Original Research

Implementation status of national airborne infection control guidelines in the health care facilities of a North Indian State: A mixed method study

Pallvi Kaushal [a], Garima Sangwan [a], Kirtan Rana [a], Manisha Biswal [b], Manmeet Kaur [a], P.V. M. Lakshmi [a,*]

[a] Department of Community Medicine and School of Public Health, PGIMER, Chandigarh, India
[b] Department of Medical Microbiology, PGIMER, Chandigarh, India

A B S T R A C T

Objective: Healthcare-acquired infection (HCAIs), have become a significant cause of morbidity as well as mortality among the hospitalized patients and health care workers. The implementation of air-borne infection control measures play an important role in prevention of health care acquired infections (HCAIs). Hence, this study was planned to assess the implementation status of National Airborne Infection Control Guidelines in the health care settings of a North Indian State.
Study design: A mixed method study was planned in all the 13 health facilities of Himachal Pradesh having both the Anti-Retroviral Therapy (ART) Centre and Directly observed Treatment Short course (DOTS) for TB center in the same facility.
Methods: The implementation of airborne infection control measures was evaluated using a Standardized Health Care Facility Airborne Infection Risk Assessment Tool and an observational checklist. In-depth interviews are conducted with hospital staff. At all health facilities, risk assessment and implementation of airborne infection control was evaluated by using a pretested semi-structured questionnaire. The qualitative data was analyzed manually and transcripts prepared from hand written notes and audio tape records were analyzed thematically.
Results: Only 5 out of 13 health facilities were having specially designated airborne infection control committee. The incidence of tuberculosis among hospital staff was 2.32% at secondary level health care facilities and 0.35% at tertiary care level health facilities. Among the tuberculosis cases, maximum were nursing staff (59.5%) as compared to other categories of health care workers. Improper functioning of health care system and individual factors were main reasons for deficiencies in the implementation of air-borne infection control measures.
Conclusion: The health care facilities were not implementing the infection control measure to the fullest both at secondary and tertiary care health facilities. There is a need to set up the surveillance of airborne infections in the hospital and especially the passive surveillance of tuberculosis among health care workers.

1. Introduction

Globally healthcare-acquired infections (HCAIs) have become a significant cause of morbidity as well as mortality among the hospitalized patients. Exposure of human beings to different airborne pathogens has resulted in the emergence of epidemics of respiratory infections [1]. The infectious patient can infect the other individuals who have had no direct contact with the primary source through droplet infection. Airborne transmission in the health care settings through droplet nuclei becomes more important because of overburdened hospitals and the presence of immunosuppressed patients like those who had undergone surgery, cancer patients, people who are living with HIV/AIDS (PLHIV), those who are having diabetes, chronic renal disease etc.

Hospital acquired respiratory infection poses a greater risk for the health care workers, as they come in contact with patients early in the course of disease when they are highly infectious. This can lead to widespread epidemics of the respiratory infections because of two reasons. Firstly, one infected health care worker attends a large number of patients on any given day in developing countries like India and secondly, the infection to health care workers reduces the number of skilled

workforce available for treating the patients and preventing the spread of infection during an outbreak [2–6].

By the fall of 2002, a new coronavirus infection has emerged in Asia causing severe viral pneumonia, i.e., Severe Acute Respiratory Syndrome (SARS). Nearly a decade following the SARS epidemic, another new Corona virus respiratory infection has emerged Middle East Respiratory Syndrome CoV (MERS CoV). Recent outbreak of Ebola infection has posed a worldwide threat due to lack of well-established treatment [7,8]. Proper isolation and airborne infection control measures can play a major role in the prevention of such widespread epidemics [9–12].

Nosocomial infections are also of legal concern due to unacceptable increase in the morbidity and mortality resulting from improper implementation of infection control measures at health care settings. As it is difficult to eliminate the reservoirs and susceptible hosts in the health care settings, implementation of measures to eliminate the mode of transmission play a pivotal role.

To prevent cross infection of TB to immunosuppressed HIV patients, Government of India has developed "Guidelines for Airborne Infection Control in Health Care Settings" in the year 2010 and were adapted under HIV-TB collaborative activities, to be implemented at all the health care settings [9]. Though targeted for HIV-TB co-infection, these guidelines can aid in preventing the spread of air borne infections. Since then, there was no comprehensive evaluation in India whether these guidelines are being implemented and whether there was any impact on the reduction of airborne nosocomial infections. Hence, this study was planned to assess the implementation status of airborne infection control measures in the health care settings of Himachal Pradesh and to find out the gaps, in the implementation of these guidelines so as to reduce the morbidity and mortality by breaking the chain of infection and to prevent future outbreaks of air borne infections.

