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Optimizing Diagnostic Resources for Tuberculosis: Utilization Patterns of Diagnostic Tests at the District Chest Clinic and Microscopy Centers in Galle District, Sri Lanka

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ABSTRACT

Tuberculosis (TB) is prevalent in Sri Lanka and poses a considerable public health issue, even though the country is categorized as having a low burden of the disease. It ranks as the second most significant infectious disease in Sri Lanka, with around 500 to 600 fatalities each year. Early detection and effective treatment of all TB cases are crucial strategies for preventing deaths and alleviating the disease's impact. Consequently, individuals exhibiting symptoms of TB, as well as those who have been in close contact with confirmed cases, should undergo thorough investigations. Thus, evaluating the use of diagnostic resources at the district chest clinic and microscopy centers in Galle is essential for accurately diagnosing TB in the area and breaking the transmission chain.

This research examines how diagnostic tests for TB are utilized at the District Chest Clinic and microscopy centers in the Galle district of Sri Lanka. The study aims to evaluate the effectiveness of test usage, identify testing trends, and suggest recommendations for better resource management and enhanced patient outcomes.

A significant issue identified was the underutilization of sputum microscopy centers at the District Chest Clinic and microscopy facilities in Galle. To address this problem, a fish-bone diagram was employed to pinpoint contributing factors, followed by proposed interventions. The PACE Matrix was utilized to prioritize these interventions. Key solutions identified include regular staff training and capacity building, periodic supervision and review meetings, raising community awareness and education, and streamlining referral processes to improve overall conditions.

Key words: Diagnostic Test Utilization, Tuberculosis, Galle, Sri Lanka

Introduction

Tuberculosis (TB) remains a significant global health issue, affecting millions annually and ranking as the second leading cause of death from communicable diseases. The United Nations has set a target to end TB by 2030 as part of the Sustainable Development Goals (SDGs).

Although classified as a low-burden country, Sri Lanka reports approximately 7,000 to 9,000 TB cases yearly, with an estimated incidence of 64 per 100,000 people in 2021. Pulmonary TB accounts for about 72% of cases, with 79.6% confirmed bacteriologically (1). However, there is a discrepancy between the detected cases and the estimated incidence, indicating a gap of around 4,000 cases annually (2).

The National Programme for Tuberculosis Control and Chest Diseases (NPTCCD) oversees TB control efforts in Sri Lanka, collaborating with various sectors and organizations like WHO to achieve the End TB targets. NPTCCD operates through a network of clinics and centers across the country (3). To enhance diagnostic capabilities, NPTCCD has integrated advanced technologies into its services.

In Galle district, the district chest clinic also known as the “Thassim Chest Clinic” serves as a key facility for TB services, providing free diagnostic and treatment options under the guidance of health authorities. The clinic aims to ensure access to effective diagnosis and treatment for all patients with TB or respiratory diseases. Assessing the utilization of diagnostic facilities at the Galle clinic is crucial for improving TB diagnosis and interrupting transmission. Prompt diagnosis and treatment are essential strategies for reducing mortality and disease burden, necessitating thorough investigations

for individuals exhibiting TB symptoms or who have been in contact with confirmed cases. Investigations follow established guidelines and algorithms to ensure optimal use of diagnostic tests (4) (Figure1).

The following diagnostic facilities for tuberculosis are currently available in Sri Lanka (5):

