WEBINAR ON STATTISTICS FOR MICROBIOLOGISTS

JAETECH GLOBAL

Epidemiology & Microbiology: Importance of AST Data Interpretation

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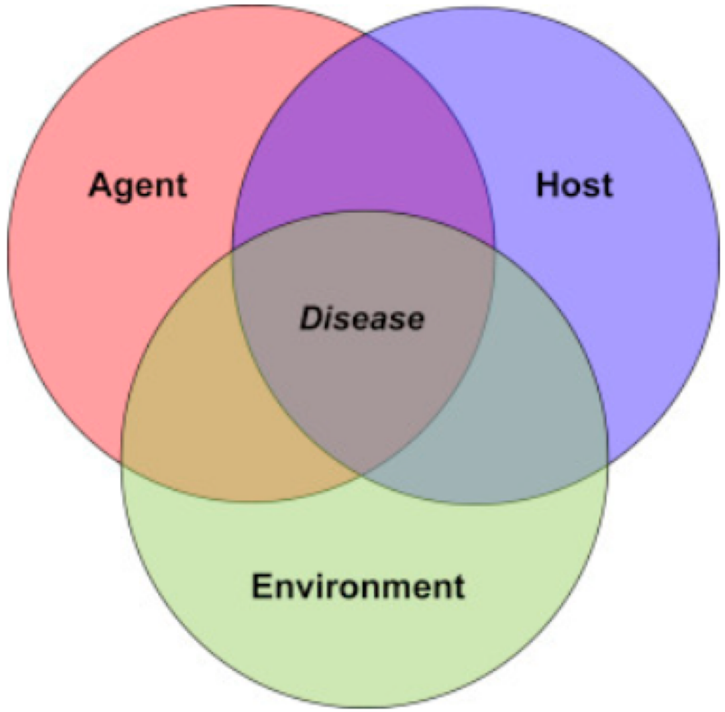
Learning objectives

After completion of this session, participants should be able to

- Think about combining Microbiology and epidemiology
- Determine different surveillance methods
- List the AST procedures
- Prioritize isolation of pathogens and standardize methods
- Determine the Role of epidemiologist in microbiology
- Integrate the AMR data in One Health Framework

The epidemiological triad model of infectious disease causation



The triad consists of an agent (pathogen), a susceptible host, and an environment (physical, social, behavioral, cultural, political, and economic factors) that brings the agent and host together, causing infection and disease to occur in the host.

