UNIT 4 EPIDEMIOLOGY OF DISEASES*

Contents

Learning Objectives

After reading this Unit, you will be able to:

- Learn the definitions of chronic and infectious disease;
- Understand methods used for studying the aetiology of chronic and infectious diseases;
- Know the surveillance methods for infectious and chronic diseases;
- Gain knowledge on prevention and control of chronic and infectious diseases; and
- Appreciate the temporal and geographic diversity of Malaria and Leishmaniasis.

* Contributed by Dr. SAA Latheef, Department of Genetics and Biotechnology, Osmania University, Hyderabad.

4.0 INTRODUCTION

Oxford English dictionary defines disease as a condition of the body or some part or organ of the body in which its functions are disrupted or deranged. Human diseases broadly can be divided into communicable or infectious or chronic or non-communicable diseases. In this unit definitions, aetiology, surveillance of chronic and infectious diseases, geographical and temporal trends of selected protozoan diseases such as malaria and visceral leishmaniasis (Kala-azar) are described.

4.1 DEFINITIONS

Chronic disease is defined as those diseases which are of longer duration and slow progression. Chronic diseases include cardiovascular diseases, arthritis, obesity, cancer, diabetes, stroke and chronic obstructive pulmonary disease. John Murray Last (1988) in the dictionary of epidemiology defined *infectious diseases* as an "illness caused by a specific infectious agent or its toxic product that results from transmission of that agent or its products from an infected person, animal, or reservoir to a susceptible host, either directly or indirectly through an intermediate plant or animal host, vector or inanimate environment. An infectious disease occurs due to the interaction of agent, host and environmental factors. Agent (bacterium, virus, protozoan, fungus and helminth) is usually microorganism that is capable of producing the infection; host (animal, bird, human and arthropods) is the organism that houses an infectious agent and environment may include water, food, milk, clothes, blood, cutley, parenteral solutions and medical tools or instruments. Examples of infectious diseases are malaria, dengue, ebola, human immunodeficiency virus, severe acute respiratory syndrome, tuberculosis, COVID-19, and hepatitis B.

Some of the infective agents (microorganisms capable of causing diseases) were shown to be responsible for chronic diseases (*streptococci* bacteria in rheumatic heart disease, *human papilloma virus* in cervical cancer and hepatitis B in hepatocellular carcinoma).

Box 4.1: Definitions of Terms

- If the infectious disease cases were reported more than usual and restricted to small geographical area it is called *outbreak.*
- If occurrence of infectious disease was reported at unexpected frequency in particular geographical area it is termed as *epidemic.*
- If the infectious disease occurrence was observed as per expected frequency in particular period of time and geography it is known as *endemic.*
- If the incidence of infectious disease was spread different countries and large populations it is labelled as *pandemic*.

Outbreaks are of four types namely point source or common source (source of infection is common to infected persons, example: food poisoning), continuous common source (continuous exposure to infection (water contamination),

propagated or progressive (transfer of infective agent from person to person, ex. Pertussis or Shigellosis) and intermittent (exposure intermittent). Outbreaks come to light while reviewing observations of unusual clustering or increase in the cases or case definition is alerted by the personnel working in health departments or investigation of suspicious case or reported by the patient themselves.

Box 4.2: Steps in the Investigation of Outbreak

(Centers for disease control and prevention, Atlanta, Unites States of America, 2012)

1) Establishing the existing of outbreak (checking if more cases are occurring in specific geographic area in a given period, whether they have common cause, related or unrelated cases).
2) *Verifying the diagnosis* by evaluating the diagnosis with clinical and laboratory findings, interviewing the affected patients for information on exposure and reporting frequency .
3) *Constructing a working definition of case/disease* based on clinical criteria. If needed case definition may be restricted by time, place and person.
4) *Finding information on additional cases* (locality of the affected people, demographic details, signs and symptoms, risk factors and source of report) to determine the extent of problem for particular geographical area and population, by sending formal letter, or interviewing patients by email or mobile phone/visiting facilities, using media and conducting a survey.
5) *Developing hypothesis using descriptive epidemiology*: For characterising the outbreak by time, place and person, the descriptive epidemiology is performed. A special type of histogram known as *epidemic curve (EC)* is used to study the time course of the disease which requires data on the onset of illness/date of onset of the case. EC provide information on the spread of cases whether it is epidemic or endemic, magnitude of cases, whether outbreak is due to common/continuous/intermittent exposure or spread from person to person, prediction of future cases, determining the how much time health personnel took to identify a problem, effect of intervention, time period in which persons exposed, incubation time (period from exposure to onset of illness) and whether outbreak is in upswing or peaked or over. Spot map is used to know the geographical spread of the affected person, source and mode of spread of infection and site of exposure. Area map is used to compare incidence between geographical regions. Collection of information on age, sex, race and medical status can be useful for examining their susceptibility to disease and obtaining information on leisure activities, medication, occupation, behavioural characteristics such as tobacco and alcohol consumption and sex with several partners may throw a light on their possible exposure. Descriptive epidemiology may also be used to calculate incidence, burden of disease, planning health infrastructure and identifying high risk individuals. Understanding the disease, visiting patients and interviewing patients and local health staff and using the data of descriptive epidemiology, hypothesis can be formulated.

6) *Evaluation of hypothesis* is done by evaluating the results of environmental and laboratory tests and if results are not convincing or, epidemiologically studied by matching the hypotheses with established facts and quantifying relationships with analytical epidemiological methods such as case-control and retrospective epidemiological methods between exposure and disease and investigating causal associations.

7) *Draw final conclusions*: If the results of the analytical studies are not convincing hypothesis can be revised. By discussing with patients, thinking for new vehicles or modes of transmission or repeating the case-control studies by selecting matching controls to find specific vehicle or exposure.

8) *Comparing the results of epidemiological, laboratory and environments studies*: Epidemiological, laboratory and environmental studies should complement each other and provide the comprehensive evidence.

