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## Knowledge, attitude and perception survey of doctors regarding antibiotic use and resistance in Karachi, Pakistan

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### Abstract

**Objective:** To establish a better understanding of physicians' knowledge and beliefs, and to compare distinctions in knowledge, attitude and perception of junior and senior doctors regarding rational use of antibiotics.

**Methods:** The cross-sectional study was conducted at a tertiary care hospital in Karachi, from June 1 to July 31, 2016, and comprised senior and junior doctors. A 26-item questionnaire divided in three sections was used to test knowledge, attitude and perception of the subjects regarding rational use of antibiotics. Data was analysed using SPSS 23.

**Results:** Of the 200 subjects, 132(66%) were senior doctors; 68(34%) were junior; 116(58%) were females; 84(42%) were males; and the highest number of respondents were from General Medicine 65(32.5%). While 182(91%) doctors realised that antibiotic resistance was a pressing issue, only 131(65.5%) felt confident about their prescriptions and 94(47%) admitted that they over-prescribed antibiotics. Among young physicians, 13(19.1%) believed that antibiotics did not cause side effects even when prescribed unnecessarily. Also, 47(69.1%) junior doctors felt that patients' demands influenced their prescriptions compared to 66(50%) senior doctors ( $p=0.01$ ).

**Conclusion:** Although physicians were found to be knowledgeable about rational use of antibiotics, there were gaps in knowledge and perception.

**Keywords:** Antimicrobial resistance, Antibiotic stewardship, Public health, Misuse of antibiotics. (JPMA 70: 1023;2020)  
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### Introduction

Antibiotic resistance is a phenomenon that has been known to the world for the past six decades. Initially touted as 'wonder drugs', the increasing use of the same antibiotics has led to natural selection of bacteria to produce resistant descendants to combat them, reducing their efficacy. Antibiotics are one of the most frequently prescribed drugs, making them susceptible to abuse; approximately 20-50% of antibiotics prescribed to patients are either unmerited or inappropriate.<sup>1,2</sup> The frequent misuse of antibiotics has become one of the major factors in the development of antibiotic resistance worldwide. The United States S Centres for Disease Control and Prevention (CDC) estimates that antibiotic-resistant organisms infect more than two million people in the US alone, resulting in approximately 23,000 deaths annually, and these numbers are estimates which means the true burden of resistance is much higher.<sup>3</sup> What makes the prospect of global antibiotic resistance a bleak one is the fact that there are no immediate solutions in sight.

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The World Health Organisation (WHO) defines rational drug use as medication that is received by the patient appropriate to their clinical needs, in doses that meet their individual requirements, for an adequate period, which is available at the lowest cost to them and their community.<sup>4</sup> However, this idea is primitive to the developing world. The excessive use of antibiotics, over-the-counter availability of antibiotics without a prescription from a licensed doctor, and poor policies for infection control are the three main contributing factors to antibiotic resistance in society.<sup>5</sup> This unrestricted access to antibiotics escalates the problem of resistance among the general population, along with poor sanitation, overcrowding, and a warm, humid climate.<sup>6</sup> Hospitals are equally responsible for antibiotic misuse as primary healthcare practitioners. Discrepancies in the knowledge, attitude and perception of physicians are at the helm of incorrect and excessive antibiotic prescription, and correcting these may be the key to a possible solution. However, they have not been researched adequately on a national level. In Pakistan, an average of 1-4 antibiotics per prescription was being prescribed by physicians among 45.19% of the patient population.<sup>7</sup> Furthermore, a study conducted in Pakistan to analyse the prescriber's approach towards reasonable drug practice found that doctors were erroneously

prescribing medication to patients on a daily basis, and the medicine prescribed was irrational with respect to patient's illness with high levels of error in choosing a medication.<sup>8</sup>

Pakistan lacks a national surveillance programme for antibiotic resistance. Furthermore, research on the root cause of antibiotic resistance, and the general physicians' point of view in the country are scarce.

The current study was planned to assess the knowledge, attitude and perception of doctors about proper use of antibiotics, and to compare distinctions on all three counts between junior and senior doctors.

### Subjects and Methods

The cross-sectional study was conducted at a tertiary care hospital in Karachi, from June 1 to July 31, 2016, and comprised senior and junior doctors. After approval by the institutional ethics committee, the sample size was calculated using frequency of physicians who agreed that antibiotics are overuse in general as 88% with margin of error 5% at 95% confidence interval (CI).<sup>9</sup> The computed sample size was 163 to which 5% non-response rate was added.

