

ORIGINAL ARTICLE

# Challenges and opportunities for scaling up infection prevention and control programmes in rural district hospitals of Tamil Nadu, India

Maya Guhan<sup>1</sup>, Mohan Kumar<sup>2</sup>, Zachary Butzin-Dozier<sup>1</sup> and Jay Graham<sup>1\*</sup>

<sup>1</sup>University of California, Berkeley, School of Public Health, Environmental Health Sciences Division, Berkeley, California, USA; <sup>2</sup>Public Health Institute, Oakland, California, USA

## Abstract

**Introduction:** The aim of this study was to explore the barriers to implementing an infection prevention and control (IPC) programme in three public district hospitals in Tamil Nadu by interviewing key stakeholders involved in the roll-out of the programme.

**Materials and methods:** Investigators conducted interviews ( $n = 17$ ) with chief medical officers (CMOs), physicians, and IPC nurses at three secondary public district hospitals and their affiliated primary health centres (PHCs).

**Results:** Six major themes emerged from the interviews: (1) prevalent IPC practices before the programme began; (2) barriers to implementation; (3) perceptions of the effectiveness of the IPC programme; (4) suggestions for future expansion of the programme; (5) the role of healthcare sanitation workers, and (6) water, sanitation and hygiene (WASH) infrastructure. Stakeholders noted improvements in IPC knowledge, infection control related behaviour, and overall healthcare quality in the three hospitals. In regards to the future of this programme, stakeholders noted the need for more institutional support, a staff nurse solely dedicated to IPC, and the continued training of all staff members.

**Discussion:** The results of this study highlight the importance of having high-functioning WASH infrastructure and training for hospital sanitary workers in order to have an effective IPC programme. While the scale-up of this IPC programme is warranted, the barriers to implementation outlined in this study should be considered. To achieve a more effective IPC programme, we suggest that the following steps be carried out: (1) dedicate at least one full-time nurse to implementing IPC activities at each district hospital; (2) ensure that state and national policies for IPC are synchronised, and (3) provide sufficient and consistent funding for IPC activities.

**Keywords:** *infection control; water; sanitation; hygiene; antimicrobial resistance; healthcare-acquired infection; India*

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An increasing number of hospitals across the globe are beginning to implement infection prevention and control (IPC) programmes in their facilities in order to prevent healthcare-associated infections (HAIs) and control the spread of antimicrobial resistance (AMR) (1). Healthcare associated infections affect millions of individuals across the world, and can lead to increased morbidity and mortality, longer hospital stays, and increased cost of treatment for patients (1–3).

Healthcare associated infections are more prevalent in low and middle income countries (LMICs) than high income countries (HICs) (1), and for every 100 hospitalised patients at a given time, seven in HICs will acquire an infection, while 10 in LMICs will acquire at least one HAI

(4). In LMICs, poor infection control practices, overcrowding, understaffing, heavy workload, and lack of knowledge regarding infection control contribute to higher rates of HAIs (1, 5, 6). Prolonged and inconsistent use of antibiotics have also led to alarming rates of AMR (7–9).

Recent research in Tamil Nadu, India revealed serious gaps in IPC (10). Specifically, there was inappropriate use of personal protective equipment and lack of adequate knowledge on infection control practices even though there were evidence-based guidelines given by the World Health Organization (WHO) on the essential components of IPC programmes (11–13). These gaps can be attributed to a lack of trained and dedicated staff present to carry out IPC activities.

Given these gaps in IPC across many countries and contexts, efforts are being made to improve IPC and train personnel to carry out IPC activities, with a specific focus on hand hygiene and antimicrobial stewardship (14–17). Studies have shown that IPC measures have prevented disease transmission, lowered the infection and sepsis rates leading to morbidity and mortality, and provided more cost-effective healthcare, relative to the time before the existence of stringent IPC protocols (18–21).

In 2016, the Tamil Nadu Directorate of Public Health and Preventive Medicine implemented an IPC programme in three public district hospitals, all secondary care facilities, and their affiliated primary health centres (PHCs) in Tamil Nadu, a state in the southern India, with the intent that these three districts would serve as a model for scaling up IPC activities across all 32 total districts in the state. Since IPC programmes are multifaceted and require both behavioural change among participants and support across institutions, it is important to analyse the unique components of this specific programme and learn any lessons (22, 23).

Provider-reported programme effectiveness (24), and interviewing key informants have been shown to be effective in providing insight into the implementation of complex processes under local and cultural contexts (25). Specifically, through key informant interviews, the quality of IPC in the hospital environment can be improved and the implementation can better be measured and related to outcomes (26).

The aim of this study was to explore the barriers to implementing an IPC programme in resource-limited, rural settings rather than high-level tertiary care facilities, and then characterise the challenges these hospitals face while implementing them. Using qualitative methods, we looked at the perceptions of key hospital stakeholders (chief medical officers [CMOs], physicians, and nurses) as a way to better plan the IPC programme's future

implementation (27). This study aims to inform the Government of Tamil Nadu's (GOT) efforts to institutionalise this programme across all 32 districts in the state of Tamil Nadu, and support the existing efforts to limit infections.