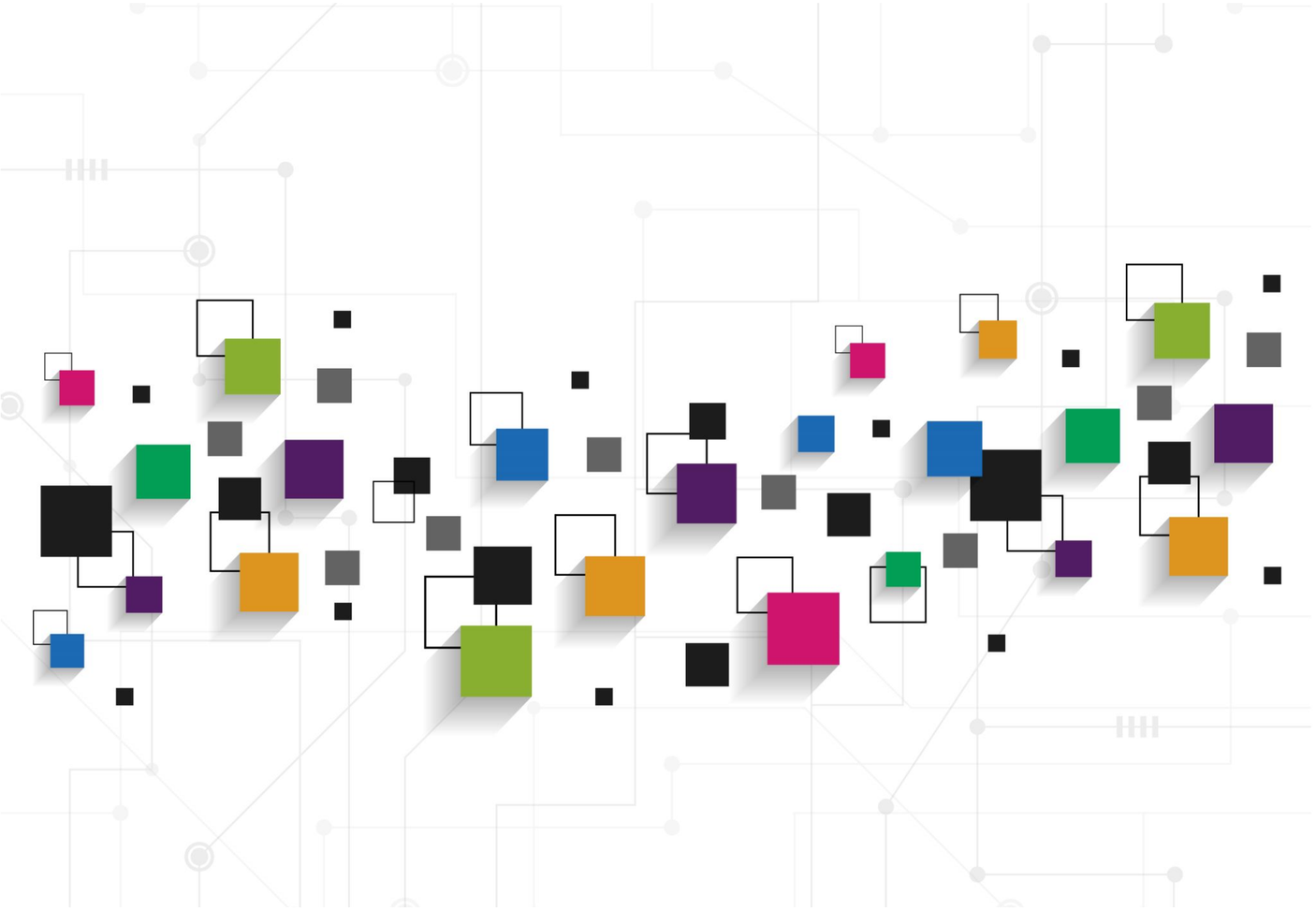
Snieszko, 1974

Power of combining microbiology and epidemiology

By combining microbiology and epidemiology, researchers can gain a deeper understanding of the biological and social factors that influence the spread and impact of pathogens.

- Some examples of the are:
  - Tracking the origin and evolution of new variants of SARS-CoV-2, the virus that causes COVID-19, using genomic sequencing and phylogenetic analysis.
  - Identifying the sources and routes of transmission of foodborne outbreaks, such as Salmonella and E. coli, using molecular typing and epidemiological investigations.
  - Developing and evaluating vaccines and therapeutics for infectious diseases, such as malaria and tuberculosis, using immunological and clinical trials.
  - Assessing the effectiveness and safety of antimicrobial agents and stewardship programs, using microbiological and epidemiological data.
  - Understanding the interactions and co-infections of different pathogens, using microbiome and metagenomic analysis.

Surveillance



Surveillance is the Systematic, ongoing:

- Collection
- Analysis
- Interpretation
- Dissemination of data

The goals of public health surveillance are to

Estimate	**estimate the size of a health problem**
Determine	**determine the geographical location of an illness**
Portray	**portray the natural history of a disease**
Detect	**detect epidemics or define a problem**
Generate	**generate hypotheses in research**
Monitor	**monitor changes in infectious agents**
Detect	**detect changes in health practices**
Facilitate	**facilitate emergency planning.**

Continuous and Episodic Surveillance

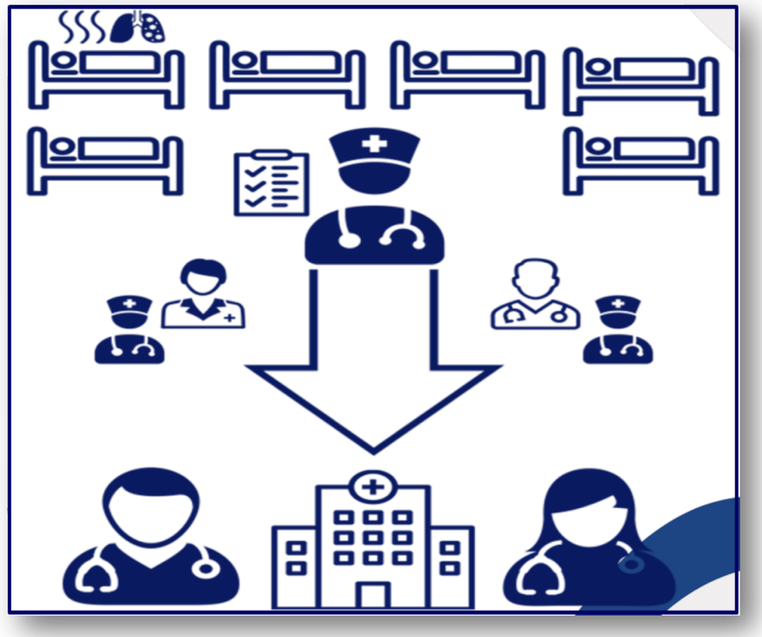
Whether surveillance should be continuous or episodic (i.e. undertaken over limited periods of time) needs to be determined in the light of the resources available;