The sample comprised senior doctors, including consultants and postgraduates (PGs), and junior doctors who were house officers working in the hospital. The PGs were included as senior doctors since they were in the final year of their structured fellowship programme and were working alongside the consultants in running the clinics and managing in-patients, hence having a greater knowledge on the subject than the house officers. Departments that had less than 15 participants were excluded, as the small number of responses from these departments could have resulted in a bias conflicting with responses from the departments with a much greater

number of participants.

A self-designed, pilot-tested, self-administered questionnaire was distributed among all the participants after taking informed consent from each of them. All doctors working in the hospital understood simple English, and, hence, that was the language of choice for the questionnaire which had 26 items that were to be answered by the physicians based on their knowledge (8 questions), attitude (7 questions), and perception (11 questions) towards antibiotic use and resistance. Each question was a statement to which the respondents had to either agree or disagree.

Data was analysed using SPSS 23, and was expressed as frequencies and percentages. No imputation techniques were used for the missing values.  $P < 0.05$  was considered statistically significant.

### Results

Of the 250 doctors among whom the questionnaire was distributed, 200(80%) completed the questionnaire. Of them, 132(66%) were senior and 68(34%) were junior doctors. Female participants were 116(58%) and 84(42%) were male. The highest number of respondents were from the Department of General Medicine 65(32.5%) (Figure-1).

In terms of knowledge, 182(91%) doctors believed that antibiotic resistance was a pressing issue, but only 131(65.5%) felt confident about their optimal use of antibiotics; 42(62%) junior and 89(67%) senior doctors ( $p=0.426$ ).

Overall, 94(47%) participants thought they overprescribed antibiotics; 30(44%) junior and 64(48.5%) senior physicians ( $p=0.537$ ).

Also, 83(41.5%) participants stated it was difficult to select

**Table:** Studies from Pakistan highlighting irrational use of antibiotics and poor infection control policies indicating need of an intervention to control such improper use which leads to antibiotic resistance.

Author	Year	Study findings
Das N et al <sup>7</sup>	2001	The prescribing practices of the consultants were found to be liberal and not rational. Overuse of antimicrobials was observed which was about 13.45%
Amin A et al <sup>8</sup>	2011	The drug prescribing practice among hospitalized patients were found to be irrational, with antibiotics being the most prescribed drug i.e. 80%.
Siddiqui S et al <sup>26</sup>	2014	A need of an intervention was strongly suggested to increase awareness regarding judicious use of antibiotics and to check un-prescribed dispensing of antibiotics.
Zaidi S et al <sup>27</sup>	2013	This review provided evidence of irrational drug use in areas of medicine prescription, dispensing and self-medication. It also pointed out the lack of an efficient drug regulation policy and need of a standardized research to improve policy making.
Hafeez A et al <sup>28</sup>	2004	According to this study, the prescription and dispensing practices of drugs were found to be unsatisfactory in the public sector health facilities with antibiotics being the most prescribed drug overall.
Bilal M et al <sup>29</sup>	2016	According to this study, the self medication rate with antibiotics were significantly higher in the rural areas of Sindh and the two most frequent reasons presented were economic (i.e. low cost of the drug compared to the physicians fee) and the easy over-the-counter availability of antibiotics from local pharmacies.