## Materials and methods

For our qualitative study, we conducted 17 interviews at three secondary public district hospitals and their affiliated PHCs during January 2019. The three centres were located in Tenkasi, Kancheepuram, and Coimbatore. At each secondary hospital, a CMO, a physician, and an IPC nurse were interviewed and at the PHC. Demographic information about the participants is given in Table 1. We arrived at our given sample size by evaluating how many professionals at these three centres could speak competently about the programme and its implementation. We selected these professionals, who had first-hand knowledge of the IPC programme, for inclusion into the study.

We focused primarily on the perspective of the IPC nurse who was directly in charge of the day-to-day implementation of the programme, the CMO who manages the programme from the executive level, as well as a staff physician who could evaluate how an increase in IPC could affect patient care. We also interviewed the District Public Health officials who were directly in charge of the implementation of this programme (2016–2019).

We included both Tamil or English speakers. We excluded those who had not been there prior to the implementation of the IPC programme and could not attest to the hospital environment before the IPC programme. We did not perform any follow-ups with these specific medical professionals after the interviews were conducted.

Interviews were primarily conducted in person in Tamil Nadu, India, in a private room in Tamil or English, depending on the proficiency level of the participant, and the discussions lasted approximately 30 min. The current

Table 1. Characteristics of participants

Organisation	Total No.	No. of participants in each category	Gender	Age
Hospital 1	5	CMO (2)	Male (1)	35 – 55 (1)
		IPC nurse (2)	Female (1)	55+ (1)
		Physician (1)	Female (2)	18 – 35 (2)
			Female (1)	18 – 35 (1)
Hospital 2	5	CMO (2)	Female (2)	35 – 55 (2)
		IPC nurse (2)	Female (2)	18 – 35 (2)
		Physician (1)	Female (1)	35 – 55 (1)
Hospital 3	5	CMO (2)	Male (1), Female (1)	35 – 55 (2)
		IPC nurse (2)	Female (2)	18 – 35 (2)
		Physician (1)	Female (1)	18 – 35 (1)
State Public Health Department	2	State Public Health Official (2)	Male (2)	35 – 55 (1); 55+ (1)

IPC monitoring form in the labour and delivery ward and the Sick Newborn Care Unit (SNCU) is included in the Supplemental Materials and was used as a baseline for our questions. The interview guide (see Supplemental Materials) consisted of 14 standardised questions and was designed to minimise bias and leading questions. All interviews were audio recorded and interviewees' names were immediately replaced with a unique code consisting of a letter and a number to maintain privacy. Audio files were transcribed and all Tamil transcripts were translated to English. After transcription, audio recordings were deleted in order to maintain privacy of the de-identified data.

The interview guide was generated based on existing scientific literature and feedback from State Public Health officials about past efforts in infection control and observations about potential barriers to institutionalising this programme over the past 3 years. This topic guide was validated during the first two interviews, which were also included in our results. The topics in the interview guide included: (1) IPC activities and training prior to initiating the IPC programme. (2) Barriers to implementing the IPC programme. (3) Perceived outcomes of this IPC programme. (4) Guidance for other districts when implementing a new IPC programme.

Data analysis of the text was done manually using grounded content analysis (28). The interview guide was used to derive themes and subsequent subthemes during transcript analyses. Following transcription, investigators identified underlying properties to determine key themes that were present across interviews. Investigators then coded these transcripts in a manner that preserved both latent and manifest content in order to determine interrelationships between themes, behaviours, and other information (29).

## Results

Our interviews provided us with six themes and several subthemes. Table 2 provides a summary of our findings and a comprehensive overview on the percentage of participants that mentioned each theme and subtheme.

### *Prevalent practices and attitudes towards IPC prior to initiating the IPC programme*

Within this theme, there were two subthemes related to infection control policies present before the initiation of the IPC programme, and the mindset regarding the need for the IPC programme.

### *IPC activities present before the initiation of the new IPC programme*

Soap was not consistently available at hospital restrooms and was not considered an IPC tool by sanitary workers and hospital staff. As a result, 41% of the respondents noted the prevalence of limited handwashing resources

and practices before the programme implementation. In addition, 29% of the respondents noted little to no training in IPC, prior to the beginning of the programme.

*'Before the program, we had no soaps in the toilets. Now, we made that available. We are insisting the patients wash their hands with soap before feeding a baby and after using toilets.'* (IPC Nurse, Hospital 2)

Personal protective equipment (PPE) was only utilised in high-risk areas like the operating room and not in areas like the labour and delivery ward.

### *Mindset regarding the need for IPC prior to programme implementation*

Sixty-five (65) percent of the respondents mentioned that they had a poor understanding of IPC. Participants reported the perception that most hospital staff did not know the benefits of handwashing or recognise the need for IPC activities. Respondents noted that IPC training helped staff gain knowledge about how IPC can safeguard their own health.

*'After this training only, we got knowledge that if we follow these procedures, we can protect ourselves from the infection. We came to know that before touching patients, we have to wash our hands and after the procedure, we must again wash our hands.'* (IPC Nurse, Hospital 3)

### *Barriers to initial implementation of the IPC programme*

Under this second theme, respondents noted overall challenges present in the implementation of the IPC programme, as well as specific challenges related to physical resources, technical resources, financial resources, human resources, and data collection and management.

### *Overarching challenges present in the implementation of the IPC programme*

Forty-one (41) percent of the respondents noted that it was a challenge to educate hospital workers about IPC, and to create an environment where hospital staff willingly practiced IPC. Specifically, the IPC nurse noted that IPC activities were initially only conducted for external purposes, in order to pass an inspection or to appease a government official.

