JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Infection prevention and control awareness, attitudes, and practices among healthcare professionals in South India

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Abstract

Introduction: Infection is a key challenge in healthcare settings around the world. Healthcare professionals (HCPs), including medical laboratory technologists (MLTs) and nurses, are at risk of infection because they are in close contact with infected patients. This investigation was conducted to evaluate the awareness, attitude, and practices of Infection Prevention Control (IPC) among HCPs working in private tertiary hospitals in two states in South India.

Methodology: This quantitative study surveyed 571 HCPs in southern India. In September 2021, an online survey was used to collect data on the respondents' demographic and IPC-related variables, as well as their awareness, attitudes, and practices of IPC.

Results: The survey revealed high level of awareness, positive attitudes, and good IPC practices. Among the IPC practices, "changing gloves between contacts with different patients" was the most often practiced and "washing hands after removal of gloves" was the least practiced. Being a nurse, being older, finishing a graduate program, attending a risk assessment training, having sufficient Personal Protective Equipment (PPE) at work, and being aware of the safety guidelines were associated with better awareness. Being a nurse, being older, and holding a diploma were associated with more positive attitudes. Being MLT, attending risk assessment training, having sufficient PPE at work, and being aware of the safety guidelines were associated with better IPC practices.

Conclusions: Measures to sustain the high awareness, positive attitudes, and good IPC practices by dealing with the factors associated with these variables identified in this study must be planned and implemented.

Key words: Healthcare; infection; medical laboratory technologist; nurses; prevention.

J Infect Dev Ctries 2022; 16(4):659-667. doi:10.3855/jidc.14746

(Received 21 January 2021 – Accepted 22 September 2021)

Introduction

Infection is one of the critical challenges in healthcare settings around the globe [1]. Healthcare professionals (HCPs), including medical laboratory technologists (MLTs) and nurses, are at risk of infection because they are in close contact with infected patients, possibly leading to the transmission of pathogens [2]. Healthcare-associated infections (HAIs) are a significant problem among HCPs, and they have disproportionately burdened developing countries, such as India. The anticipated prevalence rate of HAIs in the country is two times the prevalence rate in Europe and the US [1]. Moreover, there is a continued problem of antibiotic resistance among HAIs in the country [3]. One study in India concluded that the infrastructure of infection prevention and control (IPC) is lacking, and HAI surveillance is nonexistent [4]. In another study in a Medical Intensive Care Unit in India, 50.3% of the 346 patients developed HAIs during their hospitalization, and the rates per 1000 device days were 72.56, 3.98, and 12.4 for Ventilator-Associated Pneumonia, Catheter-Related Blood Stream Infection, and Catheter-Associated Urinary Tract Infections, respectively [5]. A study conducted in a tertiary care hospital in northern India concluded that organizational management issues prevent IPC success [6]. Therefore, a multifaceted strategy should be developed to improve healthcare systems, expand awareness, provide effective recommendations, make behavioral and attitude improvements, and maximize the productive

use of existing resources [1,2]. However, some major obstacles impede the successful implementation of an IPC program in Indian healthcare settings [4,6,7]. According to Ibrahim and Elshafie [7], HCPs with inadequate awareness and poor practices in IPC jeopardize patients' safety. The first key step in designing and implementing an effective IPC is to establish the awareness, attitude, and practices among HCPs [8]. However, studies have not investigated HCPs' awareness, knowledge, and practices of IPC, especially in South India. Therefore, this study evaluated the awareness, attitude, and practices of IPC among HCPs, namely, MLTs and nurses, working in private tertiary hospitals in two states (Kerala and Karnataka) in South India.

Methodology

A quantitative method with a descriptive and cross-sectional design was utilized to assess the HCPs' awareness, knowledge, and practices of IPC. A convenience sampling technique was employed to gather data from HCPs working in different private tertiary hospitals in two Indian states, namely Kerala and Karnataka. These two states are situated in the southern region of India. Of the 587 HCPs who responded to the online survey, 16 were excluded due to substantial incomplete data. Thus, data from 571 respondents were included in the analyses. The eligibility criteria for sample selection included the following: nurses, MLT, presently working in any private tertiary hospital in South India (Kerala and Karnataka), and with a minimum of six months of experience in a hospital. Those with less than six months of hospital experience were excluded because they were still not familiar with the organization's culture and practices in their hospitals.

