

Research Methods : Outbreak Investigation

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Outline & Learning objectives

Outline

The lecture will introduce outbreaks or epidemics;

It will cover the systems and processes involved in identifying and investigating outbreaks;

And it will explore the public health interventions or actions that can be used to control outbreaks.

Learning objectives

1. To define an outbreak;
2. To understand why outbreaks are investigated;
3. To describe how outbreaks are identified;
4. To describe the steps in an outbreak investigation;
5. To understand the role of public health interventions in outbreak control.

What is an outbreak?

Epidemic : “the occurrence in a community or region of cases of an illness clearly in excess of normal expectancy”

Pandemic : “an epidemic usually occurring worldwide, or over a very wide area, crossing international boundaries, and usually affecting a large number of people”

Outbreak : “an epidemic limited to localised increase in the incidence of a disease e.g. in a village, town or closed institution”

Source: Last (2001)

Famous outbreaks

- 1955 paralytic polio in children who received Polio vaccine – “Cutter incident”
- 1976 pneumonia at a convention of the American Legion in Philadelphia – Legionnaire’s disease
- 1976 outbreak of haemorrhagic fever near the Ebola river
- 1981 Pneumocystis Carinii Pneumonia (PCP) in gay men in US
- 2009 pandemic H1N1 influenza

What is an outbreak

Chemical

- Scrotal cancer in Chimney sweeps, first described by Potts in 1775

Biological

- Salmonella outbreak linked to Cadbury's chocolate, UK 2006
- E.coli linked to a petting farm, UK 2009

Radiological

- Acute radiation syndrome, Goiania, Brazil, 1988

What is an outbreak?

Two or more persons with the same **disease** or **symptoms** or **organism** isolated from a diagnostic sample who are **linked** through common exposure, personal characteristics, time or location

or

A **greater than expected** rate of infection compared with the usual background rate for the particular place and time

Etc.

taken from Hawker et al 2009

Why do we investigate outbreaks



Why do we investigate outbreaks

1. Prevent primary cases by identifying and controlling the source
2. Prevent secondary cases (identify cases and take action (e.g. treatment or isolation) and identify those at risk and take action (e.g. vaccination)
3. Prevent similar events in the future by learning from outbreak and implementing changes
4. Learn about the disease and its epidemiology

How are outbreaks identified

1. Report from a clinician or laboratory
2. Report from a patient(s) or member(s) of the public
3. Routine surveillance systems
4. Media reports

What is communicable disease surveillance?

“Communicable disease surveillance is the continuous monitoring of the frequency and the distribution of disease, and death, due to infections that can be transmitted from human to human or from animals, food, water or the environment to humans, and the monitoring of risk factors for those infections.”

Health Protection Agency

Approaches

Passive: Routine systems which rely on clinicians remembering to send in a case report or returns from laboratories

Active: Systems where a surveillance team actively seeks out reports, for example in an outbreak investigation

Overview of methods of surveillance

UK: Statutory notification of infectious diseases
Laboratory reports
Sentinel surveillance e.g. primary care
Enhanced surveillance

International: ECDC – European Centre for
Disease Prevention and
Control
WHO - World Health Organisation

Infectious diseases notifiable in the UK (2010)

Acute encephalitis	Legionnaires' Disease
Acute meningitis	Leprosy
Acute poliomyelitis	Malaria
Acute infectious hepatitis	Measles
Anthrax	Meningococcal septicaemia
Botulism	Mumps
Brucellosis	Plague
Cholera	Rabies
Diphtheria	Rubella
Enteric fever (typhoid or paratyphoid fever)	SARS
Food poisoning	Smallpox
Haemolytic uraemic syndrome (HUS)	Tetanus
Infectious bloody diarrhoea	Tuberculosis
Invasive group A streptococcal disease and scarlet fever	Typhus
	Viral haemorrhagic fever (VHF)
	Whooping cough
	Yellow fever

