Original Article

Antibiotic prescribing patterns and knowledge of antibiotic resistance amongst the doctors working at public health facilities of a state in northern India: A cross sectional study

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Abstract

Objectives: The aim of the study is to understand antibiotic prescribing patterns and to understand knowledge of antibiotic resistance amongst the doctors working at public health facilities of a northern Indian state. **Methodology:** A cross-sectional study among doctors of the civil hospitals of Haryana state of India was conducted 2019. Data were collected by self-administered questionnaire from a total of 215 doctors posted at the 22 district hospitals. **Results:** The response rate was 98%. Doctors (66%) perceived antibiotic resistance as a very important global problem, a very important problem in India (68%) and as an important problem in their hospital (31%). Experience in years was significantly associated with considering hand hygiene (OR, 5.78; 95% CI, 1.6420.3; *P*=0.005) and treatment of bacteria as per susceptibility report of the organism (OR, 0.54; 95% CI, 0.310.93; *P* = 0.03). Surgeons reported piperacillin-tazobactam (17%), cloxacillin (17%), and cephazolin (12.05%) and others (54.2%) as the first choice of antibiotics for infection after surgery. Doctors (52.3%) reported that they started antibiotics 12 hours before surgery; 15 (17%) prescribed antibiotics 6 hours before surgery; and 23 (27%) 1 day before the surgery. Time for stopping antibiotics after surgery, as reported by participants, was 1 day (15%), 23 days (35%), 57 days (44%), respectively. A total of 71 (83%) doctors thought that surgical incision could lead to post-surgical site infection. **Conclusion:** Findings of study can be utilized to enhance education on antimicrobial prescribing, antimicrobial surveillance, and prescribing patterns among doctors in our settings.

Keywords: Antimicrobial resistance, doctors, India

Introduction

Antimicrobials have played a significant role in reducing morbidity and mortality associated with infectious conditions.[1] Not only for their role in treating isolated cases of infections, antimicrobials have played a significant role in reducing morbidity associated with infectious complications of surgical procedures, organ transplants, andcancer chemotherapy. The effectiveness of antibiotics is threatened by the global rise in bacterialresistance[2,3] and antimicrobial resistance (AMR) is now recognized as a major public health problem.[4-6] Besides, other contributors to the development of AMR, excessive use of antimicrobials, is one of the important contributors which occurs in the area of human health, poultry, cattle farming, and aquaculture.[7,8] It has been reported that primary care is

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accountable for 80% of all antibiotic prescribing in the UK and similar trends expected globally.[9]

To address the component of the use of antimicrobials in humans, it is important to assess the knowledge, perceptions, and drivers for antimicrobial prescriptions.[10]It has been suggested that doctors are likely to change their antibiotic prescribing behavior when their understandings are aligned to the reduction of antibiotic resistance.[11]

In developing countries, awareness about AMR is beginning to increase only recently.India had made its National Action Plan for curtailing AMR (NAPAMR) in 2017 in line with the global action plan for combating AMR.[12,13] As a next step, the states were required to develop their state action plans. State of Haryana, which has a population of 28 million, is initiating the same exercise. However, before drawing out a plan, it is important to undertake a situational analysis of various components of "one health approach." Human health is one of the elements of one health approach.

In India, district hospitals are the center of the provision of secondary care services.[14] The current study was carried out with the aim of understanding knowledge about AMR and rational antimicrobial use amongst the doctors working in district hospitals (DH) in the state of Haryana.

Material and Methods

Study design and setting

A cross-sectional participant-driven study among doctors of the civil hospitals of 22 districts of Haryana state of India was conducted in August and September 2019. This study was approved by the concerned authorities of Department of Health and Family Welfare Haryana. Administrative approvals were also taken from the relevant authorities before conducting the study. DH provide secondary level care and are equipped to provide specialist care facilities. Each district hospital approximately covers an average population of 1.2 million in Haryana with a range 0.5 to 2.4 million.