2. Methodology

A mixed method study was planned in the health care facilities of Himachal Pradesh to assess the status of implementation of national airborne infection control guidelines. All the 13 health facilities having both the Anti-retroviral therapy (ART) Centre and Directly observed Treatment Short course (DOTS) for TB center in the same facility within the State of Himachal Pradesh were included in the study. Out of 13 facilities that were included in the study, two were tertiary care health facilities and eleven were secondary care facilities.

At state level and district levels, head of the health care facility i.e. Chief medical officer (CMO), Block medical officer (BMO), Medical superintendent (MS) or hospital in-charge were interviewed to know about the existence and functionality of airborne infection control committee. They were interviewed to find out the barriers and facilitators affecting formation of airborne infection control committee in the hospital. The health care facilities where air borne infection control committees were formed in-depth interviews of the chairman and two other randomly selected members of the airborne infection control committee were done. Selection of the members was done by simple random method using computer generated random numbers.

The health care staff of all the selected health care facilities were interviewed; no matter whether airborne infection control committee was existing or not. Four personnel in the selected health centers who were at high-risk for air borne infections were selected for the interview (Nursing staff, Integrated Counselling and Testing Center (ICTC) for HIV testing counsellor, lab technician working under Revised national Tuberculosis Control Programme (RNTCP) and Directly Observed Treatment Short course (DOTS) provider). One person from each of the four categories was selected by simple random sampling using computer generated random numbers. The health care workers were also asked about the number of staff treated for TB in the last 12 months. The number of staff treated for TB in the last 12 months was used as numerator for calculating the TB incidence and the total staff working in the health facility was considered as the denominator.

At all health facilities, risk assessment and implementation of airborne infection control was evaluated by using a pretested semi-structured questionnaire, i.e. Standardized Health Care Facility Airborne Infection Risk Assessment Tool and observational checklist. For filling the questionnaire, records of the health facility were reviewed and some of the questions were filled on observation basis. These tools were developed according to the revised guidelines given by National Airborne Infection Control Committee (NAICC), Government of India (GOI), Director General Health Services (DGHS) and Central TB Division (CTD). The questionnaire was filled by the investigator herself.

An observational checklist was filled for all the 13 health institutions. It comprised of 27 questions related to secondary care hospital and 31 questions related to tertiary care hospital.

The quantitative data was analyzed using MS Excel software and descriptive analysis was performed. The results were expressed as simple proportions.

The qualitative data from in depth interviews was analyzed manually. The transcripts were prepared from hand written notes and audio tape records and then thematic analysis was done.

Main themes were extracted from the transcripts and were further categorized in to sub themes supported by the illustrative quotes. The information obtained both from qualitative and quantitative data were used to identify and understand why there were gaps in the implementation of airborne infection control measures.

3. Results

3.1. Staff and services at the health facilities

The study was conducted in 13 health facilities, comprising of 2 tertiary care and 11 secondary care facilities. Majority of health care workers at tertiary health care levels were nursing staff (33%) followed by the trainee doctors (31%) and the doctors constituted about 10% of the total health workforce. In secondary care health facility, majority of the heath care workers were nursing staff (28%) followed by trainee nurses (25%) and doctors (18%) as depicted in Fig. 1. Nursing staff comprises of maximum numbers at both secondary and tertiary care health facilities. The proportion of doctors was less at tertiary level as compared to the secondary level.

In both the tertiary care facilities, out patient departments and inpatient hospital admissions cater to all specialties like medicine, surgery, chest, paediatrics and obstetrics. A separate ward for multi drug resistant tuberculosis (MDR-TB) cases was present in only one tertiary care hospital out of two hospitals. Separate ward for patients admitted with chest problems was available at only two secondary care hospitals out of eleven institutions included in the study. Nine of the hospitals were having airborne precautions rooms. None of the health care facility had separate registration area for patients attending various clinics.

3.2. Implementation of airborne infection control guidelines

The implementation of airborne infection control guidelines was evaluated at all 13 health care facilities having both functional ART and DOTS Microscopy centers. The implementation of guidelines was assessed in terms of administrative, environmental and personal control measures in line with the three-pronged strategy for control of airborne infections.

