Epidemic Preparedness
&
Outbreak Investigation

State Institute of Health & Family Welfare, Jaipur

➢ **Epidemic**- Occurrence of diseases cases in community clearly in excess to the normal expectation(measured as endemic level)

➢ **Outbreak**-Used interchangeably with Epidemic but applies to-
  ➢Diseases with **sudden** onset
  ➢**Short incubation period**

What Could Account for the Increase in Cases?

Real increase

- Increase in population size
- Changes in population characteristics
- Random variation
- Outbreak

Artificial increase

- Increased cx of stools
- New testing protocol
- Contamination of cxs
- Changes in reporting procedures

Outbreak and Epidemic: A Question of Scale

- Outbreaks
  - usually limited to a small area
  - usually within one district or few blocks
- Epidemics
  - covers larger geographic areas

Why Do Outbreaks Occur?

- Single lapse in infection control in hosp.
- Lapse in surveillance
- A hidden pocket of infection
- Smuggled animals
- Single volume of international air traffic
- Rapid mutation & Adaptation in microbial world
- Emergence of New risk groups
- Modes of transmission can change
- Drug resistance – effect on treatment and prophylaxis

Early Warning Signals for an Outbreak

- Clustering of cases or deaths
- Increases in cases or deaths
- Single case of disease of epidemic potential
- Acute febrile illness of an unknown etiology
- Two or more linked cases of meningitis, measles
- Shifting in age distribution of cases
- High vector density
- Natural disasters

Outbreak Management....Involves..

- Anticipating,
- Preventing,
- Preparing for,
- Detecting,
- Responding and
- Controlling disease outbreaks with the whole purpose of preventing or minimizing health and economic impacts of possible outbreaks

Why Preparedness in Advance?

- Emergencies caused by epidemics are frequent

- Epidemics require urgent action and

- Epidemics may often lead to panic if preparedness is not adequate

- Response can be delayed, with possibility of fast spread, and avoidable loss to human lives, and economy

Why Investigate?

- Control and prevention measures
- Knowledge of an agent
- Training
- Public concerns

Epidemiological Approaches

- **Experimental**

- **Observational**

  – **descriptive**

  – **analytical**

Tools for Quantifying the Epidemic

1. Case definition

2. Epidemic curve

· point source (common source & vehicle)

· propagated

3. Attack Rate

4. Incubation period

5. Herd immunity

Getting At the Source:

1. Mode of transmission
2. Portal of entry
3. Reservoir
4. Vector
5. Vehicle
6. Agent

Before Starting: Ask

- What's your criteria/ Purpose for investigating an apparent outbreak?
    - Number of people affected
    - Unusual or severe clinical symptoms
    - Implement control measures
    - Prevent future outbreaks
    - Level of public concern, Political pressures, Legal obligations
    - Conduct research, potential to increase medical knowledge
    - Provide training

Steps in Investigation

- Prepare for field work
- Establish existence of outbreak
- Verify diagnosis
- Define and identify cases
- Perform descriptive epidemiology

Steps in Investigation

- Develop hypotheses
- Evaluate hypotheses
- Refine hypotheses and conduct additional studies
- Implement control measures
- Communicate findings

Prepare for Field Work

- Investigation
  - Scientific knowledge--have it or get it!
  - Supplies, equipment
  - Assemble your team
- Administration
  - Review local directives or plans
- Consultation
  - Know your role, especially if off-base
- Sample questionnaires
- Key community contacts
- Laboratory containers and collection techniques

Identify Outbreak Team

- Epidemiologist
- Laboratory workers
- Environmental health specialists
- Local health department
- Other state agencies

2. Establish the Existence of an Outbreak

- Determine if disease incidence is higher than background level

- How do you determine background level ? - surveillance

- Reasons for Observed >Expected
    - Change in reporting procedures
    - Change in case definition
    - Increased awareness or interest
    - Improved diagnostics
    - New clinician
    - Change in Population
    - True increase

3.Verify the Diagnosis

- Review Clinical Data
  - Signs and symptoms
  - Onset dates
  - Common exposures
  - Obtain lab results, if any

4. Define and Identify Cases

- Outbreak Case Definition:
  - Clinical information (signs and symptoms)
    - » Person
    - » Place
    - » Time
- Case Definition Sources
  - Routine reporting:
    - » Use Standard case definitions
  - Unknown etiology:
    - » Make up your own case definition (make sure everyone uses the same case definition)

Establish Case Definition

- Criteria to decide whether person is part of outbreak
  - time, place, person
  - clinical criteria
- Can change during investigation
- Keep open at first, restrict later
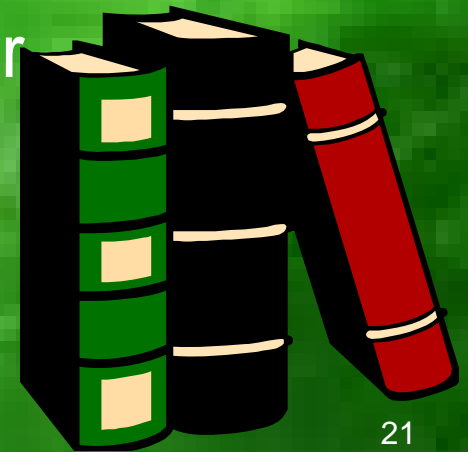
Case Classification:

- Confirmed: laboratory results
- Probable: clinical criteria without lab verification
- Suspect: some clinical criteria

Identify and Count Cases:

- Develop a wide network
- Initiate active surveillance
- Case: meets case definition
- Control: exposed, not ill

Identify Population at Risk:

- Survey hospitals
- Review surveillance data
- Question known cases to identify others
- Review guest lists, enrollment records, etc.

Questionnaires:

- Used to collect complete, uniform histories
- Identifiers
- Demographics
- Clinical information
- Risk factors
- Administer as soon as possible
  - **disseminate**
  - **interview personally**
- Both cases and controls
- Recall bias important
- Can summarize on line listing

Line Listings

- Spreadsheet format
- One row = one case
- Columns = variables

5.Perform Descriptive Epidemiology

- Describe outbreak by
  - time
  - place
  - person
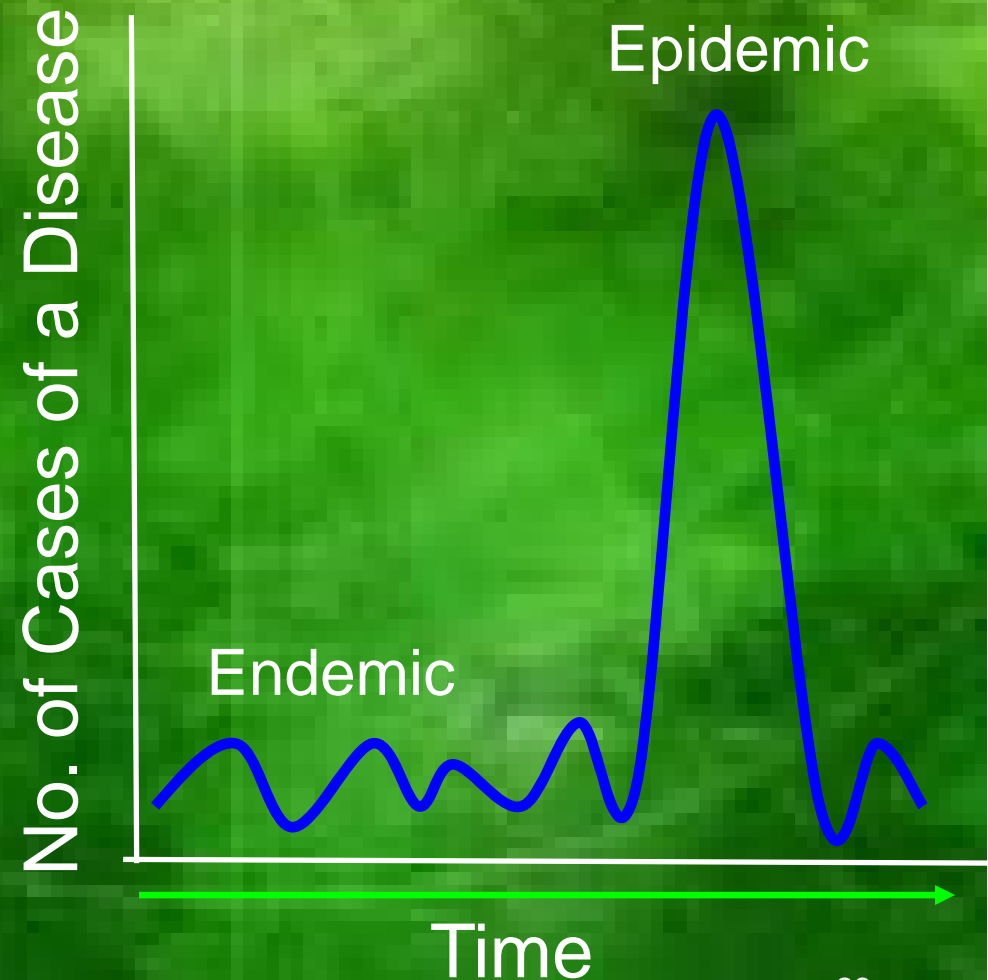- Become familiar with data
- Get clues about infectious agent