Study population and sample size

A systematic sampling procedure was done to draw a sample of 10 doctors from each district hospital (N = 22) having expertise in the Departments of Internal Medicine, Paediatrics, Obstetrics and Gynaecology, Surgery, and Dentistry to complete self-administered questionnaires. The list of doctors posted at each DH was taken from the concerned Civil Surgeons and sorted alphabetically by doctor's name. The respondent was selected following the regular interval of the fifth name starting from first. In case of non-response or non-availability of the selected candidate, the next successive name was selected for participation in the study.These doctors were engaged in specialized practice and designated as Senior Consultants (SC), Senior Medical Officers (SMO), Medical Officers (MO), and Dental Surgeons (DS) based on seniority, which in general corresponds to years of service.

Study tool

A 41 item questionnaire was developed by conducting a literature review and desk reviews with the consultants posted at the State Health Systems Resource Centre, Haryana. The state-specific adaptation was made from the original tool used for a similar survey in another state of south India. The pre-testing of the questionnaire was conducted in a pilot run done with 10 physicians posted at the local public hospital. On the basis of the pilot run, a final modified version was adopted for the final survey. The self-administered questionnaire had three parts; the first part collected information on demographics. The second part of the questionnaire comprised questions assessing knowledge of doctors regarding antibiotic resistance, susceptibility patterns, and choice of antimicrobials. The second part of the questionnaire also assessed practice patterns with regards to the participating doctor's practices and the perception regarding the practices of others. The third part of the questionnaire explored practices regarding surgical prophylaxis. Questions on knowledge of antibiotic resistance used 4-point Likert-style response options from to "great extent," "somewhat," "very little" to "not at all."

Data collection

One day workshop was held for the training of quality consultants as they were field investigators designated for data collection in this study. A team of two investigators each visited the district hospitals with data capture tools. The doctors were explained the questionnaire and objectives of the study. The same was provided in the participant information sheet, and a written/informed consent was taken from willing participants. They were asked to fill the questionnaire and clarification if needed for an item that was provided if requested. The field investigators were trained to avoid any prompting during data collection. Study participants were not allowed to surfthe internet during the activity. The quality consultants collected the completed questionnaires and sentthem to the state headquarters, where data were analyzed. The anonymity of the participants was ensured by coding the form, and no personal identifiers were part of any collected data

Statistical analysis

Statistical Package for Social Sciences Version 20, EPI software, and Microsoft Office Excel 2010 were used for data analysis. Continuous data were summarized as mean (SD) or median (range). Proportions were calculated for categorical variables. Chi-square test with Yate's correction for comparison of categorical data was used. On categorization into two categories, of those with an experience of less or more than 5 years, the Odds ratio with 95% confidence interval was calculated for various categories of responses. P value < 0.05% was considered significant.

Results

Data were collected from a total of 215 doctors posted at the 22 DH of the Haryana [Table 1]. The response rate was 98%, as 5 doctors did not consent for participation. The majority of the doctors were males 148 (69%) and MO 157 (73%).

A total of 166 (77%) of them had experience between 0 and 10 years; 114 (53 had clinical experience of more than 5 years) [Table 1]. Out of a total 215, the doctors who performed surgical procedures were 86 (40%).

Out of total 215 respondents, 142 (66%) perceived antibiotic resistance as a very important global problem, 146 (68%) perceived it as a very important problem in India. On the other hand, only 14 (31%) considered AMR as an important problem in their hospital/facility [Figure 1]. Most (74%) of the respondents prescribed antibiotics every day, 17% of doctors reported their frequency of antibiotic prescription asmore than once per week. The most frequently prescribed antibiotics in decreasing order of frequency were amoxicillin-clavulanic acid (25%), amoxicillin (21%), ciprofloxacin (17%), cefixime (10%), and ceftriaxone (7%) [Figure 2].

As reported by the participants, the most common resistant organisms in their hospital were, *Staphylococcus aureus* (31%), *Escherichia Coli* (26%), multidrug-resistant Pseudomonas (18%), Klebsiella pneumonia (8%), M*ycobacterium tuberculosis* (6%) and *streptococcus* (2%), *Streptomyces* (1%), *MRSA* (5%), *Salmonella typhae.* In total 2% participants considered organisms causing tinea to be important pathogens in their hospital.