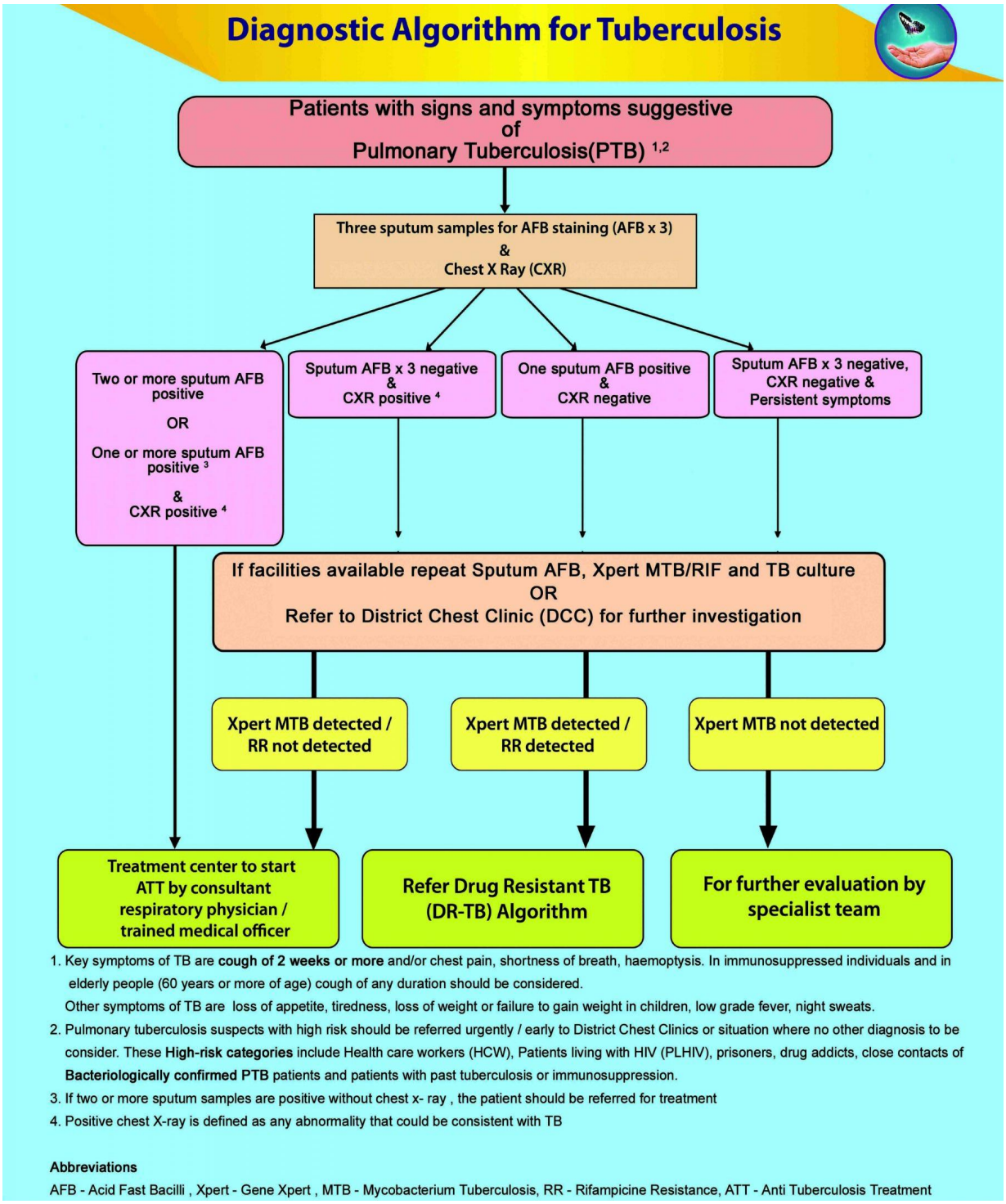
- Chest X-ray
- Sputum smear microscopy
- Xpert MTB/RIF
- Sputum culture for TB
- Tuberculin skin test (TST) and Interferon Gamma Release Assay (IGRA)

According to the diagnostic algorithm, all patients should be screened with a chest X-ray and tested with sputum smear microscopy, with certain exceptions (Figure 1). The Xpert MTB/RIF is a newer, more sensitive diagnostic method that provides automated nucleic acid amplification for the early detection of TB and rifampicin resistance. Sputum culture is more sensitive and specific than direct smear microscopy. The TST and IGRA are used to diagnose latent TB infection.