Endemic vs. Epidemic
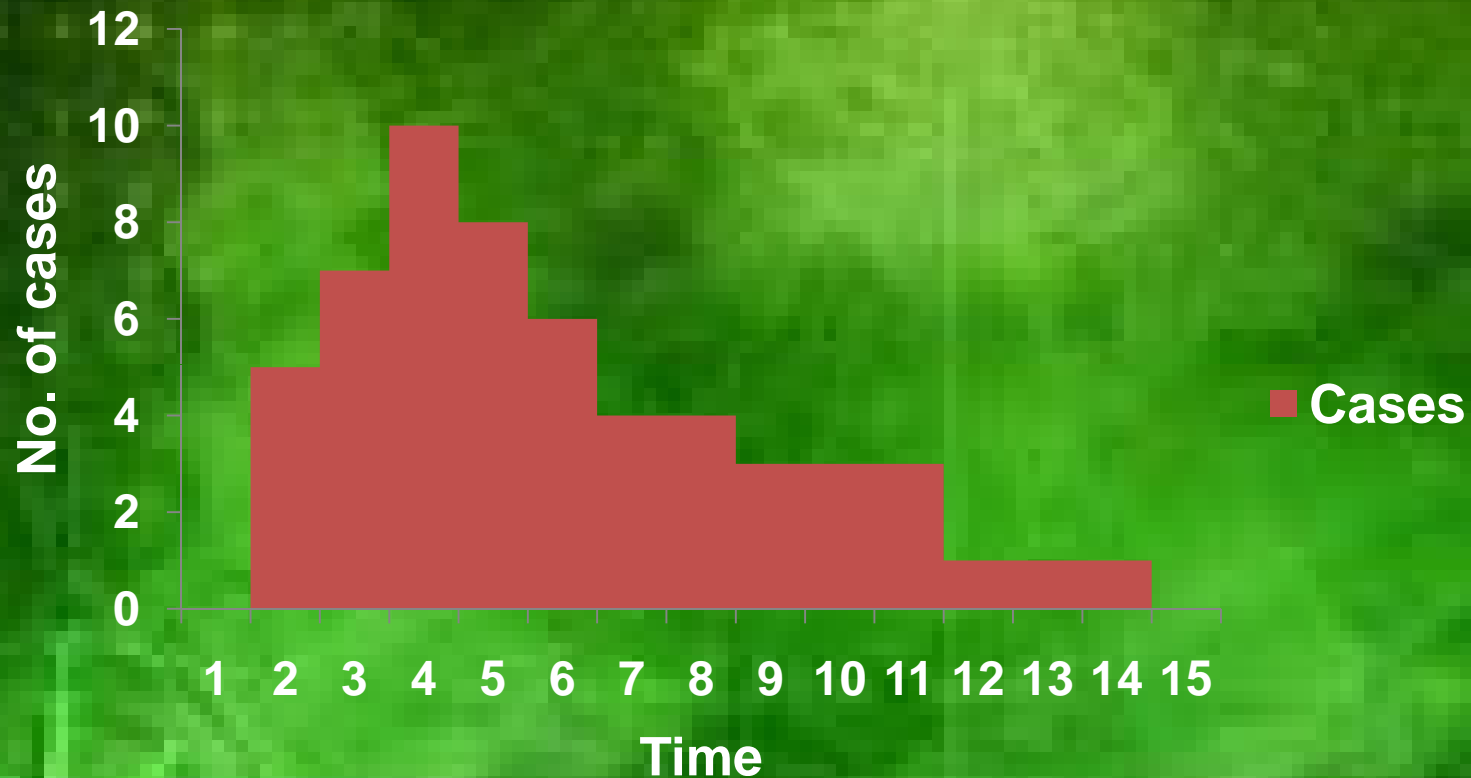
Plot number of cases by onset date

Index case: first case of outbreak

Determine time course and future course, exposure period

Epidemic Curves: Time

No. of Cases of a Disease

Epidemic

Endemic

Time

Point Source Transmission

- This is the most common form of transmission in food-borne disease, in which a **large population** is exposed for a **short period of time.**

Point Source Outbreaks

- All exposed at one time
- Cases occur suddenly after minimum incubation time
- All cases occur within one incubation period
- Outbreak stops unless secondary spread
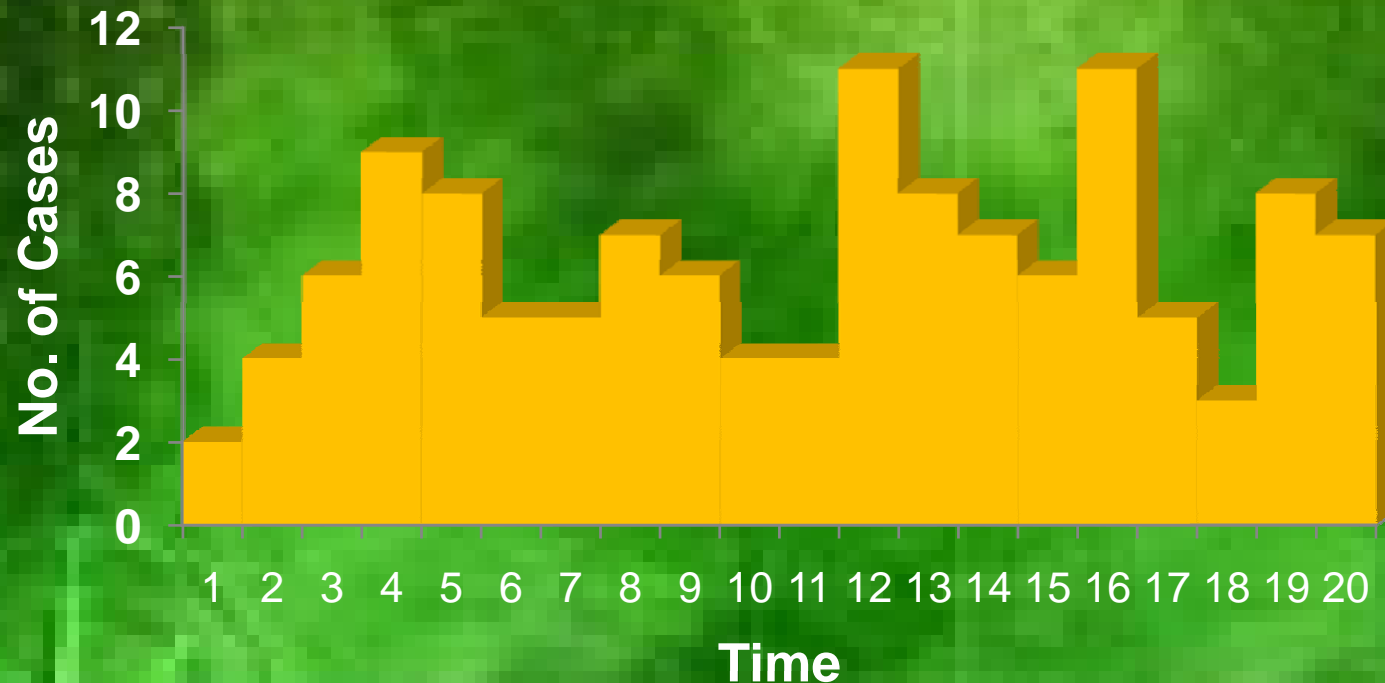- Curves have steep upslope, more gradual down slope

Continuous Common Source

- May begin suddenly or gradually
- Does not have an early peak (v/s Point source)
- Cases do not disappear because of secondary exposure
- Curves have gradual or steep upslope, plateau trickling down slope, and may repeat

Continuing Common Source or Intermittent Exposure

- In this case, there are several peaks, and the **incubation period cannot be identified.**

Propagated Outbreaks

- Typical of person-to-person outbreaks
- Secondary cases appear, at intervals corresponding to average incubation period after peak of first wave
- Taller successive waves of cases

Spot Maps: Place

- One spot = case
- Community
- Facilities
- Recreational sites
- Population density not reflected

Person

- **Host characteristics**
  - **age**
  - **sex**
- **Exposures**
  - **occupation**
  - **food consumption**
  - **leisure activities**

6. Developing Hypothesis

- **Requires familiarity with disease**
- **Hypothesis should be testable**
- **Still clueless?**
- **Talk with cases again**
- **Visit work sites or billeting area**
- **Don't forget outliers**

Develop Hypothesis

- Contact usual suspects!
- Type of agent
- Source of agent
- Mode of transmission
- Usual reservoirs
- Known risk factors
- Exposures that caused disease
- Look at person, place and time for clues
- Be able to test

7. Evaluating Hypotheses: Analytic Epidemiology

- Quantify relationships between exposures and disease
- Test hypotheses about causes
- Comparison groups
  - cohort study
  - case-control study

Evaluate Hypothesis

- Determine exposure variables. Compare ill to not ill.
- Construct a 2 X 2 table
- Perform Cohort or Case Control Study
- Use Cohort study when:
  - Population at risk is known (you have a denominator)

  - Interview "ill" and "not ill"

  - Calculate attack rates - "ate" v/s "didn't eat"

  - Put on food-specific attack rate table

-

Cohort Studies

- Defined population
- Can contact all in timely manner
- Calculate attack rate
- Calculate risk ratio to determine risk of contracting illness from exposure (see table 6.4)

