Example 1

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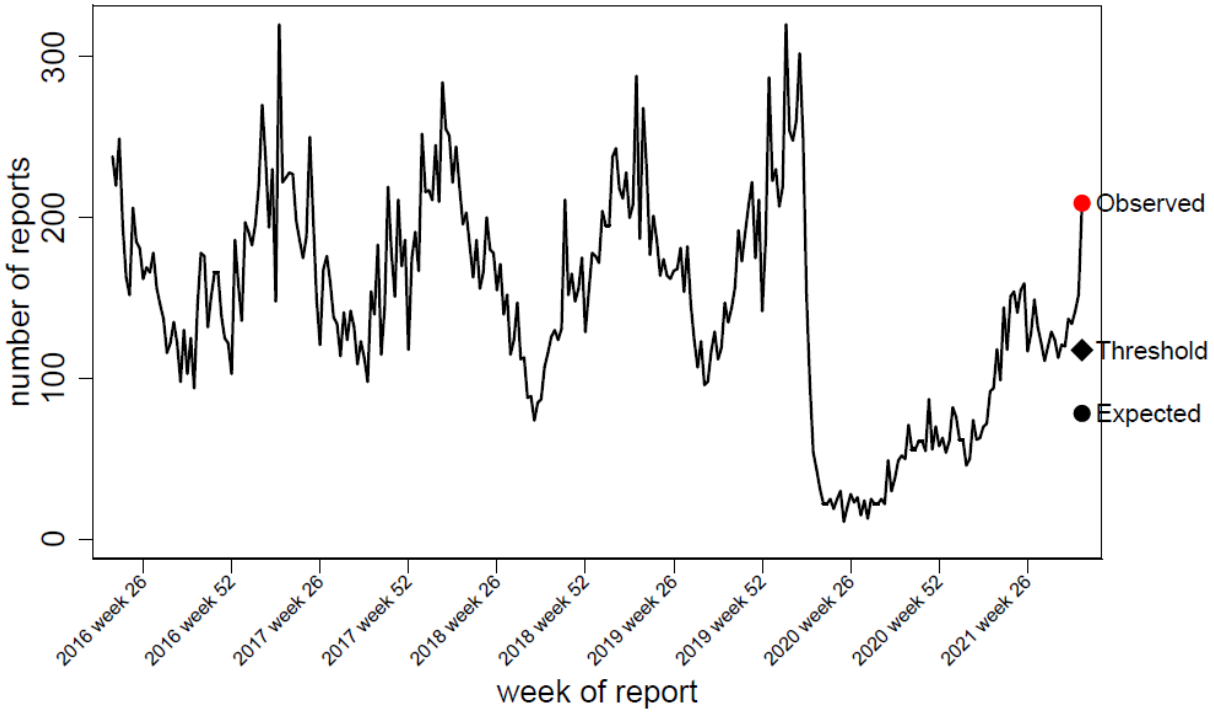
- Report covers all of Y&H



Time

Person

Place

Data removed from real context for training purposes

Example 2

- Three cases of infection B notified to the Health Protection Team in one week
- All residents of the same care home
- All with the same strain type
- Infection B can cause severe illness in vulnerable groups

Summary

- More cases than expected in time, population, place
- Regular surveillance is crucial for outbreak detection
- Increased cases do not necessarily indicate an outbreak

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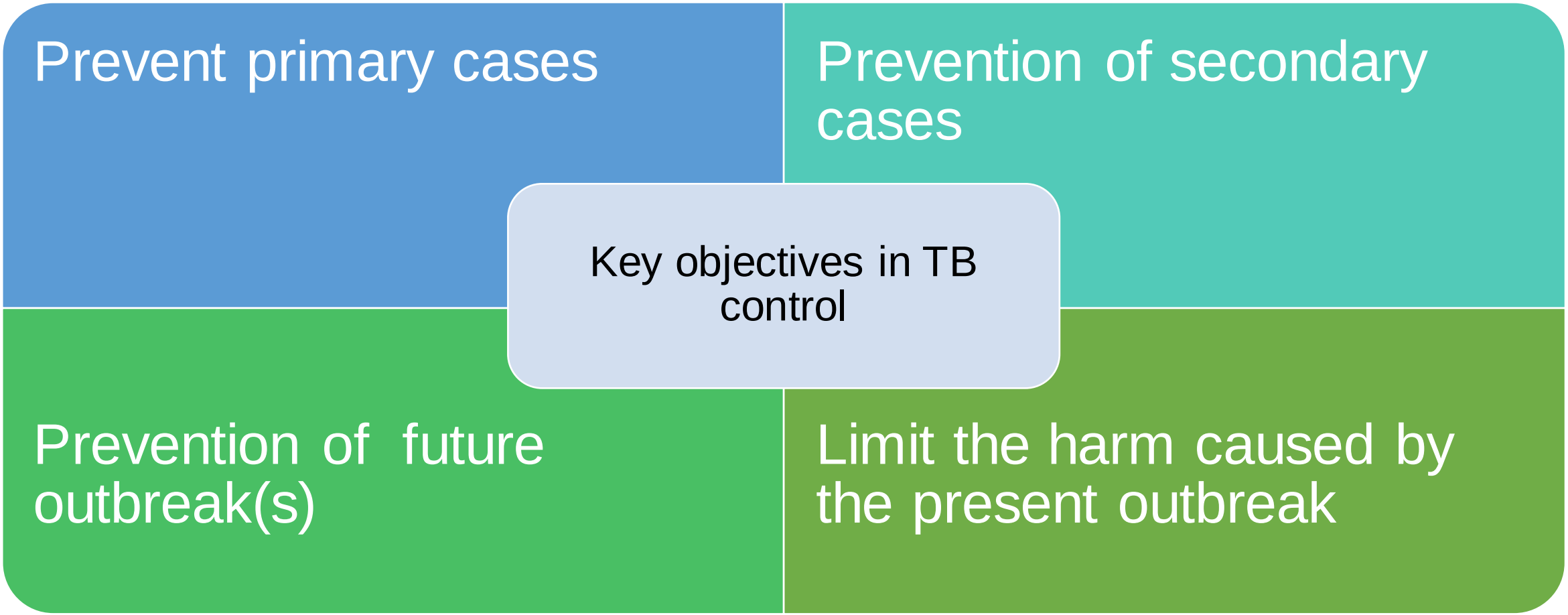
Role of UKHSA Health Protection Teams in Outbreak Management