Instrument

An online survey via Google forms was used to collect data for the study variables and was composed of two main parts. Part 1 was structured for the demographic and IPC-related variables. The demographic variables were gender, age, marital status, profession, and highest educational achievement. IPC-related information included attendance to risk assessment training in the last 12 months, hepatitis B vaccine (HBV) status, the sufficiency of personal protective equipment (PPE) at work, awareness of safety guidelines at work, and primary source of IPC information.

Part 2 was composed of three subsections that measured the study's dependent variables. The questionnaire in this section was adapted from the study of Yazie *et al.* [9]. In subsection 1, the respondents' awareness of IPC was measured with 11 items with a yes/no response option. An overall awareness score was obtained by summing the score in each item, with possible scores ranging from 0 to 11. The higher the score, the better the awareness about IPC. In subsection 2, the attitudes of the respondents toward IPC were assessed. This scale comprised 13 items with response options from 1 (disagree) to 3 (agree). Item 9 was negatively worded, so reverse scoring was performed before the overall mean was calculated. The higher the mean score, the more positive the attitude toward IPC. In subsection 3, 11 questions were included to evaluate the IPC practices of the respondents. Three response options were used for this scale: 1 = not at all, 2 = sometimes, and 3 = always. The overall mean score was computed, and the higher the mean, the better the IPC practices. Yazie *et al*. [9] indicated that the tool has acceptable reliability for measuring the IPC awareness, attitudes, and practices of HCPs in Ethiopia. The questionnaire was pilot tested on 50 HCPs (nurses and MLT) for this study. The computed values of Cronbach's alpha from this pilot testing were 0.81 and 0.82 for the attitude and practice scales, respectively. According to the Kuder–Richardson Formula 20 (KR-20), the alpha for the awareness section of the questionnaire was 0.86. These values were above the acceptable value of 0.70, suggesting that they had good internal consistency.

Data collection and ethical considerations

The ethical approval for the study was granted by the Ethics Committee of Al Shifa College of Paramedical Sciences (EC/GEN/2020/01). Data were collected in September 2020 via an online survey. The survey link was sent directly to the potential participants through emails and social media platforms, such as Facebook, Twitter, Snapchat, and Instagram. The link for the questionnaire was also posted and shared on different social media platforms. The study's description, purposes, and significance were explained in the earlier part of the survey. An invitation to participate was also provided through which the participants' rights (e.g., voluntary participation) and expected participation were specified. The inclusion criteria were also specified to ensure that only those qualified would proceed with the questionnaire. If the potential respondents decided to participate, they were instructed to affix their initials on the online informed consent to indicate their voluntary participation. No incentive was offered for participation, and no personal

identification was collected from the respondents to protect their anonymity. Confidentiality was guaranteed throughout the research by storing the data in a password-protected laptop and collectively analyzing and presenting the data.

Statistical analysis

SPSS version 22.0 was utilized to analyze the obtained data statistically. Frequencies and percentages were calculated for the demographics and IPC-related variables and the awareness, attitude, and practice variables. Mean and standard deviation were also estimated for the overall score of the IPC awareness, attitudes, and practices. Nonparametric measures were employed to test the associations between the HCPs' demographic and IPC-related variables with their IPC awareness, attitudes, and practices because of the violation of the assumption of normality data. Specifically, a Mann–Whitney test was carried out to examine the differences in the dependent variables in demographic and IPC-related variables with two groups, and a Kruskal–Wallis test was performed for independent variables with more than two groups. If the Kruskal–Wallis test found significant findings, pairwise comparisons were carried out. Significance was indicated if $p < 0.05$.

Table 1. Demographic characteristics of the respondents (n = 571).