9) *Communicating findings:*The findings of studies should be communicated both orally and in typed report by the investigator with justifiable recommendations to initiate action to the personnel involved in executing the control and prevention of outbreaks.

10) *Implementing control and preventive measures*: The control and preventive measures should be initiated at the earliest to protect the health of the public. Confidentiality should be maintained in the implementation of control measures (the disclosure of patient information leads to the stigmatization and rejection of patients from society resulting in treatment failure) and to maintain the trust of the patients. Some interventions advice blocking of transmission by isolation of infected person(s) (ex. Influenza, corona virus positive cases); elimination of vehicle to prevent from food poisoning (discarding of contaminated food); sterilization of surgical instruments and tools avoid post surgery acquired infections; changing the environment to prevent faecal-oral transmission; changing the behaviour (promoting hand washing) help to avoid future contaminated risks; filtering of air prevent from airborne diseases; spraying control the population of mosquito and protect from West Nile virus; promoting using of bed nets prevent from mosquito bites (malaria); wearing of masks and gloves by the Dentist prevent infection from Dentist to patient or vice-versa; wearing of long pants and sleeves and usage of mosquito repellents prevent from West Nile virus and Lyme disease; encouraging of vaccination offer protection against infection; and administration of chloroquine by travellers visiting malaria endemic regions preventfrom infection (malaria).

4.1.1 Aetiology of Chronic Diseases

For studying aetiology of chronic diseases, analytical (ecological, case-control, cohort) and experimental epidemiological methods (randomized controlled trials, field, community and natural trials) are used.

Table 4.1: Epidemiological Study Designs and Study Designs Used for investigating the Aetiology of Chronic and Infectious Diseases

Type of Epidemiological study designs	Epidemiological study designs used to study aetiology of chronic and infectious diseases
I) Observational studies 1) Descriptive studies a) Case reports b) Case series 2) Analytical studies a) Ecological studies b) Case-control studies c) Cross-sectional studies d) Cohort Studies II) Experimental studies 1) Randomized studies a) Randomized controlled studies b) Field trials c) Community trials 2) Non- randomized trials a) Uncontrolled trials b) Natural trials c) Interventional studies without control d) Pre and post interventional studies e) Cross over interventional studies	A) Chronic diseases I) Analytical studies a) Ecological studies b) Case-control studies d) Cohort Studies II) Experimental studies 1) Randomized studies a) Randomized controlled studies b) Field trials c) Community trials 2) Non- randomized trials a) Natural trials B) Infectious disease 1) Analytical studies a) Case-control studies b) Cohort Studies (retrospective)

4.1.2 Ecological Study

In this type of study, population is the unit of the study. Ecological study measures group level data, environmental variables of the area and global measures (population crowding and characteristics of groups). Ecological studies are carried out when the disease is rare, data on individuals are not available, study is planned to investigate the effect of risk factors on population or group level exposure to disease or risk factors, population health is to be monitored and comparisons to be made between populations. Comparative geographical (Example: Association of dietary factors and incidence of cancer in 23 countries and mortality rate in 32 countries), longitudinal/time trend (Example: longitudinal ecological study on the association of seasonal influenza deaths and climatic conditions for the period of 1999-2011 in United States) and studies on migrant populations (Example:

comparison of incidence of psychosis in Norwegian immigrants to Unites States to people in Norway) are three types falls under ecological studies aimed at studying the aetiology of diseases. Information on outcome and exposures are obtained from registries, public and private organizations and surveys done earlier. For example in ecological studies on cancer collect frequency of exposure from public or private sources and disease rates from cancer registries, surveillance programmes, and death certification systems(Silva, 1999). Another example is association between income and cancer mortality, mortality data is obtained from registers of deaths and income details from cross sectional or census data (Bhopal, 2002).

Check Your Progress

1) What types of epidemiological studies used for investigation of aetiology of infectious and chronic Diseases?

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

4.1.3 Case-control Study

In this type of study, the unit of investigation is individual. Newly diagnosed patients (based on the accepted standard criteria for each disease) are compared with the control subjects without disease. Exposure to infectious agent, treatment, prevalence of variables associated with disease are enquired with patients or patient attendants or information is collected from case sheets or by evaluating biochemical tests or measurements with instruments (blood pressure, weight etc.) In case of controls except examining case sheets, the same procedure is followed. Patients are recruited from disease registries, hospitals, cross sectional/ cohort studies/case series in a geographic area. Controls are drawn from voter lists, same geographic area, spouses, friends, same office/factory/institute colleagues or those with other than disease under investigation. Patients and controls are matched for age, sex, ethnicity and socio-economic status to minimize the confounding effect of the variables on the association of variables with disease/ outcome. Association of multiple variables (categorical or continuous) with one outcome/disease is evaluated by using Odds ratio and p value which is obtained by performing logistic regression analysis. In small sample size studies, both Odds ratio and relative risk are considered same.

Box 4.3: Odds Ratio

It is a measure used for assessing the strength of association between exposure and outcome. Odds ratio is used in case-control, cohort and cross sectional studies. Odds is indicated as OR and defined as Odds of event occurring in group compared to odds of same even occurring in another group. For example in one cross sectional study examining the association between high total cholesterol (>200mg/dl) and hypertension in logistic regression found p value of 0.01 and OR ratio of 2.194. This means that association between high total cholesterol and hypertension is significant and those with high total cholesterol have 2 time risk of developing hypertension when compared to those having normal cholesterol levels. OR values ranges from 0 to in infinity. OR=1 indicates no risk, OR>1 increased risk of event occurring and OR<1 decreased risk of event occurring.