Calculate Attack Rates

Attack rate = (Ill / Ill + Well) x 100 during a time period

If there is an obvious commonality for the outbreak, calculate attack rates based on exposure status (a community picnic)

If there is no obvious commonality for the outbreak, calculate attack rates based on specific demographic variables (hepatitis cases in a community)

Example: Calculation of Attack Rate for Food X

Ate the food				Did not eat the food			
ill	Well	Total	Attack Rate	ill	Well	Total	Attack Rate
10	3	13	76%	4	7	11	64%

Attack Rate = ill/ (ill + Well) x 100   during a time period

Attack rate   = (10/13) x 100 = 76%

(4/11) x 100 = 36%

Risk Ratios

$$\frac{\text{attack rate of ill and exposed}}{\text{attack rate of ill, not exposed}} \quad \frac{a/(a+b)}{c/(c+d)}$$

>1.0 = increased risk
1.0 = same as chance
<1.0 = decreased risk

Case–Control Studies

- Population not defined
- Select sample groups of cases and controls
- Calculate odds ratio to determine likelihood of contracting illness from exposure (see table 6.7)

Odds Ratio:

- Cross multiply and divide

a	**b**
c	**d**

$$\frac{ad}{bc}$$

$_>$**1.0 = increased likelihood**
1.0 = same as chance
<1.0 = decreased likelihood

Step 8:
Additional Studies

Clinical Specimens

- Identifies agent and confirms cases
- Obtain results if already collected
- Collect specimens if necessary
- Type of specimen depends on suspected agent, nature of outbreak

Collect Clinical Specimens

- Specimens must be labeled with patient's name and collection date

- Indicate on form that specimen is related to investigation

Collect Clinical Specimens

- Submission form (s) must be completed and enclosed with specimen

- Local health department should collect and transport specimens to lab

Environmental Investigation

- Help explain why outbreak occurred
- Begins when suspected mode of transmission identified
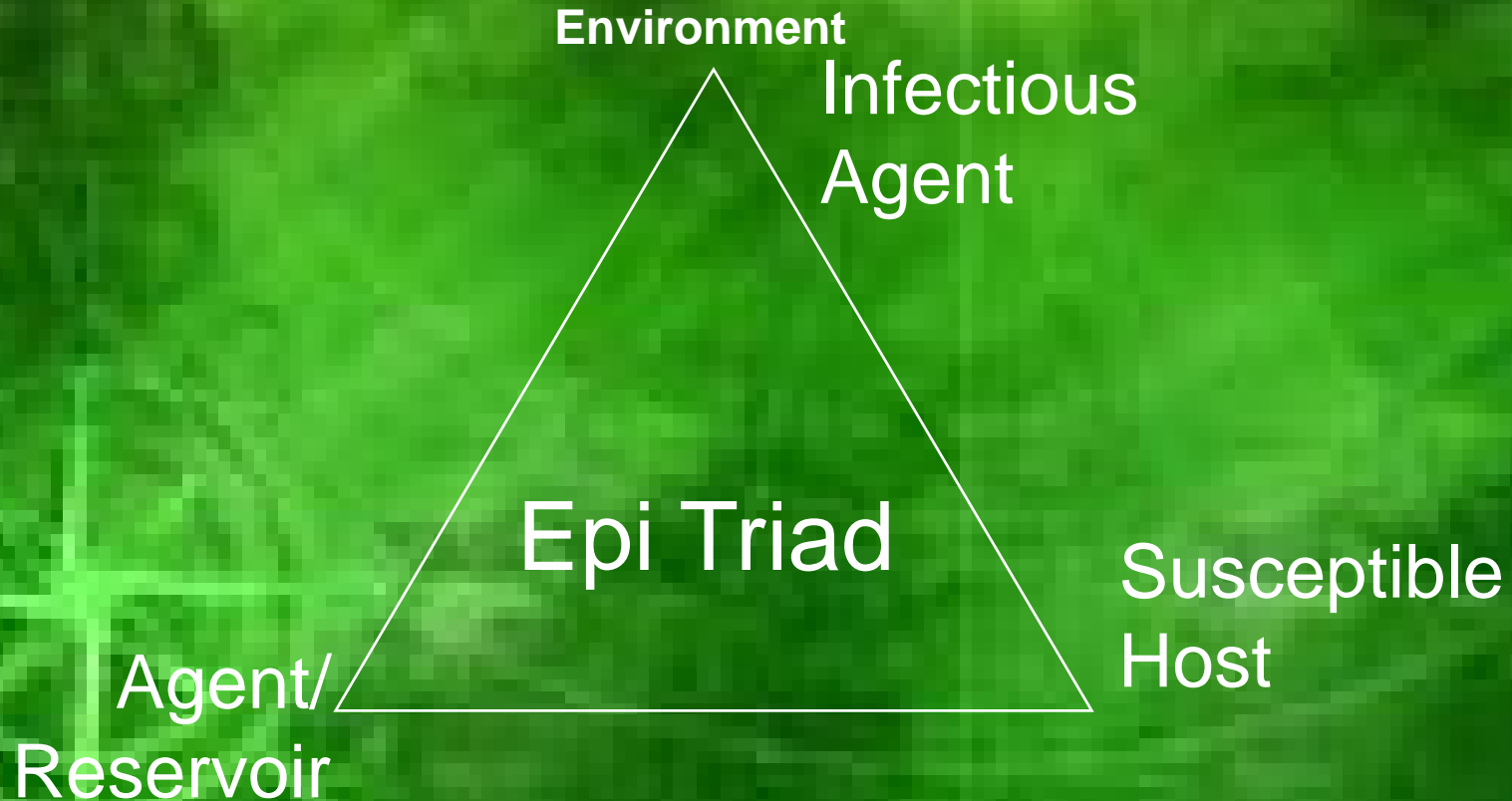- Identifies vehicle of transmission
- Samples: food, water, air

Step 9:
Implement Control Measures

Control Measures

Aim at weakest link in infection cycle

Environment

Infectious
Agent

Epi Triad

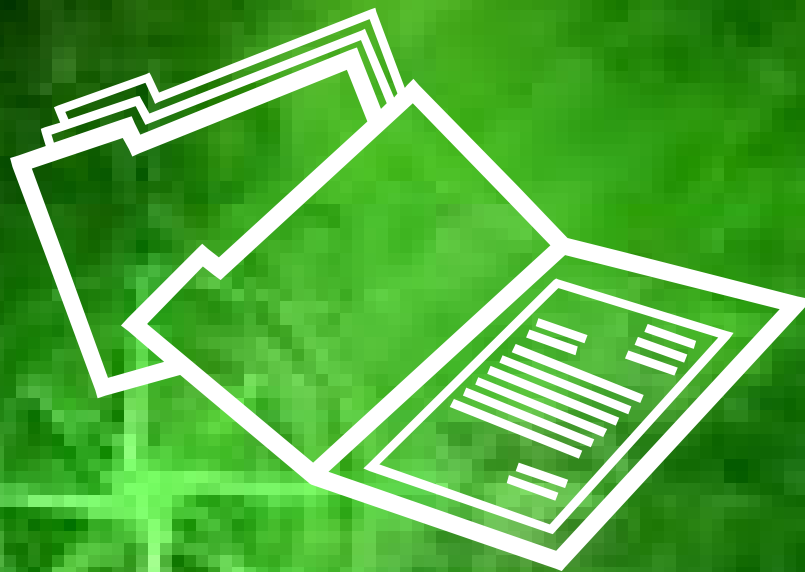Susceptible
Host

Agent/
Reservoir

Possible Options

- Post-exposure prophylaxis/treatment
- Recalling/destroying food
- Providing educational information
- Closing an establishment
- Exclusion (work, daycare, school)
- Making public announcements

Step 10:
Communicate Findings

Investigation Report

- Outlines investigation
- Agency analyzing questionnaires writes report

Purpose of Report

- Prevent similar outbreaks
- Identify trends/causal factors
- Justify resources used
- Serves as public record

Report Format

- Cover page in memo format
- Background
- Epidemiologic investigation
- Environmental assessment
- Laboratory results
- Conclusions

Media Calls

- Confirm investigation underway
- Provide only confirmed or statistically proven information
- Be careful mentioning businesses
- Never speculate or provide identifiers
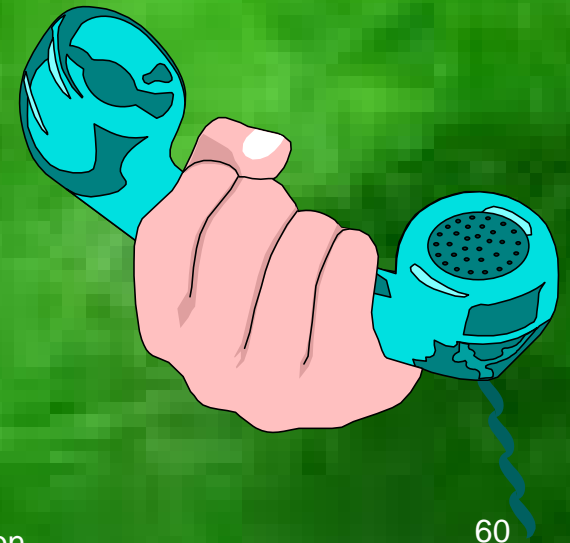- Remain calm and do not be rushed

Real–Life Examples

Investigating an Epidemic:

On June 30,2009, the local health officer of Jaipur, reported the occurrence of an outbreak of acute gastrointestinal illness to the District Health Officer. An epidemiologist-in-training, was assigned to conduct an investigation.

