Original Article

Implementation Status of Airborne Infection Control Measures in Primary and Secondary Public Health Facilities, Puducherry: A Mixed-Methods Study

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Abstract

Background: Poor ventilation in healthcare settings is a concern for airborne infections, particularly in light of the potential for coronavirus disease 2019 (COVID-19) transmission. This study aimed to assess the implementation status of airborne infection control (AIC) measures in primary and secondary public healthcare facilities (HCFs) and to explore the facilitating factors and barriers in the implementation of AIC measures. **Methods:** A mixed-methods approach was adopted, which includes a cross-sectional descriptive study using a checklist to collect data on the implementation of AIC measures in 22 primary and two secondary public HCFs in Puducherry, South India, between October 2020 and February 2021. Further, key informant interviews (KIIs) were conducted among medical officers (MOs). The qualitative data were manually analyzed, and transcripts created from handwritten notes and audio recordings were deductively evaluated. **Results:** Of the twenty-four health facilities visited, 54.2% had infection control (IC) committees. Annual IC training was held for housekeeping staff, MOs, nurses, and laboratory technicians in 23 (95.8%), 21 (87.5%), 20 (83.4%), and 14 (58.4%) facilities, respectively. Respiratory symptomatic patients were counseled on cough etiquettes in 22 (91.6%) facilities. Adequate cross-ventilation was present in outpatient departments in 16 (66.6%) institutions. N95 masks and face shields were provided in 21 (87.5%) facilities. Training through the KAYAKALP program and the presence of a separate sputum collection area were facilitators of IC, while lack of patient adherence and delays in fund release were found as barriers. **Conclusion:** Overall, the AIC measures were well-implemented, but improvements are needed in infrastructure development for patient segregation in outpatient departments and dedicated AIC training for all healthcare personnel.

Keywords: Airborne infection, community health centers, mixed-methods study, primary healthcare facilities

Introduction

Airborne infection control (AIC) measures play a pivotal role in curtailing the transmission of infectious diseases in healthcare facilities (HCFs). It has been estimated that airborne infection contributes to 10 to 20% of endemic nosocomial infections in a HCF.[1] HCFs cater to patients with a variety of ailments, and some of them may have various underlying immunocompromised conditions, which predispose them to airborne infection. Infections, such as influenza, tuberculosis, aspergillosis, and measles, are believed to be transmitted via the airborne route.[2] The source of airborne infection can be because of sneezing, coughing, vomiting, or even the breath of an infected individual.[3] Healthcare workers (HCWs) are at a greater risk of acquiring airborne infections as they are continuously exposed to infectious patients in a confined environment.[4] This can significantly raise the risk of airborne disease transmission while attending to a large number of patients, particularly in countries such as India where the burden of hospital-acquired infection is already high. Moreover, this also poses a considerable risk in the form of a decrease among the health workforce available for treatment and management of airborne infections.[5–7]

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Hospital-acquired infections additionally pose medicolegal concerns due to increased morbidity and death, as well as rising costs of illness for both providers and patients.[7,8] Research suggests that 10–24% of all hospital-acquired infections with no epidemic potential transmits via air, whereas 2–4% of hospital-acquired infections, which spread through the air, holds epidemic potential.[9] AIC measures are crucial in preventing outbreaks of infectious diseases in HCFs. The absence or inadequate implementation of these measures can lead to the spread of airborne infections, which is a significant risk to patients, HCWs, and visitors. Therefore, it is imperative to prioritize measures to prevent cross-contamination and transmission of airborne diseases in HCFs.[10]

To reduce the spread of any infectious disease, preventive measures are generally employed at different stages of infection transmission pathways.[11] Airborne transmission preventive measures are mainly categorized as managerial (like setting up of infection control (IC) committee, HCW training regarding AIC measures), administrative (related to measures to detect respiratory infectious patients early, separating them from other patients and expediting their treatment, providing counseling regarding cough etiquette, etc.), environmental (maintaining an adequate cross-ventilation in the facilities), and personal protective control.[12–17] The Government of India, in 2010, developed "Guidelines for Airborne Infection Control in Health Care Settings," which incorporates all these four types of control strategies.[12] Although the guideline was chiefly intended for curtailing tuberculosis (TB) transmission among immunocompromised patients, it can help in preventing the spread of other airborne infections.[7] Few studies in India have evaluated the operational status of these strategies at the facility level. This study is the first to assess the implementation status of AIC measures in Puducherry's public primary and secondary HCFs. We have also tried to assess the facilitating factors and barriers in the implementation of AIC measures from the provider's perspective.