4.1.4 Cohort study

Multiple effects of exposure on outcomes or effect of multiple exposures on outcome are evaluated in this study. Cohort (group) having similar characteristics are formed based on city/ occupation/ decade date of birth/marriage. They are studied for particular period of time. Within the cohort, exposure and non-exposure groups are formed. Cohort studies can be prospective (Example: Effect of socio-demographic factors on prevalence, incidence and remission of overweight including obesity in adults from 2008-2017 in Birbhan, West Bengal) retrospective (Example: Retrospective study on maternal and foetal outcomes among patients with gestational diabetes in Kerala during the period of four years) and mixed (Example: A retrospective cohort study on the evaluation of completeness of immunization and prospective cohort study to assess the immunization knowledge and practice of parents in Mosul, Iraq) depending on the outcome developed after starting the study (Prospective cohort study) or before starting the study (retrospective cohort study) or before starting study and continued further (Mixed cohort study). Before initiation of the study, the characteristics of subjects are collected from registries or, census/cross sectional surveys and definition of the outcomes are decided. Exposure data are collated from enquires with subjects, periodical evaluation of clinical and biochemical tests and environmental samples. Relative risk of developing outcome in exposed and unexposed group is investigated.

4.1.5 Randomized Controlled Trials

Experimental study design is one type of epidemiological study design. Experimental study design is of two broad types: (1) Randomized and (2) Non-randomized. Randomized control trials fall under randomized experimental study design (Table 4.1). Aetiology of the outcome/disease can be established or refuted by conducting randomized controlled trials. In randomized controlled trials subjects are randomized (assigned) to intervention or no intervention groups. Blinding is done to remove bias in the enrolled subjects and the investigator. It can be single (subjects enrolled in the study do not know their categorization in the study), double (both enrolled subjects and investigator are not aware of assignment of study groups) and triple (enrolled subjects, investigator and

evaluator of study results are not aware of allocation of study groups) blinded. Study objectives, endpoints (death/survival/decreased risk or improvement in condition or adverse effects) are decided, hypothesis is formulated, and ethical clearance is obtained. Study is carried for the intended period and finally the occurrence of outcome is compared in subjects with and without intervention using relative and attributable risk and the predictors of the outcome are evaluated by regression or logistic regression analyses.

Example 1: Randomized control trial on the, aetiology of retrolental fibroplasias (RLF) (premature retinopathy, a cause of blindness) (Kinsey and Hemphil, 1955; Parker,2013). Premature babies weighing 1500g or less were randomized into interventional or non-interventional groups. Interventional group received 50% oxygen for 28 days or non-interventional group given oxygen when the clinical situation demanded. All non-interventional babies who had received some oxygen developed retrolental fibroplasias while no case was detected in among babies who not received oxygen.

Example 2: *Randomized trial on the effect of vitamins on prevents of coronary revascularization/myocardial infarction/stroke/deaths in women*.

In randomized control trial, vitamin C (500mg) daily, vitamin E (600IU) and beta-carotene (50mg) every other day was administered to 8,171 female aged ≥ 40 years with history of cardiovascular disease or ≥ cardiovascular disease risk factors, and were followed for an average of 9.4 years on the clinical endpoints of the coronary revascularization events, occurrence of myocardial infarction, stroke, or death due to cardiovascular disease. In the follow-up period, 1450 women had one or more cardiovascular disease events refuting that vitamins had role in offering protection against cardiovascular events.

4.1.6 Field Trials

Health populations or groups are involved in this kind of trials. Multiple outcomes can be investigated by introducing interventions such as cessation of the exposure to risk factor or by modifying the treatment, the development of health risk is prevented. In this type of studies aetiology of disease can be proved. Example of this type of studies is smoking cessation and prevention of lung cancer.

4.1.7 Community Trials

Exposure to risk factor or behaviour is altered to prevent the development of diseases which are influenced by socio-economic variables. If significant reduction in the risk of disease is achieved, the strength of evidence on aetiology will be established. Communities are involved in this type of trials. Examples for this type of trials are Community trial on the protective effect of BCG vaccine in healthy people of west of Madras (1979) and community based intervention on awareness, treatment and control of hypertension in Kerala (Thankappan et. al. 2013).

4.1.8 Natural Trials

Natural (for example: earthquakes) or human caused disasters or epidemics when mimic experiments hypothesis of cause can be investigated. For example

earthquakes induced cardiovascular mortality investigated in Greece in 1981; John Snow observations on deaths in two areas in which two companies supplied water resulted in the discovery that Cholera is waterborne disease; and dropping of atom bombs on Hiroshima and Nagasaki in Japan led to the studies on the effect of radiation on the incidence of cancer.

4.2 INFECTIOUS DISEASES

4.2.1 Aetiology of Infectious Diseases

Aetiology of infectious disease is investigated by using analytical epidemiological methods such as retrospective cohort studies and case-control studies.

4.2.1.1 Retrospective Cohort Study

This kind of study design is useful for studying the outbreak in small size sample. Members of the defined population are contacted to know their exposure to sources and vehicles and determine the risk of developing as patient for the disease under investigation. Relative risk and attributable risk are calculated. Relative risk compare the attack rate in exposed when compared unexposed group to test the relationship between exposure and disease. If relative risk is higher than one (1) it indicates stronger association between exposure and disease. Population attributable risk is the per cent of illness in the study population due to exposure, but it is not considered as sensitive tool in the investigation of outbreaks as it fails to account for cross-contamination of items or sampling of spouse. Chi-square is also calculated to find larger association between exposure and disease. Reporting of confidence interval for p value is done to increase the precision of association between exposure and disease.

4.2.1.2 Case-control Study

For rapid investigation of outbreak this study design is of choice. Patients and controls without disease are compared and enquiry on the exposure is done from both groups. If exposure is higher among patients than control then exposure considered to be associated with disease. Controls should be representative of the population; they can be neighbours, friends of the patients or patients with other disease from the same hospital. Odds ratio in the case and control is calculated to test the relationship between exposure and disease. Odds ratio > 1 indicates stronger association between exposure and disease/outbreak. To calculate the statistical significance, chi-square is calculated and to increase the precision of reporting association between exposure and disease, the confidence interval is reported for p-value.

