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TUBERCULOSIS: Implications for Anaesthesia

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Abstract

Tuberculosis (TB) remains one of the major occupational risk hazards for anaesthesiologist and health care workers in operation rooms in some of the developing countries. Anaesthesiologists do come across providing anaesthesia for patients with active tuberculosis or problems unrelated to tuberculosis like trauma and for various surgeries.As per the World Health Organization (WHO) reporting in 2013, 9 million new cases are supposed to be suffering from TB; among this 2-3% cases are found to be drug resistant. It is true that effective infection control measures and the availability of effective antibiotics for mycobacterium tuberculosis have decreased the risk of nosocomial infection. However, anaesthesiologist and the health workers in the developing countries are still at the risk of tuberculosis transmission from the patients when compared to their counterparts in the developed countries; due to the lack of adequate resources to prevent nosocomial transmission of tuberculosis. Hence, the special precautions need to be under taken by the anaesthesiologist while providing anaesthesia to these patients. From the patient point of view various drug interactions, side effects of anti-tuberculosis drugs needs to be considered preoperatively along with necessary investigations. Immune compromised patients with co infected HIV have a higher risk of developing tuberculosis.

Key Words: Tuberculosis, Anaesthesia, Nosocomial Infection, Transmission, Drug resistant

Introduction

Tuberculosis still remains as one of the world's commonest communicable diseases. As per the World Health Organization (WHO) reporting in 2013, 9 million new cases are supposed to be suffering from TB; among this 2-3% cases are found to be multi drug resistant(MDR)[1,2]. India has high incidence and prevalence of disease with high rate of transmission. Prevalence of all forms of TB in India is estimated to be 5.05 per thousand people. Increasing prevalence of TB in the society definitely has significant impact on anaesthetic management. Anaesthesiologist has to face a number of challenges while providing anaesthesia to TB patient. Patient may present with pulmonary or constitutional symptoms which may affect the fitness for surgery and course of anaesthetic management.MDR requires prolonged treatment with 4 to 5 drugs resulting in the increased cost with added risk of side effects. There has been a marked increase in the number of tuberculosis cases, which has paralleled the emergence of HIV[3,4]. Anaesthesiologists are commonly involved in providing anaesthesia for TB patients with active disease or problems unrelated to TB like trauma and various other procedures. Risk of nosocomial infection to the anaesthetist and other health care providers in operation room environment[5] appears particularly high when there

is increased exposure combined with inadequate infection control measures. A thorough preoperative evaluation and investigation is essential along with consideration for various drug interactions and adverse effects of anti TB drugs while planning anaesthesia technique.

Patho Physiology

Tuberculosis is a communicable disease by Mycobacterium tuberculosis via the airborne small droplets (0.5-5µm). Usually, infection occurs between household contacts with prolonged contact. However, exposure to only a few bacteria is needed to establish infection. Because of its high oxygen tension, the primary site of infection is the upper lobe of the lung, forming the Ghon's focus. Bacteria invade and replicate within macrophages. This is followed by a T cell-mediated response, which walls off the infected cells to form a granuloma. Bacteria within the granuloma can become dormant, resulting in latent infection. At this stage, the patient will be asymptomatic, but may show a positive response to a tuberculin skin test[6].

Factors that increase the likelihood of progression to active disease include time of exposure (most common in the first year), age of the patient (younger than five years old), and the competency of the immune system[7].

Infected patient can aerosolize large number of bacteria and efficiently transmit them to the anaesthesia machine when intubated. The pathogens reside in the machine for prolonged periods of time; particularly Y-piece, mask, breathing circuit hoses will become readily contaminated with patient's secretions.

Diagnosis

Traditionally, diagnosis is made by visualizing acid-fast bacilli in the sputum. Newer technology, such as the Xpert® *M.tuberculosis*/resistance to rifampicin or GeneXpert®, makeuse of real-time polymerase chain reaction to detect specific DNA sequences. They can provide much quicker results (within two hours), as well as information on rifampicin resistance[7].

Obtaining a sputum sample can be difficult in children, and the diagnosis is usually made on the basis of signs and symptoms of tuberculosis, positive contact and a positive tuberculin skin test (Monteux)[8]. Gastric aspirates can be used, but have a pick-up rate of less than 40%[9]. T cell interferon-γ (IFN-γ) release assays, which measure the number of IFN-γ-secreting T cells, have been developed as an alternative immune-based approach to the tuberculin skin test to detect infection[10].