Methods

This study was carried out in selected public health facilities in Puducherry from October 2020 to March 2021. There were a total of 27 primary health centers (PHCs) and two community health centers (CHCs) for a population of 9.5 lakh (Census 2011) in the Puducherry District. This study involved all the public HCFs (PHCs and CHCs) within a 20 km radius of Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER). In the process, we included both the existing CHCs and 22 of a total of 27 PHCs present in Puducherry. The decision to include all facilities within the 20 km radius of JIPMER was made to ensure that the study sample was representative of the population in the selected region and to avoid any potential bias that could arise from selective sampling. The inclusion criteria for the study were based on the proximity to JIPMER and not on any other characteristics of the facilities, which further eliminates the possibility of bias in the selection of the PHCs and CHCs. Institute Scientific Advisory Committee and Institute Ethics Committee approval was obtained before data collection. This study was conducted after ethical clearance from the Ethics Committee of JIPMER, Puducherry (project no. JIP/IEC/2019/521 dated January 24, 2020). Administrative approvals were also obtained from the Directorate of Medical Services Office, Government Health Services, Puducherry, before initiating the study.

This was an explanatory sequential mixed-methods study that was carried out in two phases.

In the first phase, a cross-sectional descriptive study was conducted with the intent of assessing the implementation status of AIC measures in 24 (22 PHCs and two CHCs) selected public health facilities. The data were collected using pretested structured questionnaires. The questions were framed taking into consideration the observational checklist/reporting formats adapted from the "Guidelines on Airborne Infection Control in Healthcare and Other Settings, April 2010, DGHS, MOHFW."[12] A pilot study was conducted before data collection, and necessary modifications were made in the data collection pro forma. The site for the pilot study was chosen as one primary health facility outside the sampling frame (i.e., PHC beyond a 20 km radius from JIPMER) of this study.

Information on managerial, administrative, and environmental control measures and availability of personal protective equipment were collected from the medical officer (MO) in charge of the public health facility or were gathered by direct observation during visits to the selected health facilities. Under the managerial component, a "dedicated IC committee" is defined as a group of individuals appointed by the HCF to be responsible for overseeing and implementing infection prevention and control measures. The committee's primary purpose is to develop and monitor policies and procedures to prevent and control the spread of infectious diseases within the HCF. The committee generally consists of representatives from different departments and disciplines, including medical, nursing, housekeeping, and administrative staff.[12,18] Other relevant operational definitions can be found in the "Guidelines on Airborne Infection Control in Healthcare and Other Settings, April 2010, DGHS, and MOHFW."[12]

The methodology used to evaluate ventilation in the selected facilities is outlined in Textbox 1. Adequate ventilation was determined using the 20% rule, which was applied to various areas including examination rooms, waiting halls, and outpatient departments.[19,20] For facilities that housed laboratories as designated microscopy centers (DMCs) for tuberculosis diagnosis, ventilation was evaluated using both the 20% rule and the air change per hour (ACH) method. ACH was measured using the formula specified in Textbox 1, and airspeed was measured using a digital anemometer (HTC Instrument AVM06).[20–22] A minimum ACH of 12 was considered adequately ventilated for DMC laboratories.[19,23–25]

Data were collected and entered in online Google forms, and data analysis was carried out using Statistical Package for the Social Sciences (SPSS), version 25.0 (IBM Corp., Armonk, NY, USA).