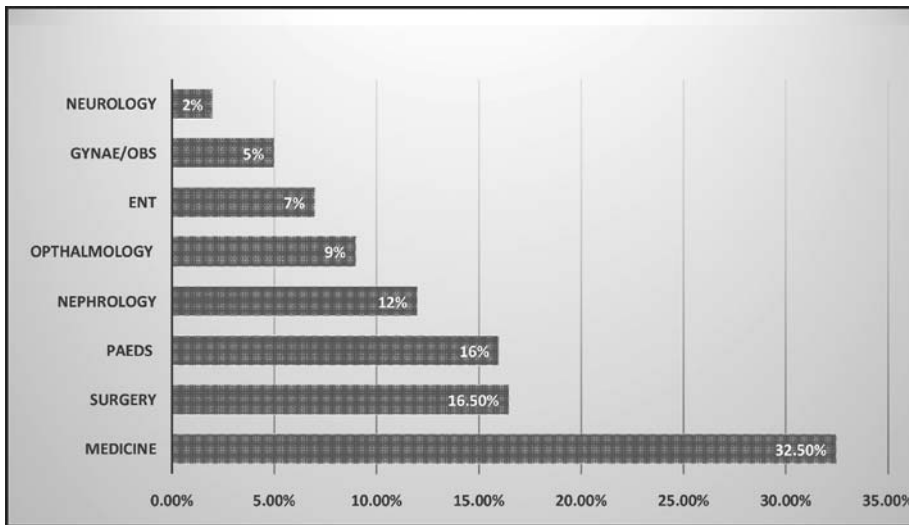


Figure-1: Percentages of response from various departments.

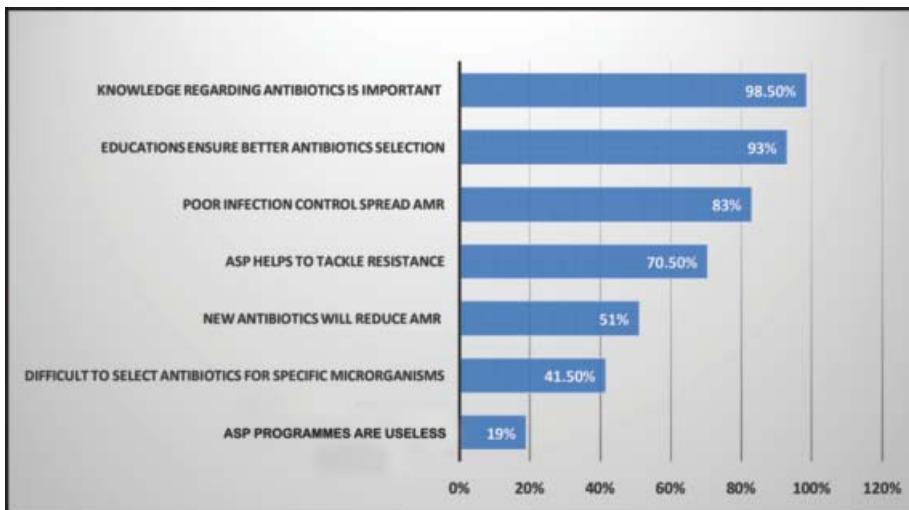


Figure-2 : Response on knowledge based questions. AMR=Antimicrobial Resistance

a single antibiotic for a specific infectious agent, and all (100%) juniors doctors thought that better education will lead to better selection of antibiotics, while 126(95.5%) of the seniors doctors also agreed.

Of the total, 197(98.5%) subjects agreed that strong knowledge of antibiotics was essential and better education on antibiotic use will lead to decreased resistance. Also, 53(78%) junior and 113(85.6%) senior accepted that poor infection control by practitioners was the main culprit behind antibiotic resistance. The greatest variation in knowledge between the two groups was on the statement that newer antibiotics will cut down on antibiotic resistance in the future, to which 41(60.3%) junior and 61(46.2%) senior doctors agreed

( $p=0.06$ ) (Figure-2).

With regards to the attitude, 178(89%) subjects believed that antibiotics were overused nationally, but only 111(55.5%) agreed that it was a trend in their own hospital. Among the junior physicians, 49(72%) and among the senior doctors, 87(65.9%) were providing awareness to their patients about completing the antibiotic course at the time of prescription. Among the young physicians, 13(19.1%) believed that antibiotics did not cause any harm to the patients even if prescribed without the need. The corresponding number among seniors doctors was 12(9.1%) ( $p=0.043$ ). Awareness of the hospital formulary was present in 23(33.8%) junior and 24(18.2%) senior doctors ( $p=0.014$ ).

Besides, 34(50%) junior doctors and 72(54.5%) seniors doctors agreed that local guidelines were more beneficial than international guidelines regarding antibiotic use. The attitude of physicians did not vary based on experience in the remaining questions ( $p>0.05$ ) (Figure-3).

