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Review Article

Airborne infection control for TB in healthcare settings: it's time to act

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ABSTRACT

Globally, an estimated 10.0 million people were affected by TB in 2018 with India leading with 27% incidence. Ending the TB epidemic by 2030 is among the health targets of the Sustainable Development Goals set by WHO. Unsuspected TB cases contribute to TB transmission because they may go unsuspected for weeks, and may visit multiple health-care facilities or be admitted indoors to non-isolation wards hence posing threat to Health care workers (HCW) who are at high risk for both latent TB and TB infection when compared to general community population. The TB infection control program should be followed by the hospitals which should include Administrative measures, Environmental measures and Personal protective measures. Health-care worker (HCW) education, training and capacity building on TB infection is an essential part of a TB infection control program. Standard precautions should be taken for maintaining TB laboratory, proper management of accidents/spillages and appropriate methods of waste handling and disposal. Effective infection control in health care workers integrated approach at National, State, Local health officials and Hospital administrative levels are required for effective tackling infection to health care workers along with political commitment and leadership at all the levels. Finally, TB infection control programs can have secondary benefits with infection control in general, which, if improved, could also prevent other infectious diseases that may be nosocomially transmitted.

Keywords: Airborne infection control in healthcare settings, Droplet infection, Nosocomial tuberculosis, Personal protective measures, Tuberculosis

INTRODUCTION

Globally, an estimated 10.0 million people were affected by TB in 2018. Eight countries accounted for two thirds of the global total, with India leading with 27% incidence.[1] Ending the TB epidemic by 2030 is among the health targets of the Sustainable Development Goals set by WHO.[1] Tuberculosis is infectious only when it occurs in the lungs or larynx. Extrapulmonary TB is usually not infectious, unless the person also has pulmonary lesions at the same time. A person who has pulmonary TB can release many tiny particles called droplet nuclei (1-5 micron size) into the air by coughing or sneezing; smaller numbers of droplet nuclei are released during normal activities like talking or spontaneously during breathing. Unsuspected TB cases contribute to TB transmission because they are not being treated and may go unsuspected for days or weeks, and may visit multiple health-care facilities or be admitted indoors to wards. Unless TB is considered, available diagnostic tests may not be used, proper treatment might not be initiated, and proper TB infection control measures might not be in place.

The global spread of Influenza A H1N1, more recently Nipah virus and currently Novel Corona Virus (COVID) infections have highlighted the need for health care facilities to implement standard infection control precautions and to improve preparedness for pandemic respiratory infections. Nosocomial transmission is of

concern because it affects not only patients who are exposed but also the healthcare workforce, which could adversely affect healthcare services over time. In a study by Pai et al the annual risk for latent TB infection was estimated to be 5% in Health care workers (HCW), whereas the community-based annual risk for infection in India is 1.5%, so the excess risk of 3.5% may be attributable to nosocomial exposure.[2]

DISCUSSION

Factors affecting the infectiousness of TB patient

Patient factors

Children are less likely to be infectious, because children are sometimes unable to produce sputum, or may have pauci-bacillary TB. Other factors which increase infectivity include presence of cavity, acid fast bacilli on sputum smear, non-compliance to treatment, undergoing cough-inducing procedures (e.g., bronchoscopy, sputum induction, and administration of aerosolized medications).

Environmental factors

Increased concentration of bacillary droplet load, enclosed spaces, recirculation of air, improper specimen handling techniques, positive air pressures in the infected patient's room which enhances spread of droplet nuclei.

Hence recognising such patients and environmental factors are vital in identification of patients with high risk of infectivity and high-risk areas of the hospital which include TB and Chest OPD, Medicine OPD, Indoor wards, DOTS - Plus sites for MDR-TB treatment, ART Centres, bronchoscopy suites, TB bacteriology culture laboratories, intensive care unit, and operating theatres.

The goals of effective TB infection control programs are to:[3]

- Detect TB disease early and promptly.
- Isolate those who have or are suspected of having TB disease.
- Treat people who have or who are suspected of having TB disease.

The TB infection control program should be based on a three-level hierarchy of control measures and include.[3]

Administrative measures (which reduce risk of exposure)

They serve as the first line of defence for preventing the spread of TB in health care settings. Administrative measures include assigning the responsibility and conducting TB infection control risk assessment.

Recommendations for administrative measures.[5]

Outpatient settings

- Screen for respiratory symptoms as early as possible upon arrival at the health care facility.
- Provide patient education on cough hygiene and sputum disposal.
- Segregate patients with respiratory symptoms.
- Fast-track patients with respiratory symptoms.

Inpatient settings

- Minimize hospitalization of TB patients
- Establish separate rooms, wards, or areas within wards for patients with infectious respiratory diseases
- Educate inpatients on cough hygiene and provide adequate sputum disposal
- Establish safe radiology procedures for patients with infectious respiratory disease

Environmental measures (which prevent spread and reduce concentration of droplet nuclei)[3]

These measures are second line of defence.

