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Survey of healthcare worker perceptions of changes in infection control and antimicrobial stewardship practices in India and South Africa during the COVID-19 pandemic

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ABSTRACT

Objective: To identify perceptions and awareness of changes in infection prevention and control (IPC) and antimicrobial stewardship (AMS) practices among healthcare workers (HCWs) during the COVID-19 pandemic in India and South Africa (SA).

Method: A self-administered online survey which included participant demographics, knowledge and sources of COVID-19 infection, perceived risks and barriers, and self-efficacy. Data were analysed using descriptive statistics. **Results:** The study received 321 responses (response rate: 89.2%); 131/321 (40.8%) from India and 190/321 (59.2%) from SA; male to female response rate was 3:2, with majority of respondents aged 40-49 (89/321, 27.7%) and 30-39 (87/321, 27.1%) years. Doctors comprised 47.9% (57/119) of respondents in India and 74.6% (135/181) in SA. Majority of respondents in India (93/119, 78.2%) and SA (132/181, 72.9%) were from the private and public sectors, respectively, with more respondents in SA (123/174, 70.7%) than in India (38/104, 36.5%) involved in antimicrobial prescribing.

Respondents reported increased IPC practices since the pandemic and noted a need for more training on case management, antibiotic and personal protective equipment (PPE) use. While they noted increased antibiotic prescribing since the pandemic, they did not generally associate their practice with such an increase. A willingness to be vaccinated, when vaccination becomes available, was expressed by 203/258 (78.7%) respondents.

Conclusions: HCWs reported improved IPC practices and changes in antibiotic prescribing during the COVID-19 pandemic. Targeted education on correct use of PPE was an identified gap. Although HCWs expressed concerns about antimicrobial resistance, their self-perceived antibiotic prescribing practices seemed unchanged. Additional studies in other settings could explore how our findings fit other contexts.

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Introduction

Since the start of the COVID-19 pandemic, healthcare workers (HCWs) across the world have had to manage and care for patients suspected of or diagnosed with infection, having to adapt their practices according to the emerging evidence about the transmissibility of this virus in healthcare settings [1,2]. Infection prevention and control (IPC) and antimicrobial stewardship (AMS) practices among HCWs continue to be of critical importance, to prevent nosocomial transmission of this viral infection and other infectious diseases, as well as to improve outcomes [3–8]. HCW approach and behaviour towards IPC and AMS practices play a role in the transmission and spread, as well as outcomes, of COVID-19 in healthcare settings [9,10]. To identify appropriate strategies for behavioural interventions to optimize IPC and AMS practices in healthcare settings, it is crucial to explore the awareness and perceptions of such practices amongst HCWs.

The coronavirus disease, first identified as a pneumonia of unknown origin at the end of 2019, has since developed into a pandemic [11,12]. The causative organism has been identified as the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) [13]. The pandemic continues to cause a significant burden to healthcare systems worldwide [14]. In India and SA, the first cases were reported on 30 January 2020 and 5 March 2020, respectively [15,16]. Currently, these two countries are among the hardest hit by the pandemic in their respective regions [17].

The importance of education in improved HCW IPC awareness and practices, together with adequate personal protective equipment (PPE) supply, and engagement of nonclinical staff in HCW compliance with IPC measures have been described in the literature [3,6]. Current information on the level of HCW awareness of IPC and AMS practice changes is limited, especially as it relates to the COVID-19 pandemic in India and South Africa, where pandemic vulnerability has been significant [17]. We undertook a survey amongst HCWs in each country through an existing research collaboration on IPC and AMS practices [18,19]. The aim of this study was to identify perceptions and awareness of changes in IPC and AMS practices among HCWs in India and SA, in the context of the COVID-19 pandemic.

Methods

Study design

A cross-sectional online survey on the *Qualtrics* platform, with data collected using a self-administered questionnaire, was performed. Some questions were mandatory, some were optional, and some were automatically included/excluded based on an earlier response provided by the respondent. Voluntary response sampling was utilised for the study whose aim was to better understand perceptions of IPC or AMS practice changes in the sampled HCW populations. Any HCW who provided informed consent prior to survey commencement was eligible to participate. The study was approved by the relevant human research ethics committees at the Amrita Institute of Health Sciences, Kerala, India (Ref: IRB-AIMS-2020-232) and the University of Cape Town, South Africa (Ref: 311/2020).

Study development

A cross-sectional survey was conducted via the online platform, *Qualtrics*. The study report followed the STROBE guidelines [20]. The research team – made up of pharmacists, physicians, nurses, social scientists, and quantitative data analysts – designed the 43-questions survey to elicit information on HCWs' perceptions and awareness of changes in IPC and AMS practices across multiple domains. The 4-part survey covered participant demographics, pandemic knowledge and awareness of IPC practices, perceived threats and barriers, and self-efficacy. The survey was piloted within the research team and refined, before wider cascading to participants.