The measures considered important for curtailing AMR at the level of their facility were, counseling patients to finish prescribed course of antibiotics (82%), having knowledge of common bacteria and which antibiotics work for them (74%), understanding of the dosage requirements for antibiotics (72%), sending samples to the labs (66%), adequate handwashing (58%), appropriate empiric choice of antibiotics (66%), removing intravenous lines/cannula and urinary catheters when not needed (55%) [Table 2].

Approximately 40% of the doctors reported linezolid as first choice of the drug followed by cloxacillin (16%) for Methicillin resistant *Staphylococcus aureus*. Piperacillin was preferred by 36% respondents for *Pseudomonas aeruginosa* followed by linezolid (11%) and cloxacillin (8%). A total of 64 (30%) marked ceftriaxone as preferred drug for *Enterococcus fecalis* and 58% preferred metronidazole for *Clostridium difficle.*

Experience in years was significantly associated with considering hand hygiene (OR, 5.78; 95% CI, 1.6420.3; $P = 0.005$) and treatment of bacteria as per susceptibility report of the organism (OR, 0.54;95% CI, 0.310.93; $P = 0.033$) as an important contributors in controlling AMR [Table 3].

Surgeons reported piperacillin-tazobactam (17%), cloxacillin (17%), and cephazolin (12.05%) and others (54.2%) as the first choice of antibiotics for infection after surgery. More than half of the 45 (52.3%) doctors reported that they started antibiotics 12 h before surgery; 15 (17%) prescribed antibiotics 6 h before surgery; and 23 (27%) 1 day before the surgery. Time for stopping antibiotics after surgery, as reported by participants, was 1 day (15%), 23 days (35%), 57 days (44%), respectively. A total of 71 (83%) doctors thought that surgical incision could lead to post-surgical site infection. In total 23 of the respondents reported that they recorded the numbers of surgical site infections. However, one participant stated that he analyzed and discussed it with the Infection control nurse (ICN) and Operation Theatre team. Majority of the 36 (42%) doctors

Table 1: Demographic characteristics of the doctors in the survey

Characteristics of participants	*n* (%)
Gender	
Male	148 (68.8)
Female	67 (31.2)
Designation	
Senior Consultant	15 (7.0)
Dental Surgeon	17 (7.9)
Medical Officers	157 (73)
Senior Medical Officers	26 (12.1)
Experience	
<10 years	166 (77)
1020 years	35 (16)
2030 years	8 (3.7)
>30 years	6 (2.7)

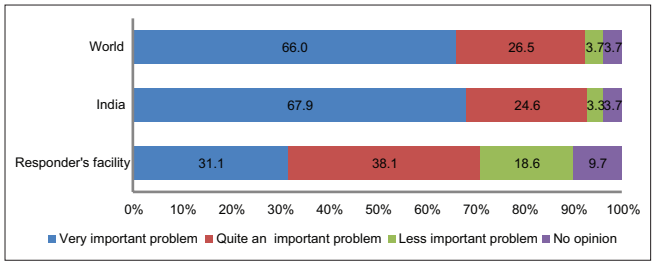

Figure 1: Perceptions of public health doctors of Haryana on grading the level of antibiotic resistance in the world. *Graph depicts data of those who responded

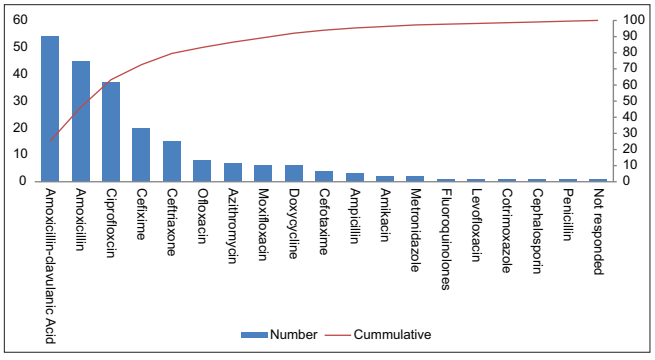

Figure 2: Pareto graph showing most prescribed antibiotics by public health doctors in the state of Haryana, 2019

Table 2: Perception of the participating doctors regarding factors that can prevent antibiotic resistance

