Pathogens Controls in Public Health

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Abstract—*This paper deals with role of pathogens in transmitting diseases among the human beings. It outlines the vector borne diseases transmission mechanism. This paper makes a special note on vector management and control with reference to basic sanitation, physical measures, use of chemical, biological methods and planning for the improvement in vector control. This paper concludes with some interesting findings.*

1. INTRODUCTION

There are a number of vectors that transmit communicable diseases. Lice, fleas, various types of flies, snails, rats and mosquitoes are widely found in India. Vectors are found within or close to human habitation; some breed in open water that may be found around homes and others breed inside the home. Certain vectors participate in the destruction of grains and household materials as well.

2. MEANING

In ancient times, insects were very important in the transmission of communicable diseases. The definition of vector was then related mostly to insects. Later on the term vector has been used more widely to include other non-human animals including snails, dogs and rats. Alternative definitions are found. For example, vectors can be defined as: arthropods and other invertebrates which transmit infection by inoculation into or through the skin or mucous membrane by biting or by deposit of infective materials on the skin or on food or other objects. Vectors can also be defined as any non-human carriers of pathogenic organisms that can transmit these organisms directly to humans. Vertebrates, such as dogs and rodents, and invertebrates, such as insects, can all be vectors of disease. This second definition focuses on the range of living things involved. Knowing this definition is helpful in the design of preventive measures for controlling living organisms such as insects and rats which carry the disease agent bacteria, virus from an infected person to a healthy person.

3. PUBLIC HEALTH IMPORTANCE OF VECTORS

Malaria, yellow fever, typhus fever, epidemic typhus, malaria, onchocerciasis, leishmaniasis, rabies and schistosomiasis are all communicable diseases that are prevalent in India. All of these are transmitted by vectors. A number of diarrhoeal diseases acute watery diarrhoea, dysentery, typhoid fever can also be transmitted by vectors and are commonly observed among children in areas where sanitation is very poor. Diarrhoea alone kills many children before they get to their fifth year.

4. VECTOR-BORNE DISEASE TRANSMISSION MECHANISMS

There are two ways that vector-borne diseases are transmitted: Mechanical transmission takes place when a vector simply carries pathogenic microorganisms on their body and transfers them to food, which we then consume. Flies and cockroaches are in this category. Flies like to rest on faecal matter and then may move on to fresh food. They can carry infectious agents through their mouth and on their legs and other body parts. They deposit these agents on ready-to-eat foods and the recipient gets infected if they consume the contaminated food. Biological transmission involves the multiplication and growth of a disease-causing agent inside the vector's body.

Malaria is a good example of biological transmission. The female mosquitoes take the malaria infectious agent (Plasmodium) from an infected person with a blood meal. After sexual reproduction in the gut of the mosquito, the infectious agent migrates into the salivary gland of the insect, where it grows in size, matures and becomes ready to infect humans. When the mosquito next bites a human the saliva is injected into the skin and transfers the infection in doing so. An infectious agent may be passed from generation to generation of vector — this happens mostly in ticks and mites.

The methods of transmission for some known vectors are shown in.

Vector	Diseases	Mechanism
Housefly	Diarrhoeal diseases, TB, polio, worms, food poisoning, infective hepatitis	Mechanical
Mosquito	Malaria, yellow fever, filariasis, dengue fever	Biological
Louse	Typhus fever, relapsing fever, dermatitis	Biological
Mite	Scabies, chigger	Biological
Flea	Plague, murine typhus/endemic typhus	Biological
Sandfly	Leishmaniasis	Biological
Blackfly	Onchocerciasis	Biological

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Bedbug	Dermatitis, Chagas disease	Biological
Cyclops	Guinea worm, fish tapeworm	Biological
Tsetse fly	Sleeping sickness (trypanosomiasis)	Biological
Freshwater snail	Schistosomiasis	Biological
Dog	Rabies	Biological

5. CLASSIFICATION OF VECTORS AND THEIR LIFE CYCLES

Arthropods

The large group of animals called arthropods includes three main types of organism that are important for the transmission of diseases: insects, arachnids and crustaceans.

