Outbreak Investigation and Response

Disease Control in Humanitarian Emergencies (DCE)
Department of Epidemic & Pandemic Alert and Response (EPR)
Objectives

• To understand:
  • The principles of detecting and controlling an outbreak
  • What is needed for preparedness
  • The role/principles of early warning systems
  • What is needed for outbreak investigation
  • What is needed for outbreak control
What is an outbreak?

- A public health emergency!
- A political emergency!
- An economic emergency!
- An event requiring rapid action!
- Surveillance failure!
- Control failure!
- An opportunity!
Definition of outbreak

- Occurrence of more cases of disease than expected in a given area among a specific group of people over a particular period of time
The Iceberg
The Iceberg

- Exposed
- Infected
- Disease
- Seek medical attention
- Clinical specimen
- Pos. specimen
- Report
The Shigella Iceberg

1000 Infections occur...

… 50 are reported

Why investigate an outbreak?

- Public Health rational
  - To reduce or prevent mortality
  - To reduce morbidity
  - To design control and preventive measures

- Delayed or improper interventions = DEATHS
Objectives of outbreak investigations

- To control the outbreak!
- To prevent future outbreaks
- To provide statutorily mandated services
- To strengthen surveillance at local level
- To advance knowledge about a disease
- To provide training opportunities
Investigation requires:

- Basic medical & public health knowledge
- Basic concepts of epidemiology
- Sources of specialized information (e.g. reference books & specialists)
- Knowledge of the environment
- Laboratory testing (but not always)
- COMMON SENSE!
Components of Effective Outbreak Management

- Anticipation/Prediction
- Preparedness
- Early warning/Surveillance
- Effective and co-ordinated response
- Evaluation
Outbreak Detection and Response
Without Preparedness

First Case
Late Detection
Delayed Response

Opportunity for control
Outbreak Detection and Response
With Preparedness

Early Detection
Rapid Response

Potential Cases Prevented

CASES
DAY
What is the objective of Early Warning/surveillance?

- To predict, detect and confirm outbreaks of public health importance in a timely fashion and to disseminate that information to those who need to know so that effective public health action can be taken.
How can early warning systems contribute to outbreak management?

- Establish the expected
- Detect the unexpected (early warning)
- Verify/Confirm the existence of an outbreak
- Monitor the evolution of an outbreak
- Tell you the when outbreak is over
- Show you where your control programme failed!
## Epidemiology as a Tool

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Investigating an Outbreak

What are the steps in investigating an outbreak?
Investigation Steps

1) Establish the existence of an outbreak
2) Confirm the diagnosis
3) Define a case
4) Count cases
5) Perform descriptive epidemiology (time, person, place)
   • Determine who is at risk
6) Develop hypotheses explaining exposure & disease
7) Evaluate hypotheses
8) Communicate findings

Control the Outbreak!
Establish the Existence of an Outbreak

Definition of outbreak

- One case – for diseases of epidemic potential (e.g., measles, cholera)
- More than the expected number of cases – for endemic diseases
- Sometimes is quantitative threshold (e.g. meningococcal meningitis)

Surveillance is critical for early detection!
Confirm the Diagnosis

- Talk with health workers
- Examine cases yourself!
- Laboratory testing (e.g., malaria, cholera, hemorrhagic fevers, etc.)

Verification of rumoured outbreaks is essential...
Develop Case definition

- Standard set of criteria for deciding if a person should be classified as affected by disease under investigation.
- Clinical criteria, restrictions of time, place, person
- Simple, practical, objective
- Sensitivity versus specificity
Case Definitions

• Must be easily applied by health workers
  – Preferably does not require laboratory results

• Must be standardized

• Should be relatively sensitive
  – Detect most cases
  – May pick up false positives
**Develop a Case Definition**

Measles: 3 possible case definitions

- Fever and runny nose
- Fever and rash and Koplik’s spots and conjunctivitis
- Fever **and** maculopapular rash (i.e. non-vesicular) **and** cough, coryza (i.e. runny nose) or conjunctivitis (i.e. red eyes)
Develop a Case Definition

Measles: 3 definitions

- Fever and runny nose
  - Too sensitive
  - Too many other illnesses produce same symptoms
  - Call many illnesses “measles”

- Fever and rash and Koplik’s spots and conjunctivitis
  - Too specific
  - Many cases of measles do not have all these signs
  - Miss many real cases of measles

- WHO case definition: Fever and maculopapular rash (i.e. non-vesicular) and cough, coryza (i.e. runny nose) or conjunctivitis (i.e. red eyes)
Develop a Case Definition

Sometimes define levels of certainty regarding diagnosis; for example, meningitis or Ebola

- **Suspect case**: suggestive clinical signs but does not fit case definition

- **Probable case**: fits all components of *clinical* case definition

- **Confirmed case**: laboratory confirmed
Count Cases

- Reinforce passive surveillance
- Active case finding

You do not have to count all cases, but
  - What proportion should be detected?
  - Depends on what you do with the data
Perform Descriptive Epidemiology

**TIME, PERSON, PLACE**
- Who is affected? (age, gender, occupation, etc)
- Where? What geographic features in common? (province, district, village; home, workplace, school, etc)
- Over what time period? (dates of exposure, dates of reporting, dates of onset...?)