Perceptions	To a great extent	Somewhat	Very little	Not at all
By telling patients to finish their course of antibiotics	178 (82.8)	34 (15.8)	3 (1.4)	0 (0)
Knowing which bacteria are common in the facility and what works for them	160 (74.4)	50 (23.2)	3 (1.4)	1 (0.5)
By understanding dosage requirements of the patient	155 (72.1)	53 (24.6)	5 (2.3)	1 (0.5)
Decreasing/minimal use of designated/reserve antibiotics (like meropenem)	149 (69.3)	40 (18.6)	18 (8.4)	7 (3.3)
By sending prompt samples to microbiology lab	144 (66.9)	59 (27.4)	9 (4.2)	1 (0.5)
Hand hygiene	125 (58.1)	37 (17.2)	20 (9.3)	32 (14.9)
Removing IV and urinary catheters at the earliest	118 (54.8)	71 (33.0)	18 (8.4)	7 (3.3)
By using antimicrobials based on culture and sensitivity data	106 (49.3)	81 (37.7)	20 (9.3)	5 (2.3)
Decreasing the use of low-end antibiotics (like ampicillin)	42 (19.5)	100 (46.5)	44 (20.5)	27 (12.6)

reported that they treated surgical site infection for 57 days; 25 (29%) for 710 days; 14 (16%) for 1014 days and 7 (8%) for <5 days.

Discussion

As per a report of NITI Aayog, a national premium policymaking body, the state of Haryana is at the top in terms of incremental performance on the health index.[15] There is a 3 tier healthcare service delivery in Haryana; MCs are at the tertiary level, 22 DH, 37 sub-district hospitals, 107 CHC constitute the secondary level. There are 367 rural and 100 urban PHCs, 2630 SC, and make up the primary level. There are 501 PHCs and sub-centers upgraded as Health and wellness centers with the appointment of an additional mid-level service provider. DHs provide specialist secondary care facilities at the district level, whereas MCs provide tertiary care services.[14] As the survey was conducted in healthcare setups which serve as point of first contact in a large proportion of patients, the study findings were pertinent to primary care setting.

Many of the surveys conducted in the past have been predominantly confined to healthcare setups affiliated to training institutesand focused on the KAP of doctors of tertiary care hospitals.[16,17] These health care setups are not linked to and responsible for the health system (at the district and sub-district level) and for the health of a community in a geographical area,[18] the responsibility of which lies with the DH. DHs house the technical expertise and authority indispensable for local implementation of state and national policies. This makes DHs a potential players in implementing, monitoring and supervising district health plans.[19] In the future, the doctors in public health systems are likely to play a crucial role in delivering the human health component of state action plan. With this background, we decided to target the doctors posted in 22 DHs of the Haryana state.

The entry-level qualification of the doctors at DH is Bachelor of Medicine and Bachelor of Surgery (MBBS), which is 4½ years plus 1 year rotatory internship and is equivalent to the graduation level of Medical Schooling in western countries. For providing specialist care in General Medicine, General Surgery, Paediatrics, Obstetrics and Gynaecology and Dentistry, a postgraduate qualification in the subject is needed which is 2 years for postgraduate diploma and 3 years for masters degrees.[20]

Our survey points out various lacunae in training concerning antimicrobial resistance. It is interesting to note that while the doctors considered it to be a big problem in the world, 18.6% regarded the problem as insignificant in their setup. Further, gaps were identified in understanding about the common microorganisms and choice of drugs for a given pathogen. As per Hospital Management Information System (HMIS), from January to December 2019, ~8.5 million patients were treated in all DH of Haryana. The highest contribution in outpatient management of patientsis from Internal medicine (21%), followed by obstetrics and gynecology (11%), pediatrics (8%), ophthalmology (8%), orthopedics (7%), general surgery (6%), dermatology (6%), dentistry (5%), otolaryngeology (4%), and others (22%).

On an average, a doctor in district hospital manage 100 patients in a day, and hence training them in good infection control practices and antimicrobial stewardship is likely to have a considerable impact.

Literature suggests that education is imperative to enhancecautious use of antimicrobials. Antimicrobial stewardship approaches within hospitals use health personnel's education as commonly employed intervention strategy.[16] Therefore, appropriate prescribing of antibiotics must be integrated into continuing medical education. Educational efforts include conference presentations, teaching sessions, and the provision of written state and national guidelines. For the implementation of NAP/ state action plans (SAP), it is essential to ensure increased availability of trained health personals and hands-on training support from tertiary care institutions.