- When Epidemiologist arrived in the field, he learned from the health officer that all persons known to be ill had attended a dinner at Hotel on June 30,2009. Family members who had not attended the Dinner had not become ill. Accordingly, the investigation was focused on the circumstances related to the supper.

Interviews regarding the presence of symptoms, including the day and hour of onset, and the food consumed at the Dinner, were completed on 75 of the 80 persons known to have been present. A total of 46 persons who had experienced gastrointestinal illness were identified.

: Is this an Outbreak?

What might be the agent?

How is this agent transmitted?

What am I looking for?

Select the correct case definition & find the error

1. All Invitees in Dinner held in Hotel on June 30,2009 between 8:00 &11:00 PM; whether they attended Dinner or not; whether they participated in food preparation, transport, or distribution or not; whether they ate or not.

2. Persons who developed acute gastrointestinal symptoms within 72 hours of eating supper and who were among Invitees in Dinner held in Hotel on June 30,2009.

3. Invitees who developed acute gastrointestinal symptoms within 24 hours of the Dinner held in Hotel on June 30,2009 between 8:00 & 11:00 PM

Select the correct case definition and find the error in the others:

1. All invitees to the Marriage Dinner held in Hotel on June 30,2009 between 8:00 PM and 11:00 PM; whether they attended Marriage or not; whether they participated in food preparation, transport, or distribution or not; whether they ate or not. Missing definition of sickness

2. Persons who developed acute gastrointestinal symptoms within 24 hours of eating Dinner on June 30,2009 and who were among invitees of the marriage dinner. **CORRECT**

3. Invitees who developed acute gastrointestinal symptoms within 24 hours Dinner on June 30,2009. Did not specify that they went to the dinner

The Dinner was held at Hotel . Food was prepared by Chefs of the Hotel. The Dinner began at 8:00 PM and continued until 11:00 PM. Food was spread out upon a table and consumed over a period of several hours.

Menu:

Baked Vegetable

Malai paneer

Dum Aaloo

Cabbage salad

Paneer Khumb

Raita

Raj bhog

Cream salad

Ice cream (van)

Ice cream (choc)

Fruit salad

Which menu item (s) is the potential culprit?

To find out, calculate attack rates.

The foods that have the greatest difference in attack rates may be the foods that were responsible for the illness.

Attack Rates by Items Served:

	Number of persons who ate specified item				Number of persons who did eat specified item			
	Ill	Well	Total	Attack rate (%)	Ill	Well	Total	Attack rate %
Baked Veg.	29	17	46	**63**	17	12	29	**59**
Malai paneer	26	17	43	**60**	20	12	32	**62**
Dum Aaloo	23	14	37	**62**	23	14	37	**62**
Cabbage salad	18	10	28	**64**	28	19	47	**60**
Paneer Khumb	16	7	23	**70**	30	22	52	**58**
Raita	21	16	37	**57**	25	13	38	**66**
Raj bhog	2	2	4	**50**	44	27	71	**62**
Cream salad	27	13	40	**67**	19	16	35	**54**
Ice cream (van)	43	11	54	80	3	18	21	14
Ice cream (choc)	25	22	47	**53**	20	7	27	**74**
Fruit salad	4	2	6	**67**	42	27	69	**61**

Major Causes of Food borne Disease

- **Improper cooling of foods**
- **Improper cooking of foods**
- **Improper reheating of foods**
- **Improper holding temperature of foods**
- **Cross contamination**
- **Infected food handlers, poor employee hygiene**

Verify the Outbreak

- Determine whether this an outbreak – an excess number of cases from what would be expected

- Establish a case definition
  - Non-ambiguous
  - Clinical / diagnostic verification
  - Person / Place / Time descriptions

- Identify and count cases of illness

Conclusion

- An attack of gastroenteritis occurred following a Dinner at Hotel.

- The cause of the outbreak was contaminated vanilla ice cream.

Case 2

A patient from village Vatika (population 5000) came to the OPD of PHC on 7-10-2009 with complaints of fever, headache, bodyaches and chills. He also informed the Medical Officer about a large number of cases having similar illness in the village, of whom many have died.

On the above report a team of Doctors surveyed the village on 8-10-2009 and got the following data :-

➤ Out of 756 patients 696 (92%) were suffering from Fever with Rigors & Chills, without any sign of meningitis. Few of them had spleen enlargement.

Confirmation of Outbreak :

- Clustering.
- Excess of expected number of Fever cases.
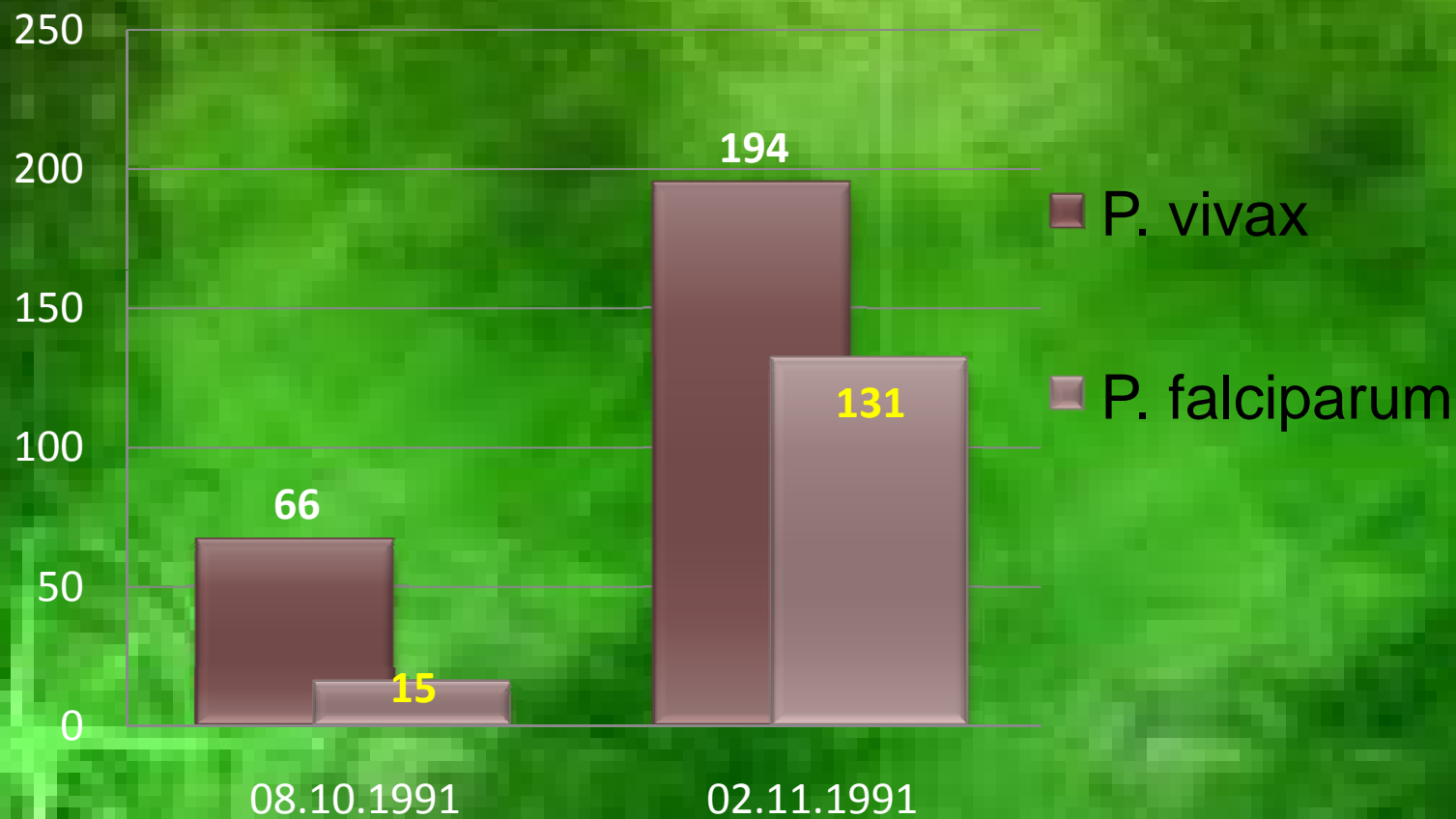- To reach the conclusion compare with the previous years incidence.

Case definition of Malaria:

A case of fever which may be accompanied with any of the following:

- Headache, backache, chills, rigors, sweating, myalgia, nausea and vomiting.

- Splenomegaly and Anemia.

- Generalized convulsions, shock, bleeding, pulmonary edema, renal failure and Death (untreated *falciparum* infection).

- Any case of fever in endemic area may be considered as malaria.

(Source: NVBDCP guidelines)

Slide Positivity:

Bar chart showing slide positivity. Y-axis ranges from 0 to 250. For 08.10.1991: P. vivax = 66, P. falciparum = 15. For 02.11.1991: P. vivax = 194, P. falciparum = 131.