Purpose of surveillance of infectious disease

to monitor **burden** and **distribution** of infectious disease, in order to

- inform priorities for control and prevention activities
- inform targeting of control and prevention efforts by time, person, place

to detect the occurrence of **outbreaks** or epidemics, in order to

- identify and control the source (e.g. outbreaks of food poisoning)
- prepare services for appropriate response such as increased numbers of patients (e.g. in a flu epidemic).

to **evaluate** the impact of control and prevention activities

Components of an outbreak investigation

1. Epidemiological Investigation
2. Control activity (Action)
3. Environmental investigation
4. Communication

Epidemiological investigation

1. Identify a potential outbreak
 2. Form an outbreak control team
-
1. Case definition
 2. Confirm cases
 3. Case finding
 4. Collect information from cases
 5. Describe the epidemiology of cases
 6. Generate a hypothesis
 7. Test the hypothesis

Example

An outbreak of *Salmonella typhimurium* 108/170 at a privately catered BBQ at a Sydney Sports Club

Jardine et al (2011) Foodborne Pathogens and Disease. Online ahead of print.
doi:10.1089/fpd.2011.0918

Scenario

1st February 2009

Two Public Health Units in Sydney

Notified by 2 Hospital Emergency Departments

People who attended a BBQ on 30th January had presented with diarrhoeal illness

What ACTION should/did the Public Health Units take at this time?

Formed a multidisciplinary team to investigate the outbreak

Epidemiological investigation

1. Case definition

Specific to each outbreak

Describes the characteristics that cases need to have to be included in the outbreak

Includes: person/place/time

Changes during the outbreak as more information becomes available

What was the case definition used in this investigation?

Epidemiological investigation

What was the case definition in this investigation?

a) Suspected case

Time: 30th January 2009

Place: Sydney Sports Club

Person: attended the BBQ **AND** experienced symptoms
(diarrhoea plus ≥ 1 nausea/vomiting/abdominal
cramps/fever/joint pain/headache)

Epidemiological investigation

2. Confirm cases

e.g. culture of a stool specimen for infectious agents

Ensure that this is an actual outbreak

Ensure that diagnosis is correct (exclude artefact e.g. laboratory error)

A confirmed case in this outbreak was defined as a suspected case with a stool sample with *Salmonella typhimurium* plus phage typing

Epidemiological investigation

3. Case finding

- Active searching for (more) cases
- Ask for active reporting of cases that fit the case definition e.g. laboratories, GPs or schools
- Determine the extent of the outbreak
- Identify the range of clinical presentations
- Find people for the descriptive and analytic epidemiology

How was active case finding performed in this investigation?

Epidemiological Investigation

How was active case finding performed in this investigation?

1. Contacted Emergency Departments and GP's
2. Local surveillance system
3. Advert in local paper
4. Information poster at venue
5. Snowballing – ask suspected cases to provide details on other attendees

Epidemiological investigation

4. Collect information from cases

- To investigate the cause of the outbreak – look for links between the cases
- Usually done by a questionnaire – self-completed or interview (telephone or face-to-face)
- Basic information about the case e.g. age, sex, occupation, travel
- Specific questions related to outbreak situation:
 - Food borne – food diary
 - Air borne- location of home/work and travel
 - Person-person – contact history (e.g. household contacts)

How was information collected in this scenario?

Epidemiological Investigation

In this outbreak investigation:

Telephone questionnaire

- Demographic information
- Food history
- Clinical syndrome

Epidemiological investigation

5. Describe the epidemiology of cases

Time	date of symptom onset and resolution
Person	demographics and clinical syndrome
Place	home/work/travel

