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# Assessment of the perception of physicians concerning antibiotic use and resistance along with the factors influencing the prescription of antibiotics: a situational analysis from Pakistan

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**A** – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

**Summary** **Background.** Antimicrobial resistance is an emerging problem worldwide, having a negative influence on patient outcomes. As compared to high and upper middle-income countries, the condition is miserable in low- and middle-income countries, including Pakistan.

**Objectives.** This study aims to assess the perception of physicians concerning antibiotic use and resistance, the factors influencing the prescription of antibiotics and interventions to improve the prescribing behavior in Pakistan.

**Material and methods.** A cross-sectional survey was performed among physicians practicing in different hospitals of Lahore, Pakistan. A 60-item survey instrument was developed in consultation with a group of experts after a literature review of previous comparable studies. The questionnaire was distributed to physicians practicing in different healthcare settings of Lahore, Pakistan.

**Results.** A total population of 200 physicians filled in the questionnaire, with a response rate of 72.7%. The majority of physicians were younger (*n* = 124, 62%), with an age group of 23–29 years. Most of the physicians reported that antibiotics are overused nationally (*n* = 190, 95%). However, they did not always agree that antibiotics are overused in their own institutions. A majority of physicians believed that strong knowledge of antibiotics is important in their career (*n* = 184, 92%). Of the total, 176 (88%) physicians believed that inappropriate use of antibiotics is professionally unethical.

**Conclusions.** Our findings showed that physicians are well aware of the importance of antibiotic resistance and reported that rational use of antibiotics will aid in resolving this issue. Therefore, the introduction of educational sessions regarding antibiotic use and its resistance and innovative approaches to attract healthcare practitioners' attention towards antibiotic stewardship programs are urgently needed.

**Key words:** drug resistance, microbial, physicians, Pakistan.

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## Background

To promote appropriate use of drugs, it is essential to collect data regarding the pattern of drug prescriptions and factors affecting prescribing options [1]. Antimicrobial resistance is an emerging public health problem worldwide, having a negative influence on patient outcomes [2–4]. About 40% of antibiotic usage is either inappropriate or unnecessary [5]. The increased use of antibiotics has led to the initiation of national guidelines and policies to enhance antibiotic stewardship in many countries [6]. The chief goal of antibiotic stewardship is to improve clinical outcomes while reducing unintentional outcomes of antibiotic use that include side effects, selection of microorganisms and development of resistance [7]. In order to improve organization of the healthcare system and to change the prescribing behavior of healthcare practitioners, a multifaceted strategy is favored [7, 8]. Proper recommendations and well-oriented interventions are often insufficient in improving the behavior of physicians in clinical settings. The success of the implementation clinical practice guidelines depends on the consideration of a variety of barriers. Factors include patient factors, to coordinate with physicians, guideline factors, such as guideline characteristics, and environmental factors, such as lack of resources, lack of time, lack of reimbursement and lack of adequate knowledge [9, 10].

Awareness of antibiotic resistance is increasing among the general public and medical community, and the impact of resistance on clinical, as well as economic, outcomes is the main issue of ongoing research. Awareness of the impact on antibiotic resistance has several benefits [2]. Firstly, this information regarding antibiotic resistance with respect to patient outcomes may provoke hospitals and healthcare professionals to initiate a multifaceted approach to prevent infections. Secondly, such knowledge can also help policy makers regarding funding of infection control and prevention programs. Thirdly, such information can also be useful for healthcare practitioners to make appropriate choices with respect to antibiotic use according to guidelines. Knowledge regarding antibiotic resistance may be substantial in elucidating the prognosis for infected individuals. Multisite studies have been published regarding physicians' attitudes towards antibiotic use, as well as the emergence of resistance and prescribing behavior in inpatient settings [11,

12]. A change in prescribing behavior will require changes in the behavior of healthcare practitioners, and thus it is necessary to figure out what healthcare practitioners know about antibiotics, how they use their knowledge and what factors affect their prescription of antibiotics [13, 14].

## Objectives

The present study is aimed at assessing the perception of physicians concerning antibiotic use and resistance, the factors influencing prescription of antibiotics and interventions to improve prescribing behavior.