Most hospital systems are hierarchical with an emphasis on seniority, while IPC nurses were often given authority despite having little experience. Hiring additional staff who were trained in IPC was a goal of this project, as IPC training was not typically provided to nurses in Tamil Nadu. Most hospital administrators reported having issues with having a young, inexperienced nurse guide the highly skilled nurses.

Table 2. Summary of findings from in-depth interviews

Themes/sub-themes	Categories	Percent of interviewees who referenced subtheme
1a. IPC activities prior to the new programme	<i>Negative response:</i>	
	Poor handwashing practices and lack of soap	41%
	Little training in IPC	29%
	PPE only in high-risk areas	29%
	Inadequate lab services	12%
	<i>Positive response:</i>	
	Following GOI IPC standards	18%
1b. Mindset prior to the new programme	Surveillance of needle stick injuries/sepsis rates	6%
	Comprehensive PPE coverage present	6%
2a. Overall challenges for the new IPC programme	Poor understanding of IPC	65%
	IPC understanding present, but guidelines not followed	29%
2b. Technical resources	Lack of IPC knowledge	41%
	Changing people's mindset to practice IPC	41%
	Hierarchy within hospital	12%
	Cultural practices that influence IPC behaviours	12%
2c. Physical resources	Mismatch between GOI and GOT IPC guidelines	12%
	Mismatch between audit form and local settings	6%
2d. Financial resources	General lack of physical resources	41%
	<i>Specific physical resources mentioned:</i>	
2e. Human resources	Lack of disposable gowns	18%
	General lack of financial resources	65%
	<i>Specific financial resources concerns mentioned:</i>	
	Reusing single-use materials	12%
2f. Data collection and management	Disparity between public and private systems	6%
	General lack of human resources	100%
	<i>Specific human resources concerns mentioned:</i>	
	Inefficient staffing for IPC programmes	59%
	Burden on existing nurses	53%
	Increase in staff could lead to better compliance	35%
3a. Improvements in knowledge and mindset	Excessive transfers	6%
	Necessity of technical team to assist with hospital data collection	24%
	Need for IPC nurse to collect data	24%
	Inadequate manpower to collect data	12%
3b. Improvements in behaviour	Automated data collection system	6%
	Constant training of healthcare workers (HCWs)	82%
	Multifaceted patient education efforts	47%
	Modelling behaviour	29%
	Workers learn to protect themselves	24%
	Willingness to engage in IPC	47%
	Sense of pride and trust	12%
3c. Improvements in healthcare quality	Complete handwashing technique	71%
	Investing in hygiene	35%
	Wearing comprehensive PPE	24%
	Limiting birth companions	12%
	Infection and sepsis rates lowered	76%
	Cleanliness increased	41%
	Able to identify and isolate infection	12%

Table 2 Continues on next page

Table 2. (Continued)

Themes/sub-themes	Categories	Percent of interviewees who referenced subtheme
4a. Potential obstacles for scaling up the programme	Human and financial resources	71%
	Mindset change	35%
	Lack of integrated technical resources	6%
4b. How to make new Programme more effective	Staff should prioritise IPC	41%
	IPC nurse position necessity	35%
	Hospital leadership prioritisation	24%
	Education for patients and medical students	24%
	Data simplification/constant monitoring	12%
	Increased time for implementation	6%
	5. Role of the healthcare facility cleaning staff	Conflicting attitudes towards incentivisation
	Lack of IPC knowledge	18%
	Lack of understanding of importance of role	18%
	Need to further train adequately	18%
6. Water, sanitation and hygiene (WaSH) infrastructure	Required water resources for IPC	35%
	Prevalent waste management is required for IPC	24%
	Lack of WaSH infrastructure	12%

In addition, there were hurdles in terms of cultural barriers. Controlling and limiting the number of family members, as a way to control the spread of infection, is a specific challenge that was noted.

*'Even a small operation will happen in private or public, so many visitors will come, we cannot isolate them as far as infection is concerned. But as far as society is concerned, it is different. It is a CULTURE.'* (CMO, Hospital 1)

#### Lack of technical resources

District Public Health officials mentioned that there was a scarcity of context-relevant handwashing audit forms. Specifically, there were a plethora of forms from the United States Centres for Disease Control and Prevention (CDC), the Government of India (GOI), and the WHO. Hospital administrators, however, found it difficult to choose the most appropriate audit form and adapt it to the local setting.

In addition, the GOI and the GOT have differing standards for infection control, as GOI provides guidelines for infection control but individual states determine whether and how to implement these guidelines. For example, GOI has shared guidelines to limit AMR, but GOT has not yet implemented these AMR-related changes. Hospital centres are required to pass quality assurance protocols for the national standard; however, the GOT was enforcing a different, more stringent standard. A key challenge noted was reconciling these two quality assurance protocols for sustainability and ensuring the highest level of infection control.

*'The mandate for IPC from GOI is not matching with the GOT approach that we have formulated... We are doing a rigorous, high end audit of IPC. For sustainability, we need to go hand and hand with the instructions of GOI and only then will it be institutionalised.'* (District Public Health Official)

#### Lack of physical resources

Forty-one (41) percent of the respondents cited a lack of physical resources as preventing them from complying with the protocol. For this programme to be effective, they stated that physical resources must be present in abundant supply. For example, 18% of the participants cited an inadequate number of hospital gowns in the facilities.

