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# The Knowledge of Aminoglycosides Among Health Science Students

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## ABSTRACT

Aminoglycosides are potent bactericidal antibiotics that act by inhibiting protein synthesis by binding to 30S ribosomes. It is clinically effective against numerous infections. However, antimicrobial resistance is alarming and becoming a major concern in a public health care system. A survey was conducted among health science students including medicine, dentistry and pharmacy students in private hospitals and dental hospitals to assess their knowledge regarding aminoglycosides. A total of 150 responses were obtained through an online Google form application and the results were analyzed using the SPSS statistical software. Based on their knowledge of aminoglycosides, 65% of the participants actually knew about the mechanism of action of aminoglycosides which was bactericidal which was not statistically significant ($p>0.05$). Streptomycin, amikacin and neomycin were chosen as a group of aminoglycosides by participants in dentistry (29.5%), medicine (36.6%) and pharmacy (33.9%) which was not statistically significant ($p>0.05$). 52.7% of the participants answered that nephrotoxicity and ototoxicity were the adverse effects of aminoglycosides. Most of the participants answered that the combination of aminoglycosides with beta-lactam antibiotics often used in treating staphylococcus aureus infections and bacterial endocarditis (28.7%). In conclusion, the awareness and knowledge among medical field students regarding aminoglycosides were at a satisfactory level. Most of the students knew about the basic knowledge of aminoglycosides even though it is rarely prescribed by medical, dental and pharmacy students during the practical courses

**KEY WORDS:** AMINOGLYCOSIDES; ANTIMICROBIAL RESISTANCE; HEALTH SCIENCE; STREPTOMYCIN.

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## INTRODUCTION

Antimicrobial resistance is a major public health concern that threatens the medical professional in treating infectious diseases (Wha68, 2015). The World Health Organization (WHO) predicted that nearly 10 million people all around the world will die due to antimicrobial resistance (O'Neill, 2014). There are several reasons behind the emergence of antimicrobial resistance and one of them is due to misuse or overuse of antibiotics (van de Sande-Bruinsma et al., 2008; Laxminarayan and Heymann, 2012). It was found that the inappropriate and over-prescription of antibiotics are prevalent worldwide (Organization and Others, 2013). The most commonly affected countries are developing countries because of their fragile regulation systems and inadequate human capacity (Mao et al., 2015).

The inappropriate use of antibiotics not only results in bacterial strain becoming resistant, but it also leads to the progression of various adverse effects and financial burdens (Gyssens, 2001). It is a tough task to treat infectious diseases which are already resistant to the antibiotics as it is difficult to reverse the resistance (Wolff, 1993). Medical professionals play an important role to decline the emergence of antimicrobial resistance in such a way that they need to follow guidelines in prescribing antibiotics and engaging the patients to follow the instructions while taking antibiotics (Fluent et al., 2016). The most commonly used antibiotics are aminoglycosides, penicillin, fluoroquinolones, macrolides, tetracyclines and cephalosporins (Sharma et al., 2019).

Aminoglycosides are a potent bactericidal antibiotic that act through the inhibition of protein synthesis (Krause et al., 2016). However, there was a shift in the systemic use of aminoglycosides in the 1980s due to the availability of less toxic and broader coverage of antibiotics such as third-generation cephalosporins, carbapenems and fluoroquinolones (Krause et al., 2016). Due to increasing resistance to aminoglycosides, new drugs were developed such as arbekacin and plazomicin (Krause et al., 2016). These drugs were designed to overcome the antimicrobial resistance by aminoglycosides and maintain potency against multidrug-resistant pathogens (Krause et al., 2016).

