Module 2

Entomological Surveillance Tools

Learning Objectives :

At the end of the module, the participant will be able to understand :

- Rationale, Definition and Objectives
- Objectives of Vector Surveillance
- Entomological sampling strategy
- Types of vector surveillance
- Selection Criteria :Sentinel and random sites

Rationale, Definition and Objectives

Vector control interventions are identified to break the chain of vector-borne disease transmission in the community by eliminating or suppressing the putative vectors below a critical threshold. Entomological surveillance is a tool to systematically collect data on vectors of public health importance to guide and inform vector control interventions. Further, entomological surveillance complements disease surveillance to provide a framework to monitor and evaluate vector control strategies in the community and measure their impact.

Entomological surveillance can be defined as the regular, systematic collection, analysis and interpretation of entomological data for risk assessment, planning, implementation, monitoring and evaluation of vector control interventions. Entomological surveillance is an integral component of surveillance activities for any vector-borne disease. The World Health Organization (WHO) Global Technical Strategy 2016-2030 outlines five core vector control elements to accelerate progress:

- Maximize the impact of vector control
- Maintain adequate entomological surveillance and monitoring
- Manage insecticide resistance and residual transmission
- Strengthen capacity for evidence-driven vector control
- Implement vector control in the context of integrated vector management

Entomological surveillance is central to all five elements, and data generated from entomological surveillance should guide intervention selection, targeting, tailoring, and deployment in space and time.

The vector surveillance and its sampling strategy in a given area depend on the laid down objective and the expected outcome. The sampling strategy for vector surveillance shall depend on routine entomological surveillance, outbreak situation and insecticide resistance monitoring. The selection of any sampling strategy and technique should always be kept in mind for its appropriate application depending on the target species. The sampling strategy shall imply that vector surveillance teams are supposed to select different options depending on the short or long-term study at hand. The present ongoing

operational vector sampling methods usually lack standardisation, quantitative comparisons across different situations in case of outbreak situations and one-time measurements, and it makes it difficult to assess the real situation.

Entomological surveillance involves the adoption of a representative sampling strategy. Sampling is selecting a portion of the vector population in a defined area, which will be representative of the vector population in a given eco-epidemiological setting. The sampling strategy may be the planning, one needs to set forth to be sure that the sample encountered represents the vector population from which the samples are drawn. Entomological sampling methods take advantage of specific vector behaviours, and each method has its own biases, advantages, and disadvantages. Selecting the appropriate sampling method and its placement (location and time) is critical to collecting relevant and accurate data. For example, a human-baited trap (e.g., CDC light trap hung near a human) placed inside houses may function very well with only indoor biting (endophytic) and anthropophagic (human-biting) mosquitoes, and sampling will thus not be representative of vectors that are more exophagic (outdoor biting) or prefer feeding on animals (zoophagic). In other words, that sampling will be biased toward indoor biting, human host-seeking vectors. Also, each method functions differently with local vector species, their bionomics, and the local environment, hence validating sampling methods locally before widespread use is critical. For example, a method that works in one vector for an area may not work in another area for other vector species due to local vector behavioural differences.

Objectives of Vector Surveillance

- Characterize receptivity (classify areas according to transmission risk) to guide stratification and selection of interventions.
- Track the relative density of vector species and their bionomics to determine the seasonality of transmission and the optimal timing of interventions.
- Track insecticide resistance as a basis for choosing insecticides. Vectors have developed physiological resistance to the insecticides used in interventions (mainly LLINs and IRS), which must be monitored closely.
- Identify other threats to the effectiveness of vector control. The composition and behaviour of the vector population may change, thus requiring modulation of vector control measures.
- Monitor vector control intervention coverage and quality to identify gaps and opportunities.

Surveillance can be categorized as preliminary or baseline surveys, routine sentinel surveys for observation of trends, spot checks for supplementary data collection and focus investigations during elimination or in response to outbreaks as follows:

1. **Preliminary or Baseline surveys:** These initial, time-limited surveys are used to gather baseline data for planning vector control measures. They provide information on the vector species present, their resting and feeding habits, changes in species composition by season and over time, types of water bodies used as larval habitats and vector susceptibility to insecticides. Information on local vector species and their ecology, biology and behaviour will often have been assembled and used to inform current control or elimination strategies. Data from these types of surveys can also be used to identify appropriate sentinel surveillance sites.
2. **Routine sentinel surveys:** Long-term observations are made regularly, such as monthly, quarterly or annually, in fixed locations. Their purpose is to identify any change in vector species density and composition, behaviour, susceptibility to insecticides and even infection rates, which may explain any observed epidemiological trends in disease transmission, and ultimately indicate the appropriate response.
3. **Spot Checks:** Spot checks may include investigations in areas where there are suspected problems in the quality of implementation of an intervention; an expected increase in receptivity and/or vulnerability, perhaps due to reintroduction or proliferation of a vector species as a result of environmental changes; the presence of vulnerable populations due, e.g. to resettlement, migration or mining; and heightened risk for importation due to increased human movement in border areas or transport routes linked to endemic countries.
4. **Focus Investigations:** These investigations are undertaken in areas of new, persistent or resurgent disease transmission to determine why the interventions being used are

no longer reducing transmission. They are short-term, reactive epidemiological investigations in settings of elimination or prevention of re-establishment.