Episodic surveillance may be suitable in resource-limited situations or for diseases that are predictably seasonal;

In these circumstances, surveillance can be developed with the possibility of extending the time period, should that be required

Active surveillance

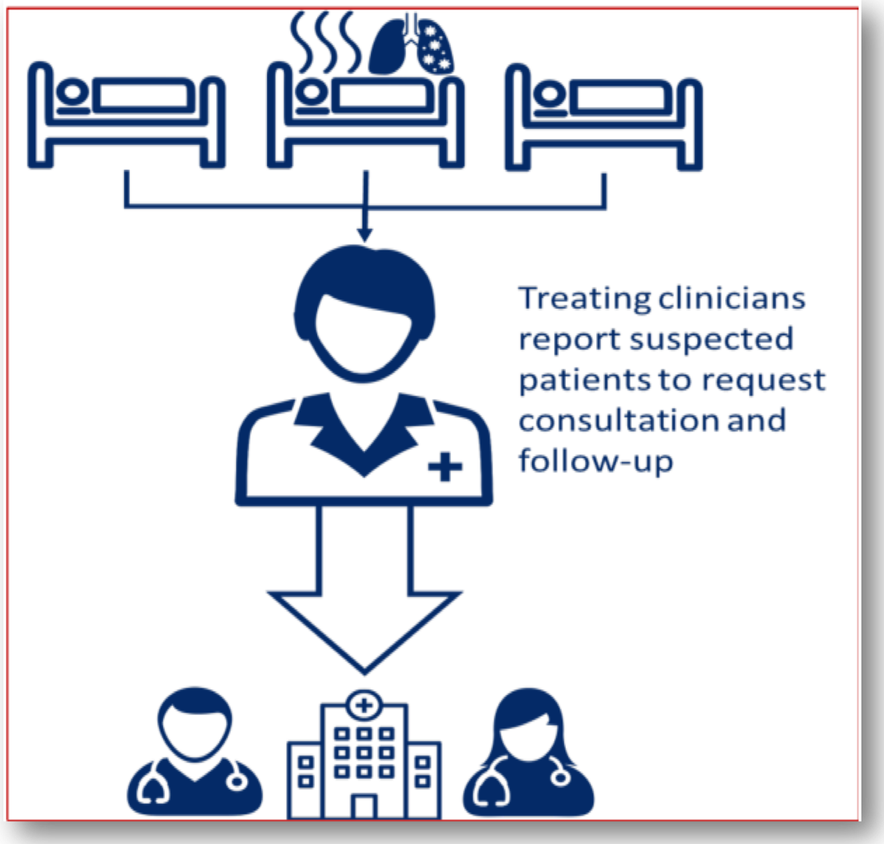
Reports are obtained from the primary data collector in the surveillance system on a regular basis.



Passive surveillance

Reports are awaited

No attempt is made to seek reports actively from the primary data collector in the surveillance system



General surveillance approaches

Population-based surveillance

- Specified disease or pathogen in the whole population at risk
- Capture of data on call cases of infection in the population
- Involvement of a wide range of clinicians and laboratories
- Suitable only for the collection of limited sets of data

Sentinel surveillance

- Collection of data from a limited catchment area or population
- Suitable where prolonged, ongoing and detailed data collection is required
- Sentinel population should be representative of the total population
- For detection of resistance emergence, a targeted approach may be more appropriate.

However, as an example in our sessions, the focus is on AMR surveillance systems

AMR Surveillance

Surveillance of antimicrobial resistance (AMR) is

- the tracking of changes in microbial populations,
- permitting the early detection of resistant strains of public health importance, and supporting the prompt notification and investigation of outbreaks.
- reporting on trends in resistance on a periodic basis.