#### Lack of financial resources

A lack of financial resources was cited by nearly two-thirds of the participants as a barrier to the implementation of the programme and its future progress and continuation.

*'We are trying to force the district HQ to do [the IPC programme] because we are monitoring. When we take away the monitoring, they are not going to keep it, simple. Not because they don't want, but because they don't have money.'* (District Public Health Official)

Stakeholders pointed out the discrepancy between private and public healthcare systems. As a result of their

increased funding, private systems are able to invest in IPC activities and retain more hospital staff. As a result, government officials claimed that if they were to also follow strict IPC standards and offer quality healthcare similar to the level offered in private hospitals, they must receive adequate funding.

The IPC nurses admitted that there were discrepancies between the protocol and the actual actions of hospital staff. These discrepancies, most notably reusing materials like gowns and oxygen masks, were because of the inadequate financial resources.

#### Lack of human resources

All respondents cited a lack of human resources as posing a direct challenge to the implementation of IPC programmes.

In most government hospitals, there is an issue of understaffing as a result of constant transfers within the system as well as inadequate financial resources to hire staff members. District public health officials stated that for every district hospital, only one-third of the required staff was present.

As a result, the staff members had to perform more tasks with less manpower. About two-thirds of the respondents stated that they were unable to follow the IPC protocol because of a lack of human resources. IPC activities require extra effort from the hospital staff and were thought of as burdensome, rather than an essential activity for the wellbeing of the patients and staff. Thus, District Public Health officials discussed the need to have a nurse that focuses solely on IPC in order to prioritise the activity.

#### Difficulties in data collection and management

The IPC nurse was noted as essential for data collection as her/his sole responsibility was to manage and collect the IPC data. Many hospital staff stated that her/his presence has made the data collection process much easier and much more efficient.

*'The IPC nurse collects all the data from us. She is an important person here. If she is not there, we suffer a lot.'* (Physician, Hospital 3)

Even with the IPC nurse's presence, other hospital administrators felt that more should be done to fully analyse the technical data generated in the hospital every day. Specifically, 24% of the respondents requested a data management team of three to four people so that those involved in patient care can devote their time to caring for patients.

In response to these complaints, the district public health officers stated that they are currently looking to

create an automated system for data collection on mobile devices in order to expedite the data collection process.

#### *Perceptions of the outcome of the implementation of the IPC programme*

Within this third theme, we discuss stakeholders' perceptions of the improvements in IPC-related knowledge, IPC-related behaviour, and overall healthcare quality.

#### Improvements in knowledge and mindset related to IPC

Following initiation of the IPC programme, healthcare workers were taught how to protect themselves against infections, from washing their hands to taking treatment for needle stick injuries. Over three-quarters of the respondents reported that they saw an increase in IPC knowledge among healthcare workers and that this increase in knowledge could be attributed to the IPC training that the hospital administered, especially in cases of high staff turnover.

*'Before this programme, the workers did not protect themselves, only the patient. Now they are aware, if we do not wash our hands properly, we may get infection. The hospital workers were not taking care of the needle stick injury, they handled the patients just like that. But now they are taking treatment for the needle stick injury.'* (IPC Nurse, Hospital 1)

Hospital administrators noted that the patients were learning proper methods to prevent infection by observing the hospital staff and treating them as role models. In addition, the staff has directly guided patients on following infection control practices to prevent infection, specifically as it relates to handling new-born babies. Forty-seven (47) percent of the respondents reported that there appeared to be an increase in the knowledge level amongst patients after educational materials were distributed in the local language.

In addition, 47% of the stakeholders noted that after the implementation of this programme, hospital staff were more willing to engage in IPC activities.

*'All stakeholders at the district HQ are approaching IPC differently after the programme. CMOs of all three hospitals are more supportive. Now physicians and nurses are giving 100% support. They are seeing the impact of IPC activities – which we are seeing by reduction in the sepsis rate, better healing timelines, etc.'* (District Public Health Official)

Participants reported an increased sense of pride among hospital staff about the cleanliness of their hospital following IPC training.

*'If you come and visit our wards then you know that our hospital looks like a private hospital because of the cleanliness. We are proud to work here.'* (IPC Nurse, Hospital 1).

#### Improvements in IPC-related behaviour

Three-quarters of the respondents described observing an increase in proper handwashing technique among staff, which is essential to limiting infection.

*'Before this programme, we washed our hands one time before touching the patient. But now we either use sterillium or handwash before and after each patient.'* (IPC Nurse Hospital 1)

Specifically, respondents mentioned that the hospital had invested more in hygiene and the staff were wearing more comprehensive PPE.

#### Improvements in overall healthcare quality as a result of the programme

Overall, the perception of the hospital's healthcare quality after programme implementation was positive. Specifically, 76% of the stakeholders reported that the infection rate was lower and 41% of the stakeholders stated that the cleanliness of the facilities had increased.

*'The IPC is included in everything... Because of this programme, the infection and sepsis rate is coming down as compared to previous reports.'* (IPC Nurse and Physician, Hospital 1)

As a result of the enhanced lab services, stakeholders reported that they were able to better identify and isolate infection sites.

#### Suggestions for future districts and guidelines for the entire state if this programme were institutionalised

Within this fourth theme, we discuss the potential obstacles for scaling up this programme across other districts in Tamil Nadu, and make suggestions on how to make the programme more effective.

