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Research Paper

Evaluation of Sputum Induction for Diagnosis of Pulmonary Tuberculosis

Medical Science

KEYWORDS : Tuberculosis, Sputum induction, diagnosis.

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ABSTRACT

Background: India is the highest tuberculosis burden country in the world. If left undiagnosed and untreated, a pulmonary tuberculosis case can infect 10-15 persons annually. Though sputum examination for acid fast bacilli (AFB) remains the mainstay for diagnosing pulmonary tuberculosis, patients having dry cough or scanty sputum pose a major diagnostic problem.

Methods: 20 ml of 3% hypertonic saline was administered by ultrasonic nebulisation for about 15 minutes, to patients. Smears from respiratory secretions thus produced were stained and examined for AFB.

Results: Out of total 244 patients who underwent sputum induction, 68 (27.9%) were found to be having sputum smear positive for AFB after procedure. However, SI procedure had to be repeated in 5 patients.

Conclusion: 27.9% sputum smear positive results translate into a significant absolute number of tuberculosis patients from sputum induction which thus remains a safe, simple, non-invasive and cost-effective diagnostic procedure; which can be applied even at primary health care centres.

Introduction

Tuberculosis (TB), an ancient disease continues to haunt us even as we have well stepped into the new millennium. With 17% of the global population, India contributes to about 26% of the global TB burden, with 2.2 million new cases every year[1] out of global 8.6 million, and if left undiagnosed and untreated, each case of lung tuberculosis can infect 10-15 persons annually. It still remains a major public health challenge in India, being responsible for the death of one person every two minutes i.e. about 750 deaths each day.[2]

The microscopic examination of sputum to detect presence of Acid Fast Bacilli (AFB) has served the world well for over past 100 years and still remains the diagnostic basis for detection of infectious tubercular cases. Adequate sputum sample is essential for quality microscopic diagnostic yield and is a prerequisite to establish the diagnosis of pulmonary tuberculosis (PTB) under Revised National Tuberculosis Control Programme (RNTCP) guidelines, as recommended by World Health Organisation (WHO). Though sputum examination for AFB is not the gold standard to diagnose PTB, however it is still the key method for diagnosis of PTB under programme conditions because of its feasibility. The chest symptomatics having dry cough and/or scanty sputum, pose a major diagnostic problem[3]. Sputum induction (SI) has been used for many years for the diagnosis of various respiratory diseases. The inhalation of an aerosol of hypertonic saline to produce sputum was first used by Bickerman et al in 1958 in cytology of lung cancer.[4] Later on, induced sputum was used for clinical purposes to detect numerous pathogenic microorganisms.[5, 6] More than three decades ago, SI was widely used for the diagnosis of PTB as it was superior in yield to gastric lavage, though after the invent of fibreoptic bronchoscopy, was abandoned for few years. But it was again revived because of low risk of TB transmission and low cost.[7, 8]

In-depth interviews revealed that most patients were not aware that 'sputum' rather than saliva has to be submitted for the diagnosis and thus were less knowledgeable about the difference between 'sputum' and 'saliva'.

Though direct sputum smear microscopy remains a fundamental tool, but may be negative in up to 50% cases of active pulmonary tuberculosis.[9]Alternative methods of obtaining sputum specimens are frequently needed in these patients; these include sputum induction (SI), gastric washings (GW) and bronchoalveolar lavage (BAL) specimens. These methods have their own pros and cons in respect of safety, tolerability, acceptability by patient and feasibility in different setups from a primary health centre to a tertiary care hospital, along with related cost factors.

GW is reported to reveal the organism only in 25-50% of children with active TB.[10] Bronchoscopy for BAL is an invasive procedure only available in the large hospitals, costly, needs experts for performance and may not be feasible if the large number of patients are to be tested; more so with risks of nosocomial infections to the operator and staff.

Sputum induction is a cheap and non-invasive alternative with a diagnostic yield 'same if not better' than bronchoscopy.[7] SI with hypertonic saline has been used in the diagnosis of various respiratory disorders. It is probable that hypertonic saline works by improving sputum transportability, enhancing mucociliary clearance and inducing cough.[12]

Aim

The present review study was carried out to evaluate sputum induction in establishing the diagnosis in patients with suspected pulmonary tuberculosis, who were unable to produce adequate sputum or were found negative on smear examinations.