Study settings and participant recruitment

The study was conducted in India and South Africa. Survey participants included HCWs over the age of 18 years – e.g., doctors, pharmacists, nurses, physiotherapists, health/healthcare researchers, and health sciences trainee students – working in any sector or area of healthcare in the two countries. Participants were recruited through personal and professional networks of the researchers in both countries. Participation was voluntary and the survey was open for participation over a three-month period.

Data collection

Data collection was by means of an online self-administered questionnaire. This took place from 15 September to 15 December 2020 and coincided with the first wave of the COVID-19 pandemic in India and the start of the second wave in South Africa. Participant Information Leaflets (PIL) were available for all participants and those willing to participate were required to provide informed consent prior to commencing the survey.

Statistical analysis

Data received from participants were exported to MS Excel and cleaned. Descriptive statistics were used to report participant characteristics and survey responses. The main outcomes of interest were awareness of changes in IPC and AMS practices since the start of the pandemic, in the following domains: pandemic knowledge and awareness of changes in infection care practices; perceived threats and barriers; and self-efficacy. Responses were captured as categorical variables, reported as percentages of received feedback for each item of interest (missing data were excluded), or scaled from *strongly agree* to *strongly disagree*, where possible. Pearson's Chi-squared test was used to assess relationships between variables and a logistic regression analysis was conducted with awareness of change in IPC and AMS as the response variable. Both Pearson's Chi-squared and regression tests were conducted using R (version 3.6.2) and $p < 0.05$ was considered statistically significant.

Results

A total of 360 responses (corresponding to 360 participants clicking on the survey link) were obtained. 354 out of 360 HCW respondents provided consent to participate in the survey (6 out of 360 respondents declined to participate). Of those who consented to participate, responses from 33 respondents were excluded as either the country of residence was not indicated, or respondents were not from either of the two countries, giving a response rate of 89.2% (321/360). Of those who participated, 59.2% (190/321) were from SA and 40.8% (131/321) were from India (Table 1).

Respondent demographics

Majority of the survey respondents in SA and India were HCWs from the Western Cape province (130/190, 68.4%) and the state of Kerala (100/131, 76.3%), respectively. There were more female (193/321, 60.1%) than male (123/321, 38.3%) respondents in the survey (Table 1). More than half of total respondents (176/321, 54.8%) were in the 30 to 39 and 40 to 49 years age groups. Most respondents were doctors (192/300, 64.0%) and 28/300 (9.3%) identified as *Other* or with multiple professional roles (24/300, 8.0%). Among those with *Other* professions in India (18/119, 15.1%), 7/18 identified as Teacher/Lecturer, 6/18 as Radiographer/Radiologist, 1/18 as a Dentist and one with no further specification. In South Africa, those with *Other* professions (10/181, 5.5%) identified as infection control