Surveillance findings are needed to

- inform clinical therapy decisions,
- guide policy recommendations, and
- to assess the impact of resistance containment interventions

There are 3 main AMR surveillance approaches

- Case-finding surveillance based on routine clinical specimens
- Case-based surveillance of clinical syndromes at sentinel sites
- Special studies and or surveys

Examples of methods for the detection of Antibiotic resistance

- Disc Diffusion Method
- MIC
- E-test Method
- Mechanism-specific Tests
- Molecular Testing (e.g. specific Genes That Confer Antibiotic Resistance

Molecular Methods for detection and monitoring of AMR

Amplification tests:	Polymerase chain reaction (PCR) Loop-mediated isothermal amplification (LAMP)
Hybridization test:	Fluorescent In Situ Hybridization (FISH) Line probe assay (LPAs)
Immunoassays:	Lateral flow immuno-assay
Sequencing tests:	WGS MLST

Select a few priority samples and standardize AST procedures

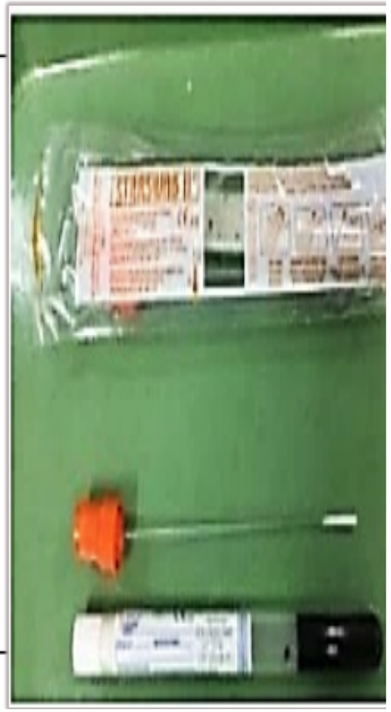
Blood

Urine

Stool

Urethral swab

Cervical swab



Prioritize isolation of pathogens and standardize methods

Gram Positives

- *Staphylococcus aureus*
- *Streptococcus pneumoniae*

Gram Negatives

- *Acinetobacter baumannii*
- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Salmonella spp*
- *Shigella spp*
- *Neisseria gonorrhoeae*

Revise laboratory request form to capture patient core data

- **Age:** the age groups reported in the global health observatory;
- **Gender:** male or female;
- **Hospital or other type of in-patient care facility:** patient admitted for > 2 calendar days when the specimen was taken or admitted to the health care facility for < 2 calendar days but transferred from another health care facility where he or she was admitted for ≥ 2 calendar days;
- **Community:** patients cared for at outpatient clinics or patients in the hospital for ≤ 2 calendar days when the specimen was taken;
- **Routine lab request requirements:** Patient identification, ward, requesting clinician, clinical notes (including the history of treatment), type of sample, date and time of collection, etc.
- Generally, the minimum core patient data should be captured on a laboratory request form