There were several studies reported on the knowledge of antibiotic resistance and prescriptions among medical students (Wasserman et al., 2017; Weier, Thursky and Zaidi, 2017; Haque et al., 2019), dental students (Radeva, Marinova-Takorova and Radev, 2019; Struzycka et al., 2019) and pharmacy students (Ahmad, Muhammad U. Khan, et al., 2015; Ahmad, Muhammad Umair Khan, et al., 2015). A reported that students' knowledge regarding antibiotic resistance and the prescription was good but the attitude towards antibiotics was poor (Ahmad, Muhammad Umair Khan, et al., 2015). Previously our department has published extensive research on various aspects of prosthetic dentistry ('Evaluation of Corrosive Behavior of Four Nickel–chromium Alloys in Artificial Saliva by Cyclic Polarization Test:An in vitro Study', 2017; Ganapathy, Kannan and Venugopalan, 2017; Jain, 2017a, 2017b; Ranganathan, Ganapathy and Jain, 2017; Ariga et al., 2018; Gupta, Ariga and Deogade, 2018; Anbu et al., 2019; Ashok and Ganapathy, 2019; Duraisamy et al., 2019; Varghese, Ramesh and Veeraiyan, 2019), this vast research experience has inspired us to research about the knowledge of aminoglycosides among medical, dental and pharmacy students.

## MATERIAL AND METHODS

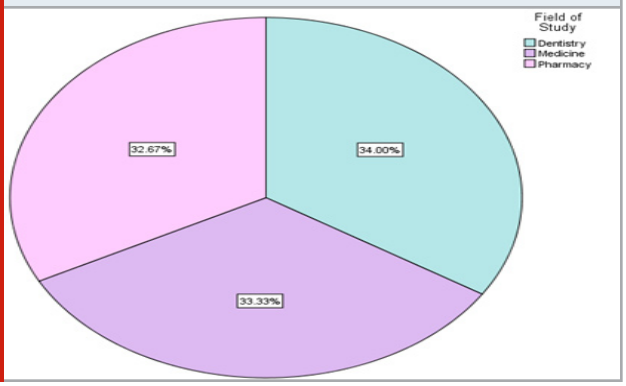
**Study setting:** This cross-sectional study was conducted in December 2019 among medical, dental and pharmacy undergraduate students in private dental hospitals in Chennai, India. A total of 150 students participated in this study.

**Study Subjects:** A total of 150 students participated in this study out of which medical students (33.3%%), dental students (34%) and pharmacy students (32.7%).

**Methodology:** Questions about knowledge, attitude and practice regarding aminoglycosides were prepared and prevalidated. The survey was conducted through an online survey using Google Form application. Health science students including medical, dental and pharmacy students were included in the study. Incomplete surveys were excluded in the study. The responses of the participants were recorded and analyzed.

**Statistical Analysis:** Data were entered in Excel and analyzed using SPSS software version 20.0. Descriptive analysis such as frequency distribution and Chi-square test were done and a significant level of less than 0.05 was set to be statistically significant.

**Figure 1: Bar chart showing the comparison based on the field of study to the question, "mechanism of action of aminoglycosides". X-axis represents the field of study and Y-axis represents the number of participants with their responses.(purple-bactericidal and yellow-bacteriostatic). Higher number of participants from pharmacy (22.7%) answered bactericidal, followed by medicine (21.3%) and dentistry (20.7%) courses. There is no significant difference between the field of study. (Chi-square test value: 0.824a, p-value: 0.662 (p>0.05) - not significant.**

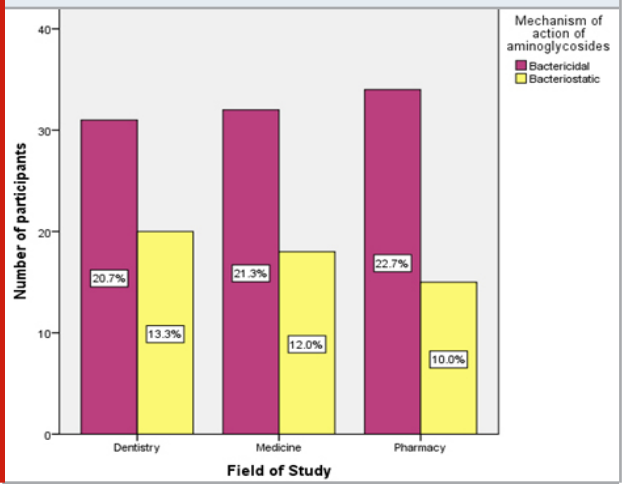


## RESULTS AND DISCUSSION

A total of 150 students participated in the study out of which medical students (34%), dental students (33.3%) and pharmacy students (32.7%) as shown in Figure 1. Several questions were prepared to assess the knowledge of aminoglycosides among the participants.