Table 1
Respondent demographics

Characteristics	Response (%)		
	India	South Africa	Total
Gender			
Male	52/131 (39.7)	71/190 (37.4)	123/321 (38.3)
Female	77/131 (58.8)	116/190 (61.1)	193/321 (60.1)
Prefer not to say	2/131 (1.5)	3/190 (1.6)	5/321 (1.6)
Age			
20 to 29 years	50/131 (38.2)	10/190 (5.3)	60/321 (18.7)
30 to 39 years	40/131 (30.5)	47/190 (24.7)	87/321 (27.1)
40 to 49 years	25/131 (19.1)	64/190 (33.7)	89/321 (27.7)
50 to 59 years	9/131 (6.9)	43/190 (22.6)	52/321 (16.2)
60 to 69 years	5/131 (3.8)	21/190 (11.1)	26/321 (8.1)
70 years and above	2/131 (1.5)	5/190 (2.6)	7/321 (2.2)
Profession			
Medical doctor	57/119 (47.9)	135/181 (74.6)	192/300 (64.0)
Pharmacist	16/119 (11.8)	17/181 (9.4)	31/300 (10.3)
Nurse	3/119 (2.5)	13/181 (7.2)	16/300 (5.3)
Surgeon	11/119 (9.2)	3/181 (1.7)	14/300 (4.7)
Researcher	14/119 (11.8)	11/181 (6.1)	25/300 (8.3)
Healthcare assistant/other qualified healthcare worker	5/119 (4.2)	3/181 (1.7)	8/300 (2.7)
Physiotherapist	0	2/181 (1.1)	2/300 (0.7)
Other	18/119 (15.1)	10/181 (5.5)	28/300 (9.3)
Identifies with multiple professional roles	11/119 (9.2)	13/181 (7.2)	24/300 (8.0)
Work setting			
Rural	5/119 (4.2)	6/181 (3.3)	11/300 (3.7)
Urban	103/119 (86.6)	160/181 (88.4)	263/300 (87.7)
Both	11/119 (9.2)	15/181 (8.3)	26/300 (8.7)
Sector of primary work			
Private	93/119 (78.2)	33/181 (18.2)	126/300 (42.0)
Public	13/119 (10.9)	132/181 (72.9)	145/300 (48.3)
Both	13/119 (10.9)	14/181 (7.7)	27/300 (9.0)
Other, please specify	0	2/181 (1.1)	2/300 (0.7)
Postgraduate training in infection management or antimicrobial prescribing			
Yes	31/119 (26.1)	94/181 (51.9)	125/300 (41.7)
Not sure	7/119 (5.9)	8/181 (4.4)	15/300 (5.0)
No	81/119 (68.1)	79/181 (43.6)	160/300 (53.3)
Involvement in the care of suspected or confirmed COVID-19 patients			
Yes	47/115 (40.9)	148/179 (82.7)	195/294 (66.3)
Not sure	2/115 (1.7)	2/179 (1.1)	4/294 (1.4)
No	66/115 (57.4)	29/179 (16.2)	95/294 (32.3)
As part of your job, do you do any of the following in relation to antimicrobials? Please tick all that apply.			
Prescribe	38/104 (36.5)	123/174 (70.7)	161/278 (57.9)
Administer	12/104 (11.5)	52/174 (29.9)	64/278 (23.0)
Review	34/104 (32.7)	75/174 (43.1)	109/278 (39.2)
Teach about infection diagnosis and treatment	47/104 (45.2)	77/174 (44.3)	124/278 (44.6)
Develop antimicrobial prescribing policy and guidelines	17/104 (16.3)	38/174 (21.8)	55/278 (19.8)
Other	30/104 (28.8)	16/174 (9.2)	46/278 (16.5)

practitioners (2/10), managers (2/10), anaesthetist (1/10), clinical psychologist (1/10), occupational therapist (1/10), optometrist (1/10), retired medical doctor (1/10) and one (1/10) with no further specification. The largest proportion of HCWs provided services in urban settings (263/300, 87.7%) and in the public sector (145/300, 48.3%); more respondents in India and SA worked in the private and public sectors, respectively. Of the two people who Indicated *Other* (in SA) and not *Public* or *Private* work settings, one worked in a non-governmental organisation (NGO) and the other provided no further clarification.

Less than half of total respondents (125/300, 41.7%) reported postgraduate training in infection management or antimicrobial prescribing, and 195/294 (66.3%) had been involved in the care of patients with suspected or confirmed COVID-19 infection, more in SA (148/179, 82.7%) than in India (47/115, 40.9%) (Table 1). Over half of respondents (161/278, 57.9%) were prescribers, 124/278 (44.6%) teach about infection diagnosis and treatment, and 15/300 (5%) of total respondents were not sure whether they had any postgraduate training in infection management or antimicrobial prescribing. Among those unsure of postgraduate training in infection management or antimicrobial prescribing were four doctors (4/7, 57.1% – three of the doctors identified as surgeons), two pharmacists (2/7, 28.6%) and one healthcare assistant/other qualified healthcare worker (1/7, 14.3%) in India. In South

Africa, 7 out of 8 (7/8, 87.5%) respondents who chose this option identified as medical doctors while 1 out of the 8 was *Other* with no further clarification.

Among participants who identified as pharmacists in India, most (13/14) noted prescription review as one of the tasks they performed in relation to antimicrobials while none noted antimicrobial administration. About half of pharmacist participants (8/17) in South Africa identified prescription review as one of the tasks they perform in relation to antimicrobials. Pharmacists in South Africa who indicated *Other* in their selections on this subject listed *Other* roles in relation to antimicrobial prescribing as dispensing and stewardship practices.

Self-reported changes in personal IPC practices since COVID-19

Most participants reported an increased frequency in their subjective perception of various infection prevention practices assessed (Table 2): use of face masks (252/258, 97.7%), hand hygiene (243/258, 94.2%), avoidance of facial contact (214/258, 82.9%), and use of gloves (187/258, 72.5%). More than half of respondents indicated that the use of aprons had increased in their daily practice (148/258, 57.4%) and 137/258 (53.1%) noted a decrease in contact with patient bedside surfaces since the pandemic.