In the second phase, a total of 10 key informant interviews (KIIs) (eight from PHCs and all the two CHCs) were carried out. In the process, ten MOs in charge of personnel were interviewed from each of the selected health facilities. To select primary health centers (PHCs) for qualitative interviews, 22 facilities were divided into two groups based on the presence or absence of DMCs, with each group further subdivided based on whether the PHCs were located in an urban or rural setting. From each of the resulting four groups (urban with DMC, urban without DMC, rural with DMC, and rural without DMC), one PHC with a high caseload and one PHC with a low caseload were selected, resulting in a total of eight PHCs that were selected for conducting the interviews. The sampling strategy adapted for choosing the PHCs for KII is also depicted in Figure 1. Following the completion of 10 KIIs, further KIIs were not conducted as data saturation was achieved. The chief MOs in charge of each selected health facility were approached during their convenient time for conducting KIIs. The KIIs were conducted by an investigator who was trained in qualitative research methods. The rationale behind choosing MOs for interviews lies in the fact that MO in charge holds the overall supervisory role in PHCs and CHCs. Before beginning the interview, steps were taken to build up a good rapport with the participants. To maintain privacy, interviews were conducted either in MO's office or at a place convenient to the MO. Before the interview, written informed consent was collected from all the study participants after they were briefed regarding the study's purpose. At the end of the interview, the key points were summarized and their concurrence was sought before finalizing the results of KII.

During the KIIs, notes were taken on paper, and recording was performed based on the preference of the participant. The audio recordings were transcribed on the same day it was conducted. To protect the confidentiality of the data, KII notes and PHC/CHC checklists were deidentified and were given unique numeric codes.

For analysis, deductive content analysis was carried out. A categorization matrix was adapted based on the four levels of AIC measures (managerial, administrative, environmental, and personal protective controls) depicted in the literature.[12] All of the transcripts were carefully read, the contents were analyzed, and codes were derived to correspond to the categories that already existed. A subject matter expert reviewed the categories to see how well they represented the codes, themes, and quotations for ensuring viewpoint validity. Further, both phase 1 and phase 2 study data were integrated by explaining qualitative findings in the context of quantitative findings (narrative technique) and visually displaying potential relationships between qualitative and quantitative findings using the joint display.[26]

Textbox 1: Assessment of the ventilation

Ventilation was assessed by the following methods[14,23]:

1. Adequate ventilation was assessed by the "20% rule":
   (Surface area of smallest opening/surface area of the room) × 100% ≥ 20%
2. Air change per hour measure was carried out using the following formula:

$$\frac{0.65 \times \text{airspeed (m/s)} \times \text{smallest opening area (m}^2\text{)} \times 3600}{\text{Room volume (m}^3\text{)}}$$

Air speed was measured using HTC Instrument AVM06 Digital Anemometer

Results

The general characteristics of 24 facilities (22 PHCs and two CHCs) assessed are presented in Table 1. Each facility served a median of 150 patients per day in the outpatient department. The objective of this study was to primarily assess the

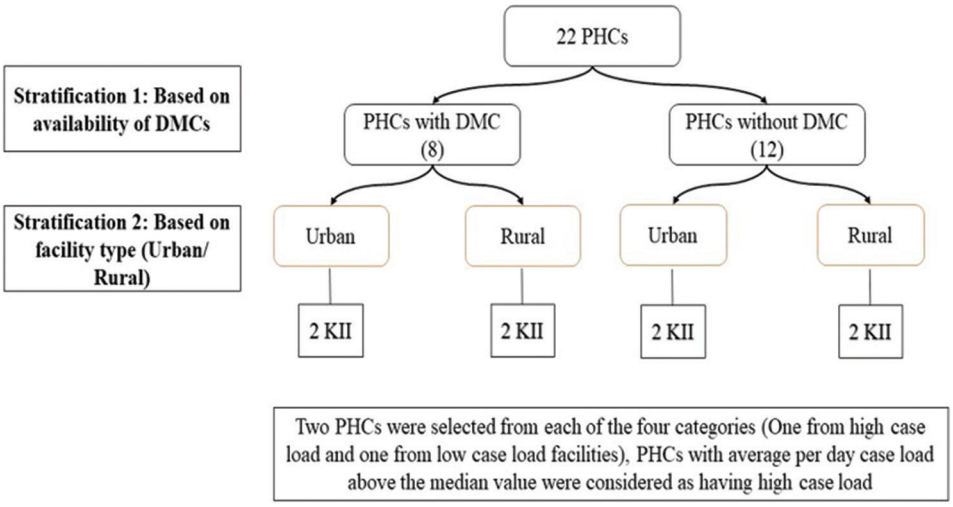

Figure 1: Sampling strategy to select the PHCs for conduction of Key informant interviews

