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 cephaloxin (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, and cancer chemotherapy. The effectiveness of antibiotics is threatened by the global rise in bacterial resistance[2,3] and antimicrobial resistance (AMR) is now recognized as a major public health problem.[4] 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
To address the component of the use of antimicrobials in humans, it is important to assess the knowledge, perceptions, and drivers for antimicrobial prescriptions. 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.

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. As a next step, the states were required to develop their state action plans. The 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. 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 surf the internet during the activity. The quality consultants collected the completed questionnaires and sent them 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. \( P \text{ value } < 0.05\% \) 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 (68.8%) 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 as more 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%), Mycobacterium tuberculosis (6%) and streptococcus (2%), Streptomyces (1%), MRSA (5%), Salmonella typhoe. 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 cloxacinil (16%) for Methicillin resistant Staphylococcus aureus. Piperacillin was preferred by 36% respondents for Pseudomonas aeruginosa followed by linezolid (11%) and cloxacinil (8%). A total of 64 (30%) marked ceftriaxone as preferred drug for Enteroxoccus faecalis and 58% preferred metronidazole for Clostridium difficile.

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%), cloxacinil (17%), and cephalozin (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

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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.\[18\] There is a 3 tier healthcare service delivery in Haryana; MCs are at the tertiary level, 22 DH, 37 sub-district hospitals, 107 CHCs 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.\[16\] 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 institutes and 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 player 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 patients is from Internal medicine (21%), followed by obstetrics and gynaecology (11%), pediatrics (8%), ophthalmology (8%), orthopedics (7%), general surgery (6%), dermatology (6%), dentistry (5%), otorlaryngology (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 enhance cautious 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
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 policy in 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 to barriers 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.[26]

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                                       |                |                |                                             |    |
| 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 (0.562)                                 | 0.6|
| Not at all                                                                       | 0              | 0              |                                             |    |
| Knowing which bacteria are common in the facility and what works for them       |                |                |                                             |    |
| 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              | 0              |                                             |    |
| By understanding the dosage requirements of the patient                         |                |                |                                             |    |
| 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              | 0              |                                             |    |
| Decreasing use of high end/reserved antibiotics (like meropenem)                |                |                |                                             |    |
| 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                                   |                |                |                                             |    |
| 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              | 0              |                                             |    |
| Hand hygiene                                                                    |                |                |                                             |    |
| 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                                       |                |                |                                             |    |
| 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                   |                |                |                                             |    |
| 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)                     |                |                |                                             |    |
| 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)
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. Optimizing surgical antibiotic prophylaxis is a high-impact intervention, and it is a decent starting point for organizations beginning an AMR initiative. 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. Ossaidiom et al. 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.

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.

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