In the Galle district, sputum smear microscopy is offered at ten microscopy centers:

1. District (Thassim) Chest Clinic, Galle
2. Teaching Hospital (TH) Karapitiya
3. Base Hospital (BH) Balapitiya
4. Base Hospital Elpitiya
5. Base Hospital Udugama
6. Divisional Hospital (DH) Baddegama
7. Divisional Hospital Imaduwa
8. Divisional Hospital Ambalangoda
9. Divisional Hospital Arachchikanda
10. Occupational Health Centre Habaraduwa

Figure 1: Diagnostic algorithm for presumptive TB patients attending OPD in institutions with integrated care for TB (4)



Chest X-rays are available at teaching and base hospitals in Galle district as well as at the District Chest Clinic. The Xpert MTB/RIF machine is located at the Teaching Hospital Karapitiya, where a Consultant Microbiologist is available. Sputum culture for AFB is also performed at the microbiology laboratory of TH Karapitiya. The objective of this study was to evaluate the utilization of TB diagnostic tests at the District Chest Clinic in Galle. Effective use of these diagnostic tests is essential for timely and accurate TB diagnosis, making the District Chest Clinic a key facility for assessing patterns and efficiency in diagnostic test utilization.

Materials and Methods

In this study, we conducted a comprehensive assessment of the diagnostic practices at various healthcare facilities in Galle District. Our objective was to identify the gaps in diagnostic test utilization and understand the factors influencing these practices. We employed both qualitative and quantitative

methodologies, including surveys and interviews with healthcare professionals, to gather data on the current state of TB diagnostics. To gain a comprehensive understanding of the testing process, we examined the current guidelines and protocols for TB diagnostic testing. Key Informant Interviews (KIIs) were conducted with the District TB Control Officer (DTCO), Medical Officers, Nursing Officers, a Public Health Inspector, a Medical Laboratory Technologist, and a Public Health Laboratory Technologist (PHLT) at the District Chest Clinic, as well as with two PHLTs from microscopy centers. Additionally, we reviewed secondary data to gather relevant statistics and conducted direct observations.

Results and Discussion

According to the "Pilot District Guide and Monitoring Indicators" created by the National Programme for Tuberculosis Control and Chest Diseases of the Ministry of Health, Sri Lanka, the following indicators have been established to monitor the optimal use of diagnostic services (6):

1. Percentage of presumptive cases tested with one or more TB diagnostics in the district during the specified quarter*
2. Percentage of presumptive cases examined via smear in the relevant district*
3. Percentage of presumptive cases assessed using Chest X-ray*
4. Percentage of presumptive cases evaluated with Gene-Xpert*

*Denominator – Number of presumptive cases identified (from the presumptive TB register) These four indicators were selected to monitor the effective utilization of diagnostic services at the District Chest Clinic in Galle.

Table 1: Utilization of diagnostic services at District Chest Clinic, Galle

Indicator	October 2023		November 2023		December 2023	
	Number	%	Number	%	Number	%
1. Number of **presumptive cases** identified (From presumptive TB register)	551	100	452	100	360	100
2. Number & percentage of presumptive cases examined with **one or more TB** tests in the given month	276	50.1	309	68.3	238	66.1
3. Number & percentage of presumptive cases examined by **sputum smear microscopy** in the given month	205	37.2	242	53.5	244	67.8
4. Number & percentage of presumptive cases examined by **Chest X-ray** in the given month	-	-	-	-	-	-
5. Number & percentage of presumptive cases examined by **Gene-Xpert** in the given month	35	6.4	34	7.5	20	5.6
6. Number & percentage of cases examined by **Culture for AFB**	00	0.0	01	0.2	00	0.0

There was a significant rise in the percentage of presumptive cases tested with one or more TB diagnostics from October to November 2023, followed by a slight decline in December. Overall, the percentage remains relatively high, suggesting an adequate level of testing in relation to the number of identified cases. The proportion of cases examined using sputum smear microscopy has shown a consistent increase over the three-month period. However, Chest X-rays were not performed at the district (Thassim) Chest Clinic in Galle due to the X-ray machine being out of service during this time. The percentage of cases assessed with GeneXpert has decreased over the three months, indicating a drop in the utilization of this diagnostic method and potential issues with its availability. Additionally, the percentage of cases examined through culture for AFB is very low, highlighting a limited use of culture tests, which may affect the detection of drug-resistant TB cases.