UKHSA Health Protection Team

What do we do?

- Protect and improve the nation's health and wellbeing, and reduce health inequalities.
- Provide evidence based PH advice
- Local & national arrangements for health protection concerns and emergencies
- Support LA's, CCG, DPH, other health professionals

Why do we do it?



What makes up a Health Protection Team

- Health Protection Teams are made up of a range of professionals
- Business support
- Epidemiologists
- Consultants in Health Protection
- Health Protection Practitioners

- There are 9 Regional HPTs
- All are similar set up and may have different people supporting outbreaks

Outbreak / incident Definition

An incident in which two or more people experiencing a similar illness are linked in time or place.

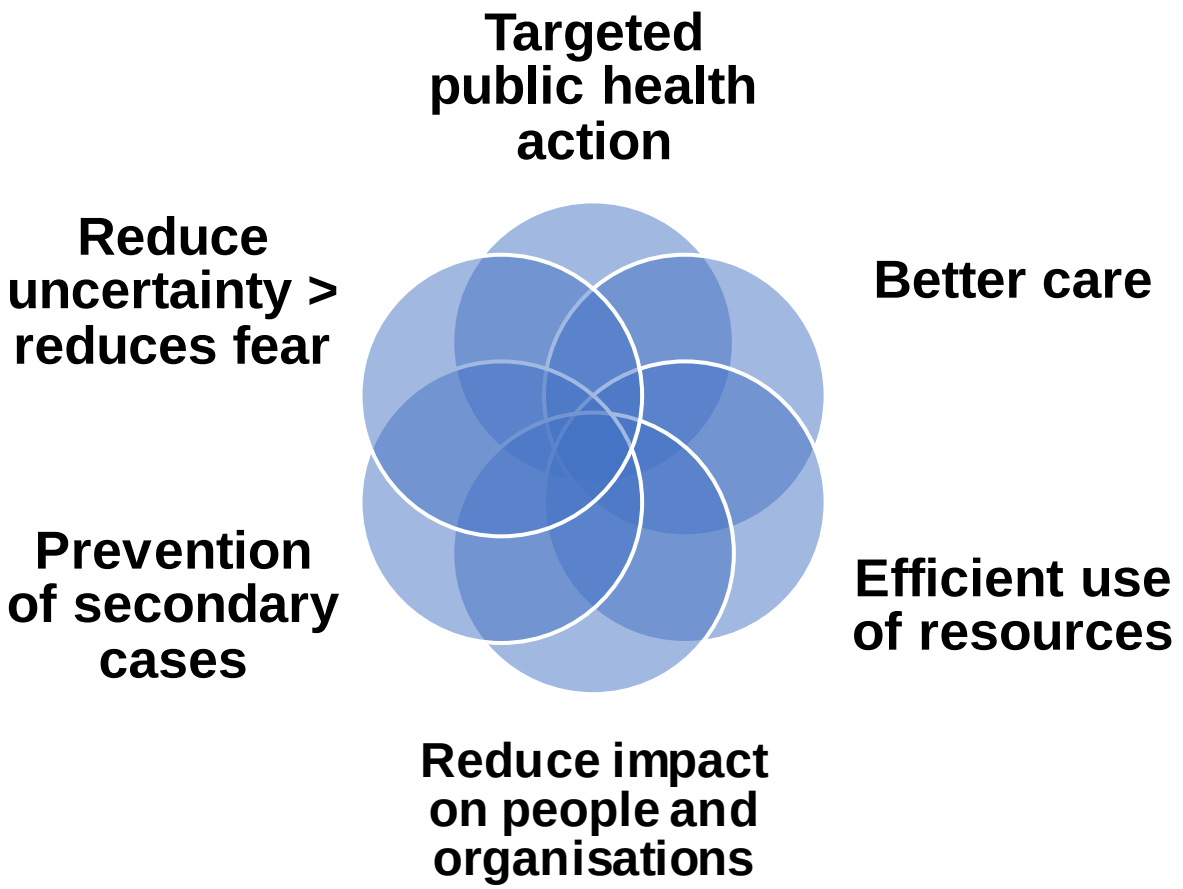
A greater than expected rate of infection compared with the usual background rate for the place and time where the outbreak has occurred.