4.3 SURVEILLANCE

Centers for disease control, United States of America, in 2012 defined surveillance as any effort to monitor, observe or determine health status, diseases or risk factors within a population. The characteristics of surveillance are to give information on temporal trends and to initiate control measures (treatment or quarantine) in the affected individuals. Characteristics and natural history of disease will guide the conductance of surveillance. Objectives of surveillance,

strengths and limitations of sources and methods for conducting surveillance will determine what type of data needed; which sources and methods are suitable for carrying out surveillance. When there is less time, diagnosis is difficult, outbreak already occurred, characteristics of affected are known and geographic boundaries are defined, surveillance is done using less specific criteria known as syndromic surveillance. Surveillance can be done continuously or periodically. If reports on diseases sent by healthcare providers to health authorities it is *active surveillance* or *passive surveillance* when it happens vice versa or sentinel surveillance when certain prearranged healthcare providers sent reports to health authorities of certain conditions only. Health problems may differ from country to country but communicable diseases are given importance for surveillance due to their immediate and increased risk to the health of the public.

In surveillance, location of health problem and affected persons are identified, case is defined, available data on health problem is collected, period of surveillance is determined and health problem is measured, collected data is interpreted and informed to those who are involved in the control of the disease who in turn initiate the measures for the control of the disease and evaluate the effectiveness of interventions.

Data for surveillance is collected from population (by carrying out surveys from representative sample (health care providers, patients or public) and results are extrapolated to the entire population),institutional level (case sheets, health care providers, registries of marriage, birth, deaths/disease/treatment/after treatment/ preventive medicine/at risk or exposed/information/skill and research, secondary data, clinical laboratories, outpatient and inpatient departments, notifications of certain disease (by specific agency for control of specific conditions), country/ state/local health related data, income tax and administrative departments; in case of chronic disease surveillance, data from death certificates, autopsy reports, census and natality statistics, demographic/economic/geological/geographical/ meteorological/agricultural data, disease and at risk registries, linked hospital records, discharge summaries, mortality data, surveys/ mass public/occupational screened/ high risk follow-up data, longitudinal or migrant studies) and monitoring of environment (air, water and animal vectors).

In India, Integrated disease surveillance Programme (IDSP) was launched in 2004 with the assistance of World Bank for rapid response and detection of outbreaks. Initially nine States implemented the IDSP now expanded to all States and Union territories. The main objectives of IDSP is integration and decentralization of surveillance activities, develop human resources, application of information communication technology for collection of surveillance data and equip adequately public health laboratories. IDSP consists of three tier organisations of National, State and District surveillance units which is manned by surveillance officers and assisted by epidemiologists, microbiologists, data entry operators and data managers. On 13 priority diseases in districts and five disease added by States, using syndromic, presumptive and lab confirmatory approaches and S,P, L formats, data is collected from public or private institutions on weekly basis. Paper format is used up to district unit from there surveillance data is transmitted to State and Central units electronically. In case of rising trend of any illness, rapid response team investigate, diagnose and control the outbreak (IDSP web site and Phalkey et al. (2013).

In case of non-communicable diseases (NCDs) risk factors, World Health Organization in 2002 proposed STEP wise approach (1-3) for surveillance of NCD risk factors by measurement of questionnaire, physical and biochemical variables. In step 1, data on demography (age, gender, marital status, religion etc.), behavioural traits such as smoking/alcohol/salt/fruit usage, physical activity and history of high blood pressure/high cholesterol/diabetes/cardiovascular disease/cancer or coverage of screening and advice received. Measurements of body weight, height, waist circumvents, and blood pressure is done in step 2, whereas assays on glucose, total cholesterol and urinary sodium are included in step 3. In an expanded list, core questions on behavioural risk factors in step 1, measurement of hip circumference and heart rate in step 2 and investigation of serum/plasma triglycerides and high density lipoprotein cholesterol are recommended. In India, to provide information on high priority risk factors to States, for planning health infrastructure, non-communicable diseases were added to the IDSP programme. In this programme, household level information such as presence of durable goods, ownership of live stock and agricultural lands and religion were collected and the individual information contained two sections. First section included demographic (age, occupation, gender, education and marital status) and behavioural (history of diabetes/ raised blood pressure, tobacco/ alcohol consumption, physical activity, diet) variables while the second section contained details such as measurement of pulse rate, blood pressure, height, weight and waist circumference). People aged 15-64 years were included in the IDSP non-communicable disease risk factor survey (Ministry of Health and Family Welfare, 2009).

Surveillance data is reported in either frequencies or rates. The denominator can be general population of state/country/local or population at risk. Patterns for seasonal, temporal or geographical occurrence of the disease are reported. For infectious disease, data of weeks/months/multiple years, if needed, is required and for chronic diseases data of multiple years is used. Adjustment of sample size is performed for reporting rates of disease by place. Analysis of diseases is also done using personal characteristics such as age, gender, occupation, workplace, behavioural traits and travel history. Depending on the prevalence/ incidence of specific diseases, interventions are planned.

Check Your Progress

2) What is surveillance?

.....

.....

.....

.....

.....

.....

.....

.....

4.4 PREVENTION AND CONTROL

Chronic Diseases

For chronic diseases, prevention can be done at four levels namely primordial, primary, secondary and tertiary. Primordial prevention aims to avoid the development of risk factors that contribute to the chronic diseases. In this type of prevention the role of government is major such as making policies for promoting healthy nutrition by increasing taxation on junk food; encouraging physical activity by constructing foot paths in roads and educating public on the benefits of physical activity; and discouraging smoking and alcoholic consumption by imposing heavy tax on these products. In primary prevention, incidence of disease is reduced by reducing average risk (ex. serum cholesterol levels) at population level and exposure to the risk in high risk groups (example chronic smokers and subjects with hypercholesterolemia). Secondary prevention attempts to reduce the development of disease by early identification and effective intervention. This type prevention is applicable when natural history of the disease is known and disease can be diagnosed easily and early. Examples include pap smear test for screening of cervical cancer and administering of Statins to individuals with hypercholesterolemia. Tertiary prevention deals with the arresting progression or complication of disease in patients by initiating measure to reduce pain/ disability/impairment and improve adjustment to the conditions, wellbeing and resume their livelihood activities. Examples are patients of myocardial infarction, stroke and poliomyelitis (Bonita et al, 2006).