In all the 13 health care facilities, facility level infection control (IC) committee/biomedical waste (BMW) management committee was in place. Only 5 out of 13 hospitals (secondary and tertiary hospitals) were having specially designated airborne infection control committee. All the committees reported that they were conducting quarterly meetings and the last quarterly meeting was conducted in the month of April 2015 at the time of the study. But minutes of the meetings were not available in any of the health care facilities. In all the 13 health care facilities, Facility IC/BMW Management plan were available in written
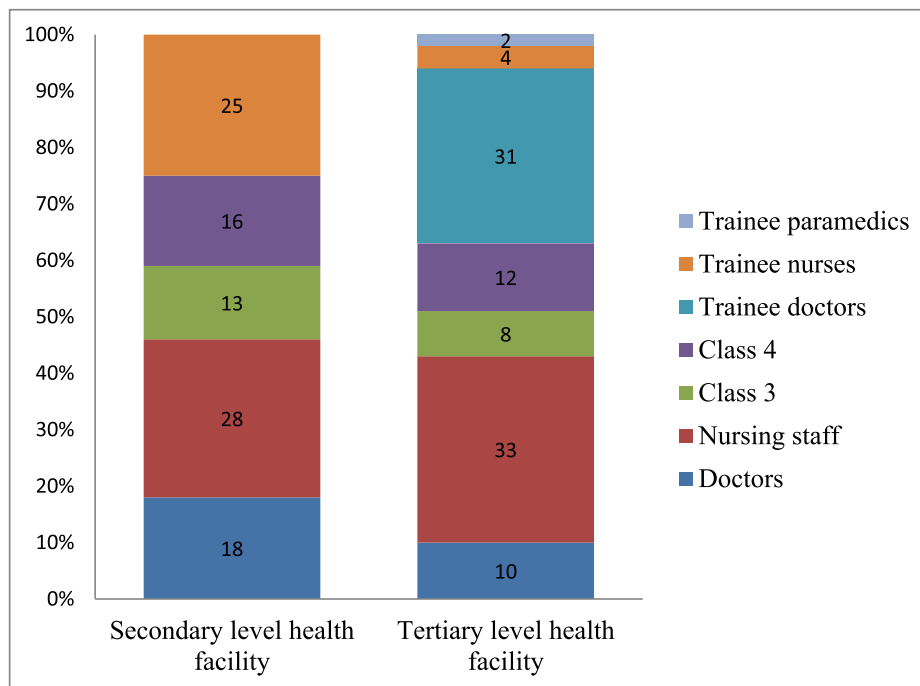
Fig. 1. Distribution of health care staff in secondary and tertiary level health facilities in Himachal Pradesh.

forms but airborne infection control was not covered in the plans. Biosafety cabinets were being used by microbiology department in all the tertiary care health facilities.

In our study, we have interviewed the head of the health care facility where there was no airborne infection control committee to find out the reasons why the committee was not formed. The findings revealed that
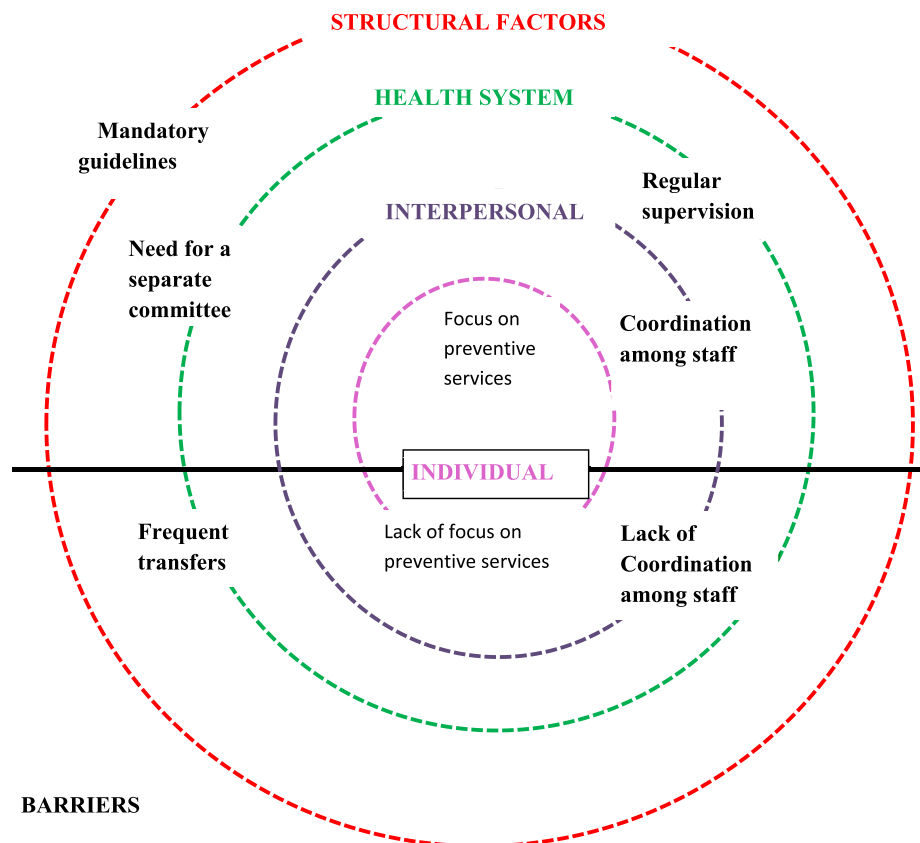

