Review of Epidemiology Concepts

**Analytical Epidemiology** – studies concerned with testing hypothetical associations or causal relationships between variables. An analytic study is usually concerned with identifying or measuring the effects of risk factors or is concerned with the health effects of specific exposure(s).

**Descriptive Epidemiology** – studies concerned with and designed only to describe the existing distribution of health variables, without regard to causal or other hypotheses. Descriptive studies can be used to measure risks, and generate hypotheses.

The **prevalence of a disease** is the number of cases present at a particular moment or period.

The **incidence of a disease** is the number of new cases occurring during a given period of time and gives an idea of the spread of the disease.

**Indicators directly related to health status**
1. Mortality
2. Morbidity
3. Nutritional status

**Types of indicators:**
1. Input indicators – resources
2. Output indicators – services
3. Outcome indicators – problems
4. Impact indicators – health status

**Indicators Related to the Environment**
1. Physical environment
2. Functioning of the health-care services
3. Economic environment
4. Social environment
5. Political environment

**Attributes of an indicator**
1. **Relevance.** It is important that the indicator does in fact measure what we are trying to measure.
2. **Precise Definition.** The indicator must be precisely defined so that any subsequent data gathered from different sources will be comparable.
3. **Measurable.** An indicator must be measurable.
4. **Sensitive.** An indicator must be sensitive to changes in what is being measured.
Relevant epidemiological programs in emergency situations include:

1. **Initial assessment** to obtain a snapshot of the public health situation at the onset.
2. **Epidemiological surveillance** to monitor on an ongoing basis the results of activities and services being provided.
3. **Ad hoc evaluations** to obtain new snapshots of the public health situation. This allows comparisons to be made to the initial assessment.
4. **Early warning systems** are surveillance systems designed to detect forthcoming emergencies so that preventive measures can be implemented or preparations made.
5. **Epidemic investigation** in an emergency situation.

### The Epidemiological Process

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Sources of indicators</th>
<th>Measurement of indicators</th>
<th>Formulation of results</th>
<th>Statistical analysis of results</th>
<th>Interpretation of results</th>
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<td>Descriptive Epidemiology</td>
<td>Statistical Analysis</td>
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<td>Statistical Analysis</td>
<td>Analytical Epidemiology</td>
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Indicators describe a situation and repeatedly measured over time reveals changes and tendencies in that situation.

### Types of Epidemiology

- **Descriptive Epidemiology**
- **Statistical Analysis**
- **Analytical Epidemiology**

### Sources of Health-related Information

1. The population
2. Administrative Services
3. Community Health Services
4. Health-Care Facilities
5. Humanitarian Agencies

### Attributes of a test or data collecting method in an emergency situation.

1. **Representativeness** – concordance between the elements sought and those that the test actually finds. (The test is examining what it is suppose to.)
2. **Validity** – Characterized by two properties:
   - **Sensitivity** - ratio between the number of positive (diseased) cases detected by the test and the actual number of positive cases in the population. Is the measure of the probability of correctly diagnosing a case, or the probability that any given case in the population will be
identified by the screening test.

- **Specificity** – ratio between the number of negative (non-diseased) cases detected by the test and the actual number of negative cases in the population. Is a measure of the probability of correctly identifying a non-diseased person with a screening test.

**Positive Predictive Value (PPV)** – the probability that an individual declared positive by a test actually has the disease.

**Negative Predictive Value (NPV)** – the probability that an individual declared negative by the test actually does not have the disease.

<table>
<thead>
<tr>
<th>SICK</th>
<th>Yes</th>
<th>No</th>
<th>Test</th>
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<tbody>
<tr>
<td>true +</td>
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<td>false +</td>
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<td>true –</td>
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</table>

“true +” is where diseased individuals are detected by the test
“false +” is where non-diseased individuals are said to be diseased by the test
“true –” is where diseased individuals are said to be non-diseased by the test
“false –” is where non-diseased individuals are detected by the test.

**Sensitivity** = \[ \frac{\text{true } +}{(\text{true } +) + (\text{false } -)} \]

**Specificity** = \[ \frac{\text{true } -}{(\text{true } -) + (\text{false } +)} \]

**PPV** = \[ \frac{\text{true } +}{(\text{true } +) + (\text{false } +)} \]

**NPV** = \[ \frac{\text{true } -}{(\text{true } -) + (\text{false } -)} \]

3. **Implications for Emergency Situations.** In an emergency situation, the tendency is to try to treat as many subjects as possible by reducing the
number of true positive cases tagged as negative by the test. This orientation gives sensitivity priority over specificity.