A single case for certain rare diseases such as diphtheria, botulism, rabies, viral haemorrhagic fever or polio.

A suspected, anticipated or actual event involving microbial or chemical contamination of food or water.

Note how this would be affected by where you are and existing disease prevalence (current number of cases) and incidence (rate of new cases)

Identifying outbreaks early



Why Investigate ?

- Control and prevention
- Severity and risk to others
- Research opportunities
- Training opportunities
- Public, political, or legal concerns

Roles & Responsibilities in Outbreaks

- Local Authority: Statutory responsibility lies with the Local Authority Director of Public Health

- LAs delegate powers to a CCDC from their local Health Protection Unit (HPU) who acts as the Proper Officer under the PH (Control of Diseases) Act
- Directors of Public Health –have lead responsibility for health protection
- Environmental Health Officers have key role in managing food-borne outbreaks
- NHS clinical
- Clinical Commissioning Groups & NHS England have duty to contribute to health protection
- All registered medical practitioners have a DUTY by law to notify SUSPECTED infectious diseases under the Public Health Act
- NHS labs have a responsibility to support the management of outbreaks and to share laboratory data that may help detect an outbreak

HPT Roles in Outbreaks

- Understanding and communication of risk
- Discussion with wider system – local authority and commissioners
- Review of laboratory data such as Whole Genome Sequencing
- Detailed epidemiological analysis with Field Services
- Co- ordination of response

- **Convene an Incident/Outbreak control team (ICT / OCT)**

Steps in Outbreak Management

- Convene the outbreak control team
- Establish the presence of an outbreak
- Verify the diagnosis – develop a case definition
- Identify cases
- Describe the outbreak – construct an epidemic curve, calculate attack rate
- Generate a hypothesis
- Test the hypothesis
- Establish preventative / control measures
- Maintain surveillance
- Write report

An Outbreak Control Team (OCT)

The purpose of the OCT is to agree and coordinate the activities involved in the management, investigation and control of the outbreak or Incident

Members

- CCDC / CHP responsible for the coordination of the OCT
- NHS TB Clinical Team (TB nurses, Physician responsible for the care of the case to establish infectious status of index case)
- Microbiology or Infectious Diseases Consultants
- Local Authority Commissioners and/or providers (i.e. Clinical Commissioning Group representative, NHS England)
- Depending upon the setting, representatives as appropriate from the implicated institutions e.g. hospital IPC or school nursing service may be appropriate

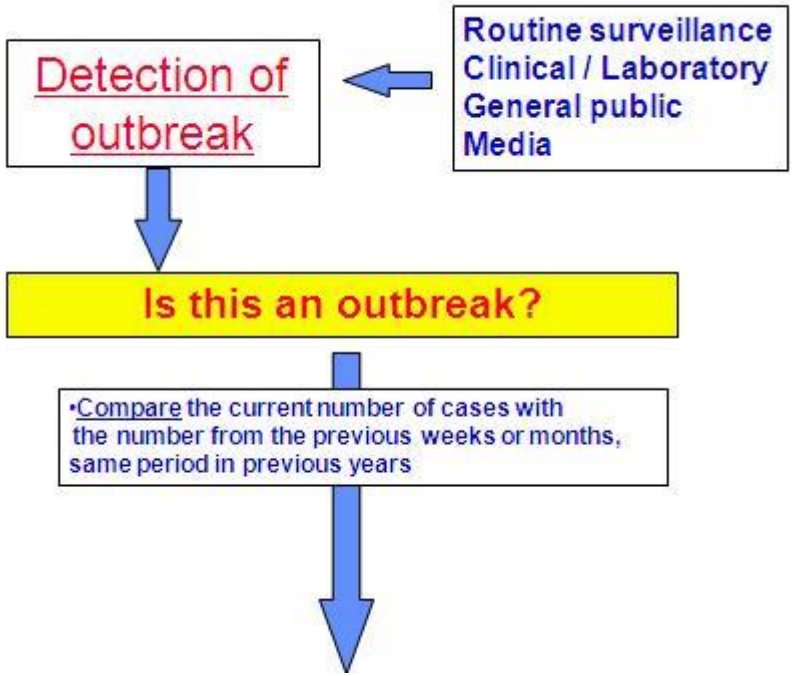
- The remit of the OCT is to agree recommendations actions and follow up this needs formal minuting

Outbreak Control Team

- Required skills
  - Leadership
  - Epidemiology & biostatistics
  - Communication
  - Clinical interviewing
  - Microbiology
  - Questionnaire design & data management
- Members include:
  - CCDC
  - DPH
  - EHO
  - Epidemiologist
  - Microbiologist
  - Communications mgt
  - Others relevant to the situation

Establish the presence of an outbreak

- Determine whether there is an outbreak – more cases than expected



- Case definition: a standard set of criteria for deciding whether a person should be classified as having the disease or condition under study.

- Usually includes :
- Clinical information about the disease
- Characteristics about the people who are affected
- Information about the location or place
- A specification of time during which the outbreak occurred.