Epidemiological investigation

Epidemic curves

Graphical display of the progress of the outbreak

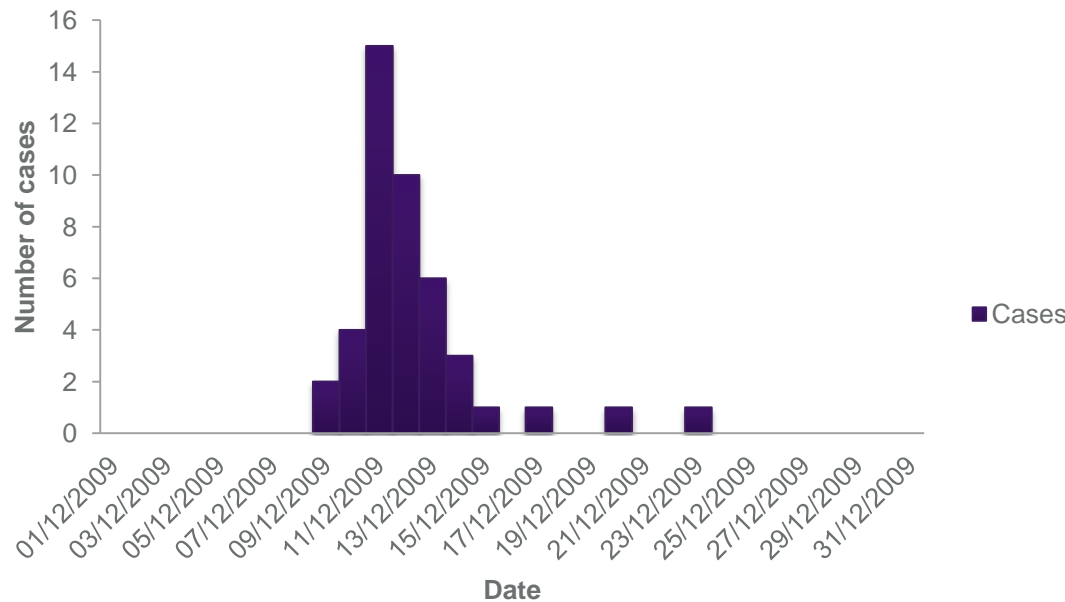
Plot the date at which cases become symptomatic

Provides information about the nature of the outbreak

- Point or common source
- Continuing source
- Propagated source

Epidemiological investigation

Point Source



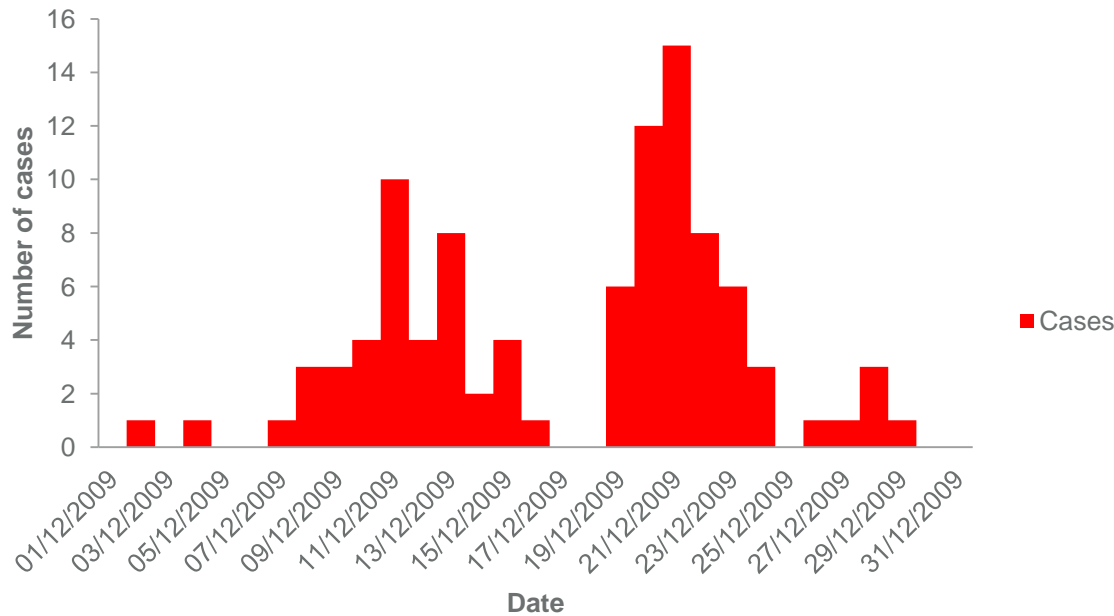
- All cases exposed over short time period
- Single peak
- All infections occur within one incubation period