implementation status of AIC measures in public primary and secondary health facilities in Puducherry. In this assessment, PHCs and CHCs have not been separately presented and the results have been analyzed cumulatively considering that there was comparable population coverage between these centers. Though at both levels there are differences in service availability and workforce, population coverage under primary- and secondary-level facilities did not vary significantly. Among the selected 22 primary facilities, the median population coverage was 25176, with an interquartile range between 13037 and 53801. In the two CHCs, the population coverage was 33666 and 8535, respectively. Of 24 facilities, 10 (41.6%) had DMCs for diagnosing tuberculosis. In these DMCs, ventilation was examined using both the 20% rule and ACH estimation, and the results have been presented separately.

Managerial component

Quantitative findings

Of 10 facilities with DMC, eight (80%) facilities had dedicated IC committee. The presence of an IC committee was even found in five (35%) of the non-DMC facilities.

In the previous year (2020), 12 (92%) of the 13 facilities that had an IC committee had conducted committee meetings twice a year as per guidelines given by the Ministry of Health and Family Welfare (MoHFW). In 11 (46%) facilities, IC guidelines were available at the time of the visit. Last year, IC training was attended by housekeeping staff and laboratory technicians in 23 (95%) and 14 (54%) facilities, respectively. Similarly, IC training was attended by MOs and staff nurses in 21 (87%) and 20 (83%) facilities, respectively [Table 2].

Qualitative findings

Figure 2 is a joint display that contains both quantitative and qualitative data on various managerial control measures.

All MOs in charge stated that it has been convenient for them to maintain the facility cleaning policy after the formation of the IC committee. Regular infection control review meetings in facilities with a dedicated IC committee helped them improve their adherence to IC guidelines.

It was also found that the recent recruitment of MOs at the subcenter level has helped to decrease overcrowding at PHCs and CHCs. The initiation of the KAYAKALP program by MoHFW has also facilitated the implementation of AIC

Table 1: General healthcare facility (HCF) information for primary and secondary healthcare centers of Puducherry, 2020 [*n*=24 (22 PHCs and two CHCs)]

	(*n*=24) Median	IQR
Number of facilities operating 24/7 (*n* (%))	13 (54.2)	--
Population catered by facilities	25176	12043-51936
Number of OPD patients attended/day	150	108-200
Number of facilities with designated microscopy center (*n* (%))	10 (41.6)	--
Burden of airborne infection—in last 3 months (August–October)		
Number of TB suspects examined by smear microscopy for the facility with DMC	9	4-19
Number of TB patients registered for treatment (August–October)	3	1-5
	CHC 1	**CHC 2**
Inpatient bed (including emergency dept.) —for CHC only	34	21
Average number of patients admitted in a month (average of August–October)—for CHC only	##	18

##At the time of the visit, it was reported that, in light of COVID-19, CHC had stopped admitting patients temporarily from March 2020, with the exception of emergency cases and patients put on observation

