

Perception and Practices of Antibiotic Prescriptions by Dental Interns - A Clinical Study

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Abstract

Aim of the Study: The aim of the study was to know the perception and prescribing practices of antibiotics use by dental interns.

Materials and Methods: The study was carried out at Genesis Institute of Dental Sciences and Research, Ferozpur. A pre validated questionnaire was used to capture the perception of knowledge and skills for rational antimicrobial use administered by interns. Clinical case scenarios were developed to assess the knowledge and skill for prescribing antibiotics in dentistry. The study also focused on their confidence, knowledge of clinical pharmacology and skills based on their ability to recall and integrate knowledge gained in previous years to choose an antibiotic based on rational drug use. The data collected was statistically analyzed. The observations from the study suggest that interns perceived knowledge of antibiotics as very important in their course, but they were unable to apply the knowledge in solving clinical problems. There is a huge gap between the perception and practice of antibiotic use. Regular reinforcement of drug information and discussion of latest guidelines on rational antimicrobial usage is must during internship. Moreover, prescription writing should be made a part of regular dental internship training program.

Keywords: Perception; Practices; Antibiotic; Drug Use; Prescriptions; Dental Interns

Background

In India, the duration of Bachelor of Dental Surgery (BDS) course is five years, four years of studying and one year of compulsory rotatory internship. Based on the curriculum set by DCI (Dental Council of India), students study the basic subjects such as Anatomy, Physiology, Biochemistry, Dental Anatomy and Histology in year one and Pharmacology, Pathology, Microbiology and Dental Materials in year two. Retention of knowledge of Pharmacology, Pathology and Microbiology is an important factor as they must apply this knowledge in their everyday practice. A medical practitioner should be able to prescribe appropriate therapies based on the principle of rational drug therapy, scientific validity, evidence, and cost effectiveness in line with the established national and regional health programs and policies laid down by MCI (Medical Council of India). Curriculum of dental training is designed by DCI to develop a student's knowledge base, nec-

essary skills and reasonable attitude that is relevant to dental practice and promotes step wise acquisition and application of knowledge and skills in life long clinical practice. Various studies have emphasized the need for development of core prescribing competencies. Competency is defined as an observable ability of health professional to integrate multiple components such as knowledge, skills, values, and attitude. The dentist should have knowledge and develop all necessary skills and attitude for future clinical practice. Prescribing is one of the core competencies for good clinical practice; however, the knowledge base for the same gets built in compartments. In the final year of BDS all the dental clinical subjects (Prosthodontics, Conservative dentistry, Pedodontics, Periodontics, Orthodontics, Oral surgery, Oral medicine diagnosis and radiology and Community Dentistry) are taught. The pre-clinical and basic sciences subjects are never revisited nor is there an attempt to apply the knowledge of these subjects during internship. Hence, the integration of knowledge and its clinical application for writing prescription does not take place.

In India, prescription writing is inherent part of dental curriculum at undergraduate level and is taught in Pharmacology course. However, in accordance with the current curriculum only 70 hours of teaching theory and merely 20 hours of practical training is allotted to Pharmacology [1], which is the least number of teaching hours when compared with other subjects in the second year.

Dentist is required to prescribe medications for the management of several oral conditions, mainly orofacial infections [2]. Acute dental abscess is a frequent and sometimes underestimated disease of the oral cavity. In dentistry, antibiotics are prescribed for the treatment of odontogenic infections, especially endodontic infections, and prophylaxis of local and systemic spread. Dentists should know the scientific basis for the prescription of antibiotics and should follow the current guidelines for antibiotic prescriptions [3,4].

Antibiotics are the most common drug class prescribed by dentists. Dentists prescribe between 7% and 11% of all common antibiotics (Beta lactams, Macrolides, Tetracyclines, Clindamycin, Metronidazole) [5]. While some studies on antibiotic prescription rate in India quote 56% to 88%, which is much higher than 30%, i.e. the maximum accepted proportion of antibiotic prescriptions recommended by the WHO in any outpatient setting [6].

However, up to 80% of prescriptions are deemed unnecessary for both therapeutic and prophylactic indications [7,8]. In addition to the potential patient harm, unnecessary prescribing contributes to the global public health issue of antimicrobial resistance, which is responsible for 700,000 deaths worldwide annually [9].