Table 2: Number and percentage of Sputum Smear Microscopy (AFB) tested

Microscopy centre	**October 2023**		**November 2023**		**December 2023**	
	Number of specimens tested	Number of specimens positive for AFB	Number of specimens tested	Number of specimens positive for AFB	Number of specimens tested	Number of specimens positive for AFB
1. District chest clinic, Galle	670	27	745	23	751	21
2. TH Karapitiya	596	16	559	09	520	13
3. BH Balapitiya	146	04	107	01	120	02
4. BH Elpitiya	82	08	85	00	116	07
5. BH Udugama	93	00	81	00	61	00
6. DH Ambalangoda	147	00	198	00	228	00
7. DH Baddegama	221	03	226	00	186	00
8. DH Arachchikanda	66	01	73	00	84	00
9. OHC Habaraduwa	240	00	310	00	237	00
10. DH Imaduwa	-	-	-	-	-	-
Total	1591	32	1639	10	1552	22

The percentage of specimens testing positive for Acid-Fast Bacilli (AFB) at each peripheral center and the district chest clinic has decreased over the three-month period. This trend may reflect enhanced diagnostic accuracy, a decrease in active TB cases, or differences in specimen quality. Many centers exhibit considerable fluctuations in positivity rates, indicating variability in case detection, specimen quality, or diagnostic methods. Several centers, such as BH Udugama, DH Ambalangoda, DH Baddegama, DH Arachchikanda, and OHC Habaraduwa, reported either zero or very low positivity rates, which could be attributed to a low incidence of TB or issues related to testing**.**

Table 3: Information regarding Gene Xpert tests at District Chest Clinic, Galle, Sri Lanka

	October 2023	November 2023	December 2023
Total number of specimens sent for Gene Xpert (To TH Karapitiya)	35	34	20
Total number of specimens tested	10	15	14
Total number of reports received to District Chest Clinic, Galle	10	15	14
Number of specimens reported as **MTB detected** (RR not detected/ detected /indeterminate)	-	-	-
Number of specimens reported as **RIF resistance detected**	01	-	-
Number of specimens reported as RIF **indeterminate**	-	-	-

The percentage of specimens tested has been low, although it has shown a monthly increase. The percentage of reports received aligns closely with the number of specimens tested, suggesting improvements in report processing or data management. Medical Officers at the District Chest Clinic expressed concerns about not conducting all specimens sent to TH Karapitiya for GeneXpert testing. Key informant interviews and a review of secondary data revealed the following issues:

1. Underutilization of sputum microscopy centers
2. Delays in receiving reports from Xpert MTB/RIF
3. Limited availability of Xpert MTB/RIF
4. Malfunctioning X-ray facilities at the District Chest Clinic
5. Interruptions in the availability of culture media
6. External factors, such as the COVID-19 pandemic
7. Insufficient human resources

These identified issues were prioritized using the nominal group technique and a problem prioritization matrix (Table 4), which evaluated the frequency, importance/severity, and feasibility of interventions for each problem. After the discussion, "Under-utilization of sputum microscopy centers" was selected for further examination. The underlying causes of this under-utilization were analyzed using an Ishikawa diagram (Figure 2).

Table 4. Priority matrix

Problem	Frequency	Importance	Feasibility of interventions	Total
Under-utilization of sputum microscopy centres	08	08	09	25
Delay in receiving reports of Xpert MTB/RIF	04	07	05	16
Limited availability of Xpert MTB/RIF	08	08	03	19
Malfunctioning of x-ray facilities at District Chest Clinic	03	08	07	18
Interruptions of availability of culture media	03	07	04	14
External factors such as the COVID-19 pandemic	04	07	02	13
Inadequacy of human resources	05	05	04	14

