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RESEARCH ARTICLE
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YIELD OF SPUTUM INDUCTION FOR THE DETECTION OF MYCOBACTERIUM TB IN SPUTUM SCARCE PRESUMED PULMONARY TUBERCULOSIS CASES

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Abstract

Background: Tuberculosis (TB) is an infectious disease caused by bacteria called mycobacterium TB. It mainly targets the lungs, although in some severe cases, this infection can be transferred from an infected individual to other organs in the body. TB remains one of the major global health threats, particularly for countries like Pakistan, where it does fall amongst the causes of the top ten mortalities.
Objectives: The main objective of the research was to assess the yield of TB positive in induced sputum with hypertonic saline among patients presenting with sputum scarcity.
Methodology: This cross-sectional study was carried out at the Abbas Institute of Medical Sciences Hospital, Muzaffarabad, AJK. In total, 54 patients were subjected to sputum induction.

Results: Subsequent tests confirmed that 55.6% of the subjects were tested positive for mycobacterium TB using Genexpert. Radiological evidence and family history of TB were also analyzed among MTB positive and negative cases.
Conclusion: The obtained results from this study provide evidence that sputum induction could be a useful diagnostic tool, especially in patients with scarce sputum, and further that it offers characteristics giving insights into the distribution of TB-related features of the studied cohort.

Key words: Mycobacterium tuberculosis, sputum induction, sputum scarcity, GeneXpert

Introduction

Tuberculosis (TB) still represents one of the major communicable diseases and public health problems. It is the 10th leading cause of death in the world and the leading cause from a single infectious agent [1]. TB is one of the major infectious diseases in Pakistan. Pakistan stands 5th amongst the high burden countries of the world. According to the WHO report, every year, 69,000 people die because of TB in Pakistan [2,3].

TB is a disease caused by a bacterium called mycobacterium TB; most often located in the lungs. The TB not only involves the lung but also invades the bone marrow and causes significant hematological abnormalities such as anemia, leukocytosis neutrophilia, lymphopenia, thrombocytopenia, and also elevated ESR in the patients [4]. Radiological images are indispensable in medical training, diagnosis, and follow-up due to the valuable information acquired on TB pathology. They play a central role in the process of diagnosing TB, where the radiologist looks out for consolidation and hilar enlargement as important pointers to the presence of TB. These findings provide vital diagnostic clues that would assure prompt and effective management for the condition [5]. TB happens to be one of those challenging competitors that the world of complex infectious diseases always has to calculate with, continuously being haunted by its airborne transmission in the vast global health. In this uprising, within TB complexities, early diagnosis now emerges as a pivot.

Astonishingly, one-quarter of the world's population has encountered TB bacteria. The present situation, therefore, underlines the need for urgency to arrive at innovative approaches to the prevention and control of this infection. Early diagnosis and treatment are the ways to prevent and control this infection. Keeping TB patients under continuous monitoring during their treatment is said to be the key to better outcomes [6,7,8]. About 25 to 40% of patients with pulmonary TB fail to produce sputum or expectorate for diagnosis. Detection of mycobacterium TB in sputum, especially the scanty amount, has posed a huge challenge in the diagnosis and management of TB, which remains an obstinate global health problem [9]. However, the scarcity of bacilli in the sputum specimens of TB suspects often confounds the diagnostic procedures and implies a higher risk of false-negative reporting, which sets off late treatment and potential transmission within communities [10]. Early and accurate detection of mycobacterium TB in sputum samples is, therefore, a requirement for effective programs controlling TB.

The present study was thus designed to establish the optimal amount of induced sputum for the detection of mycobacterium TB in cases of presumed pulmonary TB with limited sputum, which can increase diagnostic accuracy and improve treatment initiation in such cases.

Methodology

The research was carried out in the Abbas Institute of Medical Sciences (AIMS) Hospital, Pulmonology ward and OPD, Muzaffarabad, AJK from 20th March 2020 to 30th December 2020. Hypertonic saline-induced sputum, sample size n=54, produced by subjects who were radiologically-proven cases of sputum and had a family history of TB. The patients were being taken for bronchoscopy for sputum collection only after being subjected to a trial of sputum induction with nebulization of Ventolin and hypertonic saline using an ultrasonic nebulizer along with chest physiotherapy.

NPO patients are nebulized with 5mg/ml salbutamol solution mixed with 3CC NS for 5-7 minutes. Thereafter, they are nebulized on a 20CC solution of 7% hypertonic saline through an ultrasonic nebulizer for 15 minutes. This is followed by targeted chest physiotherapy toward the infected lobe. The hyperosmolarity of hypertonic saline facilitates the fluid to be drawn from the surrounding tissues, thereby aiding the patient to be able to produce sputum.

In case a patient is unable to cough, the huff-puff technique is given to the patient for sputum ejection. The present study used a prospective interventional approach in determining the proportion of MTB GeneXpert and AFB-positive cases in the cohort of sputum scarce, presumed pulmonary TB patients subjected to sputum induction with hypertonic saline.

Health care workers performed the process of sputum induction with full precautions, such as N-95 masks, hand sanitizer, disposable gowns, and gloves. The sputum samples processed further for the MTB RIF Assay in a local NTP Lab. The inclusion in the study also included those who presented scarce sputum with the presumed diagnosis of TB, while those who did not include patients who had pulmonary TB cases previously treated and were positive in sputum and who were non-responsive or dementia patients who were not able to expectorate. In sputum-scarce patients, the diagnosis of pulmonary TB becomes difficult since it is not possible for the patient to expectorate.