#### Obstacles to programme expansion

Seventy-one (71) percent of the stakeholders noted that other districts would face issues in context to lack of human and financial resources. For example, CMOs mentioned that it was easier for them to get a personal refrigerator for their office, rather than funding for essential programmes like IPC.

Another obstacle mentioned was the implementation of technical resources that integrate the GOT and the GOI's standards. Without this resource, local hospitals would not have an integrated, sustainable set of IPC regulations.

#### Suggestions on making the programme more effective

A key suggestion that was highlighted by many stakeholders was the fact that hospital leadership needs to prioritise this programme. One district public health official stated that, while state level leadership is committed to this project, momentum must be transferred to ward- and ground-level leadership.

More specifically, 41% of the respondents noted that IPC should be thought of as an investment by staff members and appropriately prioritised. It is not an expenditure or an unnecessary list of tasks. It will take at least 2–3 years for tangible results to manifest. In addition, many stakeholders noted that there needs to be a multifaceted, constant approach to IPC education that should target medical students, patients, and hospital workers.

*'[IPC training] is a process that we have to repeat... Sensitisation is not just that we deliver a lecture and come back – it must be more than that.'* (District Public Health Official)

Thirty-five (35) percent of the stakeholders noted that there should be an exclusive staff nurse focused primarily on IPC programme activities in order to adequately address the problem of human resources and keep the programme sustainable.

#### Role of healthcare facility cleaning staff

Within the fifth theme, we describe the feedback received regarding the role of sanitary workers as it relates to IPC and how evaluating and training hospital sanitary workers should be a key concern for other hospitals who seek to implement this IPC programme.

The work performed by sanitary workers is essential to IPC and maintaining a safe hospital environment. Despite the importance, sanitary workers were not directly included in IPC trainings. State public health officials noted the difficulty in training and educating sanitary workers, who are often illiterate, about the downstream implications of their work. As a result, most sanitary workers were unaware of the significance of their work and their responsibilities when it came to IPC.

After the creation of the IPC programme, hospital sanitary workers were instructed to clean and sanitise high-touch surfaces, but these workers did not understand the significance of this work and also did not receive additional compensation.

As a result, there were conflicting attitudes towards incentivising sanitary workers to fully clean the facilities. While some respondents supported a daily wage system to incentivise this work, others recommended the adoption of an award system that recognises workers who support IPC.

*‘By giving incentives to the staff, then it becomes money driven other than duty-driven. I feel the money driven model is not a sustainable model.’ (District Public Health Official)*

#### **Water, sanitation, and hygiene infrastructure**

The final theme discusses the necessity of a water, sanitation, and hygiene (WaSH) infrastructure for an effective IPC programme. Specifically, one example relates to a functioning infrastructure for waste management as it is crucial in maintaining a safe and infection-free environment.

*‘Now the government has provided a separate fund for the biomedical waste segregation and disposal, and has developed an agreement for disposing biomedical waste in barcoded bags.’ (Chief Medical Officer Hospital 3)*

In addition, many respondents reported that at times, lack of sanitation and hygiene has influenced their ability to follow IPC protocols.

*‘In regards to modifying the labour room for infection control, we cannot do that because we do not have an infrastructure for that. We don’t have a separate room for dirty clothes. We have to accommodate in whatever resources are available.’ (Physician, Hospital 3)*

Staff members also noted that running water, an adequate quality water source, and the prevalence of soap and alcohol hand rub were needed for effective infection control. Overall, a developed WaSH infrastructure was noted as an important imperative for the institutionalisation and expansion of this programme.

Several quotes regarding the six themes are not mentioned in the results section but are noted in the Supplemental Materials as they provide support for our findings. In addition, there were several quotes regarding the topic of AMR, which was out of the scope of this research study, and therefore these quotes are also noted in the Supplemental Materials.

## **Discussion**

Study participants (CMOs, physicians, and IPC nurses) described an overall perception of poor understanding about the benefits of IPCs among hospital staff, patients, and visitors prior to IPC training. Several studies had corroborated this perception and found that healthcare workers in LMICs had little understanding regarding the need for infection control policy and standard infection control measures (30–33). However, this is in contrast to HICs like Italy in which hospital staff have a higher pre-existing knowledge base regarding the standard

precautions and infections that can be acquired from patients (34).

A key finding of our present study was that policy guidelines and recommendations are not effective unless the principal barriers to sustaining infection control practices are addressed, and this was consistent with prior studies (31–33, 35). These barriers create a gap between infection control knowledge and actual practice.

A lack of financial resources, physical resources, human resources, and technical resources have contributed to this gap between infection control knowledge and practice. Several other studies echoed our findings and indicated that a lack of financial and physical resources presented a challenge to the implementation of infection control practices, led to the reuse of single-use materials, and accounted for many deviations from IPC protocols (31, 36–38).

A lack of human resources presented the most direct challenge to the implementation of this programme, because of high staff turnover, overcrowding of hospitals, low staff to patient ratios, and the heavy workload placed on existing nurses; this finding was supported by several other studies conducted in northern India (9, 38, 39).

Consistent with an IPC study in Japan, there was a lack of appropriate, clinic-specific technical resources for monitoring procedures like hand hygiene audits (40). However, this study underscored the discrepancy between state and national standards for IPC. Specifically, our study highlights the fact that the technical IPC standards given by the GOT and GOI seem to differ, presenting varying standards for local hospitals and leading to difficulties in a streamlined implementation of the IPC protocol. Thus, a consolidation of these standards in a country as diverse as India would make IPC more integrated and ensure the sustainability of this programme.