Table 2
HCW awareness of changes in care practice

Practice	Extent of change	Response (%)		
		India	SA	Total
Hand hygiene	Decreased	1/98 (1.0)	1/160 (0.6)	2/258 (0.8)
	Has not changed	2/98 (2.0)	10/160 (6.3)	12/258 (4.7)
	Increased	95/98 (96.9)	148/160 (92.5)	243/258 (94.2)
	Not applicable	0	1/160 (0.6)	1/258 (0.4)
Use of gloves	Decreased	2/98 (2.0)	5/160 (3.1)	7/258 (2.7)
	Has not changed	2/98 (2.0)	39/160 (24.4)	41/258 (15.9)
	Increased	82/98 (83.7)	105/160 (65.6)	187/258 (72.5)
	Not applicable	12/98 (12.2)	11/160 (6.9)	23/258 (8.9)
Use of face masks	Decreased	0	0	0
	Has not changed	1/98 (1.0)	4/160 (2.5)	5/258 (1.9)
	Increased	97/98 (99.0)	155/160 (96.9)	252/258 (97.7)
	Not applicable	0	1/160 (0.6)	1/258 (0.4)
Use of aprons	Decreased	7/98 (7.1)	3/160 (1.9)	10/258 (3.9)
	Has not changed	13/98 (13.3)	38/160 (23.8)	51/258 (19.8)
	Increased	59/98 (60.2)	89/160 (55.6)	148/258 (57.4)
	Not applicable	19/98 (19.4)	30/160 (18.8)	49/258 (19.0)
Avoidance of facial contact	Decreased	5/98 (5.1)	8/160 (5.0)	13/258 (5.0)
	Has not changed	10/98 (10.2)	20/160 (12.5)	30/258 (11.6)
	Increased	83/98 (84.7)	131/160 (81.9)	214/258 (82.9)
	Not applicable	0	1/160 (0.6)	1/258 (0.4)
Contact with patient bedside surfaces	Decreased	69/98 (70.4)	68/160 (42.5)	137/258 (53.1)
	Has not changed	1/98 (1.0)	28/160 (17.5)	29/258 (11.2)
	Increased	20/98 (20.4)	51/160 (31.9)	71/258 (27.5)
	Not applicable	8/98 (8.2)	13/160 (8.1)	21/258 (8.1)

COVID-19 information sources

Participating HCWs accessed information about the pandemic through a variety of sources (Figures 1a and 1b). The top sources of information were government websites and news channels/newspapers/journals including online sources. A higher percentage of respondents in SA than in India obtained pandemic-related information from non-government websites (62.0% versus 47.8%, respectively) and colleagues (80.4% versus 57.4%, respectively) while a higher percentage of respondents in India than in South Africa obtained pandemic-related information from social media (60.9% versus 36.9%), and family and friends (37.4% versus 11.7%).

On the social media front, major sources of information across both countries were WhatsApp (80.0% and 71.2% for India and South Africa, respectively), Facebook (58.6% and 45.5% for India and South Africa, respectively) and YouTube (47.1% and 33.3% for India and South Africa, respectively). More respondents in India and South Africa noted access to information via Instagram® and Twitter®, respectively.

Concerns about COVID-19 and its management

Figure 2 shows that while most HCWs agreed that they have sufficient knowledge about the pandemic to appropriately counsel patients on infection prevention measures, a lower number agreed that they have received sufficient training for managing patients with suspected or confirmed COVID-19 infection (108/123 and 24/40 in SA and India, respectively). The need for PPE training was identified by more respondents in India (72/94, 76.6% versus 47/147, 32.0% in SA). Respondents expressed confidence in their ability to use antibiotics for patients in the context of the pandemic (31/43, 72.1% in India and 96/125, 76.8% in SA). Over a quarter of respondents (37/91, 40.7% in India and 52/148, 35.1% in SA) perceived that antibiotic use had increased in their workplace; however, a lower number of those who identified as prescribers (4/29, 13.8% in India and 17/101, 16.8% in SA) associated their own prescribing practice with this increase. Of the HCWs who responded, 77/98 (78.6%) in India and 126/160 (78.8%) in SA reported willingness to be vaccinated for COVID-19 when a vaccine becomes available.

In Table 3, the effect of participant demographics on a respondent's presentation for a COVID-19 test, respondent's decision to get

the COVID-19 vaccine and respondent's concern about sub-optimal IPC behaviour in the workplace are presented; a p-value < 0.05 was considered statistically significant (adjusted p-values in parentheses). Majority of the variables tested had no statistical significance to the participant's disposition to present for a COVID-19 test or get the COVID-19 vaccine, or to concerns about sub-optimal workplace IPC behaviour. Following adjustment of p-values, participant's receipt of influenza vaccination in the preceding years was found to affect the decision for uptake of the COVID-19 vaccine in South Africa but not in India.

Antibiotic prescription preferences for different patient sub-cohorts

Survey respondents agreed that individuals infected with the COVID-19 virus were at increased risk of acquiring secondary bacterial infections, and complications from the infection will lead to increased antibiotic prescribing. For specific patient cohorts, prescribers across both countries shared some similarities and differences in tendency to prescribe antibiotics for patients in *all cases*, in *no cases* or in *selected cases* (Table 4).