Surveillance should therefore be targeted based on epidemiological data and local knowledge of disease transmission risk. Areas in which transmission patterns are changing (e.g. greater vulnerability due to a humanitarian crisis that has displaced human populations) must be identified, and entomological spot checks conducted to assess receptivity and to implement vector control accordingly.

Entomological Sampling Strategy

The entomological sampling strategy is comprised of the following steps for getting the desired outcome based on the objectives.

Step 1: Epidemiological Situational Analysis to define Sentinel Site and Target Population

A sentinel site for conducting entomological surveillance should be selected to represent a range of eco-epidemiological paradigms. The epidemiological information for 3-5 years would be required to establish the baseline trends, rise in case numbers and hot spots of the vector-borne disease. Analysis may be done village-wise/ PHC-wise for the district to understand the clustering of old incident cases. Epidemiological indices may also be taken into consideration at the micro-levels. At least 50 households would be required for each index case reported recently.

Step 2: Mapping of Breeding Potential

It is essential to enlist the potential breeding habitats of vector species in the defined area to understand the receptivity of the area. Receptivity is a function of the availability of competent vectors, suitable habitats, supportive climate and susceptible populations. This information will be useful in mapping and classification of vulnerable ecosystems into no receptivity, low receptibility, high receptivity and very high receptivity. This information will be critical to determine the selection of sentinel sites. The degree of accuracy to achieve the desired goal would depend on the appropriate sample size with the right sampling intervals in the study areas and having confidence in the representation of the vector species in that area.

Step 3: Fixed and Random Sentinel Site Selection

After deciding the sample size for undertaking vector surveys, the sampling tools and technique are to be selected keeping in view the objective of the study. The sampling tools may be chosen based on the need for fixed and random sites.

Fixed Sampling: At least four representative areas of the population may be selected as fixed sampling stations based on the past and recent endemicity of the disease. Fixed sampling is usually done for undertaking a longitudinal study on the seasonal vector prevalence, distribution, and biology in specific ecological niches.

Random Sampling: Random sampling is the selection of the sample sites which is done in and around the fixed sites on a random basis so that the left area may also be a part of the representative area planned for sampling. The only important point to be kept in mind is that the random sampling spots should be in the vicinity or periphery of the fixed stations. Changing the sampling sites should be done from time to time. Usually, four random stations are to be taken up during each vector surveillance and are not to be repeated.

Step 4: Determining Sampling Frequency

The sampling frequency is to be determined in view of the life cycle, longevity, and gonotrophic cycle of the vector species. Moreover, the objective of the vector sampling may be taken into consideration to determine the frequency and intervals for the fixed and random sentinel sites.

Step 5: Selection of Appropriate Sampling Tool and its Application (Technique)

The selection of the appropriate sampling tool is quite important keeping in view the objective. The sampling strategy is always planned based on the sampling of larval stages or adult vectors and the success of the yield shall depend on the application of proper sampling tools and techniques in the field conditions. There may be insufficient information on vectors if the sampling strategy is not proper with the proper selection of representative areas, sampling tools, and procedures.

Sampling is short-term and indicates the presence of a vector and its probable role in the transmission of a particular disease under surveillance. During routine vector surveillance, the sampling technique is based on the frequency and time interval based on multiple sites. The outcome of such routine vector surveillance may help in planning a proper vector control strategy.

Sampling of Mosquito Vectors

Objective

- Prevalence and distribution of mosquito vectors
- Vector biology and bionomics
- Parasite/ virus detection among vectors
- Preference for different vector species in eco-settings
- Understanding the level of susceptibility status against insecticides among mosquito vectors
- Evaluation of the vector control activities in the area

The above objectives can be achieved with the selection of an appropriate sampling technique and in view of the endemicity of the area and the presence of evidence for the vector mosquito species. However, entomological sampling may be undertaken in the sentinel sites, potential hotspots, and susceptible populations.

Selection of Sentinel Sites

- Sentinel sites are selected based on the recent hotspots or past endemicity of the disease at the village level in a district. The seasonal variability and the parasitic reservoir shall determine the onset of disease transmission in that area
- An area having a susceptible population near a high malaria transmission risk area and having potential breeding habitats for the vectors
- An area reporting frequent outbreaks in the past may be due to a migratory population or inaccessibility due to difficult terrain features Entomological Sampling Tool