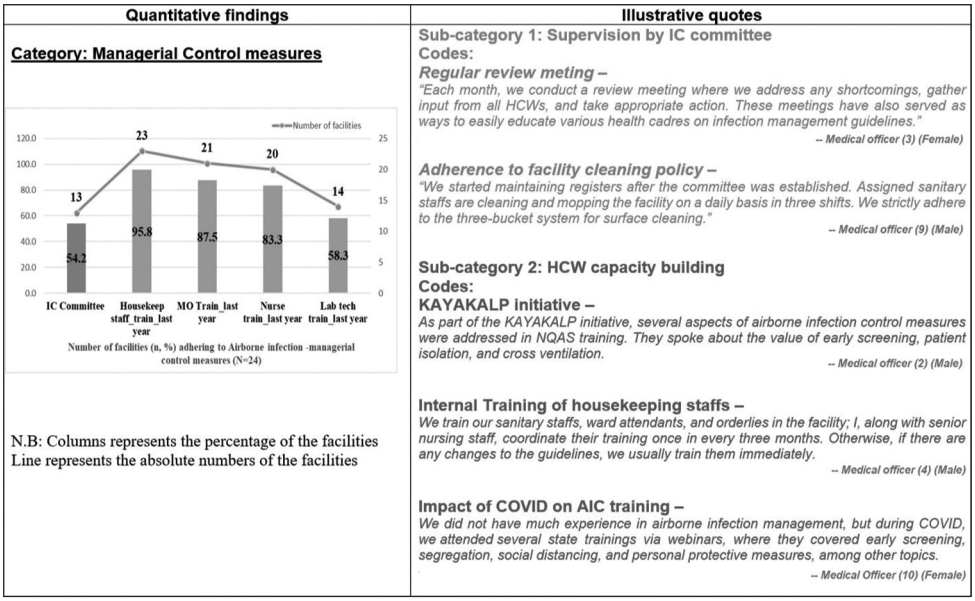

Figure 2: Joint display of quantitative and qualitative findings on managerial airborne infection control measures in public primary & secondary healthcare facilities in Puducherry

measures, as the focus of this program is on improving the public health infrastructure and maintenance of cleanliness in public health facilities. This has also served as a motivator for HCWs to maintain strict hygiene standards.

It was also felt that multiple webinar sessions and online conferences during the coronavirus disease 2019 (COVID-19) pandemic have contributed to increased knowledge regarding AIC and practices among HCWs.

Administrative control measures

Quantitative findings

In 22 (91%) facilities, respiratory symptomatic patients were counseled on cough etiquette, mask wearing, and other personal protective measures. Early screening and fast-tracking of respiratory symptoms were observed in 20 (83.3%) facilities. Information, Education and Communication (IEC) display about cough etiquette and mask wearing was displayed in the registration and waiting areas of all the facilities. Among the 23 facilities where sputum collection for TB diagnosis was happening, 19 (79.2%) of them had a secluded, well-ventilated, open space. Three (12.5%) facilities identified segregating respiratory symptomatic patients in a separate waiting area as per guidelines. Masks were given to respiratory symptomatic patients who arrived at the hospital without a mask in five (21%) facilities [Table 2].

Table 2: Implementation status of managerial and administrative control measures of airborne infection control in primary and secondary health centers of Puducherry, 2020 [*n*=24 (22 PHCs and two CHCs)]

	n (%)	95% CI
Number of facilities having infection control committee	13 (54.2)	33-75
Facilities having infection control committee and conducted committee meeting >2 times a year (*n*=13)	12/13 (92.3)	--
Number of facilities having written infection control guideline	11 (45.8)	26-67
Number of facilities where the AIC plan was present or covered in infection control guideline (*n*=11)	3/11 (27.3)	--
Number of facilities where housekeeping staff has attended any infection control training in the last year	23 (95.8)	79 – 99
Number of facilities where laboratory technician has attended any infection control training in the last year	14 (58.4)	38 – 75
Number of facilities where MO has attended IC training in last one year (2019)	21 (87.5)	67 – 97
Number of facilities where staff nurses have attended IC training in the last one year (2019)	20 (83.4)	62-95
Number of facilities where	***n* (%)**	**95% CI**
Respiratory symptomatic patients are counseled regarding cough etiquettes and mask wearing	22 (91.6)	73-99
Separating respiratory symptomatic patients through early screening	20 (83.3)	63-95
Fast-tracking of respiratory symptomatic patients	20 (83.3)	63-95
Separate sputum collection area	19 (79.2)	57-93
Segregation of respiratory symptomatic patients in the separate waiting area	3 (12.5)	12-51
Display of IEC materials/posters of cough etiquette information in registration counter/waiting areas	22 (91.6)	73-99
Patient without mask was provided mask in facility	5 (21.0)	9 – 40

Qualitative findings

Figure 3 is a joint display that contains both quantitative and qualitative data on various administrative and personal protective control measures. During the KIIs, it was found that setting up a screening outpatient department (OPD) at the entrance of each facility helped in the early screening of people having respiratory symptoms.