First-line antibiotic for COVID-related pneumonia varied, with common choices favouring azithromycin and co-amoxiclav – more in India (36.8% versus 8.5%) and South Africa (22.2% versus 5.3%), respectively. These agents were also noted in cases where respondents preferred more than one antibiotic. Ceftriaxone was also among the preferred first-line antibiotics for COVID-related pneumonia, mostly by respondents in SA (18/117, 15.4%) rather than those in India (1/57, 1.8%).

Discussion

This study provides insight into HCW's awareness of changes in IPC and AMS practices in the context of the COVID-19 pandemic in India and SA. The study findings add to the body of knowledge on HCW readiness and needs for pandemic mitigation, providing an understanding of HCW perceptions which can be further explored for improved IPC and AMS practices.

Most of the respondents in India were from the private sector while in SA, most respondents were from the public sector. This reflects, to some extent, the public/private healthcare provisions in the countries [21,22]. HCWs reported an awareness of and improvement in IPC

Table 3
Relationship between participant demographics and selected outcomes

Participant's presentation for a COVID-19 test		
Affected by:	p-value (India)	p-value (South Africa)
- Gender (male/female/prefer not to say)	0.3758	0.4736
- Age	0.0200 (0.6797)	0.0038 (0.1276)
- Work setting (rural/urban/both)	0.2969	0.1615
- Work sector (public/private/both/other)	0.8869	0.4692
- Participant training (yes/no/not sure)	0.5106	0.7217
Participant's decision to get the COVID-19 vaccine		
Affected by:	p-value (India)	p-value (South Africa)
- Gender (male/female/prefer not to say)	0.9413	0.3696
- Age	0.7058	0.1926
- Work setting (rural/urban/both)	0.3835	0.0196 (0.6664)
- Work sector (public/private/both/other)	0.6408	0.5992
- Participant training (yes/no/not sure)	0.9404	0.2385
- Positive COVID-19 test	0.3435	0.3281
- Influenza vaccination in preceding years	0.5354	4.456e-07 (1.5150e-05)
Participant's concern about sub-optimal infection prevention behaviour in work environment		
Affected by:	p-value (India)	p-value (South Africa)
- Age	0.4853	0.7364
- Work setting (rural/urban/both)	0.5437	0.2927
- Work sector (public/private/both/other)	0.0535	0.1220
- Participant training (yes/no/not sure)	0.0963	0.7292
- Positive COVID-19 test	0.7439	0.0689

Table 4
Self-reported antibiotic prescription preferences for different patient sub- cohorts

	Response (%)		
	India	South Africa	Total
COVID-19 pneumonia			
In all cases	12/39 (30.8)	7/117 (6.0)	19/156 (12.2)
In no cases	3/39 (7.7)	49/117 (41.9)	52/156 (33.3)
In selected cases	24/39 (61.5)	61/117 (52.1)	85/156 (54.5)
COVID-19 pneumonia requiring oxygen			
In all cases	15/39 (38.5)	12/117 (10.3)	27/156 (17.3)
In no cases	4/39 (10.3)	36/117 (30.8)	40/156 (25.6)
In selected cases	20/39 (51.3)	69/117 (60.0)	89/156 (57.1)
COVID-19 pneumonia requiring hospital admission			
In all cases	20/39 (51.3)	15/118 (12.7)	35/157 (22.3)
In no cases	2/39 (5.1)	34/118 (28.8)	36/157 (22.9)
In selected cases	17/39 (43.6)	69/118 (58.5)	86/157 (54.8)
COVID-19 pneumonia with elevated biomarkers (CRP, PCT)			
In all cases	26/38 (68.4)	28/118 (23.7)	54/156 (34.6)
In no cases	1/38 (2.6)	19/118 (16.1)	20/156 (12.8)
In selected cases	11/38 (28.9)	71/118 (60.2)	82/156 (52.6)
COVID-19 pneumonia requiring ICU admission			
In all cases	24/39 (61.5)	33/116 (28.4)	57/155 (36.8)
In no cases	1/39 (2.6)	18/116 (15.5)	19/155 (12.3)
In selected cases	14/39 (35.9)	65/116 (56.0)	79/155 (51.0)
COVID-19 pneumonia in immunocompromised patient			
In all cases	27/39 (69.2)	28/118 (23.7)	55/157 (35.0)
In no cases	1/39 (2.6)	13/118 (11.0)	14/157 (8.9)
In selected cases	11/39 (28.2)	77/118 (65.3)	88/157 (56.1)
COVID-19 pneumonia patient with worsening symptoms			
In all cases	27/39 (69.2)	40/118 (33.9)	67/157 (42.7)
In no cases	1/39 (2.6)	7/118 (5.9)	8/157 (5.1)
In selected cases	11/39 (28.2)	71/118 (60.2)	82/157 (52.2)
First line antibiotic regimen for COVID pneumonia (multiple answers enabled)			
Azithromycin	21/57 (36.8)	10/117 (8.5)	31/174 (17.8)
Co-amoxiclav	3/57 (5.3)	26/117 (22.2)	29/174 (16.7)
Ceftriaxone	1/57 (1.8)	18/117 (15.4)	19/174 (10.9)
Multiple antibiotics	4/57 (7.0)	31/117 (26.5)	35/174 (20.1)