Variables	n (%)
Gender	
Male	138 (24.2)
Female	433 (75.8)
Age	
21-30	351 (61.5)
31-40	189 (33.1)
41-50	31 (5.4)
Marital status	
Single	171 (29.9)
Married	400 (70.1)
Profession	
Nurse	207 (36.3)
Medical Laboratory Technologist	364 (63.7)
Education	
Diploma	166 (29.1)
Baccalaureate	334 (58.5)
Graduate (Masters/ Doctorate)	71 (12.4)
Had taken risk assessment training in the last 12 months	
No	307 (53.8)
Yes	264 (46.2)
HBV status	
Not vaccinated	60 (10.5)
One dose only	38 (6.7)
Two doses	36 (6.3)
Three doses	437 (76.5)
Sufficient personal protective equipment at work	
No	103 (18.0)
Yes	468 (82.0)
Awareness on safety guidelines at work	
No	84 (14.7)
Yes	487 (85.3)
Primary source of information about infection prevention and control	
In-hospital training	309 (54.1)
Guidelines, books, articles	207 (36.3)
Others (Colleagues, internet)	55 (9.6)

Results

A total of 587 HCPs responded to the online survey; 16 were excluded because of substantial incomplete data. Hence, data from 571 samples were included in the analyses. As reflected in Table 1, 364 (63.7%) of the respondents were medical laboratory technologists (MLT), and the remaining respondents (n = 207, 36.3%) were nurses. The majority of the respondents were females (75.8%), aged 21–30 years (61.5%), married (70.1%), and baccalaureate graduates (58.5%). A higher percentage of the respondents had not taken any risk assessment training for the last 12 months (53.8%) compared with those who attended such training (46.2%). More than three-fourths of the respondents reported that they had sufficient PPE in their workplace (82.0%) and were aware of the safety guidelines at work (82.0%). More than half of them received information about IPC in trainings conducted by their hospital (54.1%), and 36.3% obtained information on IPC from guidelines, books, articles, and 9.6% from other sources. More than three-fourths of the sample received the complete doses of HBV (76.5%), whereas 6.3% and 6.7% received two doses and one dose, respectively. In addition, 10.5% of them were not vaccinated for HBV.

Awareness about infection prevention and control and associated factors

All items in the questionnaire on the awareness of IPC were responded affirmatively by the majority of the respondents. Among the items, "know how to handle used needles and sharp objects safely" received the highest percentage of a "yes" response (99.1%), followed by the items "aware of the risks in the working environment" (98.2%), "know about the color coding of the segregation of healthcare wastes" (97.9%), "washes hands before and after you contact with patients" (97.2%), and "wearing personal protective equipment reduces the risk of infection" (97.2%). The item with the lowest "yes" response was "occupational safety is a problem for healthcare organizations" (73.6%), followed by "know how to perform a risk assessment" (73.7%) and "health hazards are associated with healthcare wastes" (80.9%; Table 2).

Table 2. Results of the descriptive analyses on the items about awareness of infection prevention and control (n = 571).

Item	Yes n (%)	No n (%)
Occupational safety is a problem for healthcare organizations	420 (73.6)	151 (26.4)
Healthcare workers are responsible for occupational health and safety	503 (88.1)	68 (11.9)
Know how to use personal protective equipment	546 (95.6)	25 (4.4)
Know how to perform a risk assessment	421 (73.7)	450 (26.3)
Know the transmission mechanisms of infectious agents	534 (93.5)	37 (6.5)
Wash hands before and after you contact with patents	555 (97.2)	16 (2.8)
Aware of the risks in the working environment	561 (98.2)	10 (1.8)
Know how to handle used needles and sharps safely	566 (99.1)	5 (0.9)
Know about color coding segregation of healthcare wastes	559 (97.9)	12 (2.1)
There are health hazards associated with healthcare wastes	462 (80.9)	109 (19.1)
Wearing personal protective equipment reduce the risk of infection	555 (97.2)	16 (2.8)

Table 3. Results of the non-parametric test of association between the respondents' demographics and awareness of infection prevention and control (n = 571).