The provision of a dedicated sputum collection area in an open space, outside at facility premises, was reported as another facilitating factor. It assisted in limiting the proximity of suspected tuberculosis patients to other patients at the health center.

Steps for early detection of TB were being done in all the PHCs irrespective of whether it was a DMC or not. Sputum samples collected in non-DMC PHCs are sent to DMCs on a triweekly basis. This strategy has also helped in reducing patient crowding in the DMCs. At the time of diagnosis, TB patients were getting counseled for personal protective measures by a dedicated counselor/medical social worker (MSW).

Environmental control measures

Quantitative findings

In 17 (70.8%) facilities, adequate cross-ventilation was present in examination rooms and waiting rooms. In seven (29%) facilities, proper seating arrangements for doctors and patients were maintained while considering directional airflow as per recommendation [Table 3].

Ventilation status in DMCs

Seven (70%) of the total ten DMC laboratories assessed had unrestricted fixed openings, and five (50%) DMCs had adequate cross-ventilation. In six (60%) facilities, the laboratory was located at the far end and was physically separated from the rest of the hospital. The presence of anteroom was found in two of 10 (20%) healthcare centers with sputum microscopy facilities as per recommended guidelines. ACH was measured in the DMC laboratories of eight PHCs and two CHCs. The median ACH was calculated to be 28.5 with an interquartile range (IQR) of 25 to 31, which was better than the minimum recommended ACH of >12.

Personal protective measures

Quantitative findings

Gloves and surgical masks were adequately available for all the staff in all the facilities visited. Every health staff was

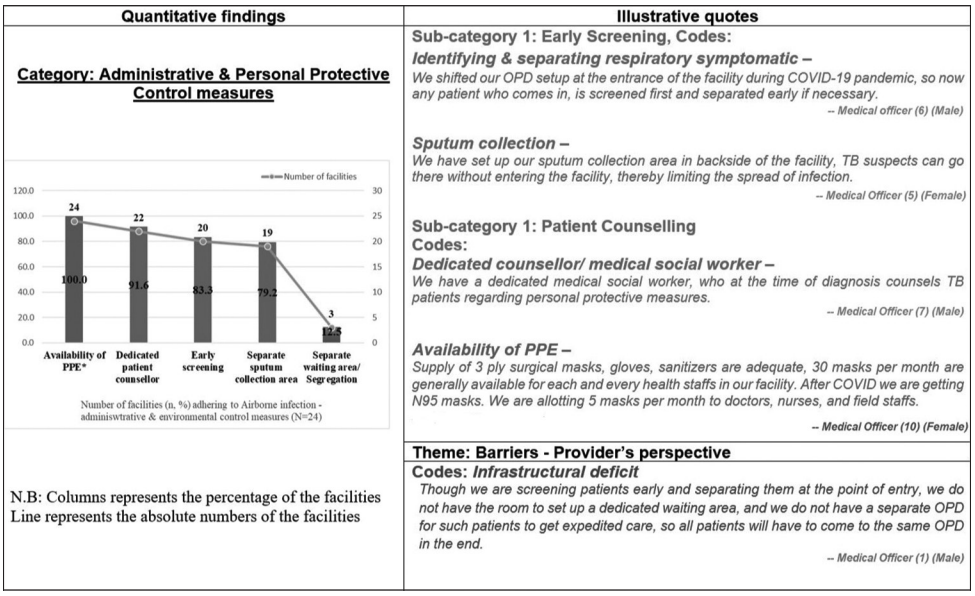

Figure 3: Joint display of quantitative and qualitative findings on administrative & personal protective airborne infection control measures in public primary & secondary healthcare facilities in Puducherry

getting one surgical mask a day for single shift duty, and for a double shift, two masks per day were made available. In 21 (87.5%) health centers, doctors and nursing staff received protective eyewear or a face shield; in 22 (96%) facilities, doctors and nursing staff received N95 masks. Field workers, such as Accredited Social Health Activist (ASHAs) and health inspectors, were also given N95 masks in 21 of 24 facilities. N95 masks were provided to laboratory technicians in six (25%) facilities [Table 3].