## Material and methods

### Study design, period and setting

A traditional paper and pencil cross-sectional, anonymous and voluntary survey was conducted among physicians practicing in different hospitals of Lahore, Pakistan. Lahore is a major metropolitan city of Pakistan with advanced healthcare settings. The study was conducted between December 2017 and March 2018. The study was started after receiving ethics approval from the human ethics committee of the University College of Pharmacy, University of the Punjab (HEC/1000/PUCP/1925PhKAP). The physicians involve in this survey were qualified as resident physicians to specialized physicians.

### Survey instrument

A 60-item survey instrument was developed in consultation with a group of experts after a literature review of previous comparable studies [5, 11–13, 15–20]. The questionnaire consists of 5 sections: the first section consists of demographics and the professional profile of the physician; the second section consists of perception about antimicrobial use; the third section consists of perception about antimicrobial resistance; the fourth section consists of factors influencing antimicrobial prescription; and the fifth section includes interventions to improve prescription of antibiotics. For the series of questions regarding perceptions about antibiotic use and resistance, a 5-item Likert scale was used, with response options from "strongly disagree" to "strongly agree". Whereas, another 5-item scale including never, rarely, sometimes, often and always was used to explore factors influencing prescription of antibiotics. Face and content validity was carried out by experts in the field of quantitative research. Cronbach's alpha determined the average correlation of items or internal consistency in the survey instrument to gauge its reliability (0.761). Before the full-scale study, pilot data was collected from 10 physicians, and changes were made in the survey instrument by removing any flaws accordingly.

### Survey administration

The sample size was calculated by using the Raosoft sample size calculator ($n$ = 268). Questionnaires were distributed to 275 physicians using the non-probability convenience sampling technique. The questionnaire included a detachable cover letter consisting of a consent form, which enabled tracking. The cover letter, comprised of details about the handling of the survey instrument and delinking of identity of respondents, was assured for its anonymity. A hard copy of the survey instrument was distributed to physicians practicing in different healthcare settings after receiving approval from each corresponding hospital. The filled in questionnaires were checked thoroughly, and any incomplete questionnaires were removed. There was no incentive for respondents in order to motivate participation.

### Data analysis

After circulation and collection of the questionnaires from all physicians, data was organized and compiled. All data was analyzed with SPSS software. Descriptive analyses included percentages for categorical and ordinal data. We tested for association among the various variables by using chi-square test. A $p$-value less than 0.05 was considered statistically significant.

## Results

Table 1 provides an overview of the basic demographics and professional profile of participating physicians. A total population of 200 participants filled in the questionnaire, with a response rate of 72.7% from different hospitals in Lahore. Most of the physicians were younger ($n$ = 124, 62%) in the age group of 23–29 years. Of the total, 118 (59%) respondents had graduated from public institutions, and the others had graduated from private institutions, having between 1–5 years of experience ($n$ = 108, 54%). Among all the physicians, 73 (36.5%) were medical officers, while the others include house officers ($n$ = 66, 33%), post graduate residents ($n$ = 39, 19.5%) and consultants ($n$ = 22, 11.0%). More than half of the respondents noted that they had been involved in less than 16 prescriptions of antibiotics in the last week ($n$ = 130, 65%) before the survey, while the others prescribe more than 16 antibiotics per week ($n$ = 70, 35%).

**Table 1. Demographic characteristics of participating physicians**

| Demographics | *n* | % |
|---|---|---|
| Gender | | |
| Male | 95 | 47.5 |
| Female | 105 | 52.5 |
| Age | | |
| 23–29 | 124 | 62.0 |
| 30–60 | 76 | 38.0 |
| Medical school | | |
| Public | 118 | 59.0 |
| Private | 82 | 41.0 |
| Experience | | |
| < 1 year | 32 | 16.0 |
| 1–5 year | 108 | 54.0 |
| 6–10 year | 27 | 13.5 |
| > 10 years | 33 | 16.5 |
| Medical specialty | | |
| General physician | 119 | 59.5 |
| Specialized physician | 81 | 40.5 |
| Designation | | |
| Medical officer | 73 | 36.5 |
| House officer | 66 | 33.0 |
| Post graduate resident | 39 | 19.5 |
| Consultant | 22 | 11.0 |
| Clinical setting | | |
| Inpatient | 34 | 17.0 |
| Outpatient | 27 | 13.5 |
| Approximately equal time between both | 139 | 69.5 |
| No. of antibiotics prescribed last week | | |
| 1–8 | 72 | 36.0 |
| 8–16 | 58 | 29.0 |
| > 16 | 70 | 35.0 |
| Practice setting | | |
| Public | 71 | 35.5 |
| Private | 42 | 21.0 |
| Both | 87 | 43.5 |
| Hospital type | | |
| Secondary | 54 | 27.0 |
| Tertiary | 58 | 29.0 |
| Teaching | 88 | 44.0 |