Fig. 2. Multi-level barriers and facilitators influencing implementation of airborne infection control measures in health care facilities.

committee formation is influenced by facilitators and barriers operating at four levels namely individual level, interpersonal level, health system level and structural level (Fig. 2).

The most important factor operating at individual level was lack of focus on the preventive services, which prevents the clinical staff to draw their attention away from curative services. This is reflected in the comments of one of the head of health facility. *"We don't have public health cadre in the state. Most of the staff working here are for curative services. We ourselves are the clinicians, so we are not able to focus on the preventive part. This has now become our basic temperament because things are like this only for the past so many years."* (CMO-G).

Lack of coordination among hospital staff was another barrier at interpersonal level as expressed by one of the respondent. *"Forming a committee and running it successfully is entirely dependent on the coordination amongst the staff involved, and this is very difficult. If there is coordination among the staff, they will understand each other's view point otherwise such committee will remain on papers and will never be implemented."* (CMO-C) Interpersonal conflicts hinder day-to-day functioning and ultimately leads to failure of any activity which needs team work. If this barrier could be addressed then the coordination among the staff can become one of the strong facilitators for effective implementation of guidelines.

Frequent transfer of administrative staff, and unfelt need for a separate committee were some of the key barriers at health system level. For example, one of the interviewee said, *"It is important to have committee and we are working on that. May be by next month we will have the committee in place. Main reason is that in government settings, hospital staff keeps on getting transferred every 4–5 months and this hinders the process. The moment we start progressing in committee formation and function, the people involved will get transferred and we reach the same place from where we started."* (CMO-H) While another *said "Airborne infection control measures are being covered under so many other committees already running in the hospital. This is the reason that attention is never given for having a separate committee in the hospital."* (CMO-A).

When probed, lack of supervision by higher authority was also observed to be one of the reasons why such committees are not formed. One of the respondents said *"We don't have pressure from higher authorities to make the committee. There is no supervision from their side. If they will ask us again and again to make the committee then definitely we will have to, but if they will not supervise this, then obviously things will get delayed."* (CMO-I) Thus monitoring and supervising can facilitate the formation of committees as well as their functioning.

At structural level, it has been seen that if guidelines are made mandatory and a strict action is being taken against violation of guidelines then the in-charges of the facilities would be forced to form the committees.

In all the 13 health care facilities, all the members of ART and DOTS were trained in universal precautions and waste segregation and disposal, but none of them were trained on airborne infection control measures. There was no staff-training plan for infection control/ biomedical waste management. No IC training has been conducted for any cadre of staff in the past 12 months. There was non-availability of standardized training material for training of the staff on infection control in all the 13 facilities.

In facilities where there were IC committees, the members were interviewed regarding their roles and responsibilities and implementation of IC measures. The investigator also observed the implementation of IC measures at the facilities. Most of the IC Committee members were aware of their roles and responsibilities. All the committee members considered implementing universal precautions and BMW management as their main responsibilities as these can reduce the chances of infection by interrupting the chain of transmission.

In most of the health facilities ART centers were located away from the DOTS centers to avoid spread of TB infections to HIV positive individuals. Some of the respondents feel that maintaining the appropriate distance between ART centers and DOTS centers as their prime responsibility. *"I consider maintaining an adequate distance between ART and DOTS centers as the main responsibility as it can reduce infection. This was the first thing I had done to control air borne infections."*

Some of the members felt that display of IEC materials is very important as this can change the attitudes and practices of the staff as well as patients and attendants. One of the respondent said, *"We have placed boards and other IEC material to keep the staff motivated and general population aware of the preventive steps one has to take. Boards were strategically placed where they are highly needed and most noticeable by target audience."*

All the committee members informed that universal precautions and bio medical waste management were being implemented. Frequent wet mopping of the floor was being carried out. Most of the committee members considered maintaining adequate ventilation is an important measure to control air borne infections. One of the respondents informed, *"Mostly all rooms were ventilated. It is of prime importance. Where there is lack of adequate ventilation we tried to install the exhaust fans especially in the high-risk areas."*

Disease surveillance for TB or other nosocomial infection in health workers was not being done in any of the health facility. There was passive reporting of TB diagnosed/treated among the staff of health faculties as a part of routine reporting system. Though all the newly joined hospital staff were being screened for TB/other respiratory infection, there was no system of periodic repeated examination in place. No records were found related to TB among health care staff in any of the facilities.