World Health Organization (2000) proposed three strategies for prevention and control of chronic diseases such as surveillance, primary prevention and strengthening of health care systems. Surveillance details for chronic disease are given under the heading of surveillance. Primary prevention is mainly deals with reducing prevalence of risk factors in population. This can be done by Government by increasing taxation on tobacco, alcohol and junk food products, instructing the food industries to reduce salt, saturated fat and trans fats in food items, enforcing ban on public smoking, withdrawing advertisements on smoking/ alcohol/junk food items in Television and Cinema halls, creating physical activity friendly environment in schools, public places and residential areas, increasing the number of health personnel and basic medical facilities, vaccinating infants for Hepaptitis B and human papilloma virus in girls, promoting awareness on the benefits of preventive measures and identifying and administering drugs to high risk groups can reduce the prevalence of risk factors for chronic diseases. Apart from government role, individuals have to adopt health lifestyles.

In health care systems of lower to middle income countries, infrastructure has to be improved; availability of medical specialists and paramedical staff has to be increased; facilities for diagnosis and treatment of chronic disease for continuous care have to be developed; essential drugs should be made available especially generic drugs; there is a need to train paramedical staff and improve the ability of doctors; promoting of wider application of mobile apps for data acquisition, diagnosis and treatment, is needed; and country specific actions should be initiated for the prevention and control of chronic diseases. Government of India has started national programme for prevention and control of cancer, diabetes, cardiovascular diseases and stroke in the year 2010 and set 10 targets to prevent

and reduce NCDS by the year 2025. These are reducing mortality from chronic diseases by 25%; arrest the rise of prevalence of obesity and diabetes; reduce the prevalence of insufficient physical inactivity by 10%, decrease the high blood pressure by 25%; reduce the mean salt/sodium intake by 30%; decrease the usage of alcohol 10%, tobacco (30%) and solid fuel (50%); increasing the eligibility of persons to receive drug therapy and counselling to prevent heart attacks and strokes by 50% and enhance the availability of essential NCD and basic technologies to treat major NCDs in public and private health care centres

Infectious Diseases

Measures which reduce the incidence and prevalence and consequence of disease can be called disease control. The methods for this purpose are dictated by availability of tools, cost, efficiency and reliability. Prior to the epidemiological studies, disease control measures for infectious diseases (eliminating or controlling the reservoir, interrupting the transmission and protecting the host) should be initiated. If the source of reservoir is animal that can be killed and disposed off. In case of humans in order to reduce the load of infective agent, first illness is identified, notified to the health authorities responsible for initiating control measures and for disease (yellow fever, cholera, plague, typhus fever, malaria, paralytic polio, plague, small pox, severe acute respiratory syndrome, COVID-19, swine flu and relapsing fever) which are covered under international health regulations should be notified to the WHO. This enables the early detection of the outbreak and lead to the initiation of control measures. After notifying the disease to the concerned organization an epidemiological study is conducted to know the infective agent, source, vehicles/vectors, hosts and spread of the outbreak. To protect the transfer of infective agent from infected person to susceptible persons, affected persons are isolated till the communicability of infection ends using hospital/ring (encircling the infected with immune persons)/ chemical isolation methods. Treatment is given either to individual or group of infected persons to reduce communicability of infection/duration of illness and to prevent the risk of developing secondary cases. Limiting the movement and isolation of persons infected or suspected to be exposed to infection for the period of incubation to monitor the illness and to prevent the spread of infection to the susceptible persons in the community is known as "quarantine'. This can be done absolutely, partially or segregating for special purposes.

Box 4.4

In India, Patients with COVID-19 (caused by infection of SARS Corona Virus-2) are maintained in isolation, their mobility is restricted and monitored (quarantained) in health care delivery centres for 14 days. Suspect cases of COVID-19 are also quarantined for 14 days.

Interrupting the transmission of infection is done by changing the components of environment and preventing the spread of infection from infected/carrier to susceptible persons such as treatment of water (chlorination), discarding of contaminated food, adequate cooking and refrigeration of food items, promoting personal hygienic practices such as hand washing and following standard practices for the disposal of secreted fluids and excreted materials, destroying the breeding areas of vectors and killing of infected animals.

Control and prevention of infectious can be explained by discussing examples of tuberculosis, cholera and malaria. In tuberculosis, control measures including finding patient sputum positive for tuberculin tests (Mantoux intradermal or Heaf test), treatment with directly observed treatment, short course chemotherapy (DOTS) consisting of Isoniazid, Rifampicin, Pyrazinamide, Ethambutol and Streptomycin and prevention by BCG (Bacille Calmette Guerin) vaccination. Control measures of cholera consisting of finding a patient stool positive for Vibrio cholera, treatment with dehydration fluid and antibiotics, defining the extent of the outbreak, mode of transmission, providing boiled or chlorinated water and building effective sanitary latrines to the community, promoting the use of cleaned utensil, sale of safe and hygienic food, proper individual food handling practices, eating of boiled and hot food, use of cresol and bleaching powder for disinfection, advising the contacts of cases for using the tetracycline as chemoprophylaxis and vaccination with cholera vaccines (Dukoral and Sanchol and mORCVAX) as a preventive measure. Malaria control consists of diagnosis with microscopy of thick and think blood films and rapid diagnostic test (detection of parasite antigen with dipstick format), treatment with chloroquine for *Plasmodium Vivax* cases and artemisinin combination therapy followed by primaquine for *Plasmodium Falciparum*, advising of chemoprophylaxis with anti-malarial drugs to travellers from non-endemic area and also to soldiers, police personnel and labours employed in endemic areas, spraying of insecticides (fenitrothion and malathion) in indoor areas of houses, using of pesticides either in fog or mist form, promoting the usage of mosquito repellents, bed nets and protective clothing, oiling or dusting of standing water collections with paris green, using of mosquito breeding reducing site techniques such as alteration of salt content of water, intermittent irrigation, management of water level, filling or drainage and flushing or deepening and employment of personal protection or bioenvironmental measures (Park, 2013).