In term of perception, 193(96.5%) participants agreed that inappropriate use of caused antibiotic resistance, and 184(92%) agreed that better use and feedback on antibiotic selection will reduce the problem. Besides, 70(35%) doctors believed that pharmaceutical representatives provided useful information on antibiotic selection. Among the junior doctors, 27(39.7%) and among the senior doctors, 50(37.9%) agreed that residents overprescribed antibiotics more than faculty members. Also, 47(69.1%) junior doctors felt that patients' demands influenced their prescriptions compared to 66(50%) senior doctors ( $p=0.01$ ). Among the junior doctors, 64(94.1%) were more inclined towards consulting fellow physicians before prescribing antibiotics than their seniors 102(77.3%) ( $p=0.003$ ). Overall, 86(43%) doctors believed that the use of antibiotics in the agricultural industry supported the

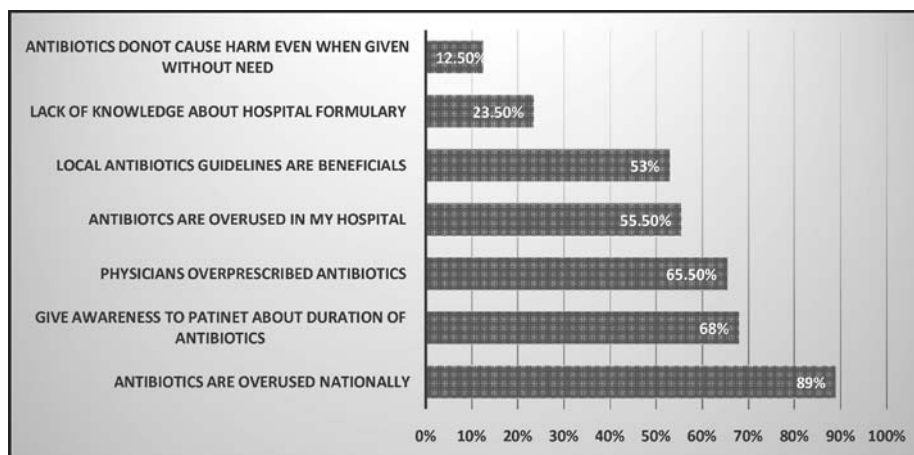


Figure-3: Participants who agreed on attitude-based questions.

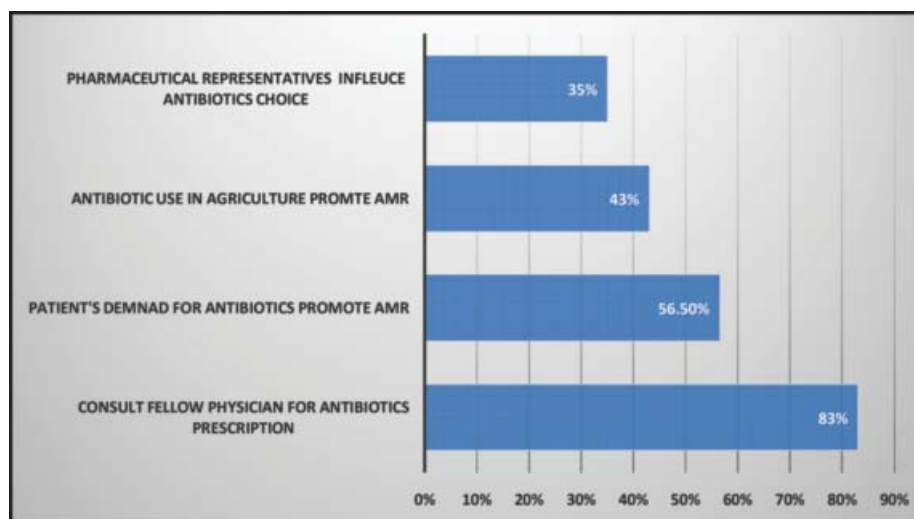


Figure-4: Participants who agreed on perception-based questions. AMR= Antimicrobial Resistance

spread of antibiotic resistance in the community. There were no other significant differences in perception between junior and senior doctors (Figure-4).

## Discussion

Antimicrobial resistance (AMR) and spread of multidrug-resistant organisms (MDROs) are major public health concerns. Physicians can play a central role in preventing the spread of AMR and dissemination of awareness about rational use of antibiotics, hence saving antibiotics to be available for treatment of infections for future generations.

Majority of participants in the current study had good understanding of issues related to antibiotic prescription, and supported the need of good infection control practices and antibiotic stewardship programme (ASP) to

decrease the spread of MDROs.