The health care staff was interviewed to understand the facilitators and barriers in the implementation of IC measures (Fig. 3).

The most common reasons mentioned for non-implementation of IC measures were lack of commitment from the side of health system administration, non-dissemination of guidelines and interrupted logistic supply.

"I don't know that whether there is any such committee or guidelines. We were neither called for any meeting related to airborne infection control nor told about anything like this, If somebody will tell then only we will come to know."

"I don't know whether there is any committee or not. There are so many committees existing only on paper. Committees are useful only when they are implementing what they are intended to, otherwise there is no fun in making them".

The committee members strongly expressed that following universal precautions and biomedical waste management are key steps to prevent hospital-acquired infections. Though the committee members told that universal precautions were being implemented, the health care staff reported that generally they do not have enough supply of gloves, mask etc and hence were incapable of following them all the time. One of the respondents mentioned, *"We don't use universal precautions all the time as this is not practically possible. Moreover we don't have enough supply of all the things like gloves, masks, soaps etc. Sometimes we don't even get after putting the demand so many times."*

Though all the committee members felt that good ventilation is important for control of airborne infections, exhaust fans were available in only in only 7 (53.9%) of the DOTS centers and none of the ART centers had exhaust fans for ventilation. Only 30.8% of the all the health facilities inspected had well ventilated waiting and seating areas. Though one of the committee member mentioned that they tried to install exhaust fans in the high risk areas the response of the health care staff was totally in contrast with the information provided by the committee member. *"All of the rooms should have exhaust fans ideally but we don't have. We have given demands so many times but were not supported by the administration. Our rooms are full of files and papers. It is so suffocating here. But then this is the government system and all things will be like this. Everybody knows it takes time, sometimes years to get the things done."*

The individual level factors, which contribute for non-implementation of air borne infection control measures, were wrong practices because of misconceptions, perception that use of masks was
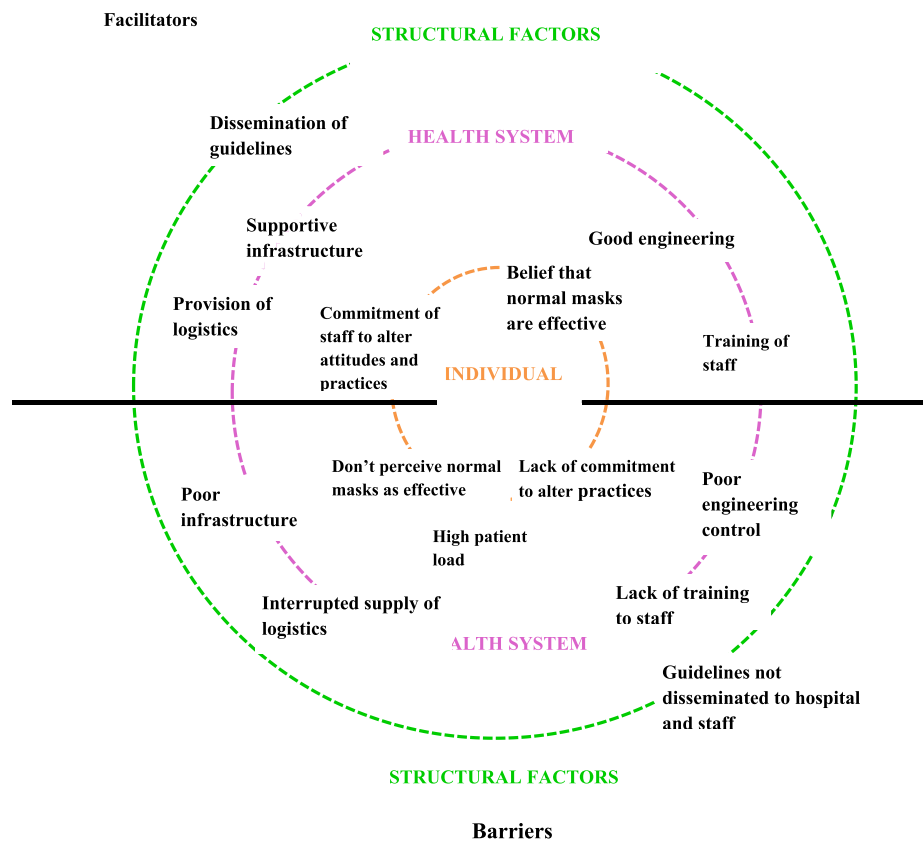
Fig. 3. Multi-level barriers and facilitators influencing implementation of airborne infection control measures in health care facilities.

not effective, stigma for patients and high patient load.