Baubie *et al.*[21] identified that the presence of a microbiology laboratory, antibiogram, established guidelines for empiric prescribing, and committed leadership was important facilitators of an effective antibiotic stewardship program in a hospital. In Haryana, all 22 DHs have functional laboratories; however, well-equipped microbiology labs are functional in 12, and antibiograms are being generated in only 5. It remains to be seen how doctors can utilize these facilities in a better way not

Table 3: Perception of the doctors posted in public health facilities on factors that can prevent antibiotic resistance as stratified by years of experience (>5 and <5 years)

Characteristics	>5 years *n*=114	<5 years *n*=101	Odds ratio (with 95% confidence interval) **	*P**
By telling patients to finish their course	*n*=114	*n*=101		
To a great extent	95	83	0.9 (0.451.8)	0.8
Somewhat	17	17	0.86 (0.411.8)	0.8
Very little	2	1	0.5 (0.56.2)	0.6
Not at all	0	0		
Knowing which bacteria are common in the facility and what works for them	*n*=114	*n*=100		
To a great extent	83	77	0.83 (0.451.54)	0.7
Somewhat	30	20	1.42 (0.752.71)	0.3
Very little	1	2	0.43 (0.034.85)	0.9
Not at all	0	1	-	0.9
By understanding the dosage requirements of the patient	*n*=113	*n*=101		
To a great extent	85	70	1.34 (0.732.45)	0.4
Somewhat	25	28	0.74 (0.391.37)	0.4
Very little	3	2	1.35 (0.228.24)	1.0
Not at all	0	1	-	0.9
Decreasing use of high end/reserved antibiotics (like meropenem)	*n*=114	*n*=100		
To a great extent	81	68	1.15 (0.642.07)	0.7
Somewhat	18	22	0.66 (0.331.32)	0.3
Very little	13	5	2.44 (0.837.12)	0.1
Not at all	2	5	2.94 (0.5515.5)	0.3
By sending prompt samples to microbiology lab	*n*=114	*n*=99		
To a great extent	76	68	0.91 (0.511.62)	0.8
Somewhat	32	27	1.04 (0.561.90)	1.0
Very little	6	3	1.77 (0.437.30)	0.6
Not at all	0	1		0.9
Hand hygiene	*n*=113	*n*=101		
To a great extent	66	59	1 (0.581.7)	0.9
Somewhat	19	18	0.93 (0.451.89)	0.9
Very little	17	3	5.78 (1.6420.3)	0.0
Not at all	11	21	2.43 (1.105.34)	0.03
Removing IV and urinary catheters faster	*n*=114	*n*=100		
To a great extent	67	51	1.36 (0.792.35)	0.3
Somewhat	36	35	0.85 (0.481.51)	0.7
Very little	7	11	0.52 (0.191.42)	0.3
Not at all	4	3	0.85 (0.183.89)	1.0
By treating all the bacteria grown from samples in the report	*n*=112	*n*=100		
To a great extent	48	58	0.54 (0.310.93)	0.03
Somewhat	51	30	1.95 (1.103.43)	0.03
Very little	11	9	1.10 (0.432.77)	1.0
Not at all	2	3	1.70 (0.2710.3)	0.89
Decreasing the use of low-end antibiotics (like ampicillin)	*n*=113	*n*=100		
To a great extent	19	23	0.67 (0.341.33)	0.3
Somewhat	59	41	1.57 (0.912.70)	0.13
Very little	23	21	0.96 (0.491.86)	1.0
Not at all	12	15	1.48 (0.653.34)	0.4

*chi-square test was used to estimate univariate associations. **Unadjusted odds ratio (OR) at 95% confidence interval (95% CI)

only for improved patient outcomes but also for addressing the threat of antimicrobial resistance.