Treatment

The cornerstone of treatment is directly observed treatment (DOT) for at least six months. First-line treatment includes rifampicin, isoniazid (INH), ethambutol and pyrazinamide, given according to guidelines for new cases, retreatment, and children younger than eight years of age[11].

Tuberculosis treatment has the potential for serious side-effects, some of which may impact on the anaesthetist. Rifampicin can cause thrombocytopaenia when given in high doses. INH may cause sensory neuropathy, which should be ascertained clinically before performing regional nerve blocks. This complication can be prevented by adding pyridoxine (vitamin B_6) in high-risk cases. Ethambutol has the potential to cause optic neuritis. Hence, it is not routinely given to children.

Drug-induced hepatitis is a worrying complication. When tuberculosis treatment is combined with concomitant antiretroviral therapy, a mild elevation in liver enzymes is common. However, symptomatic hepatitis has a mortality of almost 5%[11-13], and requires immediate halting of tuberculosis drugs, with careful re-introduction under specialist care. Wherever possible, surgery should be avoided during this period.

Anaesthetic Management

The patient of TB may require anaesthesia for diagnostic procedures (Lymphnode biopsies, Brochoscopies), complications of tuberculosis (Hydrocephalus, intestinal obstruction) and other emergency surgeries. Three major concerns for the anaesthesiologist include: general state of the patient's health (nutrition and aneamia), impact of the disease on organ function, and potential drug interactions between antitubercular agents and anaesthetic agents. Further, nosocomal infection transmission to the staff, anaesthetist and other patients is the threat of active disease.

Pre Operative Assessment of Patient

The preoperative care of these patients involves a thorough assessment involving accurate medical history, physical examination and evaluation of required necessary investigations. Depending on the clinical evaluation, investigations like sputum culture, chest x-ray, PFT, LFT, ABGmay be considered. These patients should preferably undergo evaluation in negative pressure ventilated room or isolated room to prevent the spread of aerosol infection. In a known case of TB, sputum smear examination for negative AFB has its own importance. For patients under

treatment, sputum smear for AFB taken on three different days need to be negative. It is preferable to postpone the elective procedures until patient is no longer infective. The nutritional status of the patient, aneamia, temperature needs to be evaluated and documented. The treatment history includes the details of anti- tubercular drugs and their effects on various organs like liver (rifampicin), nervous system (INH and streptomycin),hematology (thrombocytopenia) and kidney (ethambutol). Drug induced hepatitis is a serious complication in patients with TB associated with HIV. Symptomatic hepatitis is generally responsible for 5% mortality hence TB drug therapy needs to be stopped immediately; if possible surgery should be avoided during this period. Subsequently under strict supervision by specialist, drugs can be restarted. However, during routine anaesthetic management the patient on medication should continue the drugs even on the day of operation with sips of water.

Anaesthetic Technique

Choice of anaesthetic technique depends on the patient, the procedure and the severity of the disease. Regional anaesthesia is often preferred in patients with chronic lung disease to avoid problems due to disease as such and potential drug interactions. Local anaesthetic agents exert their action primarily at the site of injection, and help to avoid many of the drug interactions. Increased metabolism may result in a decreased risk of local anaesthetic toxicity.However, this may not be possible in some procedures and patient may require general anaesthesia. When general anaesthesia is planned drugs should be tailored and planned to limit the expected drug interaction. Hepatotoxic drugs must be avoided.

Recovery from the effect of intravenous induction agents is primarily due to redistribution. Anti TB agents lead to enzyme induction (P-450) which may result in enhanced metabolism of anaesthetic drugs there by accumulation of toxic metabolic products[11].This increased metabolism may have potential for awareness during total intravenous anaesthesia.Inhalational agent, halothane having a potential for hepatotoxicity should be avoided.

Action of depolarizing muscle relaxants (MR) will not be affected until pseudocholine esterase levels are markedly reduced due to severe hepatic dysfunction. Non depolarizing MR atracurium, cis-atracurium (alternate metabolism) and pancuronium (renal excretion) are minimally affected by TB therapy[12]. Streptomycin may potentiate the effects of non depolarizing MR hence, NMR have to be titrated as per response with frequent evaluation by nerve stimulator.