ASP is an organised intervention to increase and measure the appropriate use of antimicrobial agents and helps in the proper selection of the best antibiotics regimen, including dosing, duration of therapy, route of administration etc.<sup>9</sup> Successful implementation of infection prevention and control practices also decreased the spread of MDROs and contained the spread of AMR.<sup>10</sup> There is an urgent need of ASP and proper infection control practices in every hospital to combat the threat of DMRO spread in the community. Educating and creating awareness among freshly medical graduates and senior doctors is the key to counter this detrimental issue.<sup>11,12</sup>

Although most of the physicians in the study knew that antibiotic resistance was a pressing issue, a little more than half felt confident about their optimal use of antibiotics, including over-prescription of antimicrobial agents with no difference between junior and senior doctors. This is in contrast with findings of previous studies which showed senior doctors to be more confident than junior doctors in their antimicrobial use.<sup>5,13</sup> The probable

reason for less confidence among senior doctors in our study may be due to the increased incidence of MDROs in our country, particularly in hospitalised patients, with only a few antibiotic choices left to treat the patients.

Furthermore, greatest variation in knowledge between the two groups was seen when more than half of senior doctors did not feel that newer antibiotics will cut down resistance. Multiple years of practising and daily prescription may have made senior doctors too comfortable in their own way to welcome newer drugs. If used optimally, older antibiotics may be the key in treating multi-drug resistant infections,<sup>14</sup> which senior doctors may have seen in practice with positive results and, hence, they see no reason to change. Fresh graduates are given immense knowledge about the rise

of antibiotic resistance and, thus, are open to the idea of using newer antimicrobials that can combat this problem.

We found that most doctors, regardless of their experience, believed that misuse of antibiotics and antibiotic resistance are more of national problems than a problem at their own institution, indicating that clinicians may be disregarding or overlooking antibiotic resistance present in their hospitals due to a lack of awareness about their institution's data on incidence of MDROs, lack of active surveillance of MDROs in the healthcare facility, lack of ASM, lack of organization's antibiotics guidelines and policy or simply due to bias. These findings were similar to previous studies which also reported that doctors agree on the magnitude of antibiotic resistance on a theoretical basis, but not a practical one when considering their own practices.<sup>13,15</sup>

Our data showed that a significantly higher proportion of junior doctors felt that antibiotics do not cause adverse effects even if the patient does not need them. Inexperienced doctors do not realise that taking antibiotics when unnecessary can result in resistance due to the effects of antibiotics on harmless microbial ecosystems within the human body.<sup>16</sup> This attitude may, in turn, be contributing to their over-prescription of antibiotics and AMR. A substantial proportion of study participants were not aware of hospital formulary and did not consider that local antibiotics guidelines were more beneficial than international guidelines, which the doctors can depend on while choosing an appropriate management option for their patients. Local guidelines are more helpful in cases where a specific organism is seen having a higher resistance rate to an antibiotic compared to other regions, where the resistance rate is less of a problem. This has been noted among urinary tract infection (UTI)-causing organisms in certain Latin American countries.<sup>17</sup> Another example is the recent outbreak of extensively drug-resistant (XDR) *Salmonella* Typhi in Sindh.<sup>18</sup> However, doctors may prefer international guidelines because they are more reliable and heavily researched than the local ones.

A significant number of physicians do not counsel their patients about proper use of antibiotics. Patients' influence on the doctors for prescribing antimicrobials was more noticed with doctors; a fact also observed in other studies.<sup>19,20</sup> Physicians through proper communication can play an important role in educating the patients about appropriate use of antibiotics and can have a positive impact on decreasing AMR incidence.<sup>21</sup>

A large and compelling body of scientific evidence demonstrates that injudicious use of antibiotics in agriculture, particularly in animal food, contributes to the

emergence of resistant bacteria and their spread to humans.<sup>22,23</sup> One intervention of the global action plan on antimicrobial resistance by WHO is to reduce use of all classes of medically important antimicrobials in food-producing animals.<sup>24</sup>

A significant number of participants stated that pharmaceutical representatives influenced the selection of an appropriate antibiotic for their patients, which is a fact very well recognised.<sup>11,25</sup> It points out that pharmaceutical representatives do play a major role in antibiotic resistance which may be due to inadequate knowledge, or an ulterior motive to increase the marketing value of their drug.