Malaria Situation in CHC Vatika, 2005–2009:

Year	Slides Collected	Slides positive for MP		
		P. vivax	P. falciparum	Total
2005	3170	9	0	9
2006	5921	7	0	7
2007	5822	4	0	4
2008	7384	2	0	2
2009	7233*	2	0	2

* 948 slides still to be examined.

Note: Population of CHC is about 2 lakhs.

Case Summary

In a single village, 22 members (including 2 visitors) of 8 families developed similar symptoms. Of them,15 were taken to the Medical College Hospital for T/t.

i. Clinical findings:
  i. Initial symptoms:- Diarrhoea &/or vomiting associated with pain abdomen
  ii. Neurological symptoms after an approximate interval of 1-3 wks
    I. Gradual onset of peripheral neuritis - calf muscles with tingling & numbness
    II. Gradual development of paralysis of extremities specially lower limbs
    III. Exhibited high stepping gait & stocking & gloves type of sensory loss
    IV. Ankle jerk absent in all cases
    V. Plantar reflex absent or flexor
  iii. No cases showed any rise in temp.
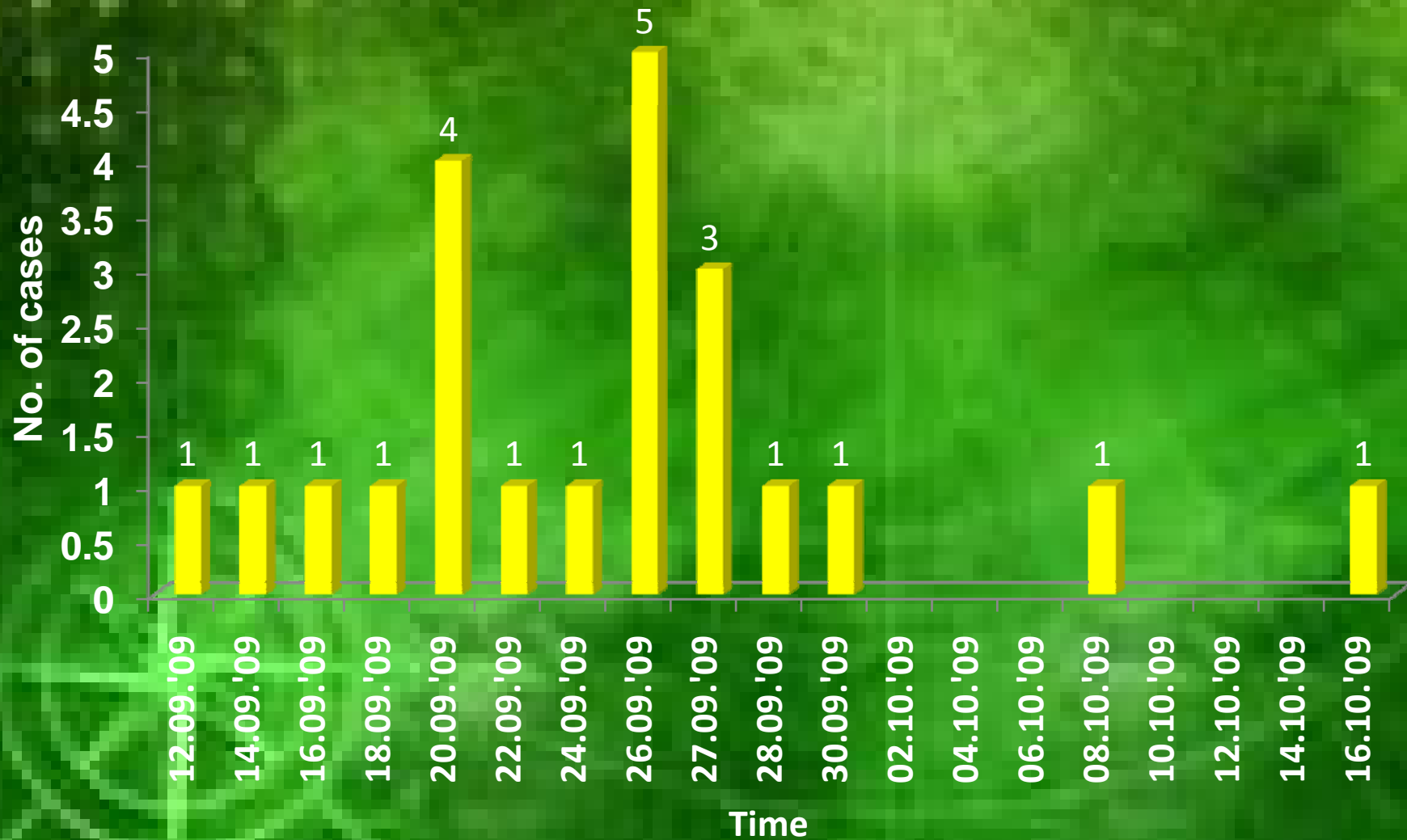 iv. No case of death

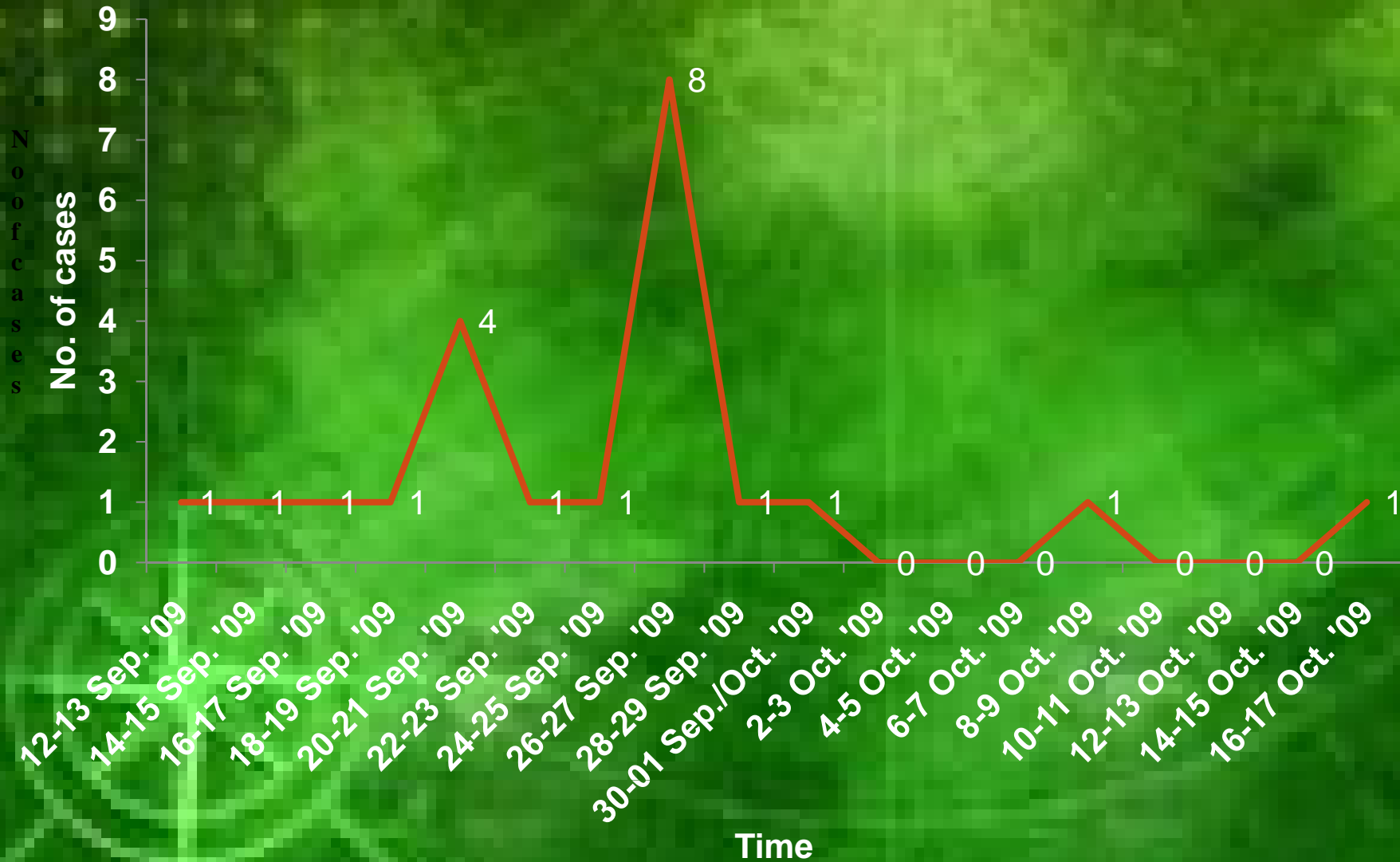# Q1– Characterization by time, place & person

- Is it an outbreak ?