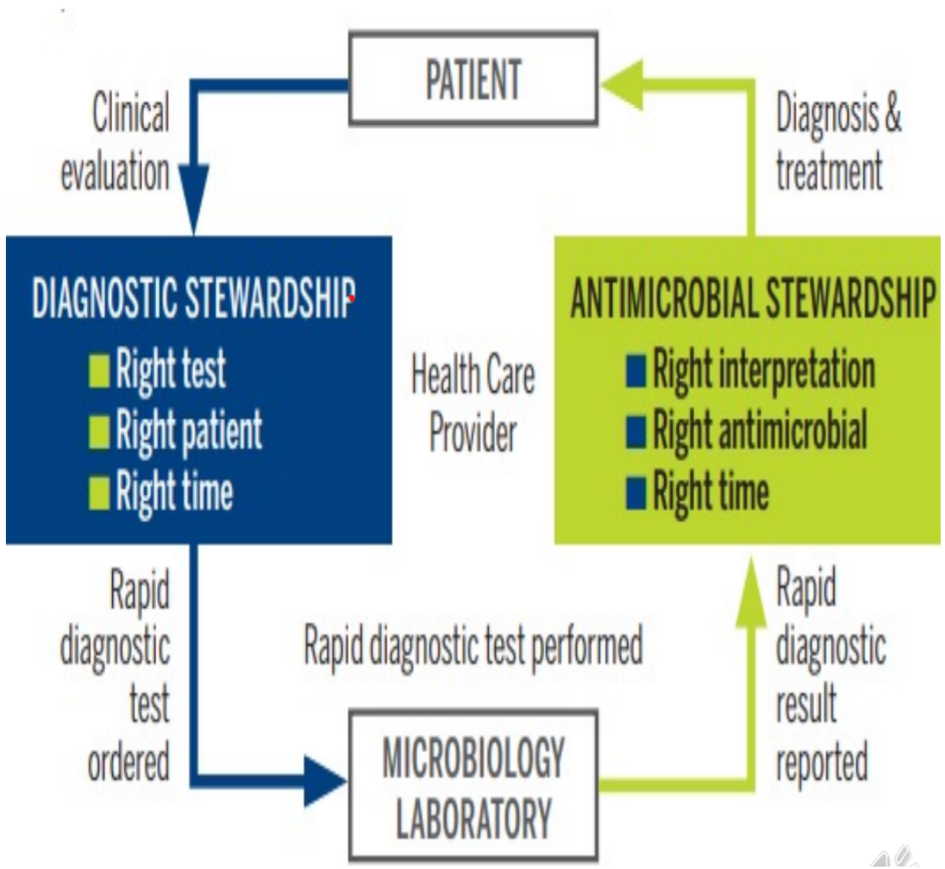
Utilization of laboratory results through diagnostic and antimicrobial stewardship

Diagnostic stewardship is coordinated guidance and interventions to improve appropriate, and timely use of microbiological diagnostics to support therapeutic decisions;

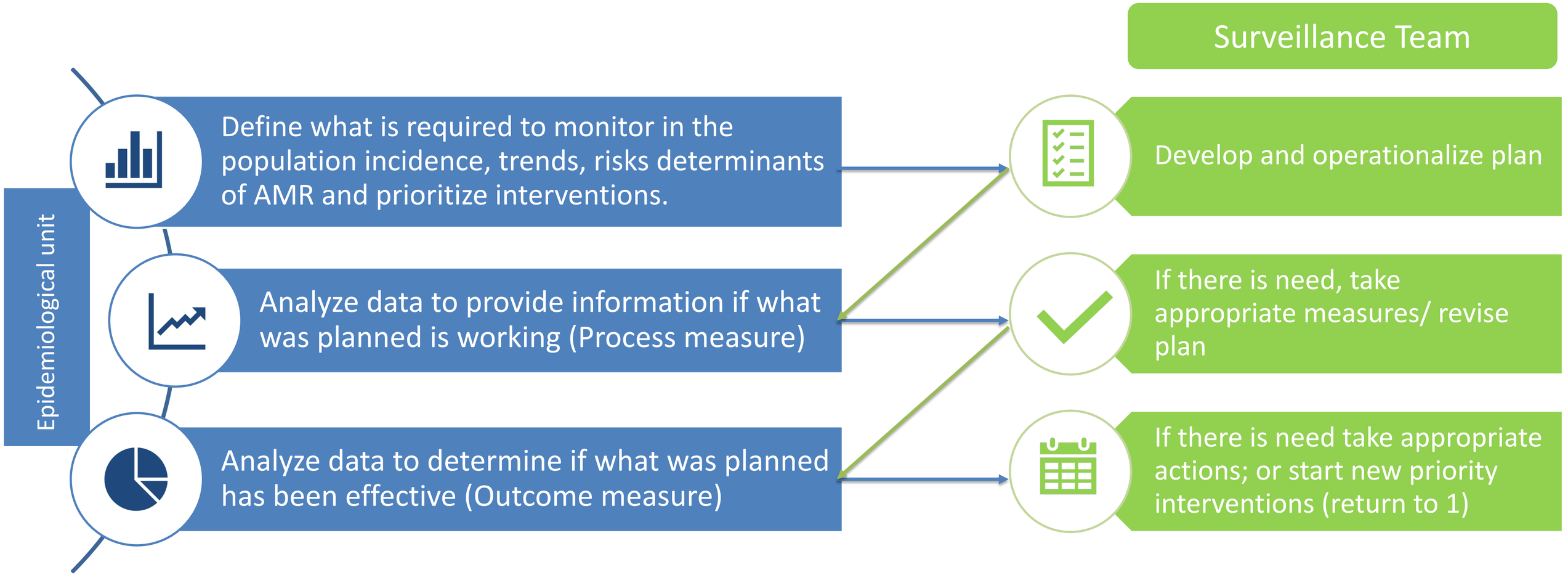
Such efforts are directed at specimen collection, and pathogen identification and accurate, timely reporting of results to guide patient treatment;

Timely and accurate microbiological results available to de-escalate from empiric to more targeted treatment.