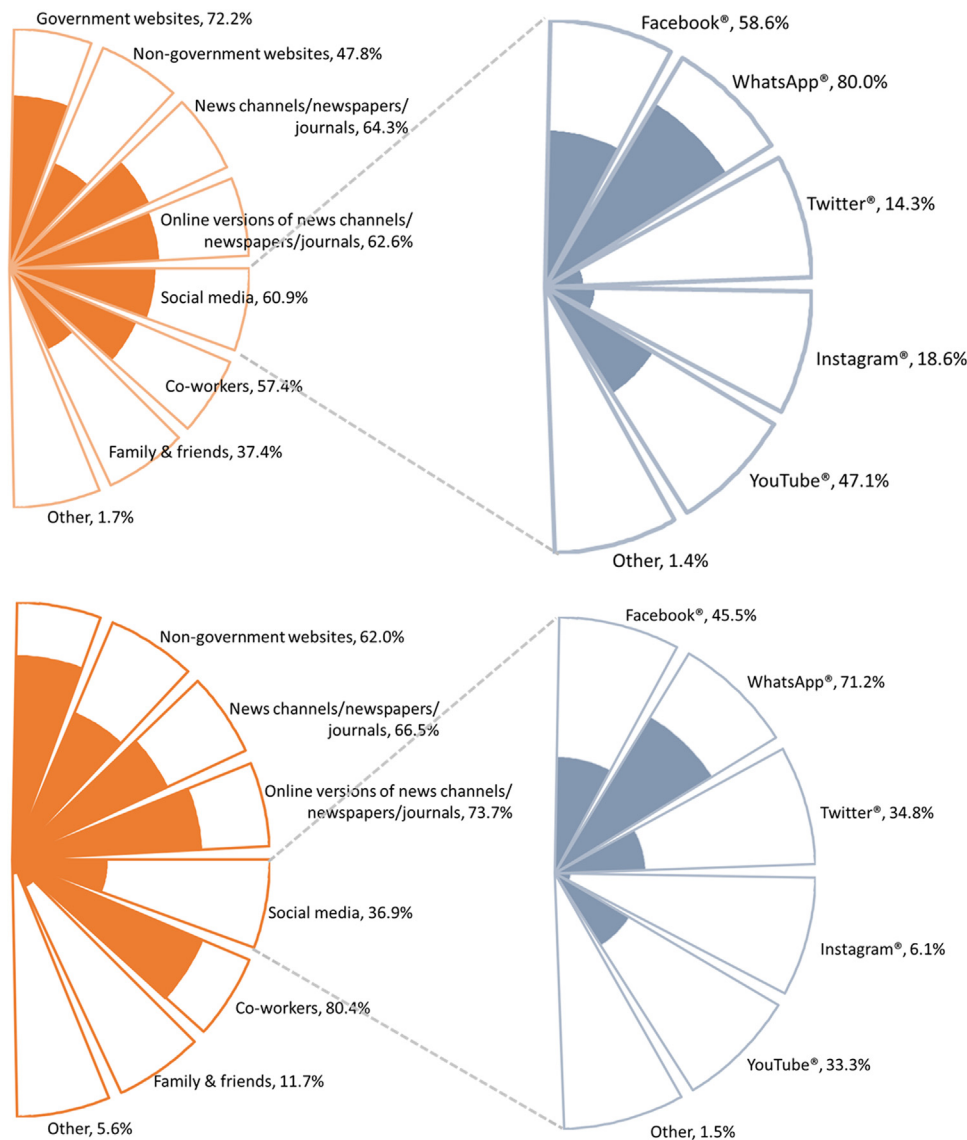


Figure 1. a: Respondents’ sources of COVID-19 information from general (n = 115) and social media in India. b: Respondents’ sources of COVID-19 information from general (n = 179) and social media in South Africa

practices since the pandemic. They also noted an increase in antibiotic prescription volumes within their institutions though, generally, did not associate their own practice with such increase.