Based on their knowledge of pharmacology, a higher number of pharmacy students (35.1%) answered bactericidal as the mechanism of action of aminoglycosides followed by medical students (33%) and dental students (32%) which was not statistically significant (p>0.05) as shown in Figure 2. Aminoglycosides act by inhibiting protein synthesis through binding on the A site of 30S ribosome (Kotra, Haddad and Mobashery, 2000). All aminoglycosides are bactericidal even though the exact mechanism varies based on the chemical structure (Davis, 1987).

Figure 2: Bar chart showing the comparison based on the field of study to the question, "group of aminoglycosides". X-axis represents the field of study and Y-axis represents the number of participants with their responses. (green-erythromycin, azithromycin, yellow-penicillin, amoxicillin, purple-streptomycin, amikacin and neomycin, blue-tetracycline, doxycycline). Higher number of participants from medicine (27.3%) answered streptomycin, amikacin and neomycin followed by pharmacy (25.3%) and dentistry (22%) courses. There is no significant difference between the field of study. (Chi-square test value: 7.444a, p-value: 0.282 (p>0.05) - not significant).




When asked about the group of drugs classified under aminoglycosides, a higher number of medical students (36.6%) answered streptomycin, amikacin and neomycin followed by pharmacy students (33.9%) and dental students (29.9%) which was not statistically significant (p>0.05) as shown in Figure 3. The first aminoglycosides introduced in clinical use was streptomycin in 1944. Several other drugs were introduced over the intervening years such as neomycin, kanamycin, gentamicin, netilmicin, tobramycin and amikacin (Krause et al., 2016).

Overall, most of the participants (75%) knew the drugs in the group of aminoglycosides.

Figure 3: Bar chart showing the comparison based on the field of study to the question, "aminoglycosides should not be mixed with other drugs in the same syringe/infusion bottle". X-axis represents the field of study and Y-axis represents the number of participants with their responses. (blue-yes, red-no). Higher number of participants from dentistry (27.3%) answered yes followed by medicine (24.7%) and pharmacy (21.3%) courses. There is no significant difference between the field of study. (Chi-square test value: 2.925a, p-value: 0.282 (p>0.05) - not significant).

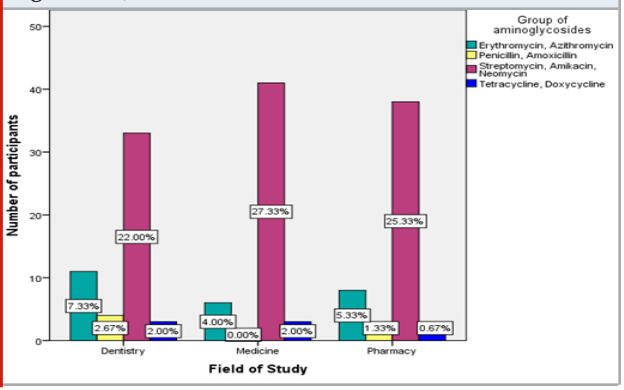
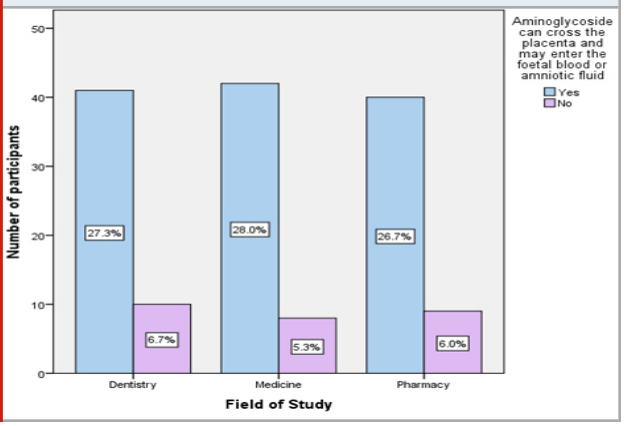