Note: The effort is expected to result in better patient care and increased demand for lab services

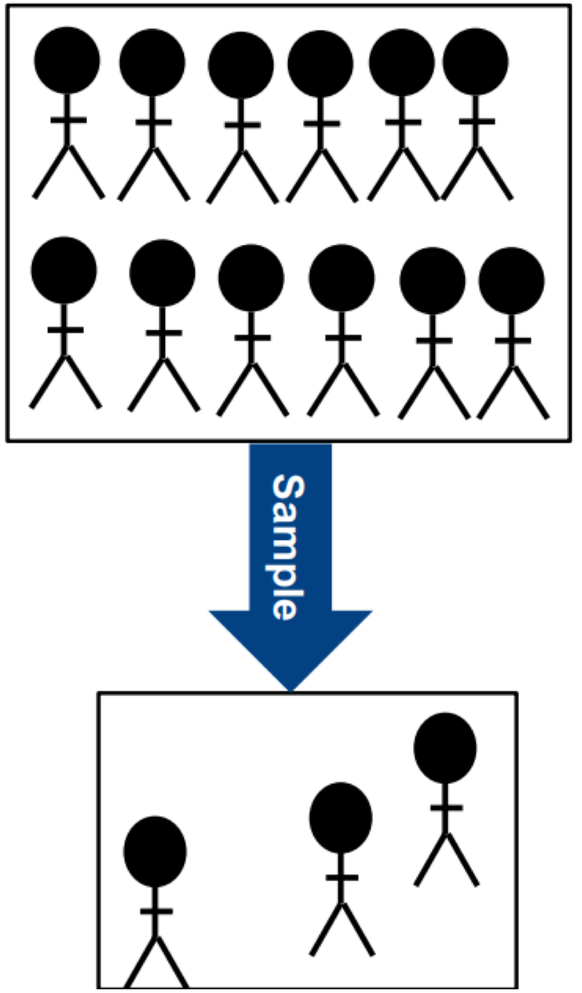


Seek technical assistance from the Epidemiology unit



Epidemiologists should ensure the representativeness of the population surveyed

- The presentation of patients to health care services and their subsequent investigation is neither uniform nor consistent;
- Therefore, it is important to understand the relationship of the population surveyed to the wider population;
- It may be appropriate to undertake cross-sectional studies periodically to establish the extent to which data from sentinel sources reflect the wider community.



Epidemiologists define protocols that ensure that the numerators are correct

- For microbiological data, only the first positive culture from the patient for each disease episode should be reported for surveillance purposes, even if several positive cultures are obtained, or resistance emerges during treatment;
- This will be the reliable numerator for antimicrobial resistance surveillance.

Epidemiologists define protocols that ensure that the denominators are correct

Since the submission of microbiological specimens for analysis is inconsistent and varies widely, the use of laboratory specimens and isolates as denominators produces rates that are of limited epidemiological relevance unless linked to disease incidence;

Wherever possible, rates should be expressed in terms of cases within a defined human population in a defined time period.

Scientific writing and data interpretation example

Table: Univariate logistic regression analysis

Variable	Options	N	NS (%)	Adjusted OR (95% CI)	P-value
Gender	Female	6 564	51.52	Ref	
	Male	7 365	60.01	1.3 (1.05 - 1.54)	0.015
Age	<1	653	56.97	1.2 (0.95 - 1.52)	0.122
	1-17	1 871	54.89	1.1 (0.96 - 1.31)	0.162
	18-49	5 726	51.15	Ref	
	50-65	2 769	59.91	1.3 (1.14 - 1.54)	0.001
	>65	2 910	62.37	1.4 (1.26 - 1.59)	0.001