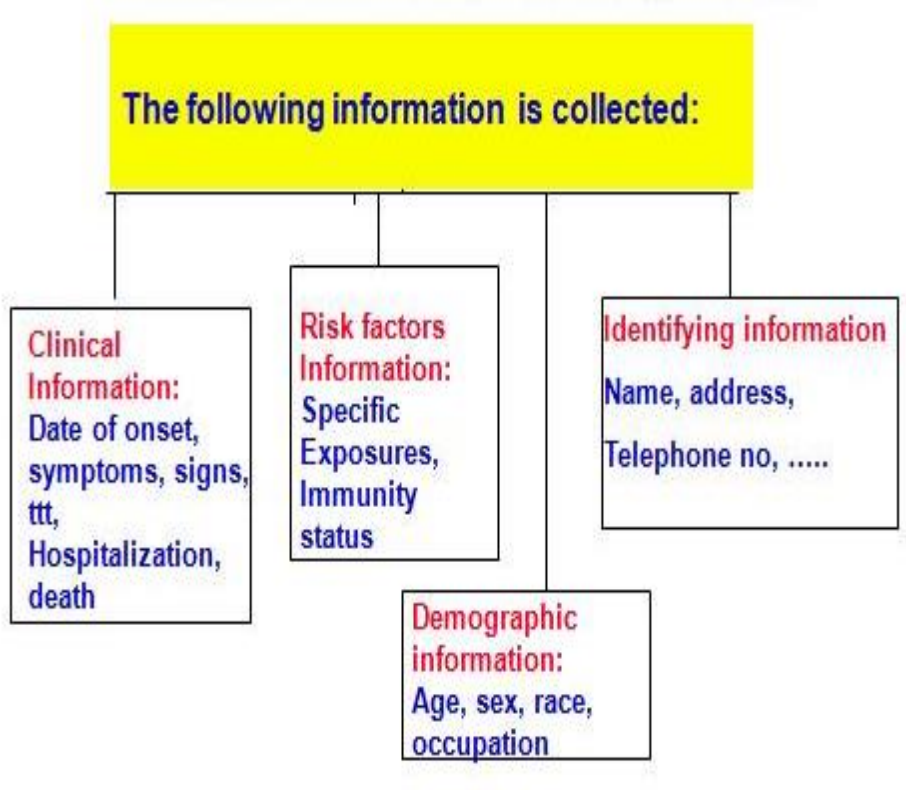
Examples of case definitions

- Confirmed:
  - Clinical features (+ location / exposure) + laboratory confirmation
- Probable:
  - Clinical features (+ location / exposure)
- Possible:
  - Not all the clinical features

- Confirmed:
- Patient with bloody diarrhoea who attended ‘Farm X’ between 1 - 20 June 1998, with E. Coli O157 isolation from faeces of patient
- Probable:
- Patient with bloody diarrhoea who attended location X’ between set dates
- Possible:
  - Patient with diarrhoea

Identify cases

- Identify all potentially exposed and gather information



- Methods - Questionnaires administered:
  - In person (face to face)
  - Over the telephone
  - By email
  - On websites
  - Social media– Facebook etc