Example

- Food poisoning from a contaminated buffet

Epidemiological investigation

Propagated Source



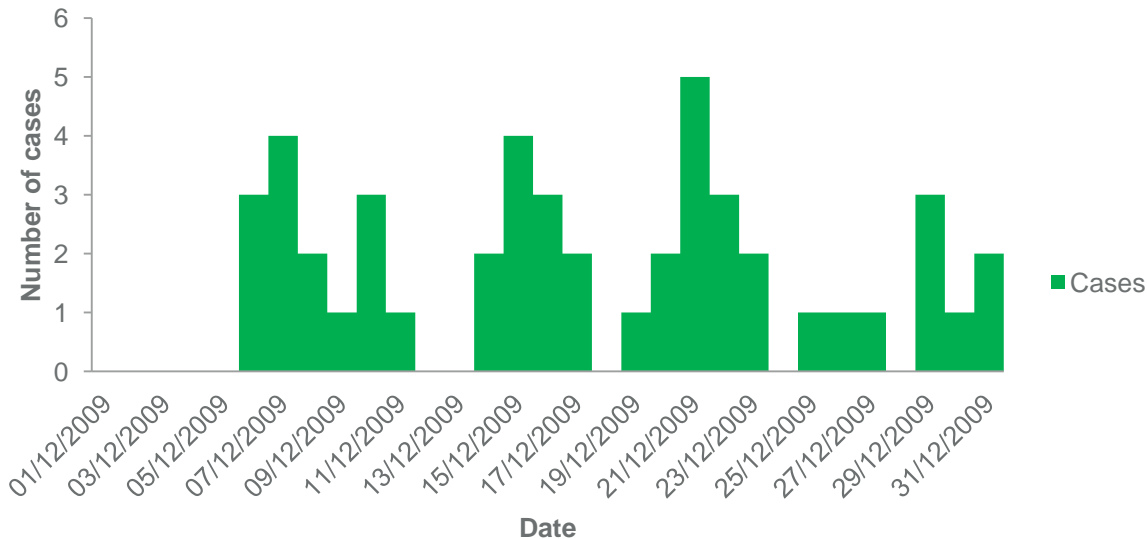
- Infection can spread from one person to another
- Multiple peaks
- Infections occur over several incubation periods

Example

- Measles outbreak at a school

Epidemiological investigation

Continuing Source



- An ongoing source of infection
- Infections occur randomly when compared to the incubation period