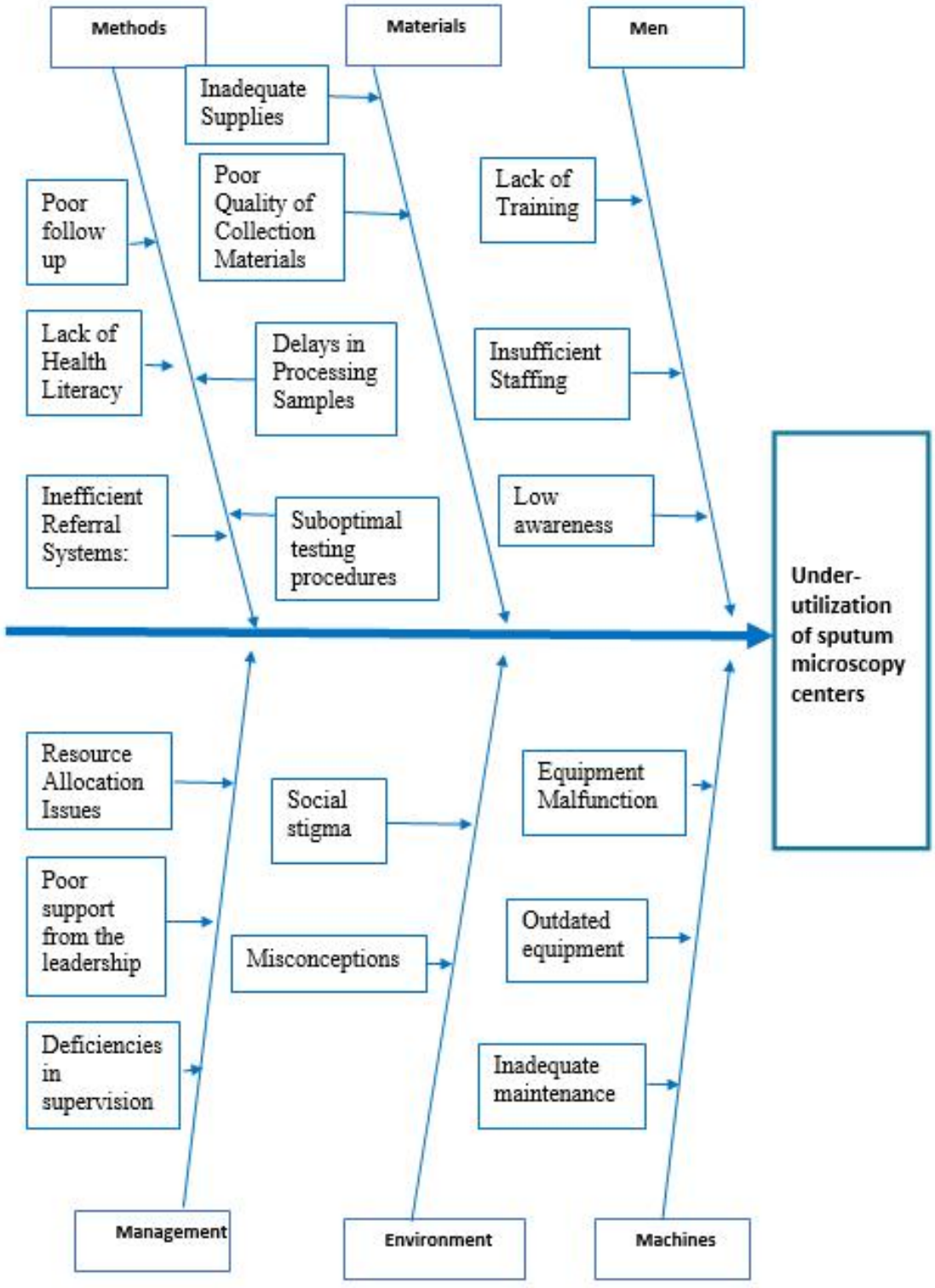


Figure 2. Root cause analysis for Under-utilization of sputum microscopy centers

Factors Related to Men

- Awareness Gaps: There is often a general lack of awareness among healthcare workers about the importance of timely referrals for sputum microscopy. This can lead to missed opportunities for early diagnosis, as providers may not recognize TB symptoms or understand the urgency of testing.

- Insufficient Training: Many healthcare providers lack specialized training regarding the role of sputum microscopy in TB diagnosis. This deficiency can result in inadequate knowledge of procedures, causing healthcare workers to overlook or underutilize sputum microscopy services.
- Staff Shortages: Healthcare facilities frequently face a shortage of qualified personnel, including public health laboratory technicians. This shortage can lead to excessive workloads, delays in testing, and a reduced capacity for sputum microscopy.