Figure 4: Bar chart showing the comparison based on the field of study to the question, "aminoglycosides can cross the placenta and may enter the foetal blood or amniotic fluid". X-axis represents the field of study and Y-axis represents the number of participants with their responses. (blue-yes, purple-no). Higher number of participants from medicine (28%) answered yes followed by dentistry (27.3%) and pharmacy (26.7%) courses. There is no significant difference between the field of study. (Chi-square test value: 0.299a, p-value: 0.892 (p>0.05) - not significant).

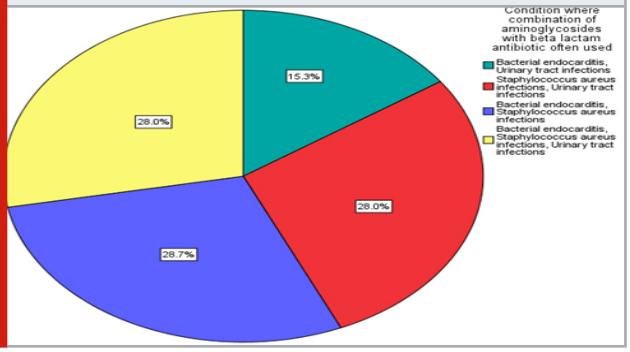



Based on their knowledge of drug interaction with antibiotics, a higher number of dental students (37.3%) answered that aminoglycosides should not be mixed

with other drugs in the same syringe or infusion bottle followed by medical students (33.6%) and pharmacy students (29.1%) which was not statistically significant as shown in Figure 4. A combination of aminoglycosides with beta-lactam antibiotics showed a synergistic interaction against gram-negative bacteria (Mohapatra et al., 2018). However, due to the physical properties of aminoglycosides such as highly polar in nature, it is incompatible to combine aminoglycosides and beta-lactam antibiotics in a syringe (Mohapatra et al., 2018). Therefore, precautions must be taken to avoid mixing aminoglycosides with other drugs.

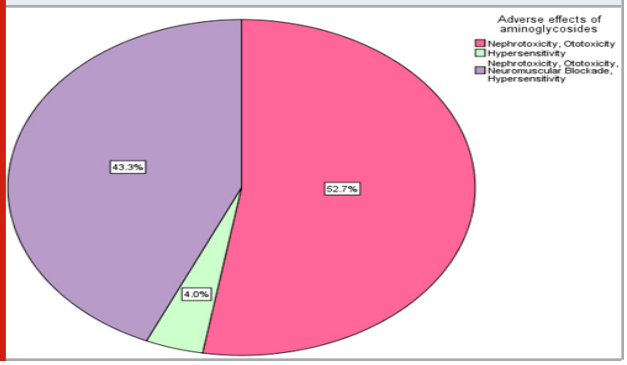
When asked about whether aminoglycosides can cross the placenta and pass through fetal blood and amniotic fluid, a higher number of medical students (34.1%) agreed with the statement followed by dental students (33.3%) and pharmacy students (32.5%) which was not statistically significant ($p>0.05$) as shown in Figure 5. First trimester is crucial for pregnant mothers as organogenesis takes place, thus it is essential to avoid drug exposure (Malm et al., 2003). Aminoglycosides can cross the placenta and their concentration in the amniotic fluid ranges from 30% to 60% of the average maternal concentration in blood (Yoshioka, Monma and Matsuda, 1972). A study reported that the administration of aminoglycosides caused severe intrauterine otological damage (Robinson and Cambon, 1964). Therefore, aminoglycosides should be avoided by pregnant mothers as it may harm both the mothers and the baby.