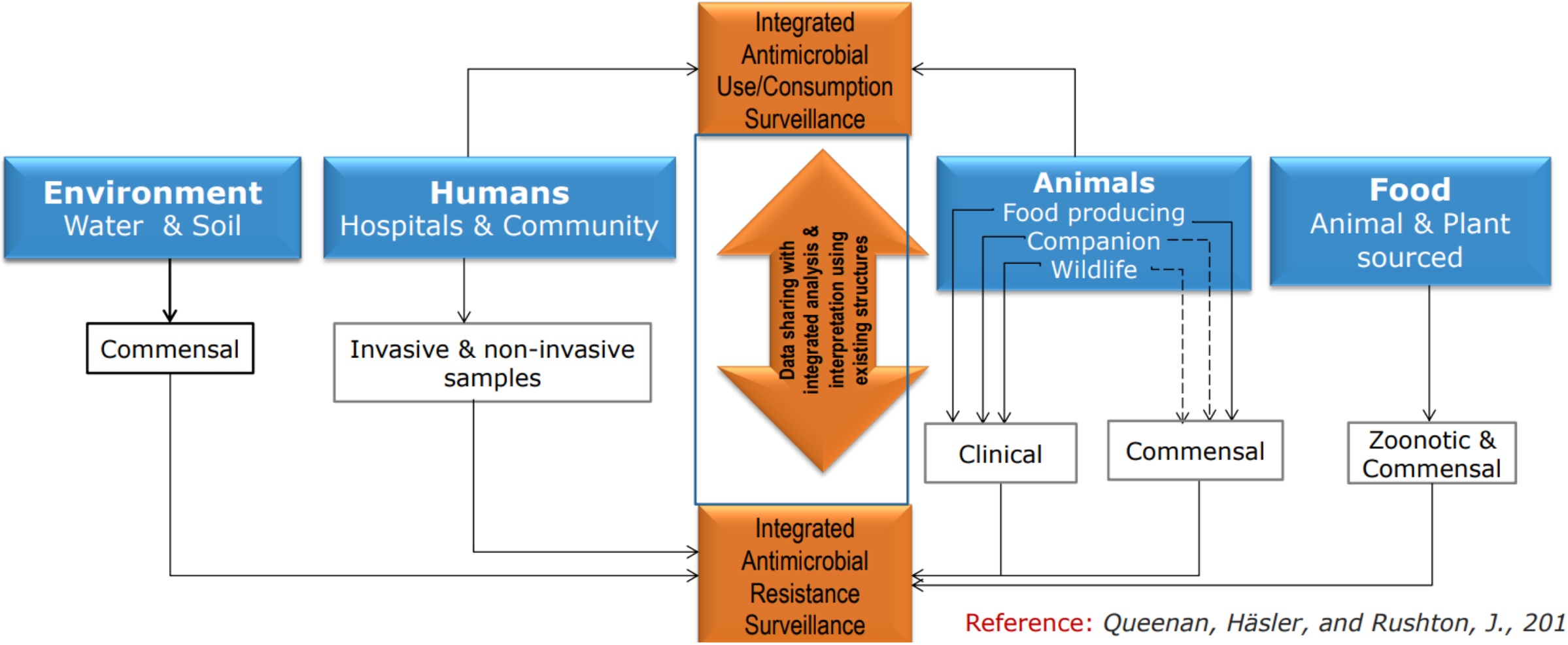
N=number of tested isolates; NS (%)=proportion of non-susceptible isolates.

Information on other patient factors was unavailable or inadequate for analysis.

Interpretation: *Two variables namely, age and gender were evaluated for possible association with AMR. The data availability of these variables was age; 90.6% and gender; 95.4%. The univariate logistic regression analysis revealed that males were more likely to have resistant infections (OR 1.4, 95% CI 1.18 – 1.72).*
In addition, people aged above 50 years were more likely to have resistant infections (OR 1.4, 95% CI 1.27 – 1.61; OR 1.6, 95% CI 1.41 – 1.78). Both variables were included in the multiple logistic regression model based on the set inclusion criteria. When adjusting for the effect of gender, age groups 50 – 65 years (OR 1.3, 95% CI 1.14 - 1.54), and >65 years (OR 1.4, 95% CI 1.26 - 1.59), were more likely to have resistant infections. Further, when controlling for the effect of age, males were still more likely to acquire resistant infections (OR 1.3, 95% CI 1.05 – 1.54).

Source: https://aslm.org

Basic Components of One Health AMR/AMU/C Surveillance Framework



Reference: *Queenan, Häsler, and Rushton, J., 2016*

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THANK YOU

If you have any questions or queries, I will be happy to answer them during the QA session.

Feel free to drop an email with your query to: info@jaetech.co