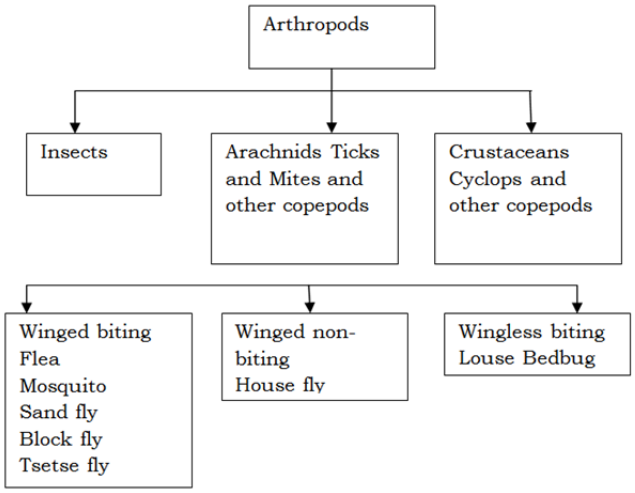

Figure 1: Classification of arthropods this diagram only shows types of arthropod that are disease vectors. There are many others not involved in disease transmission.

6. COMMON INSECT VECTORS

Take a look around your household environment: the kitchen, wastes, walls and clothes. What insect vectors might you find? You may want to ask someone else as well.

7. HOUSEFLY

We are all familiar with this small creature that disturbs us in and around the household and in workplaces. The female lays 200–250 eggs at a time on organic matter. The organic matter could be human faeces, decaying animal and vegetable matter, fresh food or dung. Eggs are white and about 1 mm long. Within 8 to 48 hours the eggs hatch into tiny larvae. These maggots feed voraciously and pass through the three larval stages rapidly; then after four to eight days they pupate. The pupa gradually hardens and changes colour from yellow through red to brown and finally to black. This pupal stage takes three to five days under optimum conditions. The adult fly is attracted to breeding sites that will provide food and warmth for larvae

8. MOSQUITOES

There are three main mosquito groups: Anopheles, Culex and Aedes. Anopheles mosquitoes breed in stagnant, relatively clean water bodies; Culex breed in polluted water; and Aedes like relatively clean water. Eggs are laid in a group (150–200 for Anopheles, 200–500 for Culex) on the water surface and hatch into larvae within a few hours. The larvae breathe oxygen from the air and stay at the surface of the water. They feed on organic matter and microorganisms in the water or on the surface. The larva changes into a pupa which can propel itself using paddles at the bottom of the abdomen.

Only female mosquitoes bite and suck blood; the males feed on the nectar of flowering plants. Females are attracted to a host by heat and exhaled carbon dioxide. A blood meal is required before viable eggs can be laid. During feeding on humans, a small amount of anticoagulant saliva will be injected into the host to prevent the blood from clotting. The malaria infectious agent is introduced into the bite site while feeding on blood. Different species of mosquito carry different diseases. Malaria is transmitted by Anopheles mosquitoes; yellow fever and dengue fever mostly by Aedes. Identification of mosquitoes is difficult without training but breeding behaviour and physical markers can be used to identify the main groups.

9. LICE

There are three types of human louse: the head louse, body louse and pubic louse. All of them are wingless biting insects and live by sucking human blood. They differ in colour and, as their names suggest, in the places on the human body where they are typically found. Head lice are particularly common in children. Being bitten by lice is painful, disturbing and embarrassing, and may cause an allergic reaction. Head lice eggs are laid at the base of the hair and then hatch, leaving the pale-coloured egg casing, known as a ‘nit’, on the hair. The larvae feed on blood until they reach sexual maturity. The life cycle takes about 15 days with laying of about 300–350 eggs at a time. Body lice live in the clothing of the host, especially hiding in the seams. They move towards to the skin of the host to feed. Pubic lice favour the coarser body hair found in the pubic area and armpits.