Factors Related to Methods

- Ineffective Referral Systems: The referral pathways from primary healthcare facilities to sputum microscopy centers are poorly defined. Consequently, patients referred from institutions without microscopy centers must wait again in the outpatient department of the facility where the microscopy center is located. This inefficiency can delay testing and result in missed diagnoses and extended illness.
- Low Health Literacy: Many patients may lack an understanding of the significance of sputum microscopy in diagnosing TB due to low health literacy. This misunderstanding can cause delays in seeking testing or complete avoidance of the diagnostic process. If patients are unaware of TB symptoms or the need for sputum tests, they may not seek testing.
- Sample Processing Delays: Administrative issues, such as slow sample transportation or lengthy approval processes for testing, can significantly hinder the testing timeline. These delays may lead to longer waiting periods for patients, negatively impacting health outcomes.
- Inadequate Follow-Up Mechanisms: Ineffective follow-up on patients who have provided sputum samples can result in missed treatment opportunities. If patients do not receive timely reminders or support for follow-up appointments, they may miss critical testing opportunities, delaying diagnosis and treatment.
- Variable Testing Procedures: Differences in sputum sample collection methods can lead to poor-quality specimens. Various microscopy centers may use different techniques, resulting in contamination or insufficient sample volume, which impacts test reliability.

Factors Related to Materials

- Supply Shortages: There may be frequent shortages of essential materials for sputum collection and testing, such as sterile containers and reagents. These shortages can impede the testing process and discourage healthcare providers from using sputum microscopy.
- Quality of Collection Materials: The materials used for sputum collection may be of low quality, leading to contamination or degradation of samples. Poor-quality specimens can yield inaccurate test results, further dissuading providers from relying on sputum microscopy.

Factors Related to Management

- Resource Allocation Challenges: Insufficient funding and resources allocated to sputum microscopy centers can affect their availability and operational effectiveness.
- Weak Leadership Support: A lack of strong leadership and advocacy for TB services at the institutional level (e.g., Divisional Hospital) can result in neglect of sputum microscopy centers. Without adequate leadership support, these services may not receive necessary attention and resources.
- Inadequate Oversight: Insufficient monitoring and supervision of sputum microscopy services can lead to inconsistent practices and subpar testing quality. Institutional leaders may not regularly assess healthcare staff performance, preventing the identification and resolution of issues within the testing process.

Factors Related to the Environment

- Social Stigma: The stigma surrounding TB can deter individuals from seeking testing. Fear of being labeled or facing discrimination may prevent patients from accessing sputum microscopy services.
- Cultural Misconceptions: Cultural beliefs about TB and its treatment can influence individuals' willingness to pursue diagnostic services. If patients perceive TB as a shameful illness, they may avoid seeking assistance altogether.

Factors Related to Machines

- Equipment Failures: Frequent breakdowns of microscopy equipment can impede testing processes and undermine the reliability of sputum microscopy services in Galle. A lack of regular maintenance may contribute to these equipment failures.
- Outdated Technology: The absence of modern diagnostic equipment can limit the effectiveness of sputum microscopy. Older microscopes might not deliver accurate results, further discouraging healthcare providers from utilizing these services.

- Insufficient Maintenance: Inadequate maintenance of microscopes can lead to poor performance and increased downtime. If microscopes are not regularly serviced, their reliability diminishes, affecting overall testing capacity.

By addressing these root causes through targeted interventions, it is possible to enhance the utilization of sputum microscopy centers for tuberculosis diagnosis in Galle, ultimately improving patient outcomes and controlling disease spread. Proposals for Improvement:

1. Ongoing Staff Training and Capacity Building: Implement continuous training for healthcare providers on the significance of sputum microscopy and proper sample collection techniques to ensure effective testing.
2. Regular Supervision and Review Meetings: Conduct periodic supervision at microscopic centers and quarterly performance reviews for each center.
3. Duty Coverage Arrangements: Establish coverage arrangements for microscopic centers lacking permanent Public Health Laboratory Technicians (PHLTs).
4. Community Awareness Campaigns: Launch initiatives to educate the public about the importance of TB testing and the role of sputum microscopy through various media channels. Use clear materials explaining the sputum testing process and how to access these services.
5. Enhance Accessibility: Adjust operating hours at sputum microscopy centers to accommodate working patients.
6. Streamline Referral Processes: Simplify referral procedures to facilitate easier access to sputum testing while reducing bureaucratic obstacles.
7. Efficient Sample Transportation: Set up reliable transportation for sputum samples to ensure timely processing.
8. Upgrade Laboratory Equipment: Invest in modern diagnostic tools to enhance the efficiency and accuracy of sputum microscopy testing.
9. Increase Laboratory Staffing Levels: Recruit additional public health laboratory technicians to effectively manage workloads and ensure timely sample processing.
10. Patient Follow-Up Mechanism: Develop a system for following up with patients who have submitted sputum samples, reminding them to return for results and care.
11. Public-Private Partnerships: Collaborate with private healthcare providers to offer sputum microscopy services.
12. Optimize Workflow Efficiency: Create standardized protocols for sample collection, processing, and reporting to ensure consistency and efficiency.
13. Reduce Turnaround Times: Implement strategies to streamline laboratory processes and shorten the time from sample collection to result reporting**.**