Demographics	Mean	SD	Mean Rank	Statistical test	*p*
Gender					
Male	9.90	1.14	276.76	$U = 28{,}602.00$	0.425
Female	9.97	1.13	288.94		
Age					
21-30	9.86	1.18	274.18	$H = 6.09$	0.048*
31-40	10.06	1.05	300.90		
41-50	10.29	0.82	328.98		
Marital status					
Single	10.04	1.09	299.20	$U = 31{,}942.00$	0.186
Married	9.91	1.14	280.36		
Profession					
Nurse	10.16	0.88	309.14	$U = 32{,}884.00$	0.008**
Medical Laboratory Technologist	9.83	1.23	272.84		
Education					
Diploma	9.74	1.21	256.60	$H = 15.52$	<0.001***
Baccalaureate	9.97	1.12	288.45		
Graduate (Masters/ Doctorate)	10.35	0.83	343.23		
Had taken risk assessment training in the last 12 months					
No	9.74	1.21	256.22	$U = 31{,}381.00$	< 0.001***
Yes	10.20	0.97	320.63		
Sufficient personal protective equipment at work					
No	9.35	1.35	207.47	$U = 16{,}013.50$	< 0.001***
Yes	10.08	1.03	303.28		
Awareness on safety guidelines at work					
No	9.10	1.44	182.50	$U = 11{,}760.00$	< 0.001***
Yes	10.10	0.99	303.85		
Primary source of information about infection prevention and control					
In-hospital training	10.15	0.98	312.45	$H = 26.50$	< 0.001***
Guidelines, books, articles	9.82	1.19	268.10		
Others (Colleagues, internet)	9.33	1.35	204.75		

* Significant at 0.05 level; ** Significant at 0.01 level; *** Significant at 0.001 level.

Table 4. Results of the descriptive analyses on the items about attitudes toward infection prevention and control (n = 571).

Item	Disagree n (%)	Neutral n (%)	Agree n (%)
Safety precaution is important for healthcare organizations	0 (0)	3 (0.5)	568 (99.5)
Occupational health and safety training is important for healthcare workers	0 (0)	6 (1.1)	565 (98.9)
Your healthcare environment may expose you to occupational hazards	41 (7.2)	98 (17.2)	432 (75.7)
Health care workers are at high risk of infection	14 (2.5)	45 (7.9)	512 (89.7)
All personal protective equipment should be accessible in the working department/section of the healthcare facility.	13 (2.3)	32 (5.6)	526 (92.1)
Individual workplace risk exposure should be considered as a crisis of community	44 (7.7)	107 (18.7)	420 (73.6)
Risk assessment is important for occupational health and safety.	3 (0.5)	22 (3.9)	546 (95.6)
Sharp materials should be discarded in a safety box	9 (1.6)	6 (1.1)	556 (97.4)
Needles should be re recapped after use[a]	351 (61.5)	23 (4.0)	197 (34.5)
If you did not have taken HBV vaccine before, are you willing to take it?	36 (6.3)	58 (10.2)	477 (83.5)
Wearing facemask and eye goggles during procedures with aerosol production is mandatory	7 (1.2)	17 (3.0)	547 (95.8)
Vaccination for healthcare workers is mandatory	9 (1.6)	16 (2.8)	546 (95.6)
Hepatitis B virus may be transmitted through biomedical wastes	65 (11.4)	50 (8.8)	456 (79.9)

[a] Reverse coded.

As indicated in Table 3, the awareness of IPC was greater among nurses than among MLT (U = 32, 884.00, p = 0.008). A significant difference in awareness was observed between age groups (Chi-square = 6.09, p = .048). In particular, awareness was better among HCPs who had graduate degrees than that among HCPs who had diplomas (p < .001) and baccalaureate degrees (p = .022). Similarly, the awareness of IPC among HCPs who underwent a risk assessment training was better than that among HCPs without a similar experience for the last 12 months (U = 31,381.00, p < .001). The awareness of IPC among those who reported that they had sufficient PPE at work (U = 16,013.50, p < .001) and those who were aware of the safety guidelines at work (U = 11,760.00, p < .001) was higher than that among HPCs who did not report having sufficient PPE and those who were not aware of the safety guidelines. Significant differences were also observed in IPC awareness when the samples were grouped according to their primary source of IPC information (Chi-square = 26.50, p < .001). In particular, the awareness of IPC among HCPs who reported receiving information from their hospitals was better than that among HCPs who obtained their IPC information from guidelines, books, articles (p = 0.005), and other sources (p < 0.001).