10. BEDBUGS

Bedbugs are notorious night-biting insects. They are typically found in houses with poor housing sanitation and are abundant in poor urban and rural areas. They irritate the person while sleeping and disturb the sleep of children. Bedbugs love to hide around the bed and inside crevices of the wall during the daytime, and then become active at night. Female bedbugs deposit three to eight eggs at a time. A total of 300–500 eggs can be produced by a single bug in a lifetime. They are often deposited in clusters and in cracks, crevices or attached to rough surfaces with a sticky glue-like substance. Eggs

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typically hatch in a week to 12 days. There are five larval stages for bedbugs to reach maturity, which usually takes about 32–48 days. Adult bedbugs can survive for up to seven months without blood and have been known to live in empty buildings for up to one year.

11. FLEAS

Adult fleas are ectoparasites of warm-blooded animals. There are human, rat, cat, bird and dog fleas, but they can all readily feed on other species in the absence of their primary host. The human flea infests houses with poor sanitation, especially those with a warm, earth floor and dark places. The adults live by biting and sucking blood. The bite is painful, disturbing and irritating. The fleas may be seen on the host animal or on bedding or clothing. More commonly, humans will be alerted to the presence of fleas from the itching that results from being bitten. The bites of cat fleas tend to be confined to the lower legs and ankles, whereas the bites of human fleas tend to be concentrated around the waist and abdomen. Females require a fresh blood meal in order to produce eggs. Females lay eight to ten eggs in dark places. The eggs hatch within two days into larvae which feed on organic matter and develop into pupae.

12. RODENTS

Rodents are relatively small mammals with a single pair of constantly growing incisor teeth specialised for gnawing. The group includes rats and mice. Rodents are abundant in both rural and urban areas. They are found inside houses, in fields and around heaps of waste.

13. MICE

Mice are smaller in size than rats and generally prefer cereals to eat. They are excellent climbers and can run up any rough vertical surface. They will run horizontally along wire cables or ropes and can jump up to 30 cm from the floor on to a flat surface. Mice can squeeze through openings slightly larger than 1 cm across. In a single year, a female may have five to ten litters of about five to six young. Young are born 19–21 days after mating, and they reach reproductive maturity in 6–10 weeks. The life span of a mouse is about 9–12 months.

14. PUBLIC HEALTH IMPORTANCE OF RODENTS

Rodents cause a number of problems: Disease transmission: rats are the natural hosts of fleas that may carry bubonic plague and murine typhus or endemic typhus from an infected rat to a human. Food damage: mice and rats will eat stored food, mainly grains, and will spoil food by leaving their droppings. One rat can consume 15 kilograms of food per year. Rats are estimated to destroy 20% of the world's crop production. Material damage: gnawing by front teeth to doors, windows, wood, boxes, bags, clothes, etc.

15. VECTOR MANAGEMENT AND CONTROL

Vectors can be controlled using various methods. Here we describe the basic methods.

16. BASIC SANITATION

This approach targets the elimination or reduction of that part of the environment that facilitates breeding and harbourage places where vectors find refuge or shelter. It includes the elimination of all possible breeding places for insects, the prevention of stagnation of water to limit the breeding of mosquitoes, and proper solid waste management and use of a latrine to control the breeding of houseflies. The use of clean water from protected sources for drinking prevents the transmission of guinea worm. Rats are controlled by starving them and eliminating their breeding places. Personal hygiene contributes to the control of lice. Generally, a clean home and environment will prevent the breeding of insects. The use of ventilation, latrines and adequate water supply play a significant role in the control of insects.