**Figure 6: Pie chart showing the responses to the question, "condition where combination of aminoglycosides with beta-lactam antibiotics is often used". Majority of the participants answered bacterial endocarditis, staphylococcus aureus infections (28.7%).**




Besides that, based on Figure 6, most of the participants answered that the combination of aminoglycosides with beta-lactam antibiotics often used in treating staphylococcus aureus infections and bacterial endocarditis (28.7%). In staphylococcus aureus infections, the combination enhances the bactericidal activity which prevents the resistant staphylococci to persist, whereas monotherapy causes relapse once the antibiotic discontinued (Gilbert, 1995). Meanwhile, in bacterial endocarditis, combination therapy is used synergistically to facilitate aminoglycosides penetration into the cell (Gonzalez and Spencer, 1998).

**Figure 7: Pie chart showing the responses to the question, "adverse effects of aminoglycosides". Most of the participants answered nephrotoxicity and ototoxicity (52.7%).**




When asked about the adverse effects of aminoglycosides, most of the participants answered nephrotoxicity and ototoxicity (52.7%) followed by nephrotoxicity, ototoxicity, neuromuscular blockade and hypersensitivity (43.4%) and hypersensitivity only (4%) a shown in Figure 7. The most common adverse effects associated with aminoglycosides are nephrotoxicity and ototoxicity and rarely, neuromuscular blockade and hypersensitivity (Gonzalez and Spencer, 1998). In order to minimize toxicities, the medical professionals should follow clinical guidelines. They should only prescribe aminoglycosides when their unique potency is needed such as infection in critically ill patients, nosocomial infections or infections with organisms resistant to less toxic therapies (Montie and Patamasucon, 1995).

Although aminoglycosides are rarely prescribed by the medical field students, the knowledge of various types of antibiotics are essential. Antibiotics are used to treat various infections and a proper clinical guidelines should be followed to avoid the development of antimicrobial resistance. Both physicians and patients should be aware about the prescriptions. For medical field students, various programmes and curricular activity can be done to develop their skills and confidence in prescribing medicine especially antibiotics. They can refer to the lecturers and join any webinar focusing on the topic antibiotics.

The limitations of our study were less number of participants from various private dental hospitals. Responder's bias may present as the surveys were done anonymously. A study with a larger number of participants can be conducted in a future.

Figure 1: Pie chart showing the responses to the question, "field of study". The participants were from dentistry (34%), medicine (33.3%) and pharmacy (32.7%) courses.

## CONCLUSION

Within the limitations of study, it can be observed that most of the participants knew about the basic knowledge

in pharmacology of aminoglycosides. Aminoglycosides are rarely prescribed among medical field students. However, the knowledge regarding aminoglycosides was at a satisfactory level but it was statistically not significant. Prescribing medicine is an essential skill not only of medicine but also dental and pharmacy students. Various programmes should be imposed by the university in order to develop confidence and skills in prescribing medicine especially antibiotics.

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**Conflict of Interest:** No conflict of interest declared by the authors.

## REFERENCES

Ahmad, A., Khan, M. U., et al. (2015) 'Comparison of knowledge and attitudes about antibiotics and resistance, and antibiotics self-practicing between Bachelor of Pharmacy and Doctor of Pharmacy students in Southern India', Pharmacy practice. ncbi.nlm.nih.gov, 13(1), p. 523.

Ahmad, A., Khan, M. U., et al. (2015) 'Knowledge, attitude and practice of B.Sc. Pharmacy students about antibiotics in Trinidad and Tobago', American journal of pharmacogenomics: genomics-related research in drug development and clinical practice. ncbi.nlm.nih.gov, 4(1), pp. 37–41.

Anbu, R. T. et al. (2019) 'Comparison of the Efficacy of Three Different Bone Regeneration Materials: An Animal Study', European journal of dentistry, 13(1), pp. 22–28.