Qualitative findings regarding environmental control and personal protective measures: Facilitating factors from provider's perspective

During the KIIs, the MO in charge of several public HCFs reported that physical separation of the laboratory aided in the prevention of infection transmission within the facility.

Statement: "Since our pathology lab and DMC setup are in a separate building, physically separated from the hospital setting, and since there is enough space, proper cross ventilation is possible, I believe this significantly decreases the risk of infection transmission."

--Medical officer (8) (Male)

Barriers identified from the provider's perspective

Dedicated AIC Training

After the advent of COVID-19, many webinar-based pieces of training were held at the state and national levels addressing AIC strategies, but they had not attended any training program or workshop, which gave dedicated training in AIC.

Statement: "After COVID only many trainings were there, in that airborne aspect was touched, but we did not attend any dedicated training for airborne infection control. I feel it would have been beneficial if at least a training program regarding AIC is conducted once a year."

--Medical officer (4) (Male)

Human Resource

Even though all public health facilities had a sufficient number of doctors according to Indian Public Health Standards (IPHS) guidelines, a shortage of group IV personnel (especially sanitary staff and ward attendants) was identified as a barrier to the implementation of AIC initiatives.

Statement: "We have only 4 housekeeping staff presently working here and with that maintaining disinfection practices is very difficult. If all the posts are occupied, it will be easy for us to mobilize manpower to tackle airborne infections in a better way."

--Medical officer (1) (Male)

Financing

Delay in receiving funding was perceived by MOs as a barrier. It was also felt that the purchase mechanism for public HCFs needed modifications to make it more convenient for the timely procurement of necessities.

Statement: "Previously for any emergency requirement we could do local purchases. Now every spending has to be digitalized, so any transaction that happens has to happen through online or cheques only. Any purchase above rupees 5000 has to get approved by the deputy collector. Though it is a good process to limit unnecessary spending, it is a bit inconvenient at times."

--Medical officer (2) (Male)

Infrastructure

In all the facilities, there was no provision of a separate OPD area for respiratory symptomatic patients. So, segregation of

Table 3: Implementation status of environmental control measures (ventilation aspect) and availability of personal protective equipment for airborne infection control in primary and secondary health centers of Puducherry, 2020 [*n*=24 (22 PHCs and two CHCs)]

	Total (*n*=24) *n* (%) 95% CI
Number of facilities where unrestricted fixed opening of more than 20% of floor area and opening on opposite sides were found as per recommendation	
1. Examination room and waiting room	17 (70.8) 48 – 87
2. Outpatient department (OPD)	16 (66.6) 46-82
Number of facilities where optimal seating arrangement of patient and doctor was maintained	7 (29.2) 12-51
Environmental control in pathology laboratory with the provision of sputum microscopy (DMCs) (*n*=10), PHCs-8, CHCs-2	
Number of DMC laboratories where unrestricted fixed opening of more than 20% of floor area was found as per recommendation	7 (70.0)
Number of DMC laboratories with two opposite openings (window/doors)	5 (50.0)
Number of DMC laboratories where laboratory placed at the blind end of the building or physically isolated from hospital environments	6 (60.0)
Number of DMC laboratories with anterooms	2 (20.0)
Air change per hour (ACH) in DMC laboratories	**Median 28.5 IQR (25-31)**
Number of facilities where adequate availability of gloves and surgical masks to all cadre of staff was found	24 (100)
Number of facilities where adequate availability of protective eyewear/face shield to frontline staff (doctors and nursing staff) was found	21 (87.5)
Number of facilities where N95 masks were made available to different health cadres	
1. Doctors and all nursing staff	22 (91.6)
3. Laboratory technician	6 (25)
4. Field workers (ASHA and ANM)	21 (87.5)
Number of facilities where proper disposal of used masks was followed	24 (100)

chest symptomatic patients was difficult even if they were being identified early. One of the CHC MOs also pointed out regarding unavailability of a separate block for respiratory infectious diseases