The host is protected by active or passive or combined active and passive immunity, chemoprophylaxis, general measures (legislative actions for initiating and implementation of programmes towards enhancing health of the people, disease surveillance (individual/local and national population), and public health improving activities (starting public health promotion/awareness, providing adequate funding to health care delivery centres, developing good health infrastructure, ensuring the availability of essential supplies and instrumentation, recruiting adequate physicians and skilled paramedical staff and issuing advisories to the travellers on personal hygiene, safe food, immunization, chemoprophylaxis and disinfection).

Active immunization (administering inactivated or detoxified or purified components or live attenuated vaccines to produce antibodies to neutralize infective agent) is vaccinating against infection causing agents to improve the immunity levels especially of infants, young children and persons residing in areas to endemic to infectious diseases(ex. Yellow fever). For successful immunization programmes, vaccine should be given at an age beneficial to recipients, should be cost-effective, involve few visits and in tune with the cultural aspects and working patterns of the recipient community. In 1974, World Health Organization started immunization as an expanded immunization programme covering measles, tuberculosis, polio, tetanus, whooping cough and diphtheria.

India initiated immunization programme in 1978 and now in practice as universal immunization programme covering tetanus, tuberculosis, hepatitis B, polio, diphtheria, pertussis, measles and Japanese encephalitis diseases and targeting pregnant women, infants and children.

Passive immunization involves administration of normal or hyper immune human immunoglobulins or antisera or antitoxins to non-immune persons to provide short term immunity for 1-6 weeks when exposed to infection or likely to be exposed to infective agent. For some infective diseases such as diphtheria, tetanus, rabies, both active and passive immunization strategy are used.

In chemoprophylaxis, drugs are administered to prevent the development of infectious disease and this approach is followed for plague, meningitis, malaria, influenza, diphtheria, conjunctivitis and cholera.

Check Your Progress

3) Describe the levels of prevention in chronic disease?

.....

.....

.....

.....

.....

4.5 TEMPORAL AND GEOGRAPHICAL TRENDS OF SELECTED PROTOZOAN DISEASES

Protozoan are primitive unicellular nuclei containing organisms and use flagellum or cilia for locomotion. They depend on other organisms for food source (parasites) except Euglena. Examples include amoeba, plasmodium, paramecium etc. Around 70 protozoan pathogens and among them, 90 species are known to cause infection in humans. The rise in protozoan diseases are attributed to widespread living habitats, deforestation, increased international travel and increasing number of immune compromised individuals. In Indian context, malaria and visceral leishmaniasis (Kala-azar) are significant protozoan disease and data for geographical and temporal trends are available which are discussed in this unit.

Table 4.2: List of Protozoa and Diseases Caused by them

Protozoa	Disease
Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale and Plasmodium malariae	Malaria
Leishmania donovani, Leishmania infantum, Leishmania chagasi	Leishmaniasis
Giardia lamblia, Giardia duodenalis, Giardia Intestinalis	Giardiasis
Entamoeba histolytica	Amoebiasis

Cyclospora cayetanensis	Cyclosporiasis
Cryptosporidium	Cryptosporidiosis
Babesia microti, Babesia divergens and Babesia bovis	Babesiosis
Blastocystis hominis	Blastocystis
Toxoplasma gondii	Toxoplasmosis
Balantidium coli	Balantidiasis
Trypanosoma brucei gambiense, Trypanosoma brucei rhodesiense, Trypanosoma cruzi, Trypanosoma evansi	Trypanosomiasis
Dientamoeba fragilis	Dientamoebiasis
Trichomonas vaginalis	Trichomoniasis
Acanthamoeba	Acanthoameoba keratitis

4.5.1 Malaria

It is caused by the infection of species of *Plasmodium* and transmitted to human by the bite infected species of female Anopheline mosquito. Malaria develops after 8-21 days of biting of infected mosquito depending upon the type of Plasmodium species, climatic conditions and host immunity. Fever, vomiting, headache and flu like symptoms are observed, when red blood cells are destroyed it results in anaemia, fits and loss of conscious. Cerebral malaria occurs when parasites are transferred to brain. If pregnant gets infected with malaria it can cause abortion or stillbirth. Severe complications of malaria include renal failure, hypoglycaemia, fluid, electrolyte and acid-base disturbances, circulatory collapse, pulmonary edema, malaria hemoglubinuria and hyperpyrexia. Above 5000 feet above sea level, <16 degree centigrade, malaria is not found and high incidence is observed during the months of July to November.

Plasamodium species complete life cycle in two phases, schizogony (asexual phase) in human and sporogony, sexual phase in mosquito. Four *Plasmodium* species namely *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale and Plasmodium malariae* are responsible for the spread of malaria through the world. Sixty to 65% of malaria in India is casued by *P. falciparum*, 35-40 % by *P. vivax* and 1% by *P. malariae*. *P. malarieae* is confined to Karnakta and Orissa. Infection from P. Vivax is considered as severest form of malaria.

About 95% of population of India is endemic to malaria. Orissa, Jharkhand, Madhya Pradesh, Chhattishgarh, West Bengal and north- east contribute 60% of malarial burden. Passive surveillance data is collected from primary health centres, malaria clinics, secondary and tertiary care centres, community health centres and visits of ASHA (Acredited Social Health Activist) workers. Diagnosis is based on the micoroscopic examination of blood films prepared on slides, flouroscent antibody test and rapid diagnosis test of antigen detection of malaria causing parasite.

Box 4.5: Accredited Social Health Activist

ASHA must be women in the age group of 25-45 years belonging to the village she works from and has minimum qualification of 10th standard.

Act as interface between community and healthy care systems.