Descriptive Epidemiology – Person Time Place

- Describe by person
- Age
- Gender
- Occupation

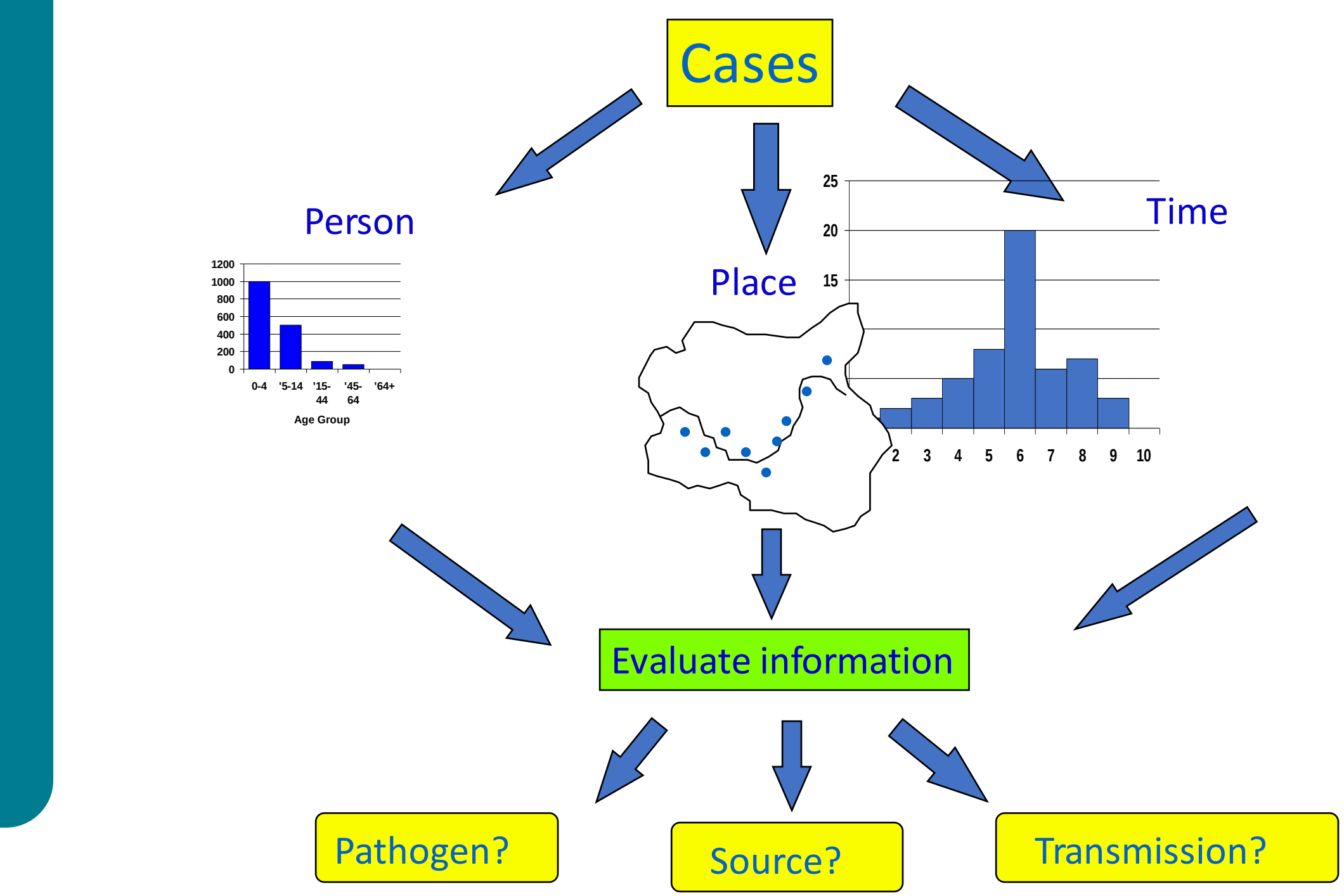
- Describe by place
- Assessment by place provides information on the geographic extent of a problem;
- May show clusters or patterns that reflect potential sources eg water supplies, a restaurant, butcher.

Step 6: Generate a hypothesis

- Based on descriptive epidemiology
- Time, place, person
- Clinical features
  - Onset date
  - Duration of symptoms
  - Incubation period

- Identify risk factors:
  - Travel history
  - Food history
  - Common exposure - catering premises, catered function
  - Institutional exposure – nursery, care home, hospital

- Those who pose a risk to others
  - E.g.. food handlers, child carers


Cases
Person
Place
Time
1200
1000
800
600
400
200
0
0-4
'5-14
'15-44
'45-64
'64+
Age Group
25
20
15
2
3
4
5
6
7
8
9
10
Evaluate information
Pathogen?
Source?
Transmission?

Wider Actions

- The OCT will agree that wider actions in relation to the case may be needed

- Inform and Advise
- Wider screening
- Active case finding

Communication

- Joint communication is key in outbreak management
- There can be sensitive especially in workplaces / schools
- High risk of deductive disclosure
- Information is for both wider stakeholders and cases / contacts
- Outbreaks are often picked up by local media outlets
- Briefing and reactive press statements should be drawn up prior to events

Outbreak Conclusion ?

- Document and record actions and outcomes from screening
- Agreement on further actions
- Where possible hold a ‘wash-up’ to review any learning
- Share findings

Summary

- HPTs are involved in establishing, control and co-ordination of outbreaks
- HPTs support the detailed epidemiology and analysis
- An IMT / OCT is convened to bring all partners on board to agree actions
- Once and OCT is convened actions are agreed acted on
- There is a sequence of steps in outbreak control and invertigation

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Outbreak Management & Epidemiological methods

Adrian Wensley, Field service NE&YH

Objectives

- Case definitions
- Line lists
- Epidemic curves
- Why are epidemiological studies important
- Common types of epidemiological study designs

Case definition

- A standard set of criteria for deciding if a person should be linked to the outbreak under investigation
    - Count cases consistently

Epidemiological case definition ≠ Clinical case definition

Components of a case definition

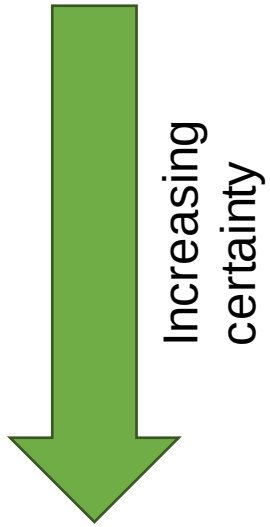
Time		Time period during which cases are considered to be at risk of exposure
Place		Geographic area or facility associated with outbreak
Person	Demographics	age, sex, occupation exclusion criteria
	Clinical features	Signs and symptoms, symptom duration
Laboratory criteria		Specimen type, organism detected, typing, local or reference lab testing

Sensitivity vs specificity

Person	A person who developed diarrhoea*
Time	within 1 to 10 days after
Place	visiting Farm X

Commonly used case definitions

- **Suspected cases**
  - Case has (some) clinical indicators and linkage by place and time only
- **Probable cases**
  - Case has clinical indicators and linkage by place, time and a possible exposure
- **Confirmed cases**
  - Case has clinical indicators, linkage by place, time, a possible exposure and a laboratory confirmed diagnosis of the causative organism