It may be possible to hypothesize:
- Who is at risk?
- What is source of infection?
- What is mode of transmission?
Descriptive Epidemiology - Person

• Numerators
  – Number of cases, often in terms of
    • age, sex,
    • other parameters: refugee / displaced / residents
    • immunized, not immunized

• Denominators
  – Population from which the numerators came

• Compare rates to identify high risk groups
Descriptive Epidemiology - Place

- Map cases: identify geographic places at risk

- Determine where disease acquired: Home, work, travel, etc…
Field Mapping of Gulran Cases
Descriptive Epidemiology - Time

- Distribution of cases by date of onset
- X axis: time
- Y axis: number of cases
- Shows:
  - Time limits / duration of the outbreak
  - Peak / incubation period
  - Form of curve: evolution of outbreak
  - Formulate hypothesis regarding source
Epi Curves

- Epi curves are histograms
  - There should be little space between the x-axis categories

- Label each axis

- Provide a descriptive title
  - Epi-curve should be able to stand alone

- Include the pre-epidemic period to show the baseline number of cases
Epi Curve

Figure 3. Epidemic curve of laboratory-confirmed tularemia cases (n = 247) in Kosovo, by month of onset of symptoms, October 1999–May 2000.

Examples of epidemic curves

**Point source**

**Common source**

**Propagated: person to person**
Epi Curve – Interpretation?

![Epi Curve Diagram](image)
Point Source

Number of cases

Date

0 2 4 6 8 10 12

1 2 3 4 5 6 7 8 9

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Epi Curve – Interpretation?

![Graph showing an epidemic curve with dates on the x-axis and number of cases on the y-axis. The graph displays fluctuations in case numbers over time.]
Common Source

Date

Number of cases

1  3  5  7  9  11  13  15  17  19  21

0  1  2  3  4  5  6  7  8  9  10
Epi Curve – Interpretation?

![Epi Curve Graph]

The graph above illustrates an epi curve, which is a graphical representation of the number of cases over time. Each bar represents the number of cases on a specific date. The x-axis represents the date, while the y-axis represents the number of cases. The pattern and trend in the epi curve can provide insights into the dynamics of an outbreak, helping in the investigation and response efforts.
Propagated
Soho, London, 1854

- Large urban population, densely populated, widespread poverty. No sewage or sanitation system.
- On 31 August 1854, a major outbreak of cholera struck Soho.
  - "the most terrible outbreak of cholera which ever occurred in the kingdom."
- Over the next three days 127 people on or near Broad Street died.
- In the next week, three quarters of the residents had fled the area. By 10 September, 500 people had died and the mortality rate was 12.8 percent in some parts of the city.
"A Court for King Cholera"
John Snow’s Map of Cholera Cases
"Cholera in Broad Street, Soho"
Soho, London
Ebola epidemic, Yambuku, Zaire 1976

Yambuku 4.5
Yamolembia 2.6
Yamisole 2.7
Badjoki 1.8
Bongola 1.6
Kokoko 0.8
Yasoku 0.2
Yambala 0.7
Yambala 0.1
Yapiki 0.7
Yaeto-Liku 1.3
Yalosemba 1.0
Modjambole 0.8

World Health Organization
Develop Hypotheses

- Often obvious from descriptive epidemiology
- Formulate idea about source of outbreak and mode of transmission
Test Hypotheses

• Case – control study
  – Identify cases
  – Select control group
    • Possibly matched on age or sex or location
    • Neighbours, community members, clinic patients, etc
  – Compare exposures among cases and controls
  – Calculate odds ratios for various exposures

• Cohort study
  – Compare attack rates among those differently exposed
  – Less commonly done during outbreak investigation
Control the Source of Pathogen

- Remove source of contamination
- Remove persons from exposure
- Inactivate / neutralise the pathogen
- Isolate and/or treat infected persons
Interrupt transmission

- Interrupt environmental sources (safe water, sanitation, adequate shelter, standard infection control precautions in HCFs)
- Control vector transmission (IRS, larvicide, environmental hygiene)
- Improve personal hygiene (health education, soap)
Control measures
Ebola Haemorrhagic Fever, Uganda - September 2000 to January 2001

• Identify and isolate cases in a safe environment (425)
• Identify and monitor contacts (>6,000)
• Educate the population on how to avoid infection
• Safe burial
Modify host response

- Immunise susceptibles
- Use prophylactic chemotherapy
- Treatment of cases
Communication

- Prepare written report
- Communicate public health messages
- Impact public health policy
- Evaluate performance
Communication: Report

- Clarifies your own ideas / synthesis
- Creates a record
  - Guide public health interventions, prevention activities
  - Extremely valuable for similar outbreaks in the future
- Advocacy: MOH, UN, other NGOs, donors
Identify & count cases

Obtain information

Perform descriptive epidemiology

Clearly identifiable groups
- Hospitals
- Laboratories
- Schools
- Workplace, etc
Identify & count cases

Obtain information
- Identifying information
  - Demographic information
  - Clinical details
  - Risk factors

Perform descriptive epidemiology
Identify & count cases

Obtain information

Perform descriptive epidemiology

Orient cases in
- time
- place
- person
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Evaluate information

Pathogen?  Source?  Transmission?

Cases

Person

Place

Time

Age Group

0-4 '5-14 '15-44 '64+ 0-4 '5-14 '15-44 '64+
Develop hypotheses

- Who is at risk of becoming ill?
- What is the disease causing the outbreak?
- What is the source and the vehicle?
- What is the mode of transmission?

Compare hypotheses with facts
Analytical epidemiological studies

Test specific hypotheses

Without a comparison group there is no epidemiological evidence
Implement control measures

Control the source of the pathogen

Interrupt transmission

Modify host response

Prevent recurrence

May occur at any time during the outbreak!!
Thank You

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