"Using masks and gloves are not that effective. Main thing that I follow is to have breakfast in the morning. Whenever I feel hungry, I eat something and this builds up the immunity and prevents from getting infected by TB."

"I am working here for past so many years, I guess 9 or 10 years. We generally work like this. Nothing has happened to us in the last so many years."

3.3. Burden of tuberculosis among hospital staff

In our study, prevalence of TB among the hospital staff was 0.89%. Most of the TB cases were among nursing staff. There were 42 health care workers who were treated for TB in past 12 months with maximum number of reported cases from nursing staff (25) followed by trainee nurses (6) and least in doctors and trainee paramedics. The incidence of Tuberculosis among health care staff working in various facilities is presented in Table 1. The incidence of TB was higher in secondary care facilities (2.32%) as compared to tertiary care facilities (0.35%).

4. Discussion

The key finding of this study was that the health care facilities were not implementing the infection control measure to the fullest both at secondary as well as tertiary care health facilities. The gaps in implementation were found at all the three levels i.e. administrative, environmental and individual levels. It is one of the first studies in India that has assessed the status of implementation of national airborne infection control guidelines.

The pneumonic plague outbreak in Himachal Pradesh and the SARS outbreak in 2002 reveal the importance of airborne infection control measures in the protection of health care staff and the patients admitted to the hospital [13,14]. Hospitals are host to lots of patients having low

Table 1
Incidence of tuberculosis among health care staff in various health facilities of Himachal Pradesh.

Level of Health Facility	Health facility	Total number of staff	TB cases among staff in the past 2 years	Incidence (%)
Secondary	Solan	152	1	0.66
	Kullu	112	2	1.78
	Una	105	2	1.9
	Bilaspur	156	3	1.92
	Chamba	135	3	2.22
	Nahan	122	3	2.45
	Dehra	40	1	2.5
	Hamirpur	150	4	2.67
	Nalagarh	98	3	3.06
	Mandi	168	6	3.57
	Palampur	56	2	3.57
	Average	1294	30	2.32
Tertiary	Shimla	1898	5	0.26
	Tanda	1512	7	0.46
	Average	2410	12	0.35

levels of immunity because of their health conditions. This paves a way for easy spread of infections among themselves as well as to the health care workers working there.

The success of any intervention depends upon how well it has been implemented. Strong political commitment at the higher levels of administration coupled with regular supervision is essential for success of any programme [15–17]. As most of the gaps were identified at this level, hence more emphasis is required. Firstly, airborne infection control committees have to be formed at all levels. Secondly, there should be a training programme for all the health workers. Additionally, there should be baseline assessment of all the health facilities followed by periodic assessment to see whether the guidelines are being properly

implemented or not. All the findings found during assessments should be shared with workers. For proper implementation adequate supply of logistics such as masks and gloves should be ensured. Fast tracking of patients with chest symptomatics should be an integral part of preventing the HIV TB co infection.

Studies have also shown that training and implementation of airborne infections control measures have led to reduction of nosocomial infections and lower prevalence of tuberculosis among health care workers [18,19].

Surveillance is needed for guiding whether our interventions are working or not. The incidence of Tuberculosis cases among health care workers was taken as proxy for the level of implementation of air borne infections in a particular facility. The current study found tuberculosis prevalence of 0.89% among hospital staff. The incidence of TB among the staff at secondary levels (2.32%) is higher than the general population (1–2%) [20]. This study for the first time has shown the difference in the incidence of tuberculosis among health care workers working at various levels. The incidence of tuberculosis is high among health workers in secondary care facilities as compared to tertiary care facilities. This might be due of lack of infrastructure i.e. less number of rooms as compared to the services rendered and also inadequate supply of logistics such as masks at lower levels of health care. The tertiary care facilities also being teaching hospitals has separate department of pulmonary medicine. Thus, designated staff who are more specialized were better aware of current guidelines as compared to the staff working at lower levels. They were following the infection control measures more strictly than the staff working in general settings.

During interviews, frequent transfer of the administrative staff emerged out as one of the key reasons leading to non-formation of committees. The transfers were more frequent among the administrative staff of secondary facilities leading to delay in committee formation and hence delayed implementation of infection control leading to rise in risk of infection in the staff working in the hospital. Another reason can be that majority of the patients visiting tertiary health care facilities are referred from secondary hospital and have already started their treatment. Starting treatment early make them less infectious when they come in contact with the staff of tertiary hospital than in the case of secondary hospital where patient contacts the health care worker in the early infectious stage of the disease.