Example

- Legionella from a contaminated air conditioning unit

Epidemiological Investigation

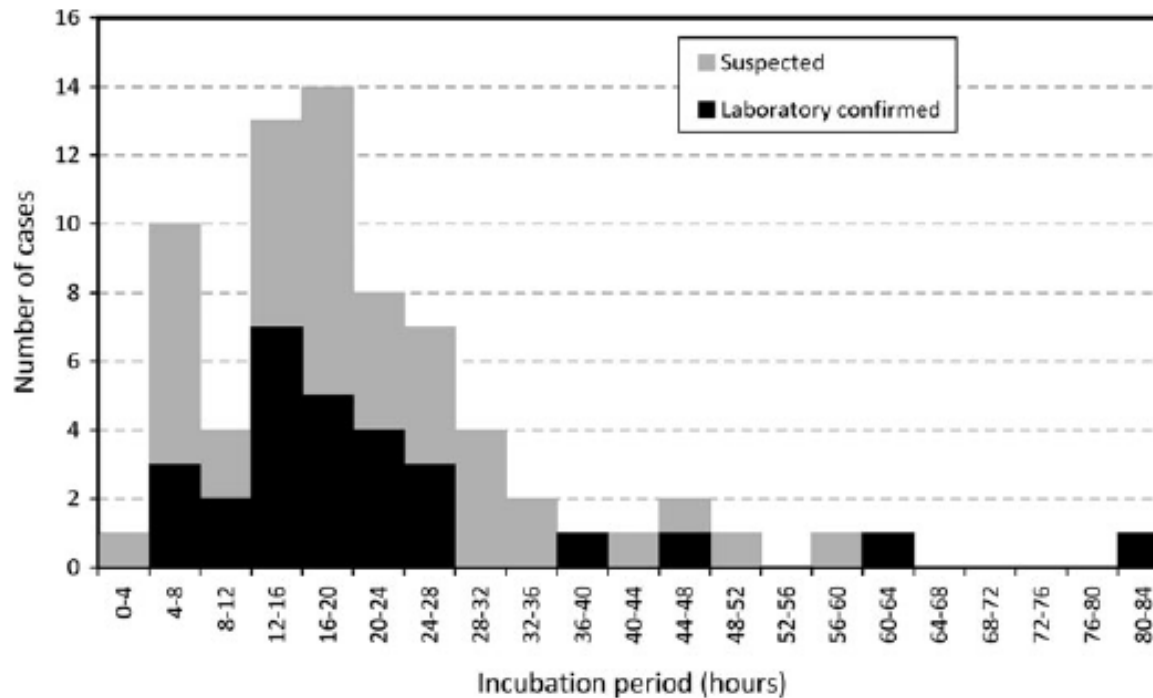


FIG. 1. Cases of gastroenteritis ($n=71$), by incubation period, among attendees of a barbeque at a sports club, Sydney, January 30, 2009.

Jardine et al (2011)

What type of epidemic curve is this?

Epidemiological investigation

6. Generate a hypothesis

Using the information available make a statement about the cause of the outbreak that you can scientifically test.

Write a hypothesis for this outbreak investigation

e.g. The cause of the outbreak of *Salmonella typhimurium* in attendees of the BBQ at the Sydney Sports Club on 30th January 2009 was consumption of contaminated food.

Epidemiological investigation

7. Test the hypothesis – 2 main study designs:

a) Cohort study

take a group of people defined by their exposure
e.g. people who attended the BBQ
outcome is an estimate of relative risk

b) Case control study

take two groups of people defined by their outcome
e.g. people who developed symptoms of gastroenteritis (cases)
and people who did not (controls)
outcome is an estimate of the odds ratio

Epidemiological investigation

In this investigation, a telephone questionnaire was completed with 85 attendees of the BBQ. 71 were suspected or confirmed CASES and 14 were CONTROLS

The questionnaire asked them to report which food items they had eaten/put on their plate

Epidemiological investigation

Summary of the questionnaire results:

	Food Items			
	Lettuce	Tomato	Russian Salad	BBQ Chicken
Cases	56	46	59	36
Controls	7	5	5	5

Epidemiological investigation

Re-tabulation of questionnaire results for :

		Outcome		
		Ill (cases)	Not ill (controls)	Total
Exposure	Russian Salad	59	5	64
	No Russian Salad	12	9	21
Total		71	14	85

Epidemiological investigation

Odds of an event = $\frac{\text{number of times event happened}}{\text{number of times event did not happen}}$

Odds of gastroenteritis in people who ate salad = $59/5 = 11.8$

Odds of gastroenteritis in people who did not eat salad = $12/9 = 1.33$

Odds ratio = $\frac{\text{Odds in exposed}}{\text{Odds in not exposed}} = \frac{\text{Odds in salad}}{\text{Odds in not salad}} = 11.8/1.3 = 8.85$

		Outcome		
		Ill	Not ill	Total
Exposure	R.Salad	59	5	64
	No R.Salad	12	9	21
Total		71	14	85

Therefore people who ate Russian salad were **8.85 times** more likely develop illness than people who did not eat Russian salad

Components of an outbreak investigation

1. Epidemiological Investigation
2. Control activity (Action)
3. Environmental investigation
4. Communication

Environmental investigation

- Depending on outbreak environmental samples can identify or confirm the organism and its source
- In England and Wales – Environmental Health Department of Local Authority
- Where criminal activity may have occurred - Police
- e.g. food samples (salmonella)
water samples (legionella)

Environmental Investigation

In the example investigation:

Environmental sampling was carried out in the kitchen where the food was prepared/stored and at the venue where the BBQ was held.