Without these tests, like MTB GeneXpert and ZN Stain, the status would be just a presumption. Until the laboratory proof confirms TB, in this case, there is actually the danger of transfer to other people, I mean. Until the time of TB confirmation in the laboratory, the danger of transmission to another one exists. It's interesting to note that one carrier of the MTB can infect up to 13 other people. This therefore makes a timely and a very accurate diagnosis of high import towards effective management of TB, and especially the prevention of the spread of TB.

Operational Definition: *Sputum Induction* is a medical procedure used to assist a patient to cough out secretions emanating from the lungs with ease. The principle is that it produces excessive mucus in the airways of the lungs. Sputum induction procedure is carried out to produce a high-quality specimen of sputum. *Hypertonic Saline* (7%) is used during the procedure to induce the sputum of patients in whom sputum is scarce. It is a hyperosmolar in nature and helps the patients cough to take out secretions. *Chest Physiotherapy and Postal Drainage* are also used as a tool to clear infected lobe of the patient.

Descriptive statistics were employed to calculate the frequencies of MTB-positive and MTB-negative among the cohort. Associations between MTB status and observed characteristics on chest X-rays and family history of TB were assessed using chi-square.

Results

The pie chart shows that out of 54 patients who had sputum induction done, 30 tested positive (55.6%), while 44.4% tested negative for MTB GeneXpert. This goes to show that around half of the population in this cohort turned out to be MTB positive when subjected to the sputum induction procedure, thereby giving credibility to the fact that this way of diagnostic workup has very high significance and gives a ray of hope to diagnosing TB cases among sputum-scarce patients **(Table 1, Figure 1).**

Table 1: Distribution of MTB test results as per sputum induction using hypertonic saline

TB Test Result	Number of Individuals	Percentage
Positive	30	55.6%
Negative	24	44.4%

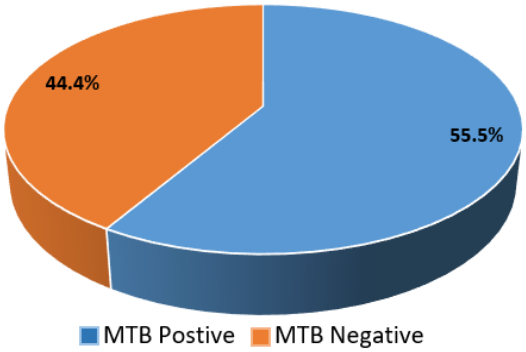

Figure 1: Proportion of MTB positive and MTB negative after sputum induction using hypertonic saline solution

Other elicited features among the subjects who were positive and negative for MTB upon sputum induction using hypertonic saline are presented in **Table 2**. 12 of them tested MTB positive, and they had radiological evidence showing opacities; 18 tested with a family history of TB. Consolidation on chest x-rays was shown in 10 individuals, while hilar enlargement was shown by 20 individuals. On the other hand, from the test-negative persons for MTB, 16 presented the radiological evidence of opacities in X-rays, while 8 had a family history of TB. Further, 18 individuals showed consolidation in their chest X-rays, and 6 had hilar enlargement. This additional information provides some insights into the distribution of characteristics among MTB positive vs. negative cases within the studied cohort.

Table 2: Characteristics of MTB positive and negative cases following sputum induction using hypertonic saline.

TB Test Result	Radiological Evidence (Opacities on X-rays)	Family History of TB	Consolidation on X-rays	Hilar Enlargement
Positive	12	18	10	20
Negative	16	8	18	6

Discussion

The current study was carried out with the sole aim of accessing the effectiveness of sputum induction in patients with scanty production of sputum in the detection of Mycobacterium TB, achieved through sputum induction following nebulization with hypertonic saline. Thus, this research was carried out on man assumed to have pulmonary TB; this is a reflection of the fact that pulmonary TB is still a challenge for man, especially in countries like Pakistan. It showed symptoms typical of TB, like the constant cough, fever, night sweat, weight loss, and weakness indicative of the disease [1,11]. The diagnostic tools ranged from using Ziel Nelson's staining for tubercle bacilli in sputum to blood or sputum cultures and radiography of the chest. Other diagnostic tools included interferon gamma release assays (IGRAs) and polymerase chain reaction (PCR), which were discussed, keeping in view the quest for rapid and cost-effective diagnostic solutions in resource-constrained settings. The study was of 54 patients, of whom 55.5% tested positive and 44.4% tested negative for mycobacterium TB through sputum induction. All this goes a long way to underline the need for searching for more innovative diagnostic approaches, including sputum induction, in order to see further improvements in the management and diagnosis of TB.

Another study [12,13] was performed among 82 patients from which sputum was successfully induced in 73, including 26 who have been previously smear-negative and 47 who have been previously unproductive in producing sputum. Of these induced sputum samples, 18 patients tested smear-positive. Mycobacterium TB was also found in culture for the 18 patients who were smear-positive and a further 12 previously smear-negative. A total of 94 smear-positive pulmonary TB cases were reported during the study period. Of these, 18 (19%) were sputum-induced.

Overall, the findings indicate that sputum induction helps in reaching a diagnosis of TB in most cases, especially in the setting of scanty sputum. In essence, its efficaciousness in the finding of mycobacterium TB points to an important role of this procedure in the increase in the diagnosis rate of TB, thereby enhancing patient care.

Conclusion

Resultantly, the outcome is depicted that the technique of sputum induction with hypertonic saline results in a high rate of expectorated sputum sample, which helps in diagnosing Mycobacterium TB amongst a few selected patients, and this technique gives a fair share of positive results and may be helpful in diagnosing TB among cases of tuberculoid persons.

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