Material and methods

This retrospective study was conducted at the Chest Diseases

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and Tuberculosis Hospital, Government Medical College, Amritsar, India. Hospital records of the patients, over a period of 1st July, 2012 to 30th June, 2014; with sputum smear negative for AFB after examination of their two sputum samples (spot and early morning), but still suspected of having disease depending on their clinico-radiological findings, were reviewed to extract the following data pertaining to the study: demographic data, clinical presentation details and investigation details with special reference to their sputum report status, sputum induction as and when applied, treatment details and follow-up. SI procedure was done on these patients after being instructed for: (a) blowing the nose, (b) washing and rinsing the mouth with water, so as to minimise external contamination; followed by intake of about 250 ml of water for adequate hydration.

20 ml of 3% hypertonic saline was administered by using ultrasonic nebulisation for about 15 minutes, and the respiratory secretions were collected by the patient in sputum container already supplied. In case the secretions were found to be less than 2 ml, the nebulisation procedure was repeated once again after 1 hour gap. The procedure was carried out in a well ventilated room, with windows open and adequate staff protection measures taken. The patient was closely monitored during the procedure and 1 hour post procedure. Bronchodilatation medication, oxygen supply and resuscitation equipments were available to meet any adversary at any occasion.

Smears were later prepared from the sputum specimens so collected, stained with Ziehl-Neelsen stain and examined for AFB.

Results

Out of total 244 patients who underwent sputum induction, 160 (65.6%) were males and 84 (34.4%) were females. Earlier,127 patients had inadequate sputum production and had submitted only saliva for examination, while 117 patients were found to be sputum smear negative for AFB after examination of two sputum specimens (including one early morning specimen), but were still suspected of having pulmonary tuberculosis depending on their clinico-radiological profile.

Chest radiography (Table 1) showed upper zone involvement in 151 patients (61.88%), while multiple zone involvement was seen in 54 patients (22.1%) including upper zone involvement. Ten patients had perihilar opacities and 7 patients had military mottling in their chest x-rays. 22 patients had other forms of non upper zone involvement in chest radiography. 232 patients (95.1%) had non-cavitatory pulmonary lesions in chest radiographs, while cavitatory lesions were present in case of 12 patients (4.9%).

Table 1. Radiographic presentation of presumptive TB patients

S. no.	Radiographic presentation	Number of patients
1.	Upper zone involvement	151 (61.9%)
2.	Multiple zone involvement including upper zone.	54 (22.1%)
3.	Non upper zone involvement	22(9%)
4.	Perihilar involvement	10 (4.1%)
5.	Miliary mottling	7(2.9%)

Overall, 68 out of 244 patients (27.9%) were found to be having sputum smear positive for AFB after sputum induction. Out of these, 117 who were earlier producing sputum, but were sputum smear negative for AFB, 34 (29.1%) were found positive on induced sputum examination; while out of 127 patients earlier producing saliva, 34 (26.8%) turned out to be sputum smear positive for AFB after SI. Amongst 205 patients with upper zone involvement, including those with multiple zone involvement on chest radiography, 61 (26.8%) were found with positive results after induced sputum examination. One patient with miliary lesions on chest x-ray also turned out to be sputum positive for AFB after SI.

However, SI procedure had to be repeated in 5 patients who on previous occasions had violent distressing cough, mucosal irritation with congestion of face during the procedure. 3 subjects were counselled repeatedly for the procedure, after they had refused for it on two previous occasions. They had history of substance abuse. Amongst 7 patients who had diabetes mellitus as co-morbid condition, three turned out to be sputum smear positive following sputum induction technique. HIV status of the patients and its impact on the yield of SI were not taken into account in the present study.