Line lists

- **Definition**: A line list is a table that summarizes information about persons who may be associated with an outbreak.
  - Each row represents a single individual
  - Each column represents a specific characteristic about that person

  - Working documents
  - Simple but important for organizing information during an outbreak investigation
  - Used to identify the criteria that may be included in a case definition
  - Provide enough data for a basic overview of the outbreak

https://foodborne.unl.edu/public/role/epidemiologist/lineLists.html

Contents of a line list

- Personal information (identifying information)
  - Name, address, phone number …
- Demographic information
  - Age or date of birth, sex, postcode, ethnicity, occupation …
- Illness Information
  - Date and time of onset, date of recovery, date of specimen collection, results of laboratory tests
  - Symptoms e.g. diarrhoea, bloody stools, vomiting, abdominal cramps, nausea, fever, and other symptoms
- Exposure Information
  - Meal location, date and time of meal, foods eaten, drinks, places visited, relevant activities

Where do we get information?

- SGSS (laboratory data)
- HPZone (from the Health Protection team)
- GDW (GI typing data)
- TB whole genome sequence data
- List of attendees at an event
- Electronic survey results download

- Initial information could be:
  - Electronic
  - Paper
  - Verbal

Descriptive epidemiology

- **Person, time, place**
  - Looking for links between cases
  - Trying to generate hypotheses:
    - Causal agent(s)
    - Type of source
    - Type of transmission
    - Time of exposure
- In order to inform public health action

Describe the outbreak by time

Epidemic curves

An epidemic curve (epi curve) is a graphical depiction (chart) of the number of cases of illness by the date (or date and time) of the onset of illness

- Inclusion depends on case definition

Epidemic curves

Epidemic curve:

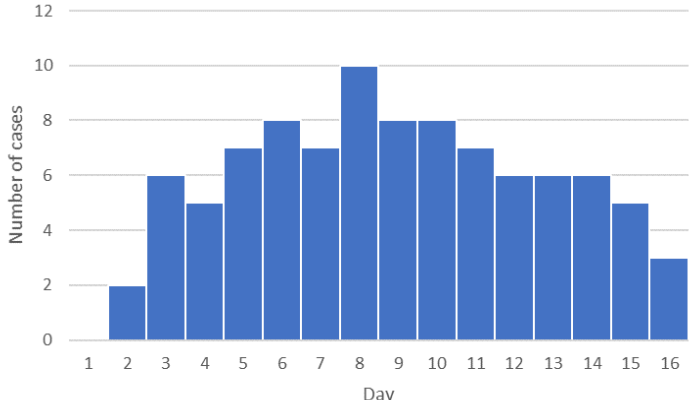
- X-axis is the date of occurrence (usually onset of illness)
- Y-axis is the number of cases: each case a single box
- Unit of time about a quarter of the duration of the incubation period

The shape can reveal:

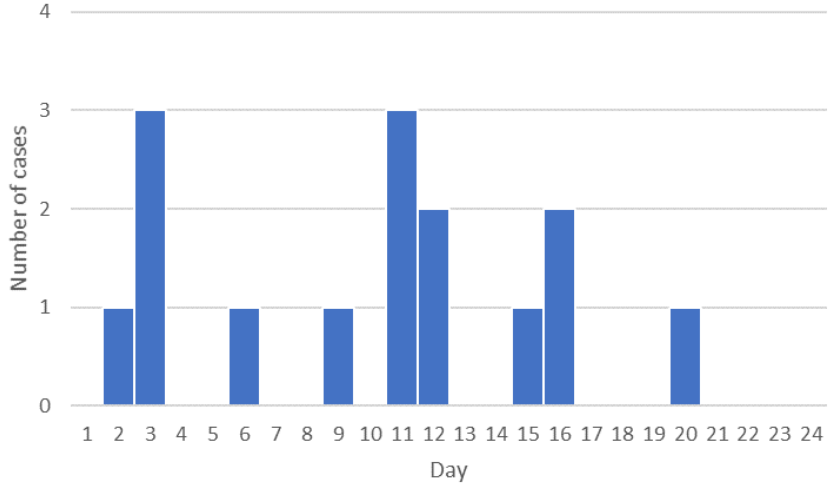
- Likely nature of transmission
  - Exposure a single point source or an ongoing one?
  - Person-to-person transmission?
- Determine likely exposure times
- Indication of the likely incubation period

Outbreak Pattern of Spread (Common Source)