Attitudes toward Infection Prevention and Control and associated factors

The respondents' mean score on the attitude scale was 2.78 (SD = 0.17). In Table 4, all the items received positive attitudes from the respondents. The item "safety precaution is important for healthcare organizations" received the most positive attitude (agree = 99.5%), followed by "occupational health and safety training is important for healthcare workers" (agree = 98.9%), "sharp materials should be discarded in a safety box" (agree = 97.4%), "wearing face masks and eye goggles during procedures with aerosol production is mandatory" (agree = 95.8%), and "vaccination for healthcare workers is mandatory" (agree = 95.6%). The most negative attitude was reported in the item "needles should be recapped after use" (disagree = 61.5%).

The Mann–Whitney test revealed that MLT had more positive attitudes toward IPC than nurses (U = 31,144.50, p < 0.001). Significant differences were also found in the attitudes toward IPC between age groups (Chi-square = 7.44, p = 0.024) and different educational attainment levels (Chi-square = 6.63, p = .036). The pairwise comparisons revealed that those with diplomas had significantly poorer attitudes than those who finished graduate programs (p = .033). Moreover, HCPs

Table 5. Results of the non-parametric test of association between the respondents' demographics and attitudes toward infection prevention and control (n = 571).

Demographics	Mean	SD	Mean Rank	Statistical test	*p*
Gender					
Male	2.79	0.17	305.46	*U* = 27,192.00	0.105
Female	2.77	0.17	279.80		
Age					
21-30	2.76	0.18	271.38	*H* = 7.44	0.024*
31-40	2.80	0.15	309.48		
41-50	2.81	0.12	308.42		
Marital status					
Single	2.76	0.18	273.88	*U* = 32,197.00	0.242
Married	2.78	0.17	291.18		
Profession					
Nurse	2.75	0.16	254.46	*U* = 31,144.50	< 0.001***
Medical Laboratory Technologist	2.79	0.17	303.94		
Education					
Diploma	2.75	0.19	265.14	*H* = 6.63	0.036*
Baccalaureate	2.78	0.17	288.42		
Graduate (Masters/ Doctorate)	2.82	0.13	323.40		
Had taken risk assessment training in the last 12 months					
No	2.78	0.16	279.59	*U* = 38,555.50	0.307
Yes	2.78	0.18	293.46		
Sufficient personal protective equipment at work					
No	2.76	0.18	269.14	*U* = 22,365.50	0.243
Yes	2.78	0.17	289.71		
Awareness on safety guidelines at work					
No	2.75	0.19	266.01	*U* = 18,775.00	.220
Yes	2.78	0.17	289.45		
Primary source of information about infection prevention and control					
In-hospital training	2.78	0.18	287.50	*H* = 0.73	.694
Guidelines, books, articles	2.78	0.16	288.46		
Others (Colleagues, internet)	2.76	0.16	268.34		

* Significant at .05 level; *** Significant at .001 level.

in the age group of 21–30 years had poorer attitudes than those aged 31–40 years (p = .027; Table 5).

Practices of Infection Prevention and Control and their associated factors

The mean score on the practice scale was 2.67 (SD = 0.24). The respondents reported "changing gloves between contacts with different patients" as the most often practiced IPC (always = 93.5%), followed by "wearing gloves during risky procedures" (always = 93.2%), "washing hands with proper detergent after contact with patients/working time" (always = 90.4%), and "monitoring the working area waste management system" (always = 90.4%). The item "washing hands after the removal of gloves" (not at all = 56.6%) was the least practiced IPC. "Practicing the separation of

Table 6. Results of the descriptive analyses on the items about infection prevention and control practices (n = 571).

Item	Not at all n (%)	Sometimes n (%)	Always n (%)
How often do you use safety guideline/ manual at your workplace?	19 (3.3)	224 (39.2)	328 (57.4)
How often do you wear gloves during risky procedures?	2 (0.4)	37 (6.5)	532 (93.2)
How often do you wash your hands with proper detergent after contact with patients/working time?	3 (0.5)	52 (9.1)	516 (90.4)
How often do you use proper personal protective equipment during your professional practice?	19 (3.3)	106 (18.6)	446 (78.1)
How often do you clean your working area after the end of working shift?	9 (1.6)	73 (12.8)	489 (85.6)
How often do you monitor your working area waste management system?	5 (0.9)	50 (8.8)	516 (90.4)
How often do you practice separate disposal of healthcare wastes?	29 (5.1)	223 (39.1)	319 (55.9)
How often do you perform risk assessment in your working department/ section?	21 (3.7)	159 (27.8)	391 (68.5)
How often do you change gloves between contacts with different patients?	0 (0)	37 (6.5)	534 (93.5)
How often do wash your hands after removal of gloves?	323 (56.6)	70 (12.3)	178 (31.2)
How often do you recap used needles?	39 (6.8)	112 (19.6)	420 (73.6)

Table 7. Results of the non-parametric test of association between the respondents' demographics and infection prevention and control practices (n = 571).