Ariga, P. et al. (2018) 'Determination of Correlation of Width of Maxillary Anterior Teeth using Extraoral and Intraoral Factors in Indian Population: A Systematic Review', World Journal of Dentistry, 9(1), pp. 68–75.

Ashok, V. and Ganapathy, D. (2019) 'A geometrical method to classify face forms', Journal of oral biology and craniofacial research, 9(3), pp. 232–235.

Davis, B. D. (1987) 'Mechanism of bactericidal action of aminoglycosides', Microbiological reviews. ncbi.nlm.nih.gov, 51(3), pp. 341–350.

Duraisamy, R. et al. (2019) 'Compatibility of Nonoriginal Abutments With Implants: Evaluation of Microgap at the Implant-Abutment Interface, With Original and Nonoriginal Abutments', Implant dentistry, 28(3), pp. 289–295.

'Evaluation of Corrosive Behavior of Four Nickel–chromium Alloys in Artificial Saliva by Cyclic Polarization Test:An in vitro Study' (2017) World Journal of Dentistry, 8(6), pp. 477–482.

Fluent, M. T. et al. (2016) 'Considerations for responsible antibiotic use in dentistry', Journal of the American Dental Association . jada.ada.org, 147(8), pp. 683–686.

Ganapathy, D. M., Kannan, A. and Venugopalan, S. (2017) 'Effect of Coated Surfaces influencing Screw Loosening in Implants: A Systematic Review and Meta-analysis', World Journal of Dentistry, 8(6), pp. 496–502.

Gilbert, D. N. (1995) 'Aminoglycosides', in Gerald Mandell John Bennett (ed.) Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases. New York: Churchill Livingstone, pp. 279–301.

Gonzalez, L. S., 3rd and Spencer, J. P. (1998) 'Aminoglycosides: a practical review', American family physician. aafp.org, 58(8), pp. 1811–1820.

Gupta, P., Ariga, P. and Deogade, S. C. (2018) 'Effect of Monopoly-coating Agent on the Surface Roughness of a Tissue Conditioner Subjected to Cleansing and Disinfection: A Contact Profilometric Study', Contemporary clinical dentistry, 9(Suppl 1), pp. S122–S126.

Gyssens, I. C. (2001) 'Quality measures of antimicrobial drug use', International journal of antimicrobial agents. Elsevier, 17(1), pp. 9–19.

Haque, M. et al. (2019) 'Antibiotic Use: A Cross-Sectional Study Evaluating the Understanding, Usage and Perspectives of Medical Students and Pathfinders of a Public Defence University in Malaysia', Antibiotics. Multidisciplinary Digital Publishing Institute, 8(3), p. 154.

Jain, A. R. (2017a) 'Clinical and Functional Outcomes of Implant Prostheses in Fibula Free Flaps', World Journal of Dentistry, 8(3), pp. 171–176.

Jain, A. R. (2017b) 'Prevalence of Partial Edentulousness and Treatment needs in Rural Population of South India', World Journal of Dentistry, 8(3), pp. 213–217.

Kotra, L. P., Haddad, J. and Mobashery, S. (2000) 'Aminoglycosides: perspectives on mechanisms of action and resistance and strategies to counter resistance', Antimicrobial agents and chemotherapy. Am Soc Microbiol, 44(12), pp. 3249–3256.

Krause, K. M. et al. (2016) 'Aminoglycosides: An Overview', Cold Spring Harbor perspectives in medicine. perspectivesinmedicine.cshlp.org, 6(6). doi: 10.1101/cshperspect.a027029.

Laxminarayan, R. and Heymann, D. L. (2012) 'Challenges of drug resistance in the developing world', BMJ . bmj.com, 344, p. e1567.

Malm, H. et al. (2003) 'Prescription drugs during pregnancy and lactation—a Finnish register-based study', European journal of clinical pharmacology. Springer, 59(2), pp. 127–133.