    - Unusual event in community

    - Clustering in time & space
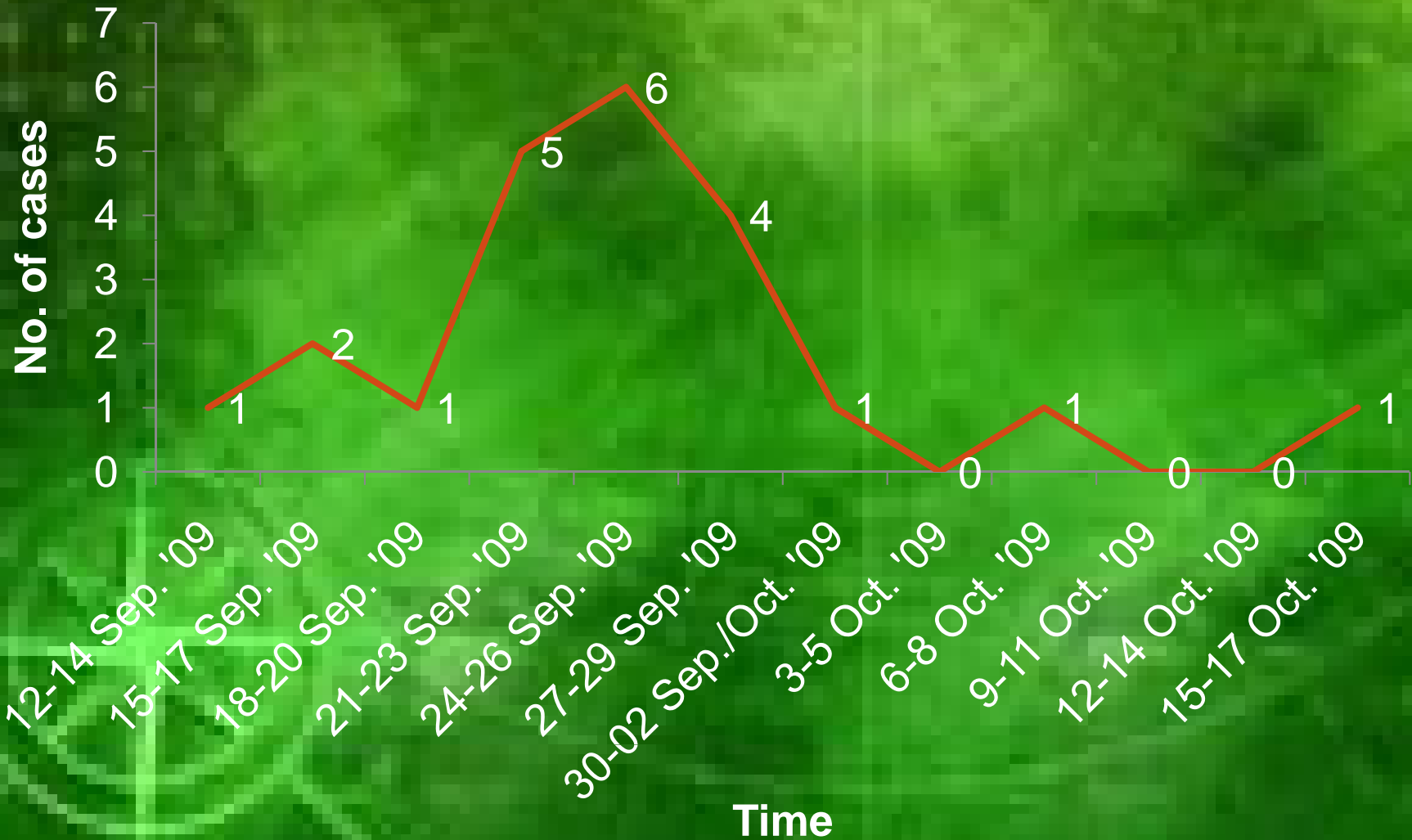
Distribution of Cases by Date of Onset

Epidemic Curve (2 day grouping)

No. of cases vs Time

Values along curve: 1, 1, 1, 1, 4, 1, 1, 8, 1, 1, 0, 0, 0, 1, 0, 0, 0, 1

X-axis labels: 12-13 Sep. '09, 14-15 Sep. '09, 16-17 Sep. '09, 18-19 Sep. '09, 20-21 Sep. '09, 22-23 Sep. '09, 24-25 Sep. '09, 26-27 Sep. '09, 28-29 Sep. '09, 30-01 Sep./Oct. '09, 2-3 Oct. '09, 4-5 Oct. '09, 6-7 Oct. '09, 8-9 Oct. '09, 10-11 Oct. '09, 12-13 Oct. '09, 14-15 Oct. '09, 16-17 Oct. '09

Epidemic Curve (3 day grouping)

Family–wise Distribution

Family code (H.No.)	No of cases
22	7
15	4
38	3
85	2
51	2
45	2
66	1
70	1
Total	22

Index Case – on 12.09.2009

❖ The blocks indicate one family each
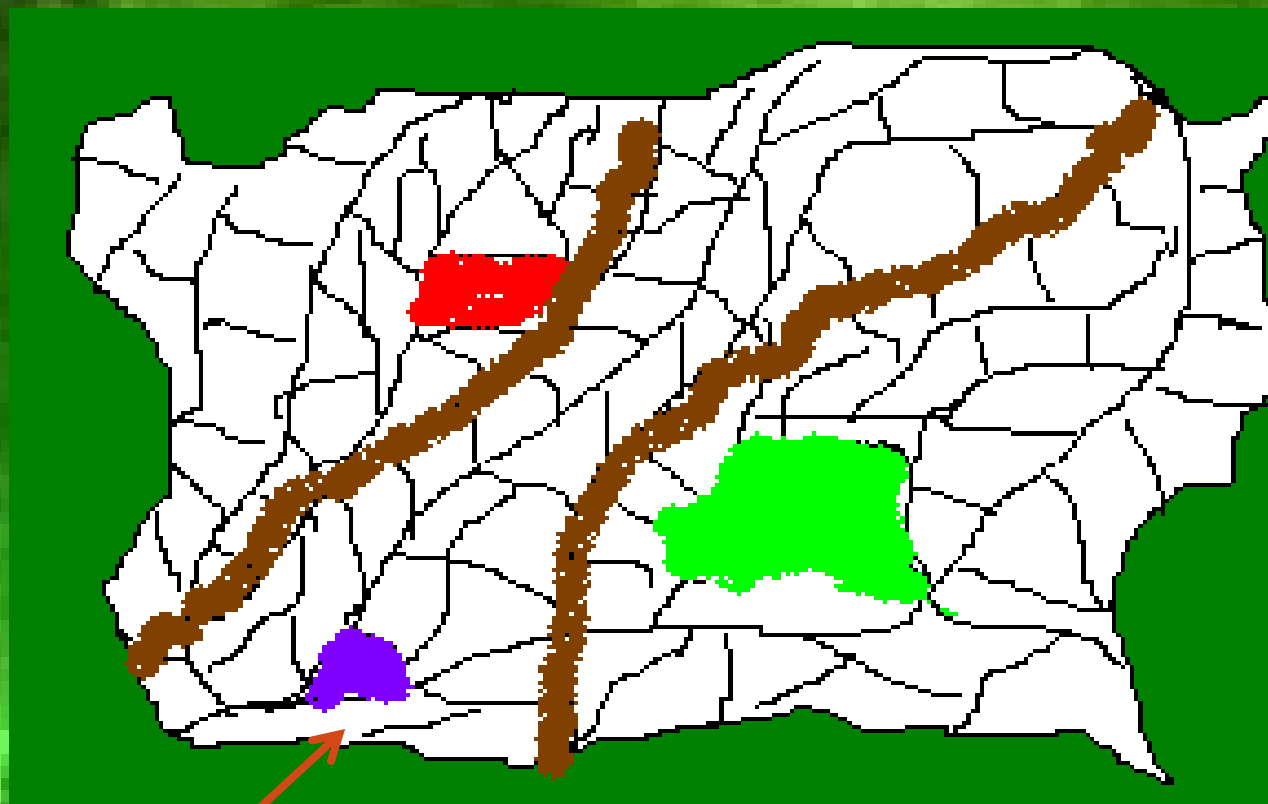
Index Case in Family no.22