National Center for Disease Control (NCDC) had brought forth national antibiotic policyin 2016; for the management of infections at all levels of healthcare.[22,23] It is imperative to propagate these guidelines as these will help in guiding the rational use of antibiotics. However, the universal adaptation of these guidelines remains deficient due tobarriers viz.; personnel shortages, trained staff, financial cutbacks, and resistance from administration; leadership and a culture that embraces change[24,25] and lack of state-specific guidelines.[25]

Although principles of surgical prophylaxis are laid down, the survey highlighted several deficiencies in the knowledge and practice regarding the same. This was reflected not only in the choice of antimicrobials but also for the duration for which these were given. Addressing surgical prophylaxis is often regarded as a low-hanging fruit for any antimicrobial stewardship program.[26] Optimizing surgical antibiotic prophylaxis is a high-impact intervention, and it is a decent starting point for organizations beginning an AMR initiative.[27] Hence, it is likely that this would be an essential component of our training programs.

Approximately double the number of doctors having <5 years of experience 21 (20.7%) presume that hand washing is not important as compared to 11 (9.7%) of the doctors having >5 years of experience. This may be attributed to the fact that the senior doctors were more experienced and experience is generally correlated with increased knowledge.[28]Ossaidiom *et al*.,[28] also reported the senior doctors/consultants had a better understanding of the importance of hand hygiene than the other cadres of doctors. The other possible reason could be that most of the time, hand hygiene viewed as an added extra rather than an essential part of the process. But the failure of doctors to decontaminate their hands reflects the tenets of attitudes, beliefs, and behavior, and there are no easy solutions.[29,30]

Our study has a limitation as we did not conduct direct observations of practice to correlate with self-reporting and undertake a prescription audit to determine the appropriate use of antibiotics. Hence, future studies should be conducted to identify barriers and facilitators to collect data on AMR. Despite these limitations, the current study offers an insight into the doctor's KAP's patterns related to antibiotic use in Haryana, India. Data from our study can be utilized to enhance education on antimicrobial prescribing, antimicrobial surveillance, and prescribing patterns among doctors in our settings. On lines of NAPAMR, SAPAMR, addressing state-specific issues of Haryana can be further developed to limit the spread of growing antimicrobial resistance in India.

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Conflicts of interest

There are no conflicts of interest.

References

1. Ribeiro da Cunha B, Fonseca LP, Calado CRC. Antibiotic discovery: Where have we come from, where do we go? Antibiotics (Basel) 2019;8:E45. doi: 10.3390/antibiotics8020045.
2. Aslam B, Wang W, Arshad MI, Khurshid M, Muzammil S, Rasool MH, *et al.* Antibiotic resistance: Arundown of a global crisis.Infect Drug Resist2018;11:1645-58.
3. Dadgostar P. Antimicrobial resistance: Implications and costs. Infect Drug Resist 2019;12:3903-10.
4. Ciorba V, Odone A, Veronesi L, Pasquarella C, Signorelli C. Antibiotic resistance as a major public health concern: Epidemiology and economic impact. Ann Ig 2015;27:562-79.
5. Jee Y, Carlson J, Rafai E, Musonda K, Huong TTG, Daza P, *et al.* Antimicrobial resistance: Athreat to global health. Lancet Infect Dis 2018;18:939-40.
6. Lomazzi M, Moore M, Johnson A, Balasegaram M, Borisch B. Antimicrobial resistance-moving forward? BMC Public Health 2019;19:858.
7. Llor C, Bjerrum L. Antimicrobial resistance: Risk associated with antibiotic overuse and initiatives to reduce the problem. Ther Adv Drug Saf 2014;5:229-41.
8. Collignon PJ, McEwen SA. One Health-its importance in helping to better control antimicrobial resistance. Trop Med Infect Dis 2019;4:E22. doi: 10.3390/tropicalmed4010022.
9. Hay AD. Antibiotic prescribing in primary care. BMJ 2019;364:l780. doi: 10.1136/bmj.l780.
10. Nair M, Tripathi S, Mazumdar S, Mahajan R, Harshana A, Pereira A, *et al.* Knowledge, attitudes, and practices related to antibiotic use in Paschim Bardhaman District: A survey of healthcare providers in West Bengal, India. PLoS One 2019;14:e0217818-e.
11. Labi A-K, Obeng-Nkrumah N, Bjerrum S, Aryee NAA, Ofori-Adjei YA, Yawson AE, *et al.* Physicians' knowledge, attitudes, and perceptions concerning antibiotic resistance: Asurvey in a Ghanaian tertiary care hospital. BMC Health Serv Res 2018;18:126.
12. Ranjalkar J, Chandy SJ. India's National Action Plan for antimicrobial resistance-An overview of the context, status, and way ahead. J Family Med Prim Care 2019;8:1828-34.
13. Singh S, Menon VP, Mohamed ZU, Kumar VA, Nampoothiri V, Sudhir S, *et al.* Implementation and Impact of an antimicrobial stewardship program at a tertiary care center in South India. Open Forum Infect Dis 2018;6:ofy290-ofy. doi: 10.1093/ofid/ofy290.
14. Services DGoH, Welfare MoHF, India Go. Indian Public Health Standards (IPHS) Guidelines forDistrict Hospitals. 2012.
15. Haryana betters health index score, ranks 12[cited 2019 Dec 2019]. Available from: https://www.tribuneindia.com/news/archive/haryana-betters-health-index-score-ranks-12-794620.
16. Thakolkaran N, Shetty AV, D'Souza NDR, Shetty AK. Antibiotic prescribing knowledge, attitudes, and practice among physicians in teaching hospitals in South India. J Family Med Prim Care 2017;6:526-32.
17. Sangma ZM, Napolean T, Singh LD, Vanlalduhsaki, Visi V, Akoijam BS. KAP of antibiotic resistance among the junior doctors in RIMS. IOSR J Dent Med Sci (IOSR-JDMS) 2018;17:64-74.
18. Kumar R. Academic institutionalization of community health services: Way ahead in medical education reforms. J Family Med Prim Care 2012;1:10-9.
19. English M, Lanata CF, Ngugi I, Smith PC. Disease Control Priorities in Developing Countries. Oxford University Press; 2006. p. 1211-28.
20. Clinical Establishment Act Standard for HOSPITAL (LEVEL