4. **Standardization** – The same measuring method should be used for a given indicator so that data from different sources or collected at different times can be compared.

5. **Reliability** – Capacity to furnish uniform results. The main elements influencing reliability are:
   - Variations in the measuring instrument itself
   - Variations in the thing measured
   - Variations in the observer
   - Variations involving differences between observers

6. **Applicability** – Ability to perform test.
   - Speed to perform
   - Simplicity
   - Reproducibility
   - Cost

7. **Acceptability** -
   - To the population
   - To the authorities

**Types of epidemiological studies used in emergencies.**

- **Cross-Sectional Studies**
  Are the type of studies most often used in an emergency. They provide a snapshot of the situation at a given moment by examining the relationship between diseases (or other health-related characteristics) and other variables of interest as they exist in a defined population at one particular time.

- **Case Control Studies**
  Used to compare two groups, on displaying a specific characteristic and the other without the characteristic. A retrospective study (looks back from outcome to its causes) of the two groups is carried out in order to determine the factors that gave rise to the characteristic in question.

- **Cohort Studies**
  Prospective studies that examine the relation between a health problem and a presumed cause of that problem by following people with different exposure levels to a risk factor over a certain period of time in order to generate reliable incidence or mortality rates in the population subsets.

**Relevant epidemiological programs in emergency situations include:**

6. **Initial assessment** to obtain a snapshot of the public health situation at the onset

7. **Epidemiological surveillance** to monitor on an on-going bases the results of activities and services being provided.

8. **Ad hoc evaluations** to obtain new snapshots of the public health situation. This allows comparisons to be made to the initial assessment.

9. **Early warning systems** are surveillance systems designed to detect forthcoming emergencies so that preventive measures can be
implemented or preparations made.

10 **Epidemic investigation** in an emergency situation.

**Measures of Central Tendency**

- **Arithmetic mean (average)** – the sum of all the observations divided by the total number of observations.
- **Median** – is the value located physically in the middle of a set of observations.
- **Mode** – the value that occurs most often in a set of observations.

For example:

<table>
<thead>
<tr>
<th>Case</th>
<th>Value</th>
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**Distribution Curve**

If all the individual values for a given population are represented on a graph, the result is the classic or "normal" distribution curve (Gaussian curve), with the arithmetic mean as its center. The individual values will be distributed around the mean, spreading out more or less in relation to the latter.
Measures of Variability
In a given population, each individual will be a different distance from the mean. The basic measures of variability are:

1. **mean deviation** – the sum of the individual deviations (ignoring negative or positive signs) divided by the number of observations
2. **variance** – the sum of the square of individual deviations divided by the number of observations
3. **standard deviation** – the square root of the variance

The mean and the standard deviation represented on a Gaussian curve produce the following result:

1. 68% of the individual values are situated within the limits constituted by the mean and ± 1 standard deviation
2. 95% of the individual values are situated within the limits constituted by the mean and ± 2 standard deviations
3. 99% of the individual values are situated within the limits constituted by the mean and ± 3 standard deviations

![Gaussian Curve Diagram](image-url)
Measures of Comparison
1. **Relative Risk** – The ratio between the rates of a variable measured in two populations, where in one of the populations the variable presents a risk.
2. **Odds Ratio** – Is the ratio between the probability that a subject has been exposed to a risk factor and the probability that a control has been exposed to it.

Sampling methods
1. **Simple random sampling** – Each individual in the population being studied has the same chance of being selected as a participant for the study. For example, give a number to each individual, and then the numbers are chosen at random.
2. **Stratified random sampling** – The population being studied is first divided into groups according to certain characteristic (sex, area of residence, etc.). After which, simple random sampling is carried out within each group.
3. **Systematic sampling** – Starting with an initial, randomly chosen unit, subsequent units are selected by adding a certain number to the first unit (depending on the size of the sample relative to the total population).
4. **Cluster sampling** – The population is considered as a set of collective units, or clusters, chosen at random, after which all the subjects in these clusters are examined.

The selection of which sampling method to use will depend on various considerations:
1. Geographical distribution of the population
2. Cost of the evaluation
3. Degree of accuracy wanted
4. Constraints inherent in emergency situations
5. Lack of qualified personnel
6. Time constraints
7. Lack of access to all the population