| Table 2. Perceptions about antimicrobial use | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Questions | SA *n* (%) | A *n* (%) | N *n* (%) | DA *n* (%) | SD *n* (%) | Age | Gender | Experience | Medical specialty | Designation | Clinical setting | Practice setting | Hospital type |
| Antibiotics are overused nationally | 92 (46.0) | 98 (49.0) | 9 (4.5) | 1 (.5) | 0 | – | – | – | – | – | – | – | 0.035 |
| Antibiotics are overused in my hospital | 48 (24.0) | 75 (37.5) | 42 (21.0) | 29 (14.5) | 6 (3.0) | – | – | – | – | – | 0.002 | 0.010 | – |
| Strong knowledge of antibiotics is important in my medical career | 127 (63.5) | 57 (28.5) | 11 (5.5) | 3 (1.5) | 2 (1.0) | – | – | – | – | – | – | – | – |
| I am confident that I use antibiotics optimally in the ICU | 41 (20.5) | 102 (51.0) | 47 (23.5) | 10 (5.0) | 0 | – | – | – | – | – | – | – | 0.013 |
| I am confident that I use antibiotics optimally in a non-ICU setting | 42 (21.0) | 93 (46.5) | 51 (25.5) | 11 (5.5) | 3 (1.5) | – | – | – | – | – | – | 0.033 | – |
| I overprescribe antibiotics | 20 (10) | 58 (29.0) | 41 (20.5) | 67 (33.5) | 14 (7.0) | – | – | – | – | – | – | 0.046 | – |
| Other doctors overprescribe antibiotics | 35 (17.5) | 71 (35.5) | 69 (34.5) | 23 (11.5) | 2 (1.0) | – | – | – | – | – | – | – | – |
| Pharmaceutical representatives do not influence my prescription of antibiotics | 56 (28.0) | 75 (37.5) | 39 (19.5) | 26 (13.0) | 4 (2.0) | – | – | – | – | – | – | – | – |
| Inappropriate use of antibiotics can harm patients | 101 (50.5) | 71 (35.5) | 25 (12.5) | 3 (1.5) | 0 | – | – | – | 0.044 | 0.008 | - | 0.031 | 0.003 |
| Inappropriate use of antibiotics is professionally unethical | 114 (57.0) | 62 (31.0) | 20 (10.0) | 3 (1.5) | 1 (.5) | – | – | – | – | – | 0.007 | – | – |
| I prescribe too many anti-microbials because of poor quality anti-microbials | 48 (24.0) | 57 (28.5) | 42 (21.0) | 44 (22.0) | 9 (4.5) | 0.027 | 0.033 | 0.013 | – | – | 0.045 | – | – |
| I prescribe anti-microbials according to availability in inventory | 48 (24.0) | 103 (51.5) | 26 (13.0) | 18 (9.0) | 5 (2.5) | – | – | 0.049 | – | – | – | – | – |

SA – strongly agree; A – agree; N – neutral; DA – disagree; SD – strongly disagree; significant difference ≤ 0.05 – non significant.