The HCW’s degree of confidence in their own IPC practices varied across the two countries. The scale-up of infection prevention measures, most notably in the use of PPE by HCWs and in patient care [23,24], was earlier affected by shortages and supply issues. The study presents data mostly from HCWs who practiced in specific regions in India and South Africa and so responses may not be generalizable. Nevertheless, the lack of PPE has been reported across both countries, as in many others [25–30]. In line with other studies, respondents reported improved IPC practices in the context of the pandemic [23,24]. This has been noted to be consistent with HCW perceptions of infection risk and concern over the COVID-19 infection and its related complications [23,24].

A willingness to be vaccinated was high among the respondents, though about a fifth provided no response to this question. Variation in COVID-19 vaccine acceptance among HCWs have been noted in various parts of the world [31–36]. Hesitation towards vaccination has been reported among non-physician HCWs, those who utilised specific social media platforms as major information sources, and those who are not positively disposed to previous or regular influenza vaccination. COVID-19 vaccine acceptance, on the other hand, has been noted among indi-

viduals of varying ages and those perceived to be at risk of infection [31–37]. The positive attitude to vaccination in our survey may be related to the cohort which were all HCWs with higher education levels, as earlier reported elsewhere [36]. Even though vaccination was not yet under way in several countries at the time of data collection and has since expanded to many countries, with HCWs in the early recipient groups, continued evaluation of attitudes towards vaccination is necessary to inform future education drives and planning for pandemic containment and mitigation [33,38]. There is also a need for ongoing education and awareness of appropriate IPC and antibiotic prescribing practices, tailored to various contexts, to further contribute to control of the COVID-19 pandemic.

HCWs expressed their preferences for antibiotic prescribing in different patient sub-cohorts, depending on the patient’s clinical presentation. As noted in this survey, amoxicillin/clavulanic acid and azithromycin also feature in the antibiotic choices considered by HCWs in other studies [39,40]. Previous studies have reported on the limited and recommended roles for broad-spectrum antibiotic prescribing in patients [41,42], as well as on records of broad-spectrum antibiotic prescribing based on clinical presentation, in COVID-19 patients [43]. Clinician experience is believed to have largely guided empiric antibiotic therapy in the context of COVID-19, especially at the early stages of the pan-