Undergo training to acquire knowledge and skills for performing roles assigned to her.

Create awareness on nutrition, sanitation, hygienic practices, for women on contraception, birth preparedness, safe delivery, antental and postnatal check-up, breast and complementary feeding, immunization and prevention of sexually transmitted diseases.

Motivate villagers for effective utilization and make accountable to the health care systems.

Provide first-aid, promote immunization and sanitisation facilities and participate in referral and escorting in reproductive, child health and health promotion activities

Deliver Oral rehydration sachets, iron/folic acid/ chloroquine tablets, birth delivery kits, iron pills and condoms to the community members.

(**Source**: National health mission, Ministry of Health and Family Welfare, Government of India webpage)

4.5.1.1 Temporal Changes

Year wise incidence of malaria from 1995 to 2019 is available on the webpage of NVBCP (National Vector Borne Disease Control Programme, Delhi). Incidence of malaria declined from 2.93 million in 1995 and maintained around 2 million till 2002 then declined steadily to 0.33 in 2019. *Plasmodium falciparum* incidence was 1.15 million in 1995 and maintained around 1million till 2001 then declined steadily to 0.15 million in 2019. Death rate was around 1000 from 1995 to 2010 peaking around 1707 in 2006 due to Malaria epidemic in Assam then steadily decreased to 50 in 2019. Annual parasite index showed decreased trend from 2001 to 2019. Slide positivity rate (% of slide positive for malaria) (2.31 million) and slide *falciparum rate* (% slides positive for *falciparum*) (1.11 million) were also found to be decreased from 2001 onwards steadily to 0.26 million and 0.12 million in 2019.

4.5.1.2 Geographic Diversity of Vectors

About 60 species of anopheline are reported as vectors of malaria in India. Six species of Anophenline mosquito such as *Anopheline culicifacies, Anopheline stephensi, Anopheline fluviatilis, Anopheline minimus, Anopheline dirus and Anopheline epirotics* are reported to be primary vectors of malaria in India. *An. Culicifacies* has 5 sibling species A-E and responsible for 60-65% of malaria burden. *A* species is vector for *P. Vivax* and *P. Falciparum* and endemic especially where there is high population of cattle and rural and semi-urban areas. B species is vector for *P. falciparum* and endemic where cattle population is low. *An.stephensi* has three variants (form, intermediate and *mysorensis*). Form variant found in urban, intermediate form in urban and rural areas, whereas *myorensis* in

rural areas. Except the latter the first two forms are vectors and found in urban and industrial areas, *An.fluviatilis* is found in forest frings, forests and hilly areas and has 4 sibling species (S,T,U and V). S sibling is an effective vector. *An.minmus* is a vector and spread in foot hills of north-east and *An.epiroticus* is restricted Andaman and Nicobar whereas *An. dirus* is a vector found in north-east part of India.

4.5.2 Visceral Leishmaniasis (Kala-azar)

Lesishmaniasis is included as one of the 17 diseases under the category of neglected tropic disease by World Health Organization to give more attention for its elimination. There are several forms of this disease such as cutaneous, mucocutaneous and visceral. These are caused by infection of parasites like *Leishmania mexicana, Leishmania brazaliensis and Leishmania donovani*. The latter form of disease is also known as kala-azar is prevalent in India and considered to be fatal if not diagnosed properly or treated. Human acquire this infection by the bite of infected female sandfly belonging to the genus *Phlebotamus argentipus*. Parasite occurs in two morphological forms i.e. amastigotes and promastogotes. Sandfly get the parasite from the infected human (amastigotes form) and parasite developed into flagellate in the sandfly (promastogotes form) and transmit to the healthy human through biting. Mud walls, plants in and around human habitations and dampness of the houses contribute to the survival of the vector (sandfly). Reticuloendothelial system (descents of lymphoid lineage from bone marrow which participate in phagocytosis (killing of the foreigner organisms)) is the primary target of this parasite but also found in spleen, liver and bone marrow. In post kala-azar disease when the parasite invades the skin cells and cause dermal lesions it is called post kala-azar dermal leishmaniasis. Discolouration of skin in face, hands, abdomen and feet (kala-azar); spleen and liver enlargement, recurrent fever, anaemia, weight loss, loss of appetite, pallor, loss of hair, dry, thin and scaly skin and lymphodenopathy are cardinal symptoms of this condition. Kala-azar is diagnosed based on the detection of IgM antibodies produced against leishmania in infected person using enzyme linked immune sorbent assay, rapid dipstick and direct agglutinin tests. Rural and low economic strata people showed higher incidence of this parasite. This disease is spread in 10 states namely West Bengal, Uttar Pradesh, Bihar, Assam, Delhi, Kerala, Punjab, Sikkim, Uttarakhand and Jharkhand. About 54 districts of India are affected with this parasite.

4.5.2.1 Temporal Changes

Incidence of kala-azar in 10 states from NVBCP website from the year 2013-2019 showed steadily decline in incidence from 13869 to 3128 and deaths from 20 to nil in the period of 2013-2019. Post kalazar dermal leshmaniasis (PKDL) reported from 2013-2019 for four states (Bihar, Jharkhand, West Bengal and Uttar Pradesh) showed steady increase from 499 cases in 2013 to 1982 in 2017 then declined to 1245 in 2018 and 817 in 2019.

4.5.2.2 Geographical Diversity

Among the 10 states for which incidence data available, Bihar contributed large number of cases followed by Jharkhand, West Bengal and Uttar Pradesh from

2013-2019. The same trend continued in PKDL also except for the years 2014 and 2015 during this period West Bengal occupied second place in the contribution of cases.