The importance of environmental measures cannot be overlooked. The importance of ventilation and sunlight has been emphasized since the past for the control of infections. It is also seen that airborne outbreaks were common in institutions with overcrowding and poor ventilation [21,22].

The measures at personal level are important not only to protect the healthcare workers but also important to protect others. One of the ethical principles in health care is Do No Harm. This principle has to be kept in mind while delivering care to all the people visiting the health facilities. One of the reasons mentioned for not wearing masks was patients might feel stigmatized. This reveals the fact the sensitization of not only the health staff but also of the patients is essential in overcoming the stigma of wearing masks. Patient education leaflets and wall paintings or hoardings etc might be used for spreading the awareness regarding infection control measures. The implementation also requires removal of barriers from the higher levels such as ensuring adequate supply of masks, gloves etc.

Most of the TB infections were found among nurses as they spend major time delivering patient care. Thus, it is important to emphasize the role of personal protection measures to them. The class 4 employees were next in order as they were involved in the cleaning and mopping of the hospitals and were in direct contact with the infectious material.

The major strength of this study lies in the study design of using mixed methods. It not only looked into the level of implementation but also adapted qualitative study methods for in-depth understanding of the gaps found in the study so that steps can be taken for implementation of the control measures.

One of the limitations of this study is that there was no record based information related to prevalence of tuberculosis among health care staff. All the information collected related to this aspect was purely based on verbal information given by interviewee. As Tuberculosis is considered to be stigmatizing, there can be underreporting of the number of TB cases detected among health care workers. This might result in underestimation of TB rather than overestimation. Thus, the incidence of TB among health care workers might be even higher which is worrisome. Another limitation was that at the time of interview, due to time constraints, only the health care staff who were present on the day of the interview were considered for the study.

5. Conclusions

The study found that the administrative control measures in the study hospitals were poorly developed and implemented. Non-formation of airborne control committees to prevent airborne infections were due to lack of commitment at higher level, problem in relationships and frequent transfer of the staff. Lack of logistics, poor infrastructure, lack of training and failure to implement personal protection control measures were other reasons found in the present study. There is a need to focus on implementation of the airborne infection control guidelines.

There is a need to sensitize the higher authorities about the need for the implementation of the guidelines and ensuring strict supervision of the staff at the lower levels whether these guidelines are being implemented or not. There need to be a planned training programme for all the staff involved in the infection control. The timely monitoring of outcomes is essential to see whether the strategies adapted and the interventions implemented are giving the expected results are not. Thus, there is a need to set up the surveillance of airborne infections in the hospital and especially the passive surveillance of Tuberculosis among health care workers. As it is not easy to modify the building once constructed, due attention needs to be paid while planning the construction to ensure adequate natural ventilation and lighting.

Ethics approval

This study was conducted after Ethical clearance from the Ethics committee of PGIMER, Chandigarh. Permission was sought from Director Health Services (DHS), Himachal Pradesh. All the persons who were interviewed were explained about the study and were interviewed after obtaining written informed consent. All the information and data were kept confidential and anonymity of the data was duly maintained. Permission from the CMO/BMO in-charge of health care setting was sought before filling the check list.

Funding

Author's contribution

1. PK: Defining the research question, data analysis and scientific writings.
2. MK: Qualitative analysis, Reviewing the article.
3. MB: Finalizing the questionnaire, Reviewing the article.
4. PVML: Framing the outline of the article, Proof reading and Reviewing the article.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] S. Shrivastava, P. Shrivastava, J. Ramasamy, Airborne infection control in healthcare settings, J. Infect. Publ. Health 6 (4) (2013) 269–275.

[2] C. Tudor, M. Van der Walt, B. Margot, S. Dorman, W. Pan, J. Farley, et al., Tuberculosis among health care workers in KwaZulu-Natal, South Africa: a retrospective cohort analysis, BMC Publ. Health 14 (2014) 891.

[3] T. Yen, C. Lu, L. Chang, Y. Tsai, L. Huang, Longitudinal seroepidemiologic study of the 2009 pandemic influenza A (H1N1) infection among health care workers in a children's hospital, BMC Infect. Dis. 12 (2012) 89.

[4] D. Pryluka, G. Lopardo, L. Daciuk, D. Stecher, P. Bonvehi, Severe acute respiratory disease in health-care workers during the influenza H1N1 pandemic in Argentina, J. Infect. Dev. Ctries. 7 (1) (2013) 36–40.