In addition, this study showed the importance of having a paid staff member who only focuses on IPC and the qualifications that make him/her successful. As a result of a huge volume of patients and a lack of nursing staff, most nurses at secondary and primary hospitals do not have the time to prioritise IPC activities. If IPC activities are to continue and be institutionalised across the state, this position is necessary. Specifically, the age and experience of the nurse should be taken into account as our results showed that older staff nurses were more resistant to taking direction from a young nurse with little experience.

The stakeholders perceived an overall improvement in healthcare quality, as they felt cleanliness had increased and sepsis rates had been reduced. Furthermore, respondents reported that most patients and visitors changed their behaviours after watching hospital staff effectively model infection control practices, which is a practice that has been demonstrated by prior studies (30).



In regards to the future institutionalisation of this programme, our study found that hospital leadership is key to prioritising this programme and ensuring that hospital staff and patients follow and incorporate aspects of this programme into their daily practice. Similar results were found in studies conducted in northern India and the Netherlands, indicating that hospital leadership and an organisational culture are essential in both high and low resource settings for adequate infection control (39, 41).

Many studies and educational IPC programmes have traditionally overlooked a fundamental group of workers, the sanitary workers, who are essential for effective IPC. Our study found that the sanitary workers had not been trained to properly understand their role in maintaining a safe and infection-free hospital environment and how to protect themselves from infection, despite the increased need for cleaning and sanitation that the IPC programme required. This raises questions with regards to the inequity present in hospital systems and society at large as training programmes for IPC are usually focused on well-educated populations and typically neglect illiterate populations like sanitary workers. As a result, these workers do not understand the downstream effects of their work and the key role they play in safeguarding patient health and wellbeing. Our study highlights the need to develop training programmes that are able to effectively engage with illiterate populations who play a key role in IPC.

Historically, studies have not focused on the impact of WaSH interventions in primary healthcare facilities (HCFs), even though LMICs have the highest rates of healthcare associated infections (HCAIs) and WaSH coverage is usually the lowest (42). Several participants noted that some aspect of WaSH was insufficient and that greater WaSH integration was necessary in order to have a proper IPC programme. Even more so, the IPC programme protocol specifically required a functioning WaSH infrastructure with the presence of a waste management system, an adequate source of water, sinks with drains, and soap near toilets. As a result, our study helps to fill an established research gap by highlighting the impact of the built environment, in the case of WaSH, on IPC especially in rural environments.

### Strengths

Most studies evaluating IPC practices are performed in tertiary hospitals that have the resources for super-specialty care and are internationally accredited; however, these studies are not generalisable to India's resource-limited settings. Our study highlights the barriers to implementation in rural areas and allows for the creation of a broader action plan to combat the spread of HAIs and AMR in India's highly varied healthcare system.

This study is also one of the few studies that has focused on the impact of WaSH and the built environment on IPC in primary HCFs. Many studies have overlooked cleaning staff and sanitary workers. Our study highlights the key role they play in IPC and the need to train them more effectively, while considering the proper incentive structures. In addition, our study emphasises a discrepancy between state and national standards as a hindrance for the sustainability of this programme. In addition, this study identifies the characteristics of an IPC nurse in relation to her age and years of experience that would make her successful in a hierarchical hospital environment.

There were some limitations to this study. One limitation is that this study evaluated perceptions of the stakeholders with regards to IPC practices rather than observing actual infection control behaviours. Thus, we recommend that future studies directly observe IPC practices to provide data on actual behaviour changes observed in regards to barriers and facilitators for IPC practices. Another limitation for this study is its sample size. A limited number of interviews were conducted for this study because the IPC programme existed at only three hospitals in the state, and only a few stakeholders at these hospitals were fully aware of the project and its scope.

### Conclusion

The perceived benefits of the IPC programme, based on comments from CMOs, physicians, and IPC nurses, were improvements in knowledge and behaviour among both patients and staff implementing IPC practices. In addition, respondents described that healthcare workers felt a sense of pride working in an institution that valued infection control and it was reported that patients also sensed a higher level of trust and satisfaction with their healthcare. As a result, this study strongly recommends that this IPC programme be scaled up while recognising the issues that were observed in its initial roll-out.

There should be a full-time IPC nurse who is tasked with implementing IPC procedures and practices and has experience in the hospital environment. In addition, an automated data management system for high-impact IPC activities such as handwashing audits should be implemented to assist in managing the data collected. A consolidation of technical resources from the GOT and GOI should occur so that the policies are clear and that standards regarding IPC can be coordinated and streamlined. In addition, funding for this programme should increase and be consistently maintained so that hospitals can adequately follow the IPC protocol and procure the necessary physical resources. Multifaceted educational efforts should continue, targeting medical school students, patients, and hospital staff with a special eye on illiterate populations like sanitary workers that are essential for hospital cleanliness.

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## Ethics and consent

This study was reviewed by the University of California Committee for Protection of Human Subjects (CPHS) and was approved under the exempt status on December 14, 2018. All authors have been involved in all aspects of this study.

## Conflicts of interest and funding

The authors declare no conflicts of interest. All material is original and not previously or currently considered for publication elsewhere. This work was partially funded by a stipend from the Stamps Scholarship Family Foundation.