Statement: "*We don't have a dedicated block for respiratory infectious diseases, so we had to make isolation wards within the hospital. Since we have space available outside, a separate infectious disease block would have been preferable.*"

--Medical officer (6) (Male)

Discussion

AIC measures were assessed under four domains—managerial, administrative, environmental, and personal protective measures. The literature suggests that managerial and administrative controls are regarded as the priority measures as they work on source control to interrupt transmission.[27] The proper implementation of these measures assures early detection of respiratory symptomatic and ensures isolation, thereby fast-tracking their care. Triage and management of symptomatic patients in outpatient clinics are crucial to limit exposure to other patients and HCWs.[27–30] The quantitative analysis revealed that dedicated IC committees were present in 13 (54%) facilities, and this was mainly present in the health centers where DMCs were present (seven of eight facilities with DMC had ICC). These findings fared well when compared to the findings in a study by Raj *et al.* (2019), They reported that an IC committee was in place at 70% of all secondary and tertiary facilities evaluated.[10] It was observed that although AIC is a part of Revised National Tuberculosis Control Program (RNTCP) training, dedicated AIC training was not imparted to the MOs of the health centers. Dedicated training on AIC for different health cadres will help in further streamlining the quality of implementation of AIC measures. MOs felt that there was a need to review the procurement mechanism for the timely purchase of the consumables and disbursement of funds for AIC. As per the facility-based observation, it was noticed that although the patients with respiratory symptoms were screened early, unfortunately, a dedicated place to segregate them was not available. Several studies have documented the beneficial effect of a separate well-ventilated waiting area for reducing the transmission potential of airborne pathogens.[31,32] Thereby, the focus should be given to necessary infrastructure development for adequate segregation of patients. A dedicated MSW offered counseling on cough etiquette and other hygienic procedures to respiratory symptomatic patients in 91.6% of the facilities. This finding was better compared to the study by Parmar *et al.* (2010), which reported that similar counseling was provided in 61% of all selected secondary and tertiary facilities assessed in India.[33]

The fundamental aim of environmental control measures is to improve ventilation to lower the number of infectious particles. Evidence from several studies suggests that natural ventilation is the most easily adaptable option for maintaining adequate ventilation in resource-constrained settings.[22,34] It was found that 67% and 71% of the facilities had sufficient cross-ventilation in outpatient departments and the patient waiting room, respectively. Moreover, median ventilation of 28.5 ACH (recommended minimum ACH for any airborne isolation room is >12[12]) was achieved only by keeping windows and doors open or unobstructed in all DMC laboratories. These results were similar to those of a study that compared mechanical and natural ventilation in eight hospitals in Lima, Peru.[34]

Strength and limitations

The strength of this study was that it included nearly all primary HCFs (22/27) and both existing CHCs. A wireless anemometer was used to objectively measure ACH.

Standard precautions (hand hygiene, use of personal protective equipment (PPE), etc.) are the minimum prerequisites for

any infection prevention.[35] In this study, a standard checklist provided by the Ministry of Health and Welfare's Central TB Division was utilized to assess the AIC implementation status, which includes some components of standard precaution (respiratory hygiene and cough etiquette). The present study could have been strengthened further had we included a complete assessment of standard precaution implementation. It is possible that some of the status indicators used to measure AIC may have been impacted by the COVID-19 pandemic. To better understand this impact, it would have been helpful to know the different specific timeframes at which these parameters were present or absent.

Conclusion

The study found that the administrative controls in the health facilities were well-implemented. The setting up of an institutional IC committee was found to be one of the facilitators in the implementation of AIC measures. Natural ventilation was identified as an effective method to maintain adequate air exchange in resource-constrained settings. A facility-based regular risk assessment by the facility IC committee, dedicated training for healthcare staff about AIC measures, streamlining fund disbursement methods, etc., were identified as areas for further improvement.

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Conflicts of interest

There are no conflicts of interest.

Abbreviations

ASHA - Accredited Social Health Activist

ANM - Auxiliary Nursing Midwifery

DGHS - Directorate General of Health Services

MOHFW - Ministry of Health and Family Welfare

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