Primary School
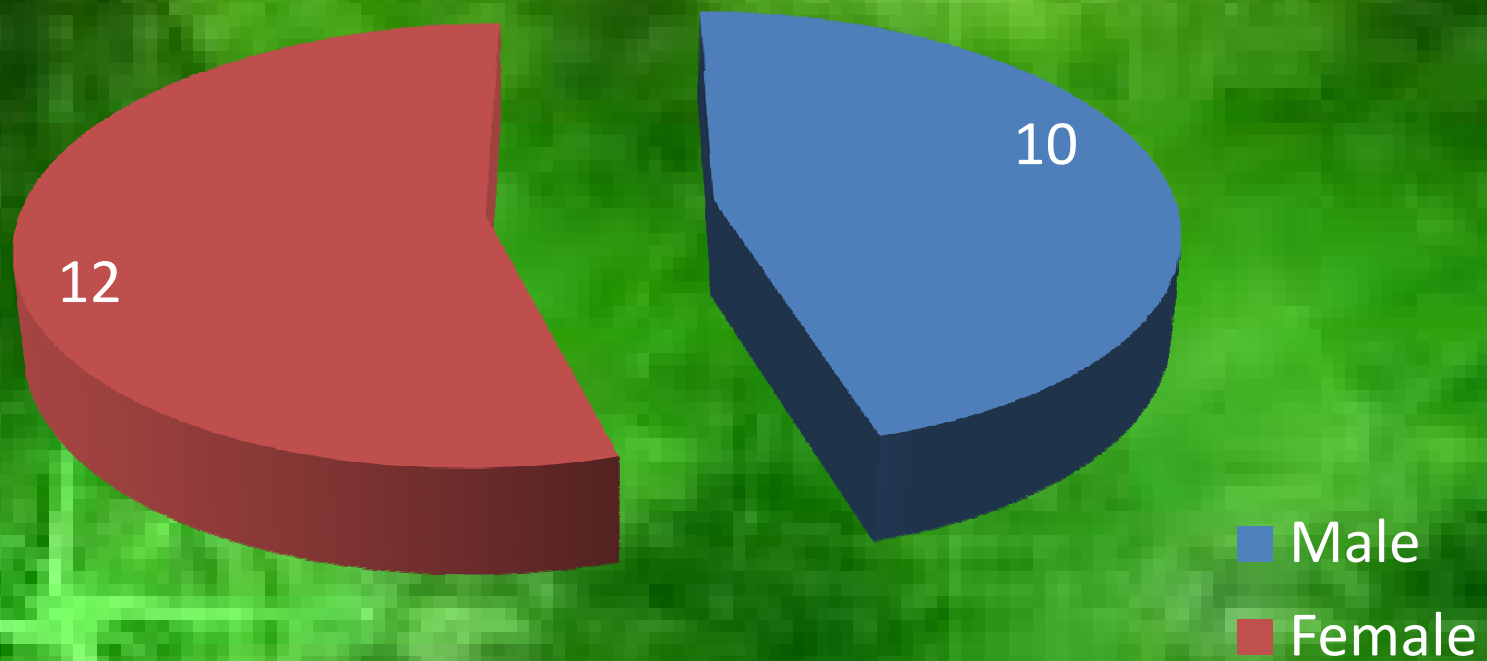Panchayat Office
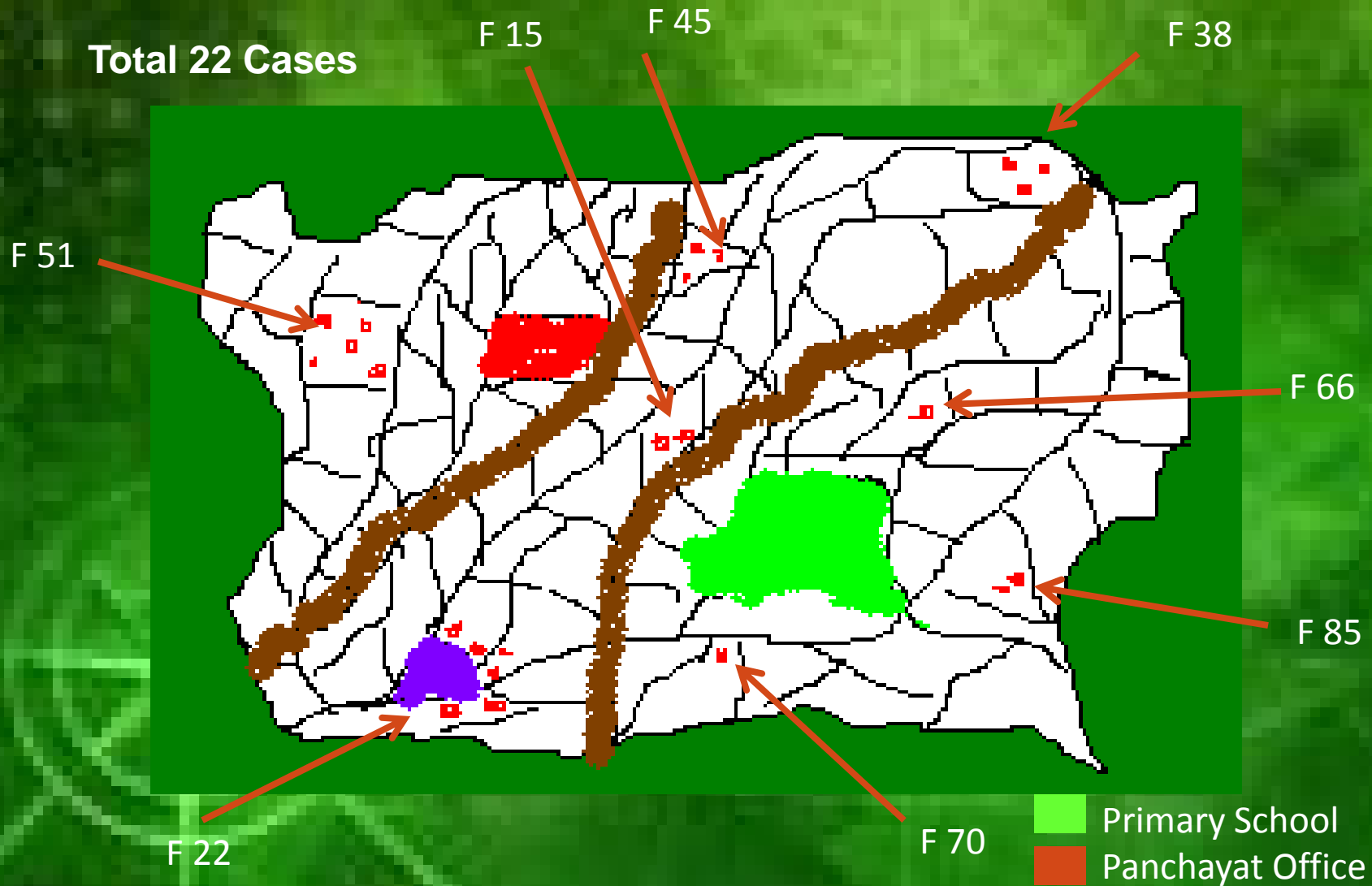
Q3 – Male : Female