**Table 3. Perceptions about antimicrobial resistance**

| Questions | SA *n* (%) | A *n* (%) | N *n* (%) | DA *n* (%) | SD *n* (%) | Medical school | Experience | Medical specialty | Designation | Clinical setting | Hospital type |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Antibiotic resistance is a significant problem nationally | 87 (43.5) | 106 (53.0) | 5 (2.5) | 2 (1.0) | 0 | – | – | – | – | – | – |
| Antibiotic resistance is a significant problem in my hospital | 46 (23.0) | 104 (52.0) | 43 (21.5) | 7 (3.5) | 0 | – | – | – | – | – | – |
| Better use of antibiotics will reduce problems with antimicrobial resistance | 96 (48.0) | 95 (47.5) | 9 (4.5) | 0 | 0 | – | – | – | – | – | – |
| Poor hand hygiene causes antibiotic resistance | 43 (21.5) | 70 (35.5) | 51 (25.5) | 31 (15.5) | 5 (2.5) | – | – | – | – | – | – |
| Excessive use of antimicrobial in livestock/animal farms can cause resistance | 57 (28.5) | 79 (39.5) | 42 (21.5) | 17 (8.5) | 5 (2.5) | 0.016 | – | – | – | – | – |
| Paying too much attention to advertising causes resistance | 23 (11.5) | 67 (33.5) | 61 (30.5) | 40 (20.0) | 9 (4.5) | – | 0.007 | – | – | – | 0.027 |
| Lengthy durations of antimicrobial treatments can result in the development of resistance | 59 (29.5) | 91 (45.5) | 33 (16.5) | 14 (7.0) | 3 (1.5) | 0.033 | – | 0.015 | – | – | – |
| Too low doses of antimicrobial treatments can develop resistance | 40 (20.0) | 91 (45.5) | 43 (21.5) | 23 (11.5) | 3 (1.5) | – | – | – | – | – | – |
| Too many broad-spectrum antimicrobial treatments can result in the development of resistance | 46 (23.0) | 95 (47.5) | 44 (22.0) | 13 (6.5) | 2 (1.0) | – | – | – | – | – | – |
| I am concerned about antimicrobial resistance in the society | 77 (38.5) | 97 (48.5) | 21 (10.5) | 4 (2.5) | 1 (.5) | – | – | – | 0.021 | – | – |
| I am concerned about antimicrobial resistance in my hospital | 87 (43.5) | 85 (42.5) | 20 (10.0) | 7 (3.5) | 1 (.5) | 0.038 | – | – | – | 0.001 | – |
| Poor infection control practices increase the spread of antimicrobial resistance | 64 (32.0) | 103 (51.5) | 29 (14.5) | 4 (2.0) | 0 | – | – | – | – | – | – |

SA – strongly agree; A – agree; N – neutral; DA – disagree; SD – strongly disagree; significant difference ≤ 0.05 – non significant.

| Table 4. Factors influencing antimicrobial prescribing practices | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Factors | A *n* (%) | O *n* (%) | S *n* (%) | R *n* (%) | N *n* (%) | Age | Gender | Medical school | Experience | Medical specialty | Designation | Clinical setting | Practice setting | Hospital type |
| Antimicrobials can save cost by reducing length of hospitalization | 35 (17.5) | 63 (31.5) | 63 (31.5) | 23 (11.5) | 16 (8.0) | – | – | – | – | – | – | 0.026 | – | 0.002 |
| To avoid risk of potential infection | 39 (19.5) | 67 (33.5) | 65 (32.5) | 24 (12.0) | 5 (2.5) | – | – | – | – | – | – | – | 0.041 | 0.031 |
| Antibiotic prophylaxis prevents postoperative infection | 29 (14.5) | 81 (40.5) | 50 (25.0) | 23 (11.5) | 17 (8.5) | – | – | 0.043 | – | – | – | – | – | 0.003 |
| Patient demands antibiotics | 34 (17.0) | 49 (24.5) | 61 (30.5) | 45 (22.5) | 11 (5.5) | – | – | – | – | – | – | – | – | 0.014 |
| Patient is critically ill | 42 (21.0) | 60 (30.0) | 59 (29.5) | 27 (13.5) | 12 (6.0) | 0.016 | 0.010 | – | – | – | – | 0.042 | 0.002 | 0.031 |
| Patient is immune compromised | 38 (19.0) | 47 (23.5) | 67 (33.5) | 37 (18.5) | 11 (5.5) | – | – | – | – | – | – | – | – | 0.008 |
| Unexplained fever even if culture results are negative | 15 (7.5) | 58 (29.0) | 64 (32.0) | 47 (23.5) | 16 (8.0) | – | 0.014 | – | 0.017 | 0.037 | 0.029 | – | – | – |
| Leukocytosis even if culture results are negative | 17 (8.5) | 45 (22.5) | 67 (33.5) | 52 (26.0) | 19 (9.5) | 0.002 | 0.047 | – | 0.046 | 0.000 | – | – | 0.003 | 0.036 |
| Too much prescribing can increase the risk of *C. difficile* colitis | 19 (9.5) | 53 (26.5) | 60 (30.0) | 50 (25.0) | 18 (9.0) | – | – | – | 0.000 | 0.007 | – | – | 0.015 | – |

A – always; O – often; S – sometimes; R – rarely; N – never; significant difference ≤ 0.05 – non significant.