Primary environmental measures

Controls the source of infection by diluting and removing contaminated air by using general ventilation measures. These include

- Natural ventilation e.g., open doors, windows.
- Mechanical ventilation equipment to circulate and move air in a building.
- Local exhaust ventilation (e.g., hoods, tents, or booths)

Secondary environmental measures

Controls airflow in areas adjacent to the source and cleans air and limits spread of droplet nuclei by

- Controlling the airflow to prevent contamination of air in areas adjacent to the source Eg. Airborne Infection Isolation (AII) Rooms.
- Cleaning the air by using high efficiency particulate air (HEPA) filtration or ultraviolet germicidal irradiation (UVGI).

Environmental control measures work on the same basic principle of dilution of infectious particles through real/effective air exchange. High-risk areas of the healthcare facility should be prioritized for immediate assessment and implementation of improved ventilation. Improved ventilation in health-care facility is the most economical, effective and essential way of preventing transmission of airborne infections and is said that as room air exchange doubles, the concentration of airborne particles in the room falls by half.

Personal protective measures (reduces risk of exposure in special areas and circumstances)[4]

HCW should take adequate precautions including all standard precautions while providing care to patients. Personal protective equipment like gloves, gowns, and goggles, masks, N95 particulate respirators should be used by healthcare workers. Particulate respirators, if properly fitting and correctly used, provide some additional protection to the user against airborne infection. Particulate respirators include those certified as N95 and FFP2, or greater protection ratings.

Masks, are effective in source control for patients, i.e. to reduce the production of respiratory droplets of all sizes. Masks for HCW may be useful for protection from large respiratory droplets, and protection of mucous membranes.

Personal Protective equipment (PPE) should be worn in the following order i) Disposable gloves, ii) Coats/suits/overalls, iii) Respirator/mask and to be removed in the following order i) Respirator/mask, ii) Coats/suits/overalls, iii) Disposable gloves. Every time personal protective equipment is removed, hand hygiene to be performed immediately. Proper implementation of administrative and environmental controls is first and second line of defence against acquisition of any airborne infection. Respirators only add a layer of insurance where the risk to HCW is especially high.

Health-care worker (HCW) education, training and capacity building on TB infection/disease is an essential part of a TB infection control program and can increase adherence to standard precautions which combine the major features of universal precautions, body substance isolation, and airborne precautions.

TB laboratory[5]

- Bio-safe centrifuge and biocontainment devices
- Biological safety cabinets (BSC) class II, with 100% exhaust (i.e. ducted outside) should be provided and used.
- Prepare slides in a Biosafety Cabinet (BSC). Before removal from BSC, heat sterilise to kill tubercle bacilli. Do not carry individual slides in hands, carry as a whole on a slide-carrying tray.
- Identify material with proper disposal labels and autoclave prior to disposal

Accidents and spillages[5]

Any major accidents in the laboratory should be entered in the register along with remedial measures taken before undertaking further work. Laboratory personnel who get accidentally exposed to an infectious TB aerosol or solution should report the incident as soon as possible. Spillages can be effectively managed by creation of a Bio-safety Cabinet which is designed to contain spills and associated aerosol release during work.

Waste disposal and handling[5]

All infectious waste should be discarded in the bio-safety disposal bin. All infectious solid waste-wipes, swabs, plastic, paper towels, gauze pads, gloves, etc., should be placed inside the double autoclave bags, sealed with autoclave tape and sterilized at 121ºC for 30 min in the autoclave.

Liquid waste, in the steel discarding bins, should be disinfected in 5% phenol for at least 1 hour, before sealing the caps and autoclaved at 121ºC for 30 min. All reusable material such as glass ware should be autoclaved in the autoclave steel trays for 121°C for 30 min before washing and repacked for sterilization.

TB infection control in non-traditional facility-based settings[3]

All non-traditional facility-based settings where patients with TB disease receive care should also establish and follow a TB infection control program on similar protocols mentioned above. These include correctional facilities, homeless shelters, long-term care facilities, home-based health-care and outreach settings and Emergency medical services (EMS). In addition HCWs who visit TB patients in their homes should instruct patients to cover their mouth and nose when coughing/sneezing, wear a respirator during the visit, collect specimens in a well ventilated area, away from other household members.

National, state, local health official and hospital administration level should be conducted for an effective control strategy managerial activities at National State Hospital administration, and Local health officials should be conducted by forming respective Infection control committees. Along with these it should ensure political commitment and leadership at all levels.

The managerial activities are based on public health principles and should also include Professionals responsible for the design, building refurbishment and organization (physical layout) of health care facilities as they ought to consider patient flow patterns so that nosocomial transmission is minimized.

Finally, TB infection control programs can have secondary benefits with infection control in general, which, if improved, could also prevent other infectious diseases (e.g., SARS and avian influenza) that may be nosocomially transmitted.

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