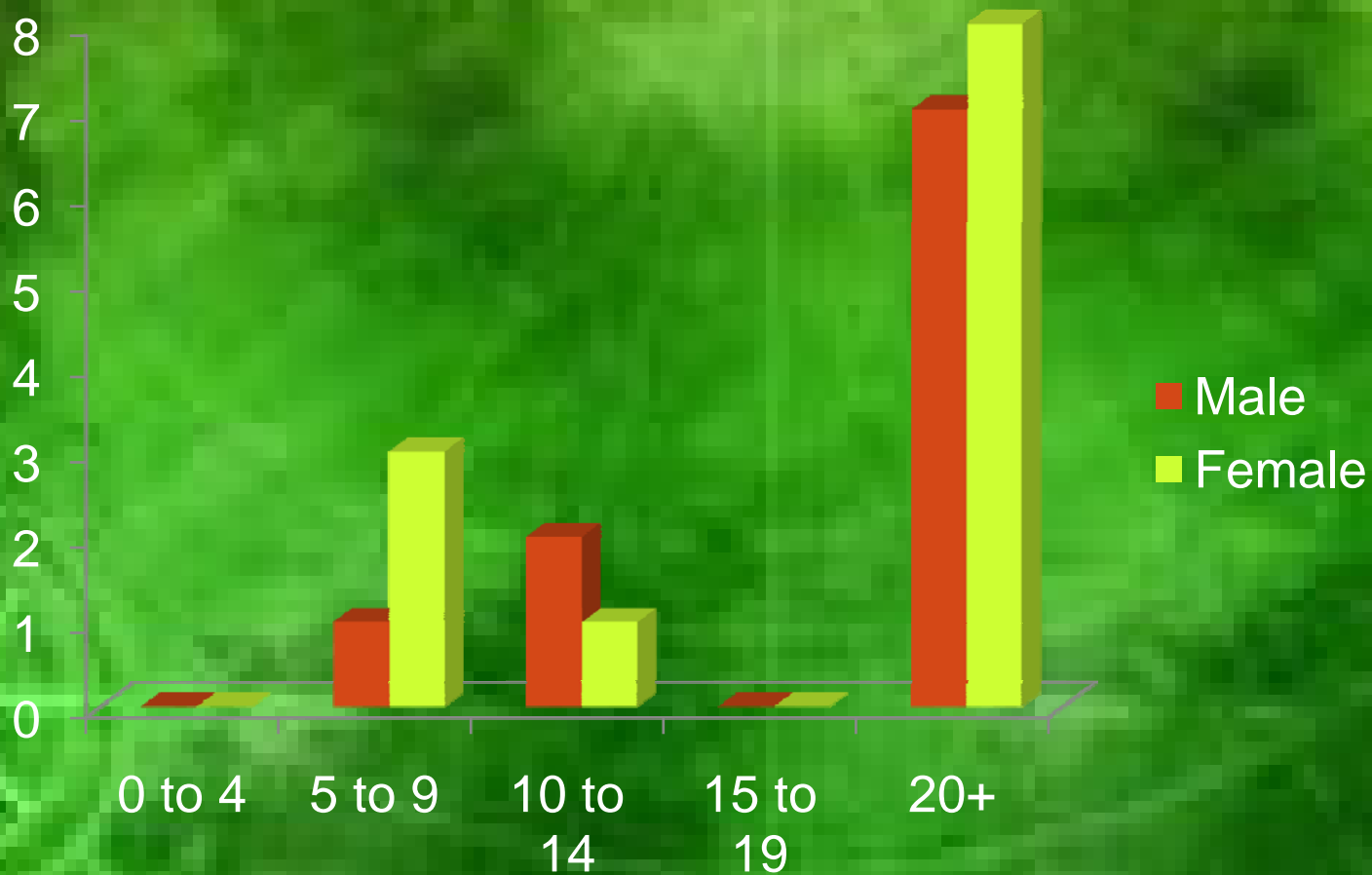**No. of Cases**

10

12

■ Male

■ Female

Q3: Age & Sex–wise Distribution

Legend:
- Male
- Female

X-axis categories: 0 to 4, 5 to 9, 10 to 14, 15 to 19, 20+
Y-axis: 0 to 8

Attack Rate (%)
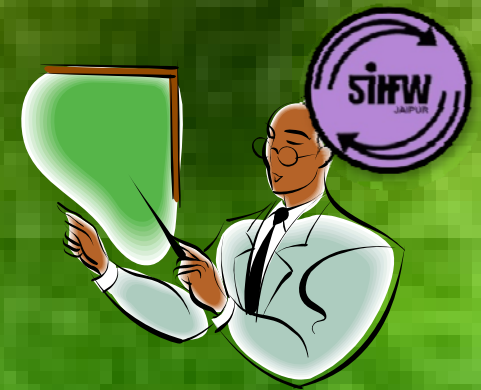
Age Grp. in yrs	Male	Female	Total
0 – 4	0	0	0
5 – 9	2.08	7.31	4.49
10 - 14	4.44	2.77	3.70
15 - 19	0	0	0
20 +	3.82	5.19	4.45
Total	2.75	3.92	3.29

Q4

a. Date of Epidemic period
- 12. 09. 2009 to 16.10.2009

b. Duration of the epidemic
- 35 days
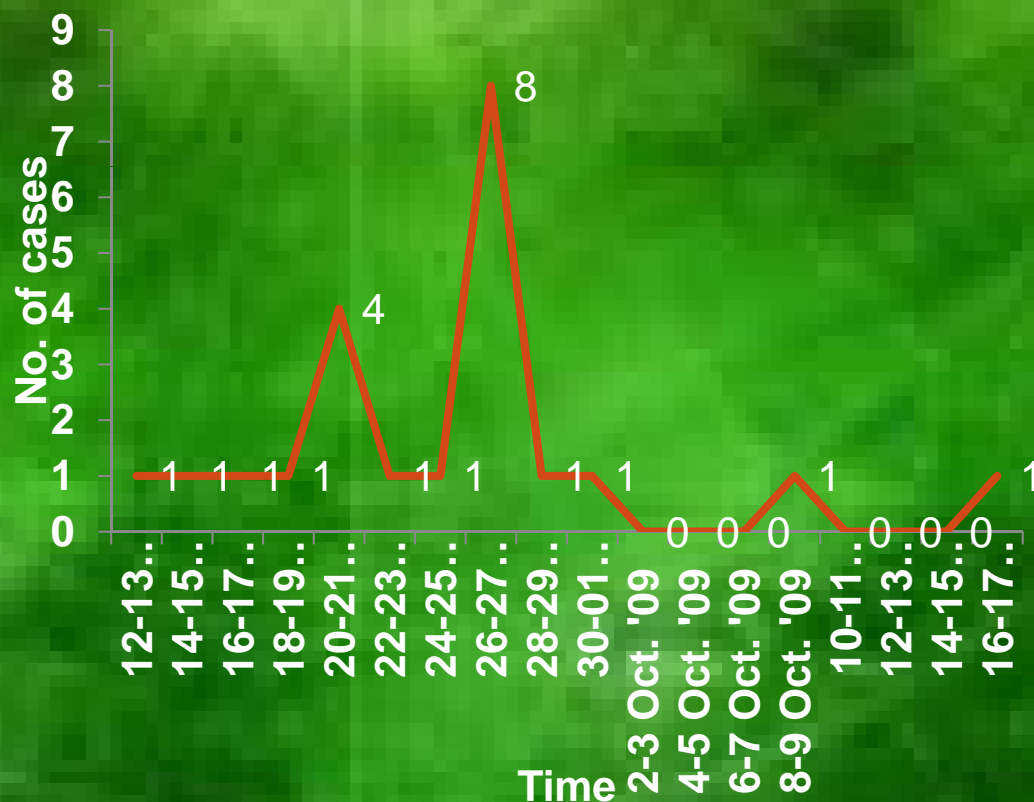
c. No of cases : Resident – 20

Non resident – 2

Total - 22

Q4d – Epidemic Curve

- Peak of the epidemic curve is between 24-26th Sept 2009.

- The rising phase is steeper than the opposite side

- Mean incubation period is approximately 15 days.

Q5 :Probable Route of Transmission

Vector- borne

i. No, as due to the flight range vectors would have spread the disease more

ii. Vector borne diseases are generally climate dependent , so the epidemic curve in that case would be more broader

iii. Attack rate would not have been higher in female and nil in 0-4 & 15-19 yr age group.

Droplet

i. No, otherwise it would have been widespread within the same time period.

ii. Attack rate would not have been higher in female and nil in 0-4 & 15-19 yr age group.

Person to person

i.   May be a possibility, as many cases are within families. (+)

ii. But attack would not have excluded any of the age groups. (-)

iv. Zoonotic

   i.   Possibly not, as it would have been more widespread with less clustering within families

v.   Common source

   i.   Most possible in the given case, as it has an epidemic curve with a single peak, without any secondary spread.

   Possibly food borne, as cases are clustered within families & seen in both males and females.

Q6

❖ To test our hypothesis of common source exposure we would need the following additional information

1. A detailed history of the dietary pattern of the cases in past 7-10 days

2. Any common occasion where they have shared food

3. Food pattern of the unaffected family members of the affected families in the same 7-10 days

Summary

The Epi Approach...

- Identify a problem
- Investigate and collect data
- Describe data in terms of person, place and time
- Formulate a hypothesis
- Test your hypothesis

Bottom Line…

- Collect good descriptive data
- Be observant -- Be objective
- Keep Authority informed
- Be sure to collect data on both the "ill" and the "not ill"
- Ask for help
- Disease prevention!

Remember:

- Only work in the field can uncover the way in which an *agent* links to a *host* in the real world (Environment) outside of the laboratory.

- Snow discovered the **waterborne** route as a major mode of communication of disease, which turned out to apply not only to *cholera*, but also to *typhoid fever* and other infections.

Possible Control Measures for Communicable Diseases:

- **ARI**
  - Early recognition and treatment
  - All children with cough carefully assessed
  - Assess signs of malnutrition
  - Refer severely malnourished to hospital
  - Manage pneumonia with antibiotics
  - Follow national treatment protocols
  - Supportive measures
  - Vaccination against measles, diphtheria and whooping cough

Cholera

- Prompt diagnosis and management
- Establish treatment centers with barrier nursing.
- Fecal material and vomit properly disinfected and disposed.
- Health Education on hygiene, safe water, safe food and hand washing.
- Funerals to be held quickly and near the place of death. Meticulous hand washing for those who handle the body.
- Promote washing hands with soap and water when food is being handled

Typhoid

- Health education, clean water, food inspection, proper food handling and proper sewage disposal.

- Early detection and control are important in prevention of spread.

- Laboratory services are essential to know the outbreak strain and the anti microbial sensitivity pattern.

Viral Hepatitis

- Enforcement of water and food sanitation.

- For Hepatitis B and C, all blood products should be screened for the two (and for HIV).

- Vaccination of target population groups for Hepatitis A recommended.

Diarrhea

- Provision of safe water supply

- Food safety

Conjunctivitis

- Personal hygiene and hand washing.
- Vector control measures to reduce fly population.
- Disinfect articles contaminated by nasal and conjunctival discharges.
- Vigorous hand washing and proper disposal of infected material.

Dengue

- Eliminate habitats of Aedes mosquitoes.
- Personal protection against mosquito bites during day time (clothes, repellants).
- In an outbreak use larvicide on all potential habitats of Aedes aegypti.
- Insecticides to reduce vector population.
- Social mobilization to eliminate breeding sites.

Malaria

- Rapid diagnosis and effective case management.

- Use of insecticide treated nets.

- Indoor Residual Spraying.

- Environmental engineering

- Chemo prophylaxis to non-immune expatriates and Intermittent Presumptive Therapy for pregnant women.

Tuberculosis

- Personal hygiene
- Avoid overcrowding
- Early diagnosis
- Drug compliance

HIV/AIDS

- Consistent & correct use of condoms
- Ensure blood safety
- Universal precautions to be used.
- Use of AD syringes
- Counseling and voluntary testing.

H1N1

- Entry screening, aircraft disinfection, isolation of suspects, sample collection/transportation, contact tracing, quarantine, prophylaxis and case management
- Active search for contacts and cases
- Use of Personal protective gears
- Public health – mass prophylaxis
- Social distancing.

- Guidelines for the case and relatives
- Movement & Visiting restrictions
- Use of PPEs when required
- Personal protective measures to be followed
- Food and other arrangements at the facility
- Watch for symptoms and complications
- Treatment with Tamiflu
- Prophylaxis for immediate contacts
- MOHFW guidelines to be followed for treatment and discharge
- Fumigation of the room and belongings

Thank You

For more details log on to
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