1A and 1B).Available from: http://clinicalestablishments.gov.in/WriteReadData/147.pdf.

21. Baubie K, Shaughnessy C, Kostiuk L, Varsha Joseph M, Safdar N, Singh SK, *et al.* Evaluating antibiotic stewardship in a tertiary care hospital in Kerala, India: Aqualitative interview study. BMJ Open 2019;9:e026193.
22. Kaur A, Bhagat R, Kaur N, Shafiq N, Gautam V, Malhotra S, *et al.* A study of antibiotic prescription pattern in patients referred to tertiary care center in Northern India. Ther Adv Infect Dis 2018;5:63-8.
23. Walia K, Ohri VC, Madhumathi J, Ramasubramanian V. Policy document on antimicrobial stewardship practices in India. Indian J Med Res 2019;149:180-4.
24. George P, Morris AM. Pro/con debate: Should antimicrobial stewardship programs be adopted universally in the intensive care unit? Crit Care 2010;14:205.
25. Alghamdi S, Atef-Shebl N, Aslanpour Z, Berrou I. Barriers to implementing antimicrobial stewardship programmes in three Saudi hospitals: Evidence from a qualitative study. J Glob Antimicrob Resist 2019;18:284-90.
26. Aiken AM, Wanyoro AK, Mwangi J, Juma F, Mugoya IK, Scott JAG. Changing use of surgical antibiotic prophylaxis in Thika Hospital, Kenya: Aquality improvement intervention with an interrupted time series design. PLoS One 2013;8:e78942.
27. Sartelli M, Duane TM, Catena F, Tessier JM, Coccolini F, Kao LS, *et al.* Antimicrobial stewardship: A call to action for surgeons. Surg Infect (Larchmt) 2016;17:625-31.
28. Omuemu V, Ogboghodo E, Opene R, Oriarewo P, Onibere O. Hand hygiene practices among doctors in a tertiary health facility in southern Nigeria. J Med Tropics 2013;15:96-101.
29. Handwashing Liaison G. Hand washing. BMJ 1999;318:686.
30. Cresswell P, Monrouxe LV. 'And you'll suddenly realise 'I've not washed my hands': Medical students', junior doctors' and medical educators' narratives of hygiene behaviours. BMJ Open2018;8:e018156.