Discussion

Although progress has been made with global tuberculosis control, India still remains the world's highest TB burden country.1 Bacteriological confirmation plays a key role in the diagnosis of tuberculosis. Sputum is the only source of microbiological samples for about 80% of all patients of active TB. In most patients, sputum sample is not available or is grossly inadequate - an unavoidable situation often encountered, and remains the major criterion for referral for SI. Sputum induction was first used in 1961 by Hensler et al in the diagnosis of active TB.[13]

The ultrasonic nebuliser produces a mist of hypertonic saline droplets. The smaller droplets are deposited peripherally in the lung. It is opined that the hypertonicity of the deposited saline draws interstitial fluid into the lower respiratory tract by osmosis. The hypertonic fluid also causes bronchial irritation which stimulates bronchial secretions, while producing more cough. Following nebulisation, the fluid thus produced mobilise the material in the airways. The loosened secretions are easily taken up by the mucociliary escalator for their upward transportation into the trachea to facilitate expectoration by the patient.[14]

The strengths of the study included study subjects, all of whom were clinically suspected to have active TB, with their complete clinical, laboratory and radiographic information; enough to warrant sputum induction. The patients were considered for sputum induction by stringent criteria having sputum negative results with direct smear microscopy of the two sputum specimens obtained at different occasions as per the RNTCP guidelines.

In the present study (n=244), 27.9% turned out be sputum smear positive for AFB after SI. Amongst these 205 patients having upper zone involvement, including those with multiple zone involvement, 26.8% yielded sputum smear positivity following induction procedure. The technique proved fruitful even in a patient, out of seven, having miliary lesions on CXR (14.3%). In a similar study, overall 32% of patients were found positive on smear examination after SI.[15] Makkar et al have reported that a single sputum induction, had better yield than three spontaneous sputum samples.[16]

Anderson et al17while comparing sputum induction with fibreoptic bronchoscopy in the diagnosis of tuberculosis, found that bronchoscopy had equivalent yield to a single sputum induction. Whereas in another significant study, bronchoscopy was found to be of lower yield than multiple inductions by McWilliams et al.[17]

Revelations from Hong Kong study have provided more evidence supporting the use of sputum induction in smear-negative pulmonary TB disease, emphasising that induced sputum significantly outperformed even supervised sputum. It showed that sputum induction increased ease of expectoration significantly as compared with supervised collection on a subjective five-point scale.[18]

However, another study[19] showed no significant difference between induced sputum and routine expectorated sputum in

establishing a diagnosis of smear positive TB disease. Such exceptional results probably reflected different sputum induction techniques, as induction with 3–5 ml of hypertonic saline resulted in an adequate specimen in only 16% of subjects, compared to 84% following administration of 30 ml of hypertonic saline with an ultrasonic nebuliser, and 95% after 60–90 ml using the same device.[7]

Other attractive features of SI are its low cost[7], lower risk of occupational exposure compared to bronchoscopy[20], excellent acceptability[13, 7],even in children[20] and safety. While only minimal adverse events (but easily manageable) were experienced in the present study, none was noticed in others.[13, 11]

Cost savings from bronchoscopy, manpower, consumables, laboratory expenses etc. are evident from the present study.

Conclusion

With overall vision of "A TB free world"- every effective step towards quality diagnosis and treatment is a health achievement in itself. With emphasis on deploying better diagnostics, SI remains a simple, safe, non-invasive, no age restriction, less time consuming, cost-effective, easily acceptable, out-patient procedure, which can be applied at primary care centre level too for the masses, to enhance both the scope and scale of diagnosis of the disease – 'a draconian monster since ages'.

With 27.9% of the cases diagnosed as sputum smear positive pulmonary tuberculosis after SI intervention in the present study, it translates into an absolute significant number of TB patients in a national programme; as the disease is on the 'radar' of WHO, as a 'global emergency'; where 'every single case counts'.

Hence, it remains advisable that sputum induction be logically incorporated into the national programme for its adequate utilisation at the peripheral health centres for improvement in diagnostic yield of cases.

In a high burden country like ours, need of the hour is to diagnose every infectious tuberculous case at the earliest and by all means with minimum and low-cost inputs, so as to arrest further spread of the disease in the community, resulting in its early, effective and recognisable control.

Conflict of interest: None.

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