Samples of food were taken; swabs of surfaces; samples of materials in contact with food

Salmonella typhimurium 108/170 was found in raw egg mayonnaise

Trace-back of eggs to grocery store to supplier and original farm

However no *Salmonella typhimurium* was detected

Control

Specific to each outbreak:

- Source
- Route of transmission
- At risk groups

Control measures:

- Safe
- Effective
- Appropriate to the risk
- Timely



- Alternative water supply
- Disinfection
- Treat cases

- Isolate cases
- Handwashing
- Needle exchange

- Vaccination
- Prophylactic antibiotics

Public Health Act 1984; Public Health Infectious Disease Regulations 1988

Control

Examples of control activity

Outbreak	Immediate	Definitive
Meningitis at a school	Prophylactic antibiotics for contacts	Vaccination for Meningitis C
Salmonella in food	Advise public not to eat the food	Formal product recall
Measles in a community	Vaccination or immunoglobulin (depending on contra-indications)	Public information campaign Vaccination campaign
E.Coli in water supply	e.g. Boil water notice	Water company to rectify fault and learn for future

Communication

Between outbreak control team and:

- Other professionals
- People involved/at risk
- Community/public
- Media

Purpose:

- Inform about the outbreak
- Inform about the condition
- Inform about action being taken – investigation and control
- Declare the outbreak over

Example of press releases



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Investigation indicates a bean sprout link with Salmonella cases

29 September 2010

The Health Protection Agency (HPA) is strongly advising caterers and the public to heed the Food Standards Agency's advice that raw bean sprouts should be washed and thoroughly cooked before they are eaten, unless they are clearly labeled as ready to eat.

An investigation in England and Scotland now has further evidence of a link between the consumption of raw or under-cooked bean sprouts and a recent increase in cases of *Salmonella* Bareilly infection.

The HPA's Centre for Infections (CFI) in Colindale has identified 106 *S. Bareilly* cases in England, Wales (3 of the cases) and Northern Ireland (one case) since the beginning of August to date. The CFI normally sees fewer than 10 cases of *S. Bareilly* in a typical month.

Example of press releases

The screenshot displays the Health Protection Agency (HPA) website. At the top right, there are links for Accessibility, High contrast version, Contact Us, and Site Map. The main navigation bar includes Home, Topics, Products & Services, Publications, News Centre, Events & Professional Training, and About the HPA. A search bar is located on the right side of the page. The main content area features a breadcrumb trail: Home > News Centre > National Press Releases > 2010 Press Releases > Three children die with suspected meningitis in Suffolk. The headline of the press release is "Three children die with suspected meningitis in Suffolk", dated 2 January 2010. The text of the release states: "The Health Protection Agency (HPA) can confirm that three children from the Ipswich area have died from suspected meningitis. The first child died in mid-December 2009." It further explains that the HPA is awaiting laboratory test confirmation on the strain of disease from the most recent cases, with results expected early next week. The HPA's Norfolk, Suffolk and Cambridgeshire Health Protection Unit (HPU) is working with NHS Suffolk to reduce the risk of further infection among contacts. Dr Torbjorn Sundkvist, Consultant in Communicable Disease Control from the HPU, is quoted as saying: "Our thoughts are with the families of these children at this terrible time. Currently we have received no information that would link all three cases but we are continuing to investigate." A quote at the bottom states: "Meningitis does not spread easily from one person to another, but we do occasionally see cases spread between close contacts such as family members. When a case of meningitis is diagnosed, the public health doctor will make sure that all those who need antibiotics are contacted."