The proposed strategies were prioritized using a simplified PACE Prioritization Matrix (Figure 3), assessing ease of implementation and expected benefits as evaluated by three Medical Administration Registrars.

Figure 3: PACE Prioritization Matrix

Benefits / **Ease of implementation**	**Low**	**High**
Easy	**Action 5,11,13**	**Priority 1, 2,4,6**
Difficult	**Eliminate 9, 12**	**Consider 3, 8, 7, 10**

Regular staff training and capacity building are essential strategies aimed at enhancing the utilization of sputum microscopy centers. Ongoing training will ensure that healthcare providers understand the importance of sputum microscopy and are proficient in proper sample collection techniques. Additionally, periodic supervision and review meetings will be conducted to monitor the performance of microscopy centers, allowing for timely evaluations and adjustments.

To address staffing shortages, arrangements will be made to cover duties at microscopy centers that do not have permanent public health laboratory technicians. Increasing community awareness and education is another critical strategy. Campaigns will be launched to inform the public about the significance of TB testing and the role of sputum microscopy. These campaigns will utilize various media channels and include easy-to-understand materials that explain the sputum testing process and how to access these services.

Improving accessibility and convenience at sputum microscopy centers is also vital; therefore, adjustments to operating hours will be made to accommodate patients who work during the day. Furthermore, simplifying referral processes will facilitate easier access to sputum testing by reducing bureaucratic hurdles. Efficient sample transportation systems will be established to ensure timely processing of sputum samples. Upgrading laboratory

equipment is necessary to enhance the efficiency and accuracy of sputum microscopy testing, which may involve investing in modern diagnostic tools. To effectively manage workloads and ensure timely sample processing, additional public health laboratory technicians will be recruited. A patient follow-up mechanism will also be helpful to remind patients who have submitted sputum samples to return for their results and subsequent care. Additionally, public-private partnerships could be explored to expand sputum microscopy services through collaboration with private healthcare providers.

Lastly, optimizing workflow and efficiency involves creating and implementing standardized protocols for sample collection, processing, and reporting. This approach aims to ensure consistency and improve overall testing outcomes. By addressing these factors comprehensively, it is anticipated that the utilization of sputum microscopy centers for tuberculosis diagnosis in Galle will significantly improve, leading to better patient outcomes and enhanced control of the disease's spread.

Conclusion

In conclusion, addressing the under-utilization of sputum microscopy centers in Galle is crucial for improving tuberculosis diagnosis and patient outcomes. A comprehensive analysis of the contributing factors revealed significant challenges related to awareness, training, staffing, referral systems, and resource allocation. By implementing targeted strategies such as regular staff training, periodic supervision, and community education campaigns, healthcare providers can enhance their understanding of the importance of timely referrals and effective testing procedures. Moreover, simplifying referral processes and improving accessibility to sputum microscopy services will facilitate patient engagement and ensure that those in need receive timely diagnostic testing. Upgrading laboratory equipment and increasing staffing levels will further strengthen the capacity of these centers to deliver accurate and efficient services. The proposed action plan emphasizes the need for collaboration among healthcare providers, patients, and community stakeholders to foster an environment conducive to effective TB diagnosis. By prioritizing these interventions, it is possible to significantly improve the utilization of sputum microscopy centers, ultimately leading to better health outcomes and a more effective response to tuberculosis in the region. The commitment to continuous improvement and resource investment is essential for overcoming existing barriers and achieving the goal of eliminating TB as a public health threat.

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Disclosure of conflict of interest

Authors have declared no conflict of interest.

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