## References

- World Health Organization. Health Care-Associated Infections FACT SHEET. Available from: [http://www.who.int/gpsc/country\\_work/gpsc\\_ccisc\\_fact\\_sheet\\_en.pdf](http://www.who.int/gpsc/country_work/gpsc_ccisc_fact_sheet_en.pdf) [cited 4 November 2019].
- Guo C, Liu YH, Tian DS. Statistical research on direct economic loss due to nosocomial infections. *Chin J Nosocomiol* 2012; 22(8): 1651–3. doi: 10.1177/1010539517717366
- Nangino Gde O, Oliveira CD, Correia PC, Machado Nde M, Dias AT. Financial impact of nosocomial infections in the intensive care units of a charitable hospital in Minas Gerais, Brazil. *Rev Bras Ter Intensiva* 2012; 24: 357–61. doi: 10.1590/S0103-507X2012000400011
- Report on the burden of endemic healthcare-associated infection worldwide, 2011. Geneva, Switzerland: World Health Organization. Available from: [http://www.who.int/infection-prevention/publications/burden\\_hcai/en/](http://www.who.int/infection-prevention/publications/burden_hcai/en/) [cited 12 April 2020].
- Allegranzi B, Bagheri NS, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet* 2011; 377: 228–41. doi: 10.1016/S0140-6736(10)61458-4
- Raka L. Lowbury Lecture 2008: infection control and limited resources searching for the best solutions. *J Hosp Infect* 2009; 72: 292–8. doi: 10.1016/j.jhin.2009.03.017
- Fernando SA, Gray TJ, Gottlieb T. Healthcare-acquired infections: prevention strategies. *Intern Med J* 2017; 47: 1341–51. doi: 10.1111/imj.13642
- Weiner LM, Webb AK, Limbago B, Dudeck MA, Patel J, Kallen AJ, et al. Antimicrobial-resistant pathogens associated with healthcare-associated infections: summary of data reported to the National Healthcare Safety Network at the Centres for Disease Control and Prevention, 2011–2014. *Infect Control Hosp Epidemiol* 2016; 37: 1288–301. doi: 10.1017/ice.2016.174
- Swaminathan S, Prasad J, Dhariwal AC, Guleria R, Misra MC, Malhotra R, et al. Strengthening infection prevention and control and systematic surveillance of healthcare associated infections in India. *BMJ* 2017; 358: j3768. doi: 10.1136/bmj.j3768
- Lakshmi APA, Jennifer HG, Stanly AM, Paul C. A study on personal protective equipment use among health care providers, Tamil Nadu. *Int J Community Med Public Health* 2018; 5(5): 1771–7.
- Allegranzi B, Kilpatrick C, Storr J. Global Infection Prevention and Control priorities 2018–2022: a call for action. *Lancet Global Health* 2017; 5(12): 1178–80. doi: 10.1016/S2214-109X(17)30427-8
- World Health Organization. Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level. 2016. Available from: <http://apps.who.int/iris/bitstream/10665/251730/1/9789241549929-eng.pdf?ua=1> [cited 12 April 2020].
- World Health Organization. Practical guidelines for infection control in health care facilities. 2004. Available from: <http://www.who.int/iris/handle/10665/206946> [cited 4 November 2019].
- Wenzel RP, Edmond MB. Infection control: the case for horizontal rather than vertical interventional programs. *Int J Infect Dis* 2010; 14(4): S3–5. doi: 10.1016/j.ijid.2010.05.002
- World Health Organization. Antimicrobial resistance: global report on surveillance. 2014. Available from: [http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf) [cited 4 November 2019].
- World Health Organization. Clean care is safer care. Available from: <http://www.who.int/gpsc/background/en/> [cited 6 October 2019].
- Wang J, Liu F, Tan J, Harbarth S, Pittet D, Zingg W. Implementation of infection prevention and control in acute care hospitals in Mainland China – a systematic review. *Antimicrob Res Infect Control* 2019; 8: 32. doi: 10.1186/s13756-019-0481-y
- Haley RW, Culver DH, White JW, Morgan WM, Emori TG, Munn VP, et al. The efficacy of infection surveillance and control programs in preventing nosocomial infections in US hospitals. *Am J Epidemiol* 1985; 121: 182–205. doi: 10.1093/oxfordjournals.aje.a113990
- Emori TG, Gaynes RP. An overview of nosocomial infections, including the role of the microbiology laboratory. *Clin Microbiol Rev* 1993; 6: 428–42. doi: 10.1128/cmr.6.4.428
- Erasmus V, Huis A, Oenema A, van Empelen P, Boog MC, van Beeck EH, et al. The ACCOMPLISH study. A cluster randomised trial on the cost-effectiveness of a multicomponent intervention to improve hand hygiene compliance and reduce healthcare associated infections. *BMC Pub Health* 2011; 11: 721. doi: 10.1186/1471-2458-11-721
- Murni IK, Duke T, Kinney S, Daley AJ, Soenarto Y. Reducing hospital-acquired infections and improving the rational use of antibiotics in a developing country: an effectiveness study. *Arch Dis Child* 2015; 100(5): 454–9. doi: 10.1136/archdischild-2014-307297
- Anderson J, Gosbee LL, Bessesen M, Williams L. Using human factors engineering to improve the effectiveness of infection prevention and control. *Crit Care Med* 2010; 38: S269–81. doi: 10.1097/CCM.0b013e3181e6a058
- Whitby M, McLaws M-L, Slater K, Tong E, Johnson B. Three successful interventions in health care workers that improve compliance with hand hygiene: is sustained replication possible? *Am J Infect Control* 2008; 36: 349–55. doi: 10.1016/j.ajic.2007.07.016
- Marshall MN. The key informant technique. *Fam Pract* 1996; 13(1): 92–7. doi: 10.1093/fampra/13.1.92
- Hartnett ME, Key IJ, Loyacano NM, Horswell RL, DeSalvo KB. Perceived barriers to diabetic eye care: qualitative study of patients and physicians. *Arch Ophthalmol* 2005; 123(3): 387–91. doi: 10.1001/archophth.123.3.387