Accessibility | High contrast version | Contact Us | Site Map

Health Protection Agency

Home Topics

Home > News Centre > National Press Releases > 2010 Press Releases > Three children die with suspected meningitis in Suffolk

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Three children die with suspected meningitis in Suffolk

2 January 2010

The Health Protection Agency (HPA) can confirm that three children from the Ipswich area have died from suspected meningitis. The first child died in mid-December 2009.

The Health Protection Agency (HPA) can confirm that three children from the Ipswich area have died from suspected meningitis. The first child died in mid-December 2009. At present it is not believed this case is linked to the most recent deaths (31st December 2009 and 1st January 2010). The HPA is awaiting laboratory test confirmation on the strain of disease from the most recent cases, with results expected early next week.

The HPA's Norfolk, Suffolk and Cambridgeshire Health Protection Unit (HPU), working with NHS Suffolk, has taken the necessary action to reduce the risk of further infection among contacts. Individuals in close household contact have been offered antibiotics to kill any bacteria they may be carrying and prevent it spreading.

Dr Torbjorn Sundkvist, Consultant in Communicable Disease Control from the HPU said: "Our thoughts are with the families of these children at this terrible time. Currently we have received no information that would link all three cases but we are continuing to investigate.

"Meningitis does not spread easily from one person to another, but we do occasionally see cases spread between close contacts such as family members. When a case of meningitis is diagnosed, the public health doctor will make sure that all those who need antibiotics are contacted."

Example of press releases



The screenshot shows the WHO website interface. At the top, there is a navigation bar with language options: عربي, 中文, English, Français, Русский, and Español. Below this is the WHO logo and name, a search bar, and radio buttons for 'All WHO' and 'This site only'. The main content area is divided into a left sidebar and a main right section. The sidebar contains links for Home, About WHO, Countries, Health topics, Publications, Data and statistics, Programmes and projects, GAR Home, Alert & Response Operations, and Diseases. The main section features a highlighted 'Global Alert and Response (GAR)' header, followed by a breadcrumb trail: WHO > Programmes and projects > Global Alert and Response (GAR) > Disease Outbreak News. A 'printable version' link is provided. The main title is 'Swine influenza - Statement by WHO Director-General, Dr Margaret Chan', dated 25 April 2009. The text of the statement begins: 'The current situation constitutes a public health emergency of international concern. However, more information is needed before a decision could be made concerning the appropriateness of the current alert level.' A link to 'Swine influenza' is also present.

Home	Global Alert and Response (GAR)
About WHO	Country activities Outbreak news Resources Media centre
Countries	WHO > Programmes and projects > Global Alert and Response (GAR) > Disease Outbreak News
Health topics	 printable version
Publications	25 April 2009
Data and statistics	Swine influenza - Statement by WHO Director-General, Dr Margaret Chan
Programmes and projects	
GAR Home	The current situation constitutes a public health emergency of international concern. However, more information is needed before a decision could be made concerning the appropriateness of the current alert level.
Alert & Response Operations	Swine influenza
Diseases	

Example of press releases

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[WHO](#) > [Programmes and projects](#) > [Global Alert and Response \(GAR\)](#) > [Disease Outbreak News](#)

[printable version](#)

Influenza updates

10 September 2010 -- On August 10 the WHO Director-General Dr Margaret Chan announced that the H1N1 influenza event has moved into the post-pandemic period. The influenza situation update will no longer be posted on the Disease Outbreak News website. The global influenza programme will continue to monitor the influenza activity worldwide on a weekly basis and every two weeks a WHO influenza update will be published on the link below.

[Influenza update - 24 September 2010](#)

Summary

- To define an outbreak
- To understand why outbreaks are investigated
- To describe how outbreaks are identified
- To describe the steps in an outbreak investigation
 - Epidemiological
 - Environmental
 - Control
 - Communication

References and further reading

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