**Table 5. Helpfulness of potential interventions to improve prescription of antibiotics**

| Interventions | SA *n* (%) | A *n* (%) | N *n* (%) | DA *n* (%) | SD *n* (%) | Medical school | Experience | Practice setting | Hospital type |
|---|---|---|---|---|---|---|---|---|---|
| Pharmaceutical representative | 38 (19.5) | 94 (47.0) | 45 (22.5) | 13 (6.5) | 10 (5.0) | 0.015 | 0.026 | – | – |
| Restricted prescription of all AM | 34 (17.0) | 103 (51.5) | 52 (26.0) | 10 (5.0) | 1 (0.5) | 0.038 | – | – | – |
| Advice from a pharmacist (hospital/clinical) | 52 (26.0) | 88 (44.0) | 35 (17.5) | 20 (10.0) | 5 (2.5) | – | – | – | – |
| Advice from infection control/antimicrobial management team | 40 (20.0) | 122 (61.0) | 33 (16.5) | 2 (1.0) | 3 (1.5) | 0.025 | 0.028 | – | – |
| Computer-aided prescribing | 48 (24.0) | 92 (46.0) | 36 (18.0) | 19 (9.5) | 5 (2.5) | – | – | – | – |
| Availability of resistance data/microbiological data | 42 (21.0) | 111 (55.5) | 43 (21.5) | 3 (1.5) | 0 | – | – | 0.006 | – |
| Advice from senior colleagues | 52 (26.0) | 109 (54.5) | 28 (14.0) | 7 (3.5) | 2 (1.0) | – | – | – | – |
| Audit and feedback | 44 (22.0) | 97 (48.5) | 51 (25.5) | 8 (4.0) | 0 | – | – | – | – |
| Educational sessions | 75 (37.5) | 90 (45.0) | 26 (13.0) | 6 (3.0) | 3 (1.5) | – | – | – | – |
| Availability of local guidelines | 77 (38.5) | 91 (45.5) | 29 (14.5) | 3 (1.5) | 0 | – | – | – | – |
| Wait for the microbiology results before treatment | 51 (25.5) | 82 (41.0) | 46 (23.0) | 20 (10.0) | 1 (.5) | – | – | – | – |
| Rapid and effective diagnostic techniques | 80 (40.0) | 92 (46.0) | 17 (8.5) | 9 (4.5) | 2 (1.0) | – | – | – | 0.001 |
| Ward rotations | 48 (24.0) | 104 (52.0) | 30 (15.0) | 13 (6.5) | 5 (2.5) | – | – | – | – |
| Off-campus lectures sponsored by pharmaceutical companies | 49 (24.5) | 86 (43.0) | 36 (18.0) | 16 (8.0) | 13 (6.5) | – | – | – | – |
| Medical journals | 67 (33.5) | 105 (52.5) | 21 (10.5) | 6 (3.0) | 1 (.5) | – | – | – | – |
| Conferences | 76 (38.0) | 90 (45.0) | 29 (14.5) | 5 (2.5) | 0 | – | – | – | – |

SA – strongly agree; A – agree; N – neutral; DA – disagree; SD – strongly disagree; significant difference ≤ 0.05 – non significant.

Table 2 depicts the perceptions of physicians concerning antimicrobial use in their daily routine. Most of the physicians were in agreement concerning the statement that antibiotics are overused nationally ($n$ = 190, 95%), although some physicians settled in tertiary hospitals remained neutral ($p$ = 0.035). A majority of the physicians believed that strong knowledge of antibiotics is important in their career ($n$ = 184, 92%). Most of the physicians were confident that they use antibiotics optimally in both ICU ($n$ = 143, 71.5%) and non-ICU settings ($n$ = 135, 67.5%), respectively. Almost equal numbers of physicians agreed ($n$ = 78, 39.0%) and disagreed ($n$ = 81, 40.5%) that they over-prescribe antibiotics, while some respondents practicing in private sectors significantly disagreed that they over-prescribe antibiotics ($p$ = 0.046). More physicians agreed that interactions with pharmaceutical representatives do not influence their antibiotic selections ($n$ = 131, 65.5%). Physicians mostly believed ($n$ = 172, 86%) that inappropriate use of antibiotics can harm patients. A majority of physicians agreed ($n$ = 176, 88%) with the statement that inappropriate use of antibiotics is professionally unethical.