People are exposed continuously

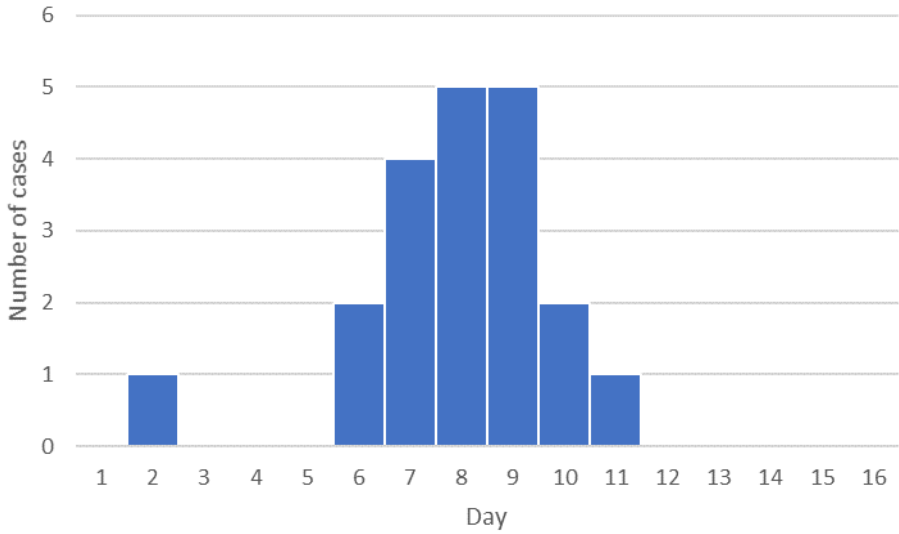


or intermittently



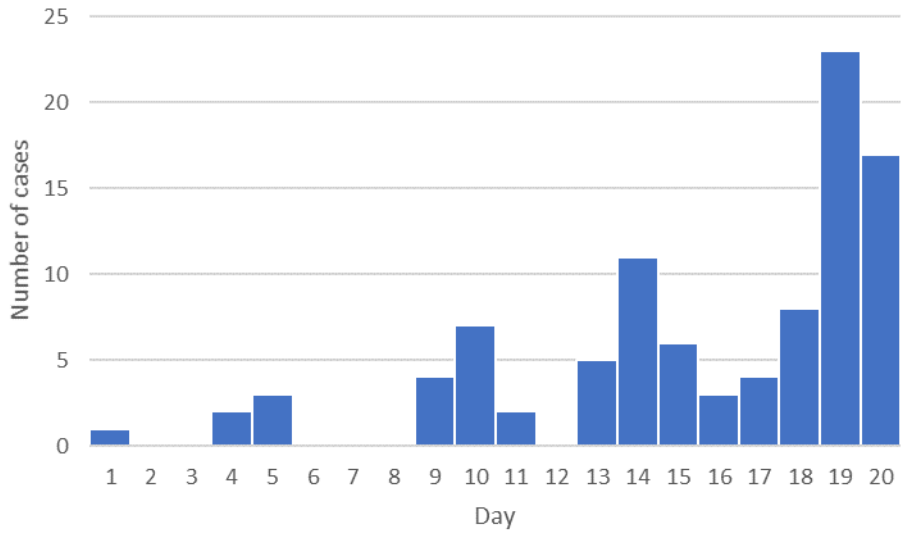
Outbreak Pattern of Spread (Point Source)

- Similar to common source
- Sharp upward slope and a gradual downward slope
- Exposure is brief
- All cases occur within one incubation period



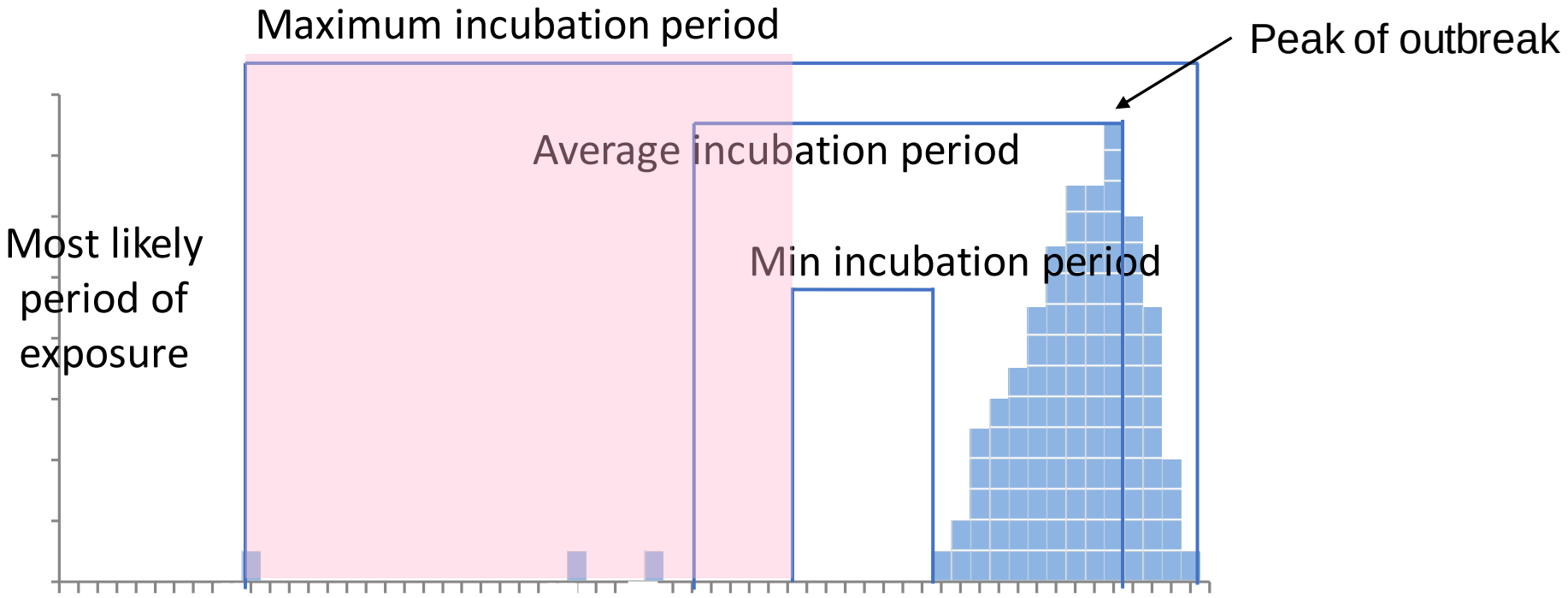
Outbreak Pattern of Spread (Propagated)