Box 4.6

IgM detection by ELISA Method: IgM is one type of immunoglobin produced in response to the exposure to the antigen of infection causing agent (Leishmania) In this test the antigen of lesihmania is coated on the walls of the microassay plate. Test sample is added to the well of the microassay plate that will result in the formation of antigen-antibody complex. Enzyme labelled antibody will be added to the mixture which will bind to the Fragment crystalizable portion of test. Substrate specific to the enzyme is added that will catalyze the substrate to give end product. The colour intensity of end product is directly proportional to the concentration of antibody in the test sample that can be measured using ELISA reader at particular wavelength.

rk39 dipstic(K39) test: K39 is epitope (part of an antigen detected by antibody) present on the amastigotes of Leishmania. By using ELISA as described for IgM, IgG antibodies (type of immunoglobins formed when exposed to the antigen of Leishmania) present in the test sample can be detected and quantified. In field, K39 impregnated nitrocellular strips used for rapid testing. When sample added to the strip it will bind with dye conjugate and move through capillary action, bind with K39 antigen present on the membrane and give red line indicating the presence of leishmaniasis.

Direct agglutination test: In this test, trypsin digested, stained and formalin fixed amastigotes of Lesihmania used as antigen which when combine with test sample containing antibodies form agglutination due to the binding of antigen-antibody.

Source: https://microbeonline.com/antibodyantigen-detection-tests-for-the-diagnosis-of-kala-azar-visceral-leishmaniasis/ and Park, 2013).

4.6 SUMMARY

In this unit, definition of chronic disease and different terms used in infectious diseases, types of outbreaks, steps outlined by Centers for disease control and prevention. United States, for investigation of outbreak, methods employed for studying aetiology as well as surveillance and prevention of chronic and infectious diseases, details of disease, geographical and temporal trends of two significant protozoan diseases of India such as malaria and visceral leishmaniasis (kala-azar) are described.

4.7 REFERENCES

Barreto, ML, Teixerira, & MG, Carmo EH. (2006). Infectious diseases epidemiology. *J Epidemiology Community Health*, 60:192-195.

Bhopal, RS. (2002). Concepts of epidemiology: an integrated introduction to the ideas, theories, principles and methods of epidemiology. Oxford: Oxford University Press.

Bonita R, Beaglehole R, & Kjellstrom, T. (2006). *Basic Epidemiology*, 2nd edition, Geneva: World Health Organization.

Cook NR, Albert CM, Gaziano JM, et al. (2007). A randomized factorial trial of vitamins C and E and beta carotene in the secondary prevention of cardiovascular events in women: results from the Women's Antioxidant Cardiovascular Study. *Arch Intern Med*. 167(15):1610–1618.

Damodar B. (2017). Need for strategic revamping to prevent and control non-communicable diseases in India. *Indian J Community Med*:42(1): 1–3.

Epidemiological methods in the study of chronic diseases. (1967). Eleventh report of the WHO expert committee on health statistics. World Health Organization.

Hunter, DJ. & Reddy, KS. (2013). Noncommunicable Diseases. *N Engl J Med*;369:1336-43.

Kinsey, VE, & Hemphill, FM: (1955). Etiology of retrolental fibroplasia: Preliminary report of a cooperative study of retrolental fibroplasia. *Amer J Ophthal,* 40:166-174.

Kurup KK, John D, Ponniah M, & George T. (2019). Use of systematic epidemiological methods in outbreak investigations from India 2008-2016: a systematic review. *Clinical epidemiology and global health* ;7: 648-653.

Last JM, ed. (1988). A dictionary of epidemiology. 4th ed. New York: Oxford University Press.

Levin KA. (2003). Study Design VI - Ecological Studies. *Evidence-Based Dentistry* 7, 60-61.

Ministry of Health and Family Welfare, Government of India. (2009). Integrated Disease Surveillance Programme on non-communicable disease risk factor survey.

National health mission, Ministry of Health and Family Welfare, Government of India webpage. Available at https://nhm.gov.in/index1.php?lang=1&level=1&sublinkid=150&lid=226

National vector borne diseases control programme. Available at: https://nvbdcp.gov.in/index1.php?lang=1&level=1&sublinkid=5774&lid=3692

Parija SC, & Giri S. (2012). Emerging protozoal pathogens in India: How prepared are we to face the threat?. *Trop Parasitol*. 2 (1):13–19.

Phalkey RK, Shukla S, Shardul S, Ashtekar N, Valsa S, Awate P, & Marx M. (2013). Assessment of the core and support functions of the Integrated Disease Surveillance system in Maharashtra, India. *BMC Public Health*, ;13:575.

Principles of epidemiology in public health practice: Self-Study Course SS1978, 3rd edition, Centres for Diseases Control, Atlanta 2012.Available from: https://www.cdc.gov/ophss/csels/dsepd/ss1978/index.html.

Riley L, Guthold R, Cowan M, et al. (2016). The World Health Organization STEP wise approach to Noncommunicable disease risk-Factor surveillance: methods, challenges, and Opportunities. *Am J Public Health*. 106(1):74–78.

Strategic plan for malaria control in India 2012-2017. A five year strategic plan. Directorate of national vector borne disease control programme, Government of India.

Silva, IDS. (1999). Cancer epidemiology: Principles and methods Lyon, International Agency for Research on Cancer. World Health Organization. Thankappan KR, Sivasankaran S, Mini GK, Daivadanam M, Sarma PS, & Abdul Khader S. (2013). Impact of a community based intervention program on awareness, treatment and control of hypertension in a rural Panchayat, Kerala, India. *Indian Heart J*. 65(5):504 509.

Trial of BCG vaccines in south India for tuberculosis prevention: first report—Tuberculosis Prevention Trial. (1979). *Bull World Health Organ*. 57(5):819 827.

4.8 ANSWERS TO CHECK YOUR PROGRESS

1) For studying aetiology of chronic diseases, analytical (ecological, case-control, cohort) and experimental epidemiological methods (randomized controlled trials, field, community and natural trials) are used. Aetiology of infectious disease is investigated by using analytical epidemiological methods such as retrospective cohort studies and case-control studies.

2) Surveillance is any effort to monitor, observe or determine health status, diseases or risk factors within a population.

3) For chronic diseases, prevention can be done at four levels namely primordial, primary, secondary and tertiary.