The anti TB drug, Rifampicin is known to enhance effect of UDP glucoronyl transferase involved in metabolism of morphine, thereby reducing efficacy of oral morphine[13]. Fentanyl and alfentanil are both extensively metabolized by CYP450 3A4, therefore, also show the potential for a shortened duration of action. Tramadol and brufen can be safely used as their effects are unchanged[11,12].

Drug	Effect of TB treatment	Recommendation
Induction agents	Unchanged	Beware of risk of awareness with total intravenous anaesthesia
Volatile agents	An increased risk of halothane hepatitis	Newer agents are preferable
Local anaestheticagents	Unchanged	Useful to avoid general anaesthetia and opioids
Muscle relaxants	Increased metabolismof rocuronium/vecuronium	Titrate/ monitor response using nerve stimulator
Opiates	Increased metabolism, often more frequent dosing	Titrate to effect. The use of regional technique and patient controlled analgesia is recommended

Fig 1: Effects of Tuberculosis Treatment on Various Anaesthetic Agents

Spread of Tuberculosis

The spread of tuberculosis to other patientsespecially immunocompromised, anaesthesiologist and theatre staff is an area of concern. Because of the close proximity of the patient's airway during intubation, mechanical ventilation,suctioning and brochoscopic procedures anaesthetists are at particular risk[14,16]. In 2005, the American Society of Anesthesiologists (ASA) has come up with guidelines relating to the perioperative management of patients with active tuberculosis19. Elective surgery should be delayed until the patient is no longer infectious. The ASA defines this as having been on treatment for 2-3 weeks, clinically getting better, and having had three negative sputum smears on different days.

Elective cases should be taken up as the last case of the day followed by fumigation to allow the decontamination of theatre following the operation. The patient should always be transferred to operation room wearing well fitting surgical mask or a N95®mask. (Fig 2) brought straight to theatre, rather than waiting in holding area to avoid exposure to other patients.Surgery should be performed with as few personnel as possible to reduce the number of potential contact with the index patient. To prevent contamination of the anaesthesia machine and circuit high efficiency particulate air(HEPA) filter should be placed between the Y connector and the mask, LMA, or endotracheal tube. Bacterial filters placed on expiratory limb of ventilator or anaesthesia machines may help to reduce discharge of TB bacilli into the ambient air. Sterilization of instruments should follow standard protocols.

Figure 2: Example of an N95® mask

Theatre staff also must wear N95® masks, especially true for high-risk procedures, such as intubation and bronchoscopy. The anaesthetist should ensure adequate anaesthesia and muscle relaxation. Unless gas flows are stopped for more than one hour between cases, M. tuberculosis has been shown to pass through the anaesthetic machine[18].

Post operative care should, if possible, take place in a room with negative pressure or ante room that provides some isolation from outside hallways. However, because most post anaesthesia care units are not so designed, immediate post operative care should be maintained in OR until the patient can be safely transferred to a suitable isolation room. Patients who require intensive care should be placed in private room with the ventilations techniques that need AFB isolation precautions. The N95® mask should be placed back on as soon as active airway management is no longer required. However, these masks increase airway flow resistance by approximately 120%.19A large venture-type face mask can be placed over the N95® mask to provide supplemental oxygenation. The N95® should not be worn by the patient if he or she is hypoxic or in respiratory distress; if hypoxia or respiratory distress occurs the maskshould be removed.

Skin testing program for at-risk staff have been advocated by ASA, as well as in the most recent National Institute for Clinical Excellence guidelines.[20] Staff members who receive a positive tuberculin skin test are prescribed INH for 6-9 months. This has been shown to prevent progression to active disease[20].

Conclusion

Given the increase in prevalence of HIV and multi drug resistance , tuberculosis will continue to be an important occupational risk for anaesthetists and operation theatre staff. By the virtue of their involvement in procedures that will induce aerosolization of the tubercular bacillus anaesthesiologists are potentially at risk. Hence, it is imperative that anaesthesia personnel should have appropriate training and education regarding the implementation of personal protective practices as well as tuberculin testing. Risk of patient to patient transmission through anaesthesia circuit is low if efficient bacterial and viral filters are used.

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