Mao, W. et al. (2015) 'Systematic Review on Irrational Use of Medicines in China and Vietnam', PloS one. Public Library of Science, 10(3), p. e0117710.

Mohapatra, S. S. et al. (2018) 'Drug interactions with antibiotics', International J. Chem. Studies. researchgate.net, 6(2), pp. 2120–2122.

Montie, T. and Patamasucon, P. (1995) 'Aminoglycosides:

the complex problem of antibiotic mechanisms and clinical applications', European journal of clinical microbiology & infectious diseases: official publication of the European Society of Clinical Microbiology. Springer, 14(2), pp. 85–87.

O'Neill, J. (2014) 'Antimicrobial resistance: tackling a crisis for the health and wealth of nations. Review on antimicrobial resistance', Review on Antimicrobial Resistance, London, United Kingdom: https://amr-review. org/sites/default/files/AMR% 20Review% 20Paper.

Organization, W. H. and Others (2013) 'Global action plan for the prevention and control of noncommunicable diseases 2013-2020'. World Health Organization. Available at: https://apps.who.int/iris/bitstream/handle/10665/94384/9789244506233_rus.pdf.

Radeva, E., Marinova-Takorova, M. and Radev, M. (2019) 'A survey among dental students on their knowledge on the indications for antibiotic therapy of endodontic infection', SYLWAN, 163(3), pp. 66–76.

Ranganathan, H., Ganapathy, D. M. and Jain, A. R. (2017) 'Cervical and Incisal Marginal Discrepancy in Ceramic Laminate Veneering Materials: A SEM Analysis', Contemporary clinical dentistry, 8(2), pp. 272–278.

Robinson, G. C. and Cambon, K. G. (1964) 'hearing Loss In Infants Of Tuberculous Mothers Treated With Streptomycin During Pregnancy', The New England journal of medicine. Mass Medical Soc, 271, pp. 949–951.

van de Sande-Bruinsma, N. et al. (2008) 'Antimicrobial drug use and resistance in Europe', Emerging infectious diseases. ncbi.nlm.nih.gov, 14(11), pp. 1722–1730.

Sharma, A. et al. (2019) 'Knowledge and Awareness Regarding Antibiotic Usage and Resistance among General Population in Delhi-NCR Region', International Journal of Medicine and Public Health. ijmedph.org, 9(4). Available at: http://www.ijmedph.org/article/656.

Struzycka, I. et al. (2019) 'Knowledge of antibiotics and antimicrobial resistance amongst final year dental students of Polish medical schools—A cross-sectional study', European journal of dental education: official journal of the Association for Dental Education in Europe. Wiley Online Library, 23(3), pp. 295–303.

Varghese, S. S., Ramesh, A. and Veeraiyan, D. N. (2019) 'Blended Module-Based Teaching in Biostatistics and Research Methodology: A Retrospective Study with Postgraduate Dental Students', Journal of dental education, 83(4), pp. 445–450.

Wasserman, S. et al. (2017) 'South African medical students' perceptions and knowledge about antibiotic resistance and appropriate prescribing: Are we providing adequate training to future prescribers?', South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde. ajol.info, 107(5), pp. 405–410.

Weier, N., Thursky, K. and Zaidi, S. T. R. (2017) 'Antimicrobial knowledge and confidence amongst final year medical students in Australia', PloS one. journals.plos.org, 12(8), p. e0182460.

Wha68, R. (2015) '7. Global action plan on antimicrobial resistance', Sixty-eighth World Health Assembly, Geneva, 26.

Wolff, M. J. (1993) 'Use and misuse of antibiotics in Latin America', Clinical infectious diseases: an official publication of the Infectious Diseases Society of America. academic.oup.com, 17 Suppl 2, pp. S346–51.

Yoshioka, H., Monma, T. and Matsuda, S. (1972) 'Placental transfer of gentamicin', The Journal of pediatrics. Elsevier, 80(1), pp. 121–123.