We found that junior doctors also tend to consult their fellow physicians much more often than senior doctors in order to avoid inappropriate prescription, which correlates with a previous study.<sup>8</sup> This finding was also in line with other studies done in Pakistan showing irrational drug practices among physicians<sup>7,8,26-29</sup> (Table). Consultation with infectious disease physicians is associated with decrease in mortality secondary to MDROs as well as the re-admission rate.<sup>30</sup>

The current study has significant limitations. Since it was a survey-based study, it is possible that the respondents gave socially desirable answers even if they did not believe that particular response to be true. To avoid this, choice of anonymity was offered to the respondents. Besides, the study was conducted at a single centre with a small sample size, which means the results cannot be generalised, and there remains a need of a multi-centre study with a large sample size to validate the results. Finally, the study provided a description of decisions and attitudes at only one point in time, which is a limitation that can be taken care of only with interventional studies.

## Conclusion

Physicians were knowledgeable about the appropriate use of antibiotics and AMR, but there were many gaps that needed to be plugged. The importance of an ASP as well as infection prevention and control protocols in healthcare facilities cannot be overemphasised.

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**Conflict of Interest:** None.

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## References

1. Pulcini C, Cua E, Lieutier F, Landraud L, Dellamonica P, Roger PM. Antibiotic misuse: a prospective clinical audit in a French university hospital. *Eur J Clin Microbiol Infect Dis*. 2007; 26:277-80.
2. Dellit TH, Owens RC, McGowan JE, Gerding DN, Weinstein RA,