The perceptions of physicians about antimicrobial resistance in patients is presented in Table 3. A majority of the physicians agreed with the statement that antibiotic resistance is a significant problem nationally and in their hospitals ($n$ = 193, 96.5% and $n$ = 104, 75%, respectively). According to physicians, the appropriate use of antibiotics can reduce problems associated with antimicrobial resistance ($n$ = 191, 95.5%). More than half of the physicians agreed that poor hand hygiene is one of the causes of antibiotic resistance ($n$ = 113, 56.5%). Most of the physicians believed that long-term therapies of antimicrobial agents can result in the development of resistance ($n$ = 150, 75%). A majority of the physicians believed that low doses ($n$ = 131, 65.5%) and the use of broad-spectrum antimicrobials ($n$ = 141, 70.5%) can result in the development of resistance. Most of the physicians ($n$ =167, 83.5%) were agreed with the statement that poor infection control practices by healthcare professionals' cause spread of antimicrobial resistance.

Factors influencing antimicrobial prescribing practices are mentioned in Table 4. Some physicians caring for outpatients ($p$ = 0.026) and those from secondary hospitals ($p$ = 0.002) said that quite often antibiotics can save on the cost of treatment by reducing the length of hospitalization. Most of the physicians believed that antibiotic prophylaxis often prevents postoperative infection ($n$ = 80, 40.5%), but some physicians who graduated from public institutions ($p$ = 0.043) and some working in a tertiary setting ($p$ = 0.003) showed that antibiotic prophylaxis quite often prevents postoperative infection. According to some physicians from teaching hospitals, sometimes patients demands antibiotics ($p$ = 0.014). About 67 physicians (37.5%) reported that antibiotics are sometimes prescribed when the patient is immune compromised. Male participants ($p$ = 0.014), physicians having experience greater than 10 years ($p$ = 0.017), some specialized physicians ($p$ = 0.037) and some post graduate residents ($p$ = 0.029) were more likely to give antibiotics when there was an unexplained fever, even if culture results are negative. Most physicians agreed that too much antimicrobial prescribing can increase the risk of developing *Clostridium difficile* colitis ($n$ = 60, 30%).

Table 5 overviews the potential interventions to improve the prescription of antibiotics. A majority of the participants believed that restricted prescription of all antimicrobials is important in improving the prescription of antibiotics ($n$ = 137, 68.5%), while some from private schools particularly agreed ($p$ = 0.038). Most of the physicians believed that advice from a hospital or clinical pharmacist is necessary in prescribing antibiotics ($n$ = 140, 70%). A majority of the physicians reported that advice from the infection control team or antimicrobial management team is helpful in the intervention of prescribing antibiotics ($n$ = 162, 81%). More physicians were in agreement that computer-aided prescribing is very helpful in prescribing antibiotics ($n$ = 140, 70%). A majority of the respondents agreed with the statements that advice from senior colleagues ($n$ = 161, 80.5%) and audit and feedback ($n$ = 70.5%) are helpful in prescribing antibiotics. Educational sessions ($n$ = 165, 82.5%) and the availability of local guidelines ($n$ = 168, 84%) were thought to be more helpful in prescribing antibiotics. Rapid and effective diagnostic techniques were thought to be an important intervention in prescribing antibiotics by most of the physicians ($n$ = 172, 86%), while some physicians working in teaching hospitals were significantly in agreement regarding this statement ($p$ = 0.001). A majority of the physicians agreed that ward rotations ($n$ = 152, 76%), off-campus lectures sponsored by pharmaceutical companies ($n$ = 135, 67.5%), medical journals ($n$ = 172, 86%) and conferences ($n$ = 166, 83%) are important and helpful interventions in prescribing antibiotics.