17. PHYSICAL MEASURES

These include methods that stop vectors from getting into close contact with humans, and methods that are used to kill vectors. They include bed nets for mosquitoes and wire mesh for flies and mosquitoes Mosquito larvae can be controlled in some water containers by putting a thin layer of used oil on the surface of the water. This acts as a barrier between the water and the air so the larvae cannot access oxygen, and suffocate. Physical methods also include traps such as adhesives to control flies and traps for rats and mice. Delousing by boiling or steaming infested clothes are physical methods for controlling lice.

18. USE OF CHEMICALS

Chemical insecticides can be used for the destruction of adults and larvae of insects. Commonly used chemicals are DDT, malathion and pyrethrums. Pyrethrum-containing aerosols are used for the destruction of cockroaches and flies in our homes. Rodenticides can be used to kill rats and mice. The indiscriminate use of these chemicals, however, could have undesired health effects on users and domestic animals. Extreme care should be taken during the application and storage of chemicals. It is always important to look at the instructions for using the chemical. Environmental health workers and veterinary technicians may be able to assist in the use of chemicals against vectors.

19. BIOLOGICAL METHODS

These include several very advanced methods that prevent the successful reproduction of pest species. They include the sterilisation of males tsetse fly, mosquito, sex distortion or replacement of genes. All of these methods are expensive and

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often complex to monitor. Other biological methods involve introducing or encouraging predators of the vector species. For example, small fish can be used to feed on larvae of mosquitoes. Reptiles, birds and frogs feed on adult insects and cats will prey on rats.

20. INTEGRATED APPROACH

Integrated vector management includes a combination of two or more of the above methods. This is often more effective than using a single method of control. For example, the rat population may be significantly reduced by combining starving with trapping. Sanitation can be combined with other cheap methods in order to be both sustainable and effective.

21. PLANNING FOR THE IMPROVEMENT OF VECTOR CONTROL

The community may seek our advice on vector management. There are situations where epidemics could be possible because of vectors such as lice and fleas. The following activities are required in order to have good planning in vector management.

22. KNOWING THE SCOPE OF VECTORS

One cannot tackle all types of vectors. However, one can be involved in the control of flies, lice, fleas, bedbugs and rats, which are the most important public health vectors. One will probably also be involved in mosquito control.

23. IDENTIFYING THE EXTENT OF THE PROBLEM

Knowing the depth of the problem is important in order to mobilise the necessary resources to deal with it. This will also help one in setting priorities for vector control. There is a need to visit a few dwellings and ask which vectors disturb the family. We should find out how common each vector is in the community.

24. IDENTIFYING CONTROL METHODS

Vector control methods vary depending on the species and there is a need to use appropriate methods of intervention according to the above descriptions. Pay attention to breeding site control through the provision of basic sanitation. The use of sanitation, with one or more other methods, is the preferred tool of intervention.

25. IDENTIFYING PARTNERS IN VECTOR MANAGEMENT

There is a need to liaise with other people and offices to tackle vector problems. These may include local government institutions the police office for prison lice management; the school office for nits and lice management among students, local NGOs, and community institutions traditional leaders. They could provide resources and advice, and help mobilise the people.

26. DESIGNING THE PLAN OF ACTION

This requires the preparation of activities under a specified timeframe based on the identified problems. Such activities include: visiting houses, advocacy, public and individual education, and conferences.

27. CONCLUSION

It could be seen clearly from the above discussion that vector is a non-human carrier of communicable diseases. Arthropods such as insects, and mammals such as rats, play major roles, The public health importance of vectors is related to disease transmission, damage to food and property, and acting as a barrier to development, There are mechanical and biological methods of disease transmission by vectors, Insects are identified by their body structure and the presence of three pairs of legs. Insects go through three or four stages to complete their life cycles, rats are vectors that inhabit and breed inside a house. They are involved in the transmission of diseases, destroying materials and damaging food. There are different methods to control them; vectors can be managed using simple control methods such as sanitation and also physical, biological and chemical methods of control. An integrated approach using sanitation in combination with others is the best option in order to effectively reduce the vector population, planning activities for vector management on an annual basis is one major task of the health practitioner.

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