- Burke JP, et al. Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America guidelines for developing an institutional program to enhance antimicrobial stewardship. *Clin Infect Dis*. 2007; 44:159-77.
3. Centres for Disease Control and Prevention. Antibiotic resistance threats in the United States, 2013. Centres for Disease Control and Prevention, US Department of Health and Human Services; 2013.
  4. World Health Organization. Promoting rational use of medicines: core components. Geneva: World Health Organization; 2002.
  5. García C, Llamocca LP, García K, Jiménez A, Samalvides F, Gotuzzo E, et al. Knowledge, attitudes and practice survey about antimicrobial resistance and prescribing among physicians in a hospital setting in Lima, Peru. *BMC Clin Pharmacol*. 2011; 11:8.
  6. Sharma M, Eriksson B, Marrone G, Dhaneria S, Lundborg CS. Antibiotic prescribing in two private sector hospitals; one teaching and one non-teaching: a cross-sectional study in Ujjain, India. *BMC Infect Dis*. 2012; 12:155.
  7. Das N, Khan AN, Badini ZA, Baloch H, Parkash J. Prescribing practices of consultants at Karachi, Pakistan. *J Pak Med Assoc*. 2001; 51:74-7.
  8. Amin A, Khan MA, Azam SM, Haroon U. Review of prescriber approach towards rational drug practice in hospitalised patients. *J Ayub Med Coll Abbottabad*. 2011; 23:19-22.
  9. Fishman N. Society for Healthcare Epidemiology of America, Infectious Diseases Society of America. Policy statement on antimicrobial stewardship by the Society for Healthcare Epidemiology of America (SHEA), the Infectious Diseases Society of America (IDSA), and the Pediatric Infectious Diseases Society (PIDS). *Infect Control Hosp Epidemiol*. 2012; 33:322-7.
  10. Swaminathan S, Prasad J, Dhariwal AC, Guleria R, Misra MC, Malhotra R, et al. Strengthening infection prevention and control and systematic surveillance of healthcare associated infections in India. *BMJ*. 2017; 358:j3768.
  11. Srinivasan A, Song X, Richards A, Sinkowitz-Cochran R, Cardo D, Rand C. A survey of knowledge, attitudes, and beliefs of house staff physicians from various specialties concerning antimicrobial use and resistance. *Arch Intern Med*. 2004; 164:1451-6.
  12. Cassir N, Rolain JM, Brouqui P. A new strategy to fight antimicrobial resistance: the revival of old antibiotics. *Front Microbiol*. 2014; 5:551.
  13. Giblin TB, Sinkowitz-Cochran RL, Harris PL, Jacobs S, Liberatore K, Palfreyman MA, et al. Clinicians' perceptions of the problem of antimicrobial resistance in health care facilities. *Arch Intern Med*. 2004; 164:1662-8.
  14. Shankar RP, Partha P, Shenoy NK, Easow JM, Brahmadathan KN. Prescribing patterns of antibiotics and sensitivity patterns of common microorganisms in the Internal Medicine ward of a teaching hospital in Western Nepal: a prospective study. *Ann Clin Microbiol Antimicrob*. 2003; 2:7.
  15. Wester CW, Durairaj L, Evans AT, Schwartz DN, Husain S, Martinez E. Antibiotic resistance: a survey of physician perceptions. *Arch Intern Med*. 2002; 162:2210-6.
  16. Rafii F, Sutherland JB, Cerniglia CE. Effects of treatment with antimicrobial agents on the human colonic microflora. *Ther Clin Risk Manag*. 2008; 4:1343-58.
  17. Andrade SS, Sader HS, Jones RN, Pereira AS, Pignatari AC, Gales AC. Increased resistance to first-line agents among bacterial pathogens isolated from urinary tract infections in Latin America: time for local guidelines? *Mem Inst Oswaldo Cruz*. 2006; 101:741-8.
  18. Klemm EJ, Shakoob S, Page AJ, Qamar FN, Judge K, Saeed DK, et al. Emergence of an extensively drug-resistant *Salmonella enterica* serovar Typhi clone harboring a promiscuous plasmid encoding resistance to fluoroquinolones and third-generation cephalosporins. *mBio*. 2018; 9:e00105-18.
  19. Fletcher-Lartey S, Yee M, Gaarslev C, Khan R. Why do general practitioners prescribe antibiotics for upper respiratory tract infections to meet patient expectations: a mixed methods study. *BMJ Open*. 2016; 6:e012244.
  20. Cole A. GPs feel pressurised to prescribe unnecessary antibiotics, survey finds. *BMJ*. 2014; 349:g5238.
  21. Cabral C, Ingram J, Lucas PJ, Redmond NM, Kai J, Hay AD, et al. Influence of Clinical Communication on Parents' Antibiotic Expectations for Children With Respiratory Tract Infections. *Ann Fam Med*. 2016; 14:141-7.
  22. Landers TF, Cohen B, Wittum TE, Larson EL. A review of antibiotic use in food animals: perspective, policy, and potential. *Public Health Rep*. 2012; 127:4-22.
  23. Van Boeckel TP, Brower C, Gilbert M, Grenfell BT, Levin SA, Robinson TP, et al. Global trends in antimicrobial use in food animals. *Proc Natl Acad Sci U S A*. 2015; 112:5649-54.
  24. Aidara-Kane A, Angulo FJ, Conly JM, Minato Y, Silbergeld EK, McEwen SA, et al. World Health Organization (WHO) guidelines on use of medically important antimicrobials in food-producing animals. *Antimicrob Resist Infect Control*. 2018; 7:7.
  25. Kotwani A, Watal C, Katewa S, Joshi PC, Holloway K. Factors influencing primary care physicians to prescribe antibiotics in Delhi India. *Family practice*. 2010; 27:684-90.
  26. Siddiqui S, Cheema MS, Ayub R, Shah N, Hamza A, Hussain S, et al. Knowledge, attitudes and practices of parents regarding antibiotic use in children. *J Ayub Med Coll Abbottabad*. 2014; 26:170-3.
  27. Zaidi S, Nishtar NA. Rational prescription & use: a snapshot of the evidence from Pakistan and emerging concerns. *Int J Pharm Pharm Sci*. 2013; 5:131-5.
  28. Hafeez A, Kiani AG, Din SU, Muhammad W, Butt K, Shah Z, et al. Prescription and dispensing practices in public sector health facilities in Pakistan-Survey report. *J Pak Med Assoc*. 2004; 54:187-91.
  29. Bilal M, Haseeb A, Khan MH, Arshad MH, Ladak AA, Niazi SK, et al. Self-medication with antibiotics among people dwelling in rural areas of Sindh. *J Clin Diagn Res*. 2016; 10:OC08-13.
  30. Burnham JP, Olsen MA, Stwalley D, Kwon JH, Babcock HM, Kollef MH. Infectious diseases consultation reduces 30-day and 1-year all-cause mortality for multidrug-resistant organism infections. *Open Forum Infect Dis*. 2018; 5:ofy026.