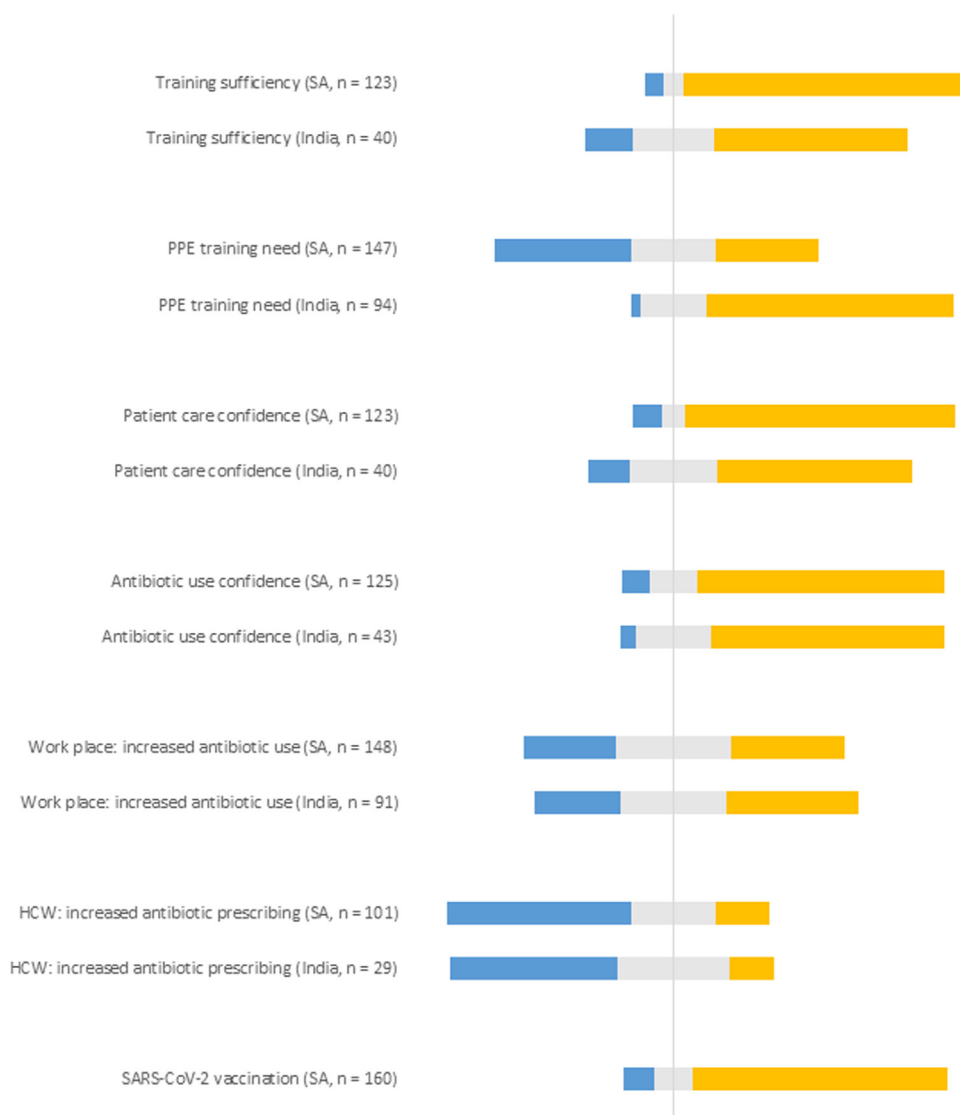


Figure 2. Healthcare workers' level of agreement and confidence with care practices

demic [44]. It is important to longitudinally study the effect of this pandemic on antibiotic prescribing patterns and epidemiology of bacterial infectious diseases, as well as the impact of the pandemic on AMS programmes [43–45]. The data generated from such studies will contribute to better understanding of the pandemic impact on antimicrobial resistance and AMS as well as support the development of sustainable and evidence-based IPC and AMS practices. The importance of effective IPC behaviours, in addition to AMS practices, for pandemic control and mitigation, cannot be over-emphasised.

Limitations

This study is subject to some limitations, which need to be considered in the interpretation of its findings. Firstly, by virtue of its design as a cross-sectional study, the survey findings are subject to change over time and with interventions, especially as HCWs gain more experience with successive waves of the pandemic. Secondly, we present data from a relatively low number of HCWs during the COVID-19 pandemic in India and SA. While the survey was rolled out across the two countries and participation amongst HCWs was not limited, responses obtained were considerably more from participants in the geographic areas where the researchers worked compared to the rest of the country. These areas were at the forefront of the COVID-19 response across both coun-

tries; however, there were also other healthcare settings at the forefront whose healthcare teams were not necessarily represented in the survey responses. The limited participation may be due to HCW preoccupation with pandemic mitigation efforts which understandably takes preference. Many of the respondents work in the geographic areas where the research team practice and so responses may be more representative of practice in the respective areas rather than of each country. The responses were obtained from HCWs across two countries at different times and phases of the pandemic; this may have had some bearing on the findings. Another limitation was posed by the online format of the study and its voluntary sampling method, which would have biased results in favour of those who had online access or those who inherently were more disposed to the subject or more disposed to participating. Lastly, response bias cannot be ruled out given the survey's reliance on a self-administered and self-reported questionnaire. For instance, while many respondents indicated that IPC measures had increased in their healthcare and work settings since the pandemic, this was from their subjective perceptions (perhaps when compared against a previously poor rate) and may not necessarily reflect or equate to appropriate practices as recommended by various guidelines.

Notwithstanding, this study fills a gap in the perceptions of IPC practices by presenting insight into HCW's views and awareness of IPC and AMS changes in patient care across two countries on different

sides of the middle-income scale, in two continents, during the early COVID-19 infection waves. It will be useful for providing information on perceptions to and awareness of pandemic containment and mitigation measures among HCWs in the response areas, in this and future infectious disease pandemics. This is beneficial given the position of HCWs in infectious disease and pandemic control. In addition, participation in the survey was voluntary and anonymous, which likely increased the likelihood of reliable responses.

Conclusion

HCWs reported awareness of improved IPC measures and changes in antibiotic prescribing during the COVID-19 pandemic. Targeted education on correct use of PPE was identified as a gap to be addressed during this pandemic. Although HCWs noted increased antibiotic prescribing in their work environment, their own antibiotic prescribing practices were perceived to be largely unchanged. Strategies for IPC interventions, including AMS, need to be strengthened in infectious disease pandemic response plans with context-specific interventions to make prescribers aware of their possible contributions to AMR. While these findings cannot be generalised, they highlight the need for continued IPC and AMS awareness amongst HCWs. Additional studies across various other settings are required to explore how much the findings of this research fit with those from other contexts.

Declaration of Competing Interests

The authors declare no conflicts of interest.

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Authors' Contributions

OM conceptualised and wrote the initial protocol for the study, with additional input and revision from CB, HL, RA, CT, S Singh and overall oversight by EC and MM. OM, S Surendran and EC coordinated the data collection with input from NZ, SSurendran, VN, and FE contributed to data capturing; OM, FE and ES contributed to the data analysis. OM wrote the first draft of the manuscript, with oversight from EC and MM. All authors contributed to subsequent revisions and approval of the final draft.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.ijregi.2022.11.010](https://doi.org/10.1016/j.ijregi.2022.11.010).

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