Demographics	Mean	SD	Mean Rank	Statistical test	p
Gender					
Male	2.69	0.24	305.12	U = 27,239.00	0.114
Female	2.66	0.24	279.91		
Age					
21-30	2.66	0.24	280.74	H = 1.19	0.552
31-40	2.68	0.23	292.20		
41-50	2.71	0.23	307.79		
Marital status					
Single	2.68	0.23	292.50	U = 33,088.00	0.534
Married	2.66	0.24	283.22		
Profession					
Nurse	2.63	0.21	249.22	U = 30,061.50	< 0.001***
Medical Laboratory Technologist	2.69	0.25	306.91		
Education					
Diploma	2.67	0.24	287.01	H = 0.78	0.677
Baccalaureate	2.67	0.24	282.30		
Graduate (Masters/ Doctorate)	2.70	0.22	301.04		
Had taken risk assessment training in the last 12 months					
No	2.62	0.24	252.74	U = 30,312.00	< 0.001***
Yes	2.72	0.22	324.68		
Sufficient personal protective equipment at work					
No	2.56	0.28	218.24	U = 17,123.00	< 0.001***
Yes	2.69	0.22	300.91		
Awareness on safety guidelines at work					
No	2.50	0.28	180.03	U = 11,552.50	< 0.001***
Yes	2.70	0.22	304.28		
Primary source of information about infection prevention and control					
In-hospital training	2.69	0.23	300.68	H = 5.51	0.065
Guidelines, books, articles	2.65	0.24	270.06		
Others (Colleagues, internet)	2.63	0.26	263.52		

*** Significant at 0.001 level.

disposal of healthcare wastes" and "using safety guideline/manual at your workplace" were also reported to be the least practiced, with 55.9% and 57.4% of the respondents reporting that they always practiced these steps, respectively (Table 6).

As reflected in Table 7, the Mann–Whitney test results indicated that nurses had poorer IPC practices than MLT ($p < .001$). Similarly, those who took risk assessment training for the last 12 months reported better IPC practices than those without a similar experience ($p < .001$). The HCPs who reported having sufficient PPE at work also reported significantly better IPC practices than those who reported having inadequate PPE ($p < .001$). Finally, being aware of the safety guidelines at work was associated with better IPC practices than those unaware ($p < .001$).

Discussion

This study assessed the HCPs' awareness, attitudes, and practices of IPC and showed that most HCPs working in private tertiary hospitals in the two southern states in India had high awareness, attitudes, and practices of IPC. This result agreed with other international studies conducted in Palestine [10], Lebanon [11], and Nepal [12], where the awareness, attitudes, and practices on IPC are high. This finding is not surprising because HCPs must uphold their code of conduct in the health profession, including IPC [1,12]. They should be equipped with the proper awareness, positive attitudes, and practices to improve IPC in healthcare systems, creating a safer healthcare environment. However, this finding should be carefully interpreted because previous studies applied different instruments and inclusion criteria in assessing the awareness, attitudes, and practices.

The other result of this study was that the HCPs' age was associated with their awareness and attitudes toward IPC. This finding indicated that the older the HCPs, the better the awareness and attitudes toward IPC. This finding was also reported by Desta *et al*. [13], who found that the awareness and attitudes toward IPC also increase as age advances; thus, their practice improves. This finding was also consistent with earlier observations, which showed that HCPs aged 30 years or older have better awareness, attitudes, and prevention activities toward IPC than those younger than 30 years old [14].

