The International Journal of Multidisciplinary Research Publications
Volume 2 Issue 2 ǁ Mar-Apr 2026.
ISSN: 3139-1087
www.theijmrp.com

Public Health Microbiology: newer perspectives

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Abstract: Microbiology is an inseparable component of public health. Pathogens abound in human specimens as well as in environmental samples like air and water. They should hence be assayed and tested. Public health Microbiology should be accorded its due importance since it can directly benefit the masses. This review highlights key microbiological investigations in a public health laboratory like testing for coliforms in drinking water, air microbiology, food microbiology and rapid diagnostic techniques for infections. A well-equipped Public health Microbiology laboratory significantly improves public health outcomes.
Keywords:- Public health, Microbiology, Pathogen. Coliforms, Mycotoxins

I. Introduction

If one contemplates the burden of infectious diseases still prevalent in our country, microbiology emerges as a critical component of public health. It serves as an interdisciplinary field that acts as a "first line of defense" against infectious diseases, integrating molecular epidemiology, environmental surveillance and advanced diagnostics (1). Historical discoveries like transmission of cholera by drinking water of tube wells and other seminal discoveries have enriched public health (2). It is also important to assess the population whom such a laboratory caters to. Microbiological tests done in public health laboratories should be designed according to the infections prevalent in the general public in that area. It actually bridges laboratory science and population health by emphasizing on detection, prevention and control of infections(3). One should, in this context, keep in mind the infections prevalent in the general population, like Tuberculosis, Malaria, UTI, diarrhoea and STDs.

II. Materials and methods:-

Thorough and scientific literature search was carried out using standard search engines like PubMed and Google scholar, and using MeSH (Medical Subject Headings) terms. Inclusion criteria were articles elaborating on public health Microbiology. Exclusion criteria were articles mentioning only the functions of a Microbiology laboratory and not its tailored role in public health.

III. Results

The tests that are usually done in the public health microbiology laboratory can be summarized as follows:-

a. Water Microbiology:-

Testing drinking water for total and fecal coliforms is very important, and indicates recent contamination of drinking water. Coliforms can be assayed by Multiple tube test or Presumptive coliform test for Total coliforms that generates MPN (Most Probable Number) , and Eijkman's test for faecal coliforms. The presence of Clostridia and Enterococci in drinking water denotes remote contamination. This is because Enterococci and Clostridia can withstand adverse conditions and survive in water for a long time. In the field settings, tests that rapidly detect H_2S-producers in water, like *Salmonella* spp. also attain significance. *Vibrio cholerae* may also be detected using Alkaline peptone water. Nowadays membrane filter technique and tests like ColiTag have largely replaced the cumbersome and time-consuming conventional tests. The image below depicts multiple tube test for total coliforms.

Fig. 1:- Multiple tube test to detect fecal coliforms (Image:- authors)

b. Air Microbiology:-

Studying airborne pathogens is important since they are incriminated in allergic and invasive disorders. Airborne microorganisms suspended in air as aerosols are tested. Air also acts as a potent reservoir for pathogens transmitting Hospital Acquired Infections (HAIs). Bacteria and molds in ambient air can be studied by settle plate (passive) method or by slit or centrifugal air sampler (active method).

c. Food Microbiology:-

Pathogenic bacteria and parasites present in food should also be screened. For this, specimens like food, stool or vomitus can be assayed microscopically, cultured, and foodborne pathogens like *S. aureus* and *Bacillus cereus* can thence be identified. They may be significant if they exceed a threshold colony count. Unpasteurized milk can be cultured for pathogens like *Brucella* spp. and *M. bovis*. Detection of aflatoxins in foodgrains, produced by *Aspergillus flavus* and *A. parasiticus* using ELISA, UV light or HPLC is important due to their carcinogenic potential (4). Other mycotoxins from foodgrains and fruits can also be assayed.

d. Culture and susceptibility of specimens for microbes:-

Common specimens processed in public health laboratory for isolating microorganisms are sputum, urine , CSF (cerebrospinal fluid) and throat swab. They are inoculated on culture media like Blood agar, MacConkey agar and CLED. Antibiogram can be done on Muller Hinton agar or other suitable media, using antibiotic disks like Cefotaxime and Tetracycline, depending on the nature of specimens. Nowadays MALDI-TOF from isolated colonies, and WGS (Whole genome sequencing) have largely replaced conventional assays like culture and antibiogram, and are lesser time-taking options (5).

e. **Entomology**:-

Surveying infection-transmitting vectors like mosquitoes, ticks, and mites also falls under the ambit of public health Microbiology. This is particularly important in the wake of outbreaks of Malaria or Dengue in the locality where society expects the public health laboratory to be involved in vector identification.

f. Serology is important to detect Hepatitis B and other infections like Toxoplasmosis and Rubella that are important in pregnant females due to potential teratogenicity.

g. Other rapid or point-of care essential tests performed in the Public health Microbiology laboratory can be enumerated as follows: -

i. Stained peripheral blood smear for Malaria parasite.
ii. CBNAAT (Cartridge-based nucleic acid amplification) for pulmonary tuberculosis to assess positivity as well as drug susceptibility (MSR or not). It is now the first line test for diagnosing TB and takes 2-3 hours.
iii. ZN (Ziehl-Neelsen) stained smear for AFB (acid fast bacilli) from sputum and extrapulmonary samples.
iv. Card based tests or rapid tests:-

A)Malaria antigen test:- It uses antibodies to detect p-LDH (in all *Plasmodium* species)and HRP-2 (in *P. falciparum*). Low parasitemia may yield false negative results and HRP-2 may persist in blood even after clearance of parasites(6).
B)Typhidot:- This detects *Salmonella* Typhi infection.
C)TPPA rapid test:- This is carried out to diagnose Syphilis.
D) Card test to detect HBsAg.

v. VDRL or RPR:-
These are useful for diagnosing secondary syphilis. Clumping should be checked using naked eye as well as microscope.
vi. From one health viewpoint, genomic surveillance of pathogens by WGS is also very pertinent(7). It is also important for molecular epidemiology.

IV. Conclusion

Thus, in many ways, laboratory personnel in Public health Microbiology laboratory can serve the general public by appropriate tests like staining, culture or other serological tests . Water, air and food testing along with rapid diagnostic methods and newer molecular techniques also play crucial roles in addressing these issues.

a. Legends:-

CLED:- Cystine-Lactose Electrolyte deficient medium.
HPLC:- High performance liquid chromatography
HRP:- Histidine- Rich protein.
LDH:- Lactate Dehydrogenase
MALDI-TOF MS :- Matrix-Assisted Laser Desorption/Ionization-Time of Flight Mass Spectrometry.
TPPA:- *Treponema pallidum* particle agglutination.

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