26. Sofaer S. Qualitative research methods. *Int J Qual Health Care* 2002; 14(4): 329–36. doi: 10.1093/intqhc/14.4.329
27. Understanding qualitative research in health care. *Drug Therap Bull* 2017; 55(2): 21–4. doi: 10.1136/dtb.2017.2.0457
28. Cho JY, Lee E. Reducing confusion about grounded theory and qualitative content analysis: similarities and differences. *Qual Rep* 2014; 19(32): 1–20. doi: 10.46743/2160-3715/2014.1028
29. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today* 2004; 24: 105–12. doi: 10.1016/j.nedt.2003.10.001
30. Zinatsa F, Engelbrecht M, van Rensburg AJ, Kigozi G. Voices from the frontline: barriers and strategies to improve tuberculosis infection control in primary health care facilities in South Africa. *BMC Health Serv Res* 2018; 18(1): 269. doi: 10.1186/s12913-018-3083-0
31. Ider BE, Adams J, Morton A, Whitby M, Clements A. Perceptions of healthcare professionals regarding the main challenges and barriers to effective hospital infection control in Mongolia: a qualitative study. *BMC Infect Dis* 2012; 12: 170. doi: 10.1186/1471-2334-12-170
32. Iliyasu G, Dayyab FM, Habib ZG, Tihamiyu AB, Abubakar S, Mijinyawa MS, et al. Knowledge and practices of infection control among healthcare workers in a Tertiary Referral Centre in North-Western Nigeria. *Ann Afr Med* 2016; 15(1): 34–40. doi: 10.4103/1596-3519.161724
33. Ogoina D, Pondei K, Adetunji B, Chima G, Isichei C, Gidado S. Knowledge, attitude and practice of standard precautions of infection control by hospital workers in two tertiary hospitals in Nigeria. *J Infect Prev* 2015; 16(1): 16–22. doi: 10.1177/1757177414558957
34. Parmeggiani C, Abbate R, Marinelli P, Angelillo IF. Healthcare workers and health care-associated infections: knowledge, attitudes, and behavior in emergency departments in Italy. *BMC Infect Dis* 2010; 10: 35. doi: 10.1186/1471-2334-10-35
35. Alp E, Leblebicioglu H, Doganay M, Voss A. Infection control practice in countries with limited resources. *Ann Clin Microbiol Antimicrob* 2011; 10: 36. doi: 10.1186/1476-0711-10-36
36. Habib F, Khan DK, Shan-E-Abbas, Bhatti F, Zafar A. Knowledge and beliefs among health care workers regarding hepatitis B infection and needle stick injuries at a tertiary care hospital, Karachi. *J Coll Physicians Surg Pak* 2011; 21: 317–8.
37. Joshi SC, Diwan V, Tamhankar AJ, Joshi R, Shah H, Sharma M, et al. Staff perception on biomedical or health care waste management: a qualitative study in a rural tertiary care hospital in India. *PLoS One* 2015; 10(5): e0128383. doi: 10.1371/journal.pone.0128383
38. Joshi SC, Diwan V, Joshi R, Sharma M, Pathak A, Shah H, et al. ‘How can the patients remain safe, if we are not safe and protected from the infections?’ A qualitative exploration among health-care workers about challenges of maintaining hospital cleanliness in a resource limited tertiary setting in. *Int J Environ Res Pub Health* 2018; 15(9): 1942. doi: 10.3390/ijerph15091942
39. Barker AK, Brown K, Siraj D, Ahsan M, Sengupta S, Safdar N. Barriers and facilitators to infection control at a hospital in northern India: a qualitative study. *Antimicrob Res Infect Control* 2017; 6: 35. doi: 10.1186/s13756-017-0189-9
40. Kudo D, Sasaki J, Ikeda H, Shiino Y, Shime N, Mochizuki T, et al. A survey on infection control in emergency departments in Japan. *Acute Med Surg* 2018; 5(4): 374–9. doi: 10.1002/ams2.360
41. Backman C, Marck PB, Krogman N, Taylor G, Sales A, Bonten MJ, et al. Barriers and bridges to infection prevention and control: results of a qualitative case study of a Netherlands’ surgical unit. *BMJ Open* 2012; 2(2): e000511. doi: 10.1136/bmjopen-2011-000511
42. Watson J, D’Mello-Guyett L, Flynn E, et al. Interventions to improve water supply and quality, sanitation and handwashing facilities in healthcare facilities, and their effect on health-care-associated infections in low-income and middle-income countries: a systematic review and supplementary scoping review. *BMJ Glob Health* 2019; 4(4): e001632. doi: 10.1136/bmjgh-2019-001632

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**\*Jay Graham**

Berkeley School of Public Health  
University of California, Berkeley  
USA  
Email: jay.graham@berkeley.edu