HCPs' profession was related to their awareness, attitudes, and practices of IPC. Specifically, nurses had better awareness, attitudes, and practices of IPC than MLT. This finding was noteworthy because nurses are responsible for implementing best nursing practices for patients who have contracted infectious diseases [12,15], while MLTs are responsible for the molecular epidemiological analysis of infectious diseases [16]. Among HCPs, nurses are primarily in contact with patients and their patients' environment; consequently, they become vulnerable to various infectious agents and serve as an accessible vessel for transmitting HAIs [17,18]. As such, strict compliance with IPC practices is necessary among them. Moreover, IPC is a vital content in nursing education and is being reinforced with hospital training for nurses. However, while the comparison of the study variables between nurses and MLTs may provide valuable information on their strengths and weaknesses, we caution the readers in interpreting and using the findings of the comparison since the study did not consider the various work-related issues that each group of HCPs is facing in terms of IPC. It is critical to emphasize that different HCPs have their roles and responsibilities in the healthcare setting with specific IPC-related issues and challenges, which should be considered in future investigations. Therefore, IPC education programs, along with seminars and feedback, are recommended to increase the safety of all HCPs.

Furthermore, HCPs' access to sufficient PPE at work was associated with their awareness and practices of IPC. This result was noteworthy because HCPs rely on PPE to protect themselves and their patients from being infected and infecting others [19]. A limited number of PPE can pose a high risk of infection on patients and HCPs and may alter the safe healthcare delivery, potentially endangering patients' safety [20]. Hence, hospital administration should ensure that PPE is sufficient and available in healthcare settings.

HCPs' education was also related to their awareness and attitudes toward IPC. This finding indicated that the higher the educational attainment, the better the awareness and attitudes toward IPC. This finding was not surprising because most previous studies reported that postgraduates have better care practice [21] and improved clinical judgment in rendering care [11] than individuals with lower education levels. Fawaz *et al.* [22] found that postgraduate education enables HCPs to meet diverse patients' needs and provide quality patient care.

A risk assessment training in the last 12 months and in-hospital training as the primary source of information about IPC positively influenced the awareness and practices on IPC of HCPs. According to Rosen *et al*. [23], these kinds of training enhance understanding, clarify roles, responsibilities, and delegate tasks. Hayes *et al.* [24] described that in-

hospital training on IPC improves HCPs' knowledge, work practice, and organization at work. Previous studies had always supported the positive impact of training on the improvement of staff's IPC competence [19,25]. Therefore, through constant reinforcement, IPC knowledge and skills in healthcare settings should be developed.

Limitations of the study

A limitation of this study was that only nurses and MLTs were selected as respondents, so the results could not be generalized to all HCPs. Other HCPs should be included in future studies. Using a convenient sample, a self-report tool, and a selected hospital could lead to response bias and yield results that could not be generalized to the entire population. Another limitation of the study is that the items in the survey were primarily open-ended questions, and no follow-up questions to gather more specific information were asked. Therefore, it is recommended that future studies incorporate follow-up questions to gather more specific data on the HCPs' IPC awareness, attitudes, and practices. For example, in the item "know how to handle used needles and sharps," follow-up questions on whether their healthcare facility uses an electric or manual needle destroying equipment, the location of this equipment, and what they do if that equipment is not working correctly. The study was only conducted in private tertiary hospitals in two states in southern India due to the difficulty of access in public hospitals. Moreover, data about the location of the hospitals (i.e., metropolis or district) were not collected in the study. Consequently, it is recommended that future studies include HCPs working in public hospitals to compare private and public hospitals. Also, future studies should gather data on the location of the hospitals to facilitate the comparison of IPC practices between HCPs working in metropolitan hospitals and hospitals located in small towns.

Conclusions

Our findings indicated that HCPs working in private tertiary hospitals in two states in South India reported high awareness, attitudes, and practices of IPC. The HCP's age, profession, education, risk assessment training, sufficient personal protective equipment at work, and awareness of safety guidelines at work were associated with IPC awareness, attitudes, and practices. This study provided valuable data regarding deficits and gaps in IPC measures, which can contribute to developing subsequent infection control strategies in India. Measures to sustain the high awareness, positive attitudes, and good IPC practices by dealing with the factors associated with the variables identified in this study must be planned and implemented. This will ensure that both patients and HCP are protected against infection in the healthcare setting, thus, ensuring high levels of patient safety across the hospital.

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Conflict of interests: No conflict of interests is declared.