## Discussion

Antibiotic resistance is a local as well as national issue in healthcare settings, resulting in an increase in mortality and morbidity rates. This study evaluated physicians' perceptions regarding antibiotic use and resistance and factors affecting antibiotic prescribing behavior. Most of the physicians were in agreement that antibiotics are overused nationally. Appropriate use of restricted antimicrobial agents can reduce the overuse of antibiotics. Occasionally, in order to resolve one issue, it may be replaced by the emergence of another issue. For example, with the restriction of use of cephalosporins in ceftazidime-resistant *Klebsiella*, the incidence of imipenem-resistant *Pseudomonas aeruginosa* is increased [21]. Antibiotic restriction targets not only the reduction of antibiotic resistance but also reduces healthcare costs, decreases the length of hospital stay and improves patient outcomes [22]. A majority of the physicians believed that strong knowledge of antibiotics is important in their career. Multidisciplinary teams composed of physicians, pharmacists, microbiologists and infection prevention and control practitioners should initiate antibiotic stewardship programs based on ongoing research regarding antibiotic use and resistance [23].

Most of the physicians believed that they over-prescribe antibiotics. Physicians mostly reported that inappropriate or unnecessary use of antibiotics can harm patients. Antibiotic management programs have demonstrated substantial healthcare cost savings as a result of decreased antibiotic usage, thus improving patient safety [7]. Inappropriate use of antibiotics is professionally unethical. Physicians were mostly in agreement that they prescribe antibiotics according to their availability in inventory. Our findings reported that a majority of the physicians believed that low doses and the use of broad-spectrum antimicrobials can result in the development of resistance. Within healthcare settings, a minimum demand of antibiotics sequentially decreases healthcare costs [24]. A majority of physicians agreed that poor infection control practices by healthcare professional causes the spread of antimicrobial resistance. Male participants, physicians having experience greater than 10 years, some specialized physicians and post-graduate residents were more likely to give antibiotics for an unexplained fever even if the culture results are negative ($p < 0.05$). Most physicians agree that too frequent anti-microbial prescriptions can sometimes increase the risk of developing *Clostridium difficile* colitis. A few studies have reported that antibiotic resistance is sometimes the most important risk factor for *Clostridium difficile* infection [25, 26]. The emergence and escalation of resistant pathogens have threatened the efficacy of antibiotics [27]. A majority of the participants believed that restricted prescription of all antimicrobials is important in improvoving prescribing antibiotics. Inappropriate prescribing or overuse of antibiotics can bring about the emergence of antibiotic resistant pathogens [28, 29]. In order to optimize the prescribing behavior, a targeted multidisciplinary approach is needed [30]. The prescribing

behavior can be affected by professional relationships and the medical hierarchy, resulting in "prescribing etiquette", including, for instance, hesitancy to change a prescription that is written by practitioners or an inclination to accompany the pattern set by senior prescribers [31, 32]. About 81% of physicians agreed that advice from the infection control team or antimicrobial management team is a helpful intervention in prescribing antibiotics. International efforts are required to hinder the emergence of resistance [33].

More physicians agreed that computer-aided prescribing is very helpful in prescribing antibiotics. A telephone-based system and computerized system have obvious benefits, requiring organizational devotion towards antibiotic management programs [23]. A majority of physicians believed that educational sessions and the availability of local guidelines were thought to be more helpful in prescribing antibiotics. Rapid and effective diagnostic techniques were thought to be an important intervention in prescribing antibiotics by most of the physicians. A majority of the physicians agreed that ward rotations, off-campus lectures sponsored by pharmaceutical companies, medical journals and conferences are important and helpful interventions in prescribing antibiotics. Antibiotic utilization can be improved by following multidisciplinary, evidence-based guidelines, which can be implemented by education and feedback providers [34].

### Limitations of the study

This study has some limitations. The primary limitation of this study was that we cannot rationalize our findings to all hospitals of Pakistan. Another potential limitation was the participants, who may not represent the overall population at the different hospitals surveyed in Lahore, Pakistan. Nevertheless, we believed that our findings are inspiring and have demonstrated a universal substructure for antibiotic restriction policies and antibiotic management programs in hospitals and other healthcare settings.

## Conclusions

Our findings showed that physicians are well aware of the importance of antibiotic resistance and reported that rational use of antibiotics will aid in the resolution of this issue. Furthermore, our results showed that most of the physicians believed that antibiotics were used unnecessarily or inappropriately, which causes the patient harm. However, they did not always agree that antibiotics are overused in their own institutions. The initiation of educational programs regarding antibiotic use and its resistance and innovative approaches to attract healthcare practitioners' attention towards antibiotic stewardship are urgently needed. Strategies such as infection prevention and control programs should also be implemented to reduce inappropriate use of antibiotics and the spread of nosocomial infection. An appropriate approach towards refining guideline adherence and a set-up for future investigation is required.

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