[5] B. Hudson, L. Toop, D. Mangin, C. Brunton, L. Jennings, L. Fletcher, Pandemic influenza(H1N1)pdm09: risk of infection in primary healthcare workers, Br. J. Gen. Pract. 63 (611) (2013) e416–e422.

[6] G. McAlonan, A. Lee, V. Cheung, C. Cheung, K. Tsang, J. Wong, et al., Immediate and sustained psychological impact of an emerging infectious disease outbreak on health care workers, Can. J. Psychiatr. 52 (4) (2007) 241–247.

[7] World Health Organization, Middle East Respiratory Syndrome Coronavirus (MERS-CoV) – Update, WHO, Geneva, 2014.

[8] Ebola virus disease in health care workers - Guinea, 2014. MMWR Surveillance Summaries; 64(8): 1083-1087.

[9] I. Eames, J.W. Tang, Y. Li, P. Wilson, Airborne transmission of disease in hospitals, J. R. Soc. Interface 6 (Suppl 6) (2009) S697–S702.

[10] G. Zayas, M. Chiang, E. Wong, F. MacDonald, C. Lange, M. King, et al., Effectiveness of cough etiquette maneuvers in disrupting the chain of transmission of infectious respiratory diseases, BMC Publ. Health 13 (2013) 811.

[11] L. Knibbs, L. Morawska, S. Bell, P. Grzybowski, Room ventilation and the risk of airborne infection transmission in 3 health care settings within a large teaching hospital, Am. J. Infect. Contr. 39 (10) (2011) 866–872.

[12] A.R. Escombe, C.C. Oeser, R.H. Gilman, M. Navincopa, E. Ticona, W. Pan, et al., Natural ventilation for the prevention of airborne contagion, PLoS Med. 4 (2) (2007) e68, https://doi.org/10.1371/journal.pmed.0040068.

[13] K. Joshi, J.S. Thakur, R. Kumar, A.J. Singh, P. Ray, S. Jain, et al., Epidemiological features of pneumonic plague outbreak in Himachal Pradesh, India, Trans. R. Soc. Trop. Med. Hyg. 103 (5) (2009) 455–460.

[14] J. Cherry, P.S.A.R.S. Krogstad, The first pandemic of the 21st Century, Pediatr. Res. 56 (1) (2004) 1–5, https://doi.org/10.1203/01.PDR.0000129184.87042.FC.

[15] N. Malangu, M. Mngomezulu, Evaluation of tuberculosis infection control measures implemented at primary health care facilities in Kwazulu-Natal province of South Africa, BMC Infect. Dis. 15 (2015) 117.

[16] E. Buregyeya, F. Nuwaha, S. Verver, B. Criel, R. Colebunders, R. Wanyenze, et al., Implementation of tuberculosis control in health facilities in Mukono and Wakiso districts in Uganda, BMC Infect. Dis. 13 (2013) 360.

[17] Ogbonnaya LU, Chukwu JN, Uwakwe KA, Oyibo PG, Ndukwe CD. The status of tuberculosis infection control measures in health care facilities rendering joint TB/HIV services in "German Leprosy and Tuberculosis Relief Association".

[18] M.M. Parmar, K.S. Sachdeva, K. Rade, et al., Airborne infection control in India: baseline assessment of health facilities, Indian J. Tubercul. 62 (4) (2015) 211–217, https://doi.org/10.1016/j.ijtb.2015.11.006.

[19] A. Raj, D. Ramakrishnan, C.R.M.T. Thomas, A.D. Mavila, M. Rajiv, R.P.B. Suseela, Assessment of health facilities for airborne infection control practices and adherence to national airborne infection control guidelines: a study from Kerala, Southern India, Indian J. Community Med. 44 (Suppl 1) (2019) S23–S26, https://doi.org/10.4103/ijcm.IJCM_25_19.

[20] Global Tuberculosis Control, Surveillance, Planning and Finacing, WHO, 2004. Report.

[21] G. Correia, L. Rodrigues, M. Gameiro da Silva, T. Gonçalves, Airborne route and bad use of ventilation systems as non-negligible factors in SARS-CoV-2 transmission, Med. Hypotheses 141 (2020) 109781, https://doi.org/10.1016/j.mehy.2020.109781.

[22] R.A. Hobday, S.J. Dancer, Roles of sunlight and natural ventilation for controlling infection: historical and current perspectives, J. Hosp. Infect. 84 (4) (2013) 271–282, https://doi.org/10.1016/j.jhin.2013.04.011.