- Spread from person to person
- Can last longer than common source outbreaks
- May have multiple waves
- The classic epi curve for a propagated outbreak has progressively taller peaks, an incubation period apart



Determining likely exposure periods

- From the peak of a point source epidemic use the likely incubation period to estimate the likely period of exposure
- Point source outbreak of hepatitis A: average incubation period = 28 days (range 15-50)



www.cdc.gov/training/quicklearns/exposure/#:~:text=Determining%20the%20Period%20of%20Exposure&text=Identify%20the%20peak%20of%20the,back%20the%20minimum%20incubation%20period.

Outliers

Outliers could represent:

- The baseline incidence of the infection
- The source of the outbreak
- Unrelated cases
- A case exposed much earlier than the others
- A case exposed much later than the others
- A case with a very long incubation period
- A case with a very short incubation period
- Secondary cases

Why do an epidemiological study?

- Descriptive epidemiology can identify a potential source
- BUT…what if there are cases that do not have exposure to this source – does that mean it is not responsible?

- An epidemiological study can give an idea of how likely it is that an exposure is associated with illness
  - Test the hypothesis generated by the descriptive epidemiology

Why do an epidemiological study?

- Understand what happened (what)
- Identify the potential source (why)
- Estimate the extent of the outbreak (quantify)
- So it can be controlled and prevented in the future (prevention + control)
- Create evidence and knowledge (learning + development)

Analytical Studies

- The most commonly used study designs for outbreak investigations are cohort studies and case control studies.
- In both study designs we calculate measures of effect (Risk Ratio, Odds Ratio)
- Alongside the measures of effect we also calculate CI and p-values which provide an indication of how strong the evidence is

Choice of analytical study design

Cohort study

- Defined exposed group
- Can directly measure incidence
- Calculate risk ratio: compare the risk in the exposed to the risk of the cohort
- Frequently used for outbreak investigations of events, e.g. wedding outbreak

Case–control study

- Exposed group – ill defined
- Start with cases
- Can not directly measure risk.
- Odds ratio used as an estimation of relative risk
- Used when increase in cases observed without defined exposure e.g. Increase in reports of *E. coli* infection

Cohort study

- A cohort study is the study of choice for an outbreak investigation in a well-defined population
- In epidemiological terms the cohort is a group of people with something in common, usually an exposure/shared experience
- It is an analytical study which aims to refute or support the existence of an association between suspected cause and outcome

Cohort study outputs

- **Risk ratio/Relative risk** (RR) is a ratio of the exposed and unexposed attack rates

- Determines if the attack rate in the exposed is higher than the attack rate in the unexposed attack rate and by how many times

  - RR greater than 1 Risk factor
  - RR = 1 No association
  - RR less than 1 Protective factor

Case control study

- A case control study is used when there is not a defined population
- e.g. increase in cases in a particular geographical area
- Cases are included and then controls are selected
- Controls must be from the same population as the cases
- i.e. they must have had a chance of becoming ill/be representative in terms of exposure
- Cases and controls will be asked the same questions
- Then compare those that were exposed against those that were not
- Provides an estimate (odds ratio) of the risk

Example

	Exposed			Unexposed				
Exposure	**Total**	**Cases**	**AR**	**Total**	**Cases**	**AR**	**RR (95% CI)**	***P***
Food items								
Chicken liver pâté	21	17	80.95	32	2	6.25	12.95 (3.33–50.36)	<0.001
Soup	**29**	**6**	**20.69**	**24**	**13**	**54.17**	**0.38 (0.17–0.85)**	**0.020**
Mints	22	11	50.00	31	8	25.81	1.94 (0.93–4.01)	0.088
Melon starter	9	1	11.11	44	18	40.91	0.27 (0.04–1.78)	0.133
Turkey	28	12	42.86	25	7	28	1.53 (0.72–3.27)	0.390
Christmas pudding	14	6	42.86	39	13	33.33	1.29 (0.61–2.72)	0.535
Crepe	3	0	0.00	50	19	38	0.00 (–)	0.545
Posset desert	17	5	29.41	36	14	38.89	0.76 (0.33–1.76)	0.555
Chocolate brownie	24	8	33.33	29	11	37.93	0.88 (0.42–1.83)	0.780
Beef	18	6	33.33	35	13	37.14	0.90 (0.41–1.96)	1.000
Cod	4	1	25.00	49	18	36.73	0.68 (0.12–3.86)	1.000

An outbreak of campylobacteriosis at a hotel in England: the ongoing risk due to consumption of chicken liver dishes
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7058644/