Research has found several lacunae in prescription writing such as inappropriate prescribing regarding disease i.e., antibiotics being prescribed for viral infections, at an inappropriate dose, and or for a wrong duration [4,10].

Inability to prescribe safely and efficaciously at a lower cost is still quite prevalent in real life situations [11]. This leads to an increased burden of disease, drug resistance and adverse drug reactions thus starting the prescribing cascade [12]. In an American study 45% interns reported of making clinical error, 15% of which were fatal [13]. Interns are prone to make prescribing errors, of multifactorial nature [14].

A US study on antibiotic prescribing before dental procedures found that nearly 81% of prescriptions were unnecessary. These errors would be defined as the error of prescribing as there was no legitimate indication. 1.4% of patients given antibiotics unnecessarily experienced serious adverse events, including allergic reactions, emergency room visits, or *C. difficile* infections. Unfortunately, most of these events were identified in medical settings, so the dentist responsible was likely unaware they ever occurred [15].

A study evaluating over 9,000 prescriptions written by 78 primary care providers in New York and Massachusetts found that illegibility errors occurred on average more than once per prescription - an alarmingly high rate [16].

A review assessing the extent of medication errors in Australian hospitals suggests that prescription errors occur at a rate of up to one per patient, with errors occurring in around 9% of medication administrations in hospital settings [17]. An audit of 3291 patient records at two Australian hospitals identified 12,567 prescribing errors, with many unreported [18].

A Spanish study that analyzed 415 adverse events associated with dental treatment found that 44.3% of adverse events were due to preventable errors, with 1.2% related to medications [19].

Meanwhile, in the recent years e-prescribing for dentists has taken a plunge in United States. A study of 3,850 e-prescriptions generated by providers in three states found that 11.7% contained errors, of which 35.0% were considered potential ADEs [12]. In this study, the most common types of errors were omitted information (particularly duration, dose, or frequency), unclear or conflicting information, and clinically incorrect information [20].

Despite the continuous emphasis on the importance of acquiring the clinical skill for writing prescriptions, the need of the hour is to identify all the lacunas and plug them. Therefore, it becomes necessary to assess the perceptions and practices of dental interns regarding drug prescription.

Methodology

This study was carried out at Genesis Institute of Dental Sciences and Research, Ferozepur, Punjab. After obtaining the Institutional Ethical Review Board clearance, the study was conducted in Interns (IEB/IRB#51-6/12/19). An anonymous questionnaire with open ended and close ended questions was designed and validated to capture the perceptions of dental interns. Case scenarios were also prepared and validated based on common clinical situations for dentists to capture practices. The questionnaire consisted of four parts.

The first part was designed to capture the perceptions of interns and their awareness about prescription of antimicrobials and rational drug use on a five-point Likert scale ranging from strongly agree, agree, can't say, disagree and strongly disagree.

The second part was to explore the dental interns' knowledge of pharmacology and microbiology in relation to antibiotics. This part consisted of a clinical situation and interns were asked to mark yes/no for the various clinical signs for which they would prescribe antibiotic viz. patient complains of pain, fever, malaise, restricted mouth opening, difficulty in swallowing, a fluctuant or diffuse swelling, or a swelling causing closure of the eye.

The third part of questionnaire was based on case-based scenarios to capture the knowledge and skill of prescription writing. Questions were framed to gauge the knowledge of intern regarding awareness of principles of rational use of antibiotics, protocol of antimicrobial prophylaxis, whether he/she prefers broad or narrow spectrum antibiotic, whether he/she prefers single or multiple drug regime, whether he/she needs to collect microbiological samples before prescribing, whether he/she would use empirical antimicrobial therapy, whether he/she find himself/herself competent to prescribe, and if they felt pressurized by parents/patients to prescribe antimicrobial therapy.

The third part of the questionnaire comprised of questions to assess the knowledge on pharmacological parameters of antimicrobial agents like whether aminoglycosides cause concentration dependent killing, whether Macrolides produce time dependent killing, whether fluoroquinolones and aminoglycosides have post antibiotic effect, whether there is a need for dose reduction of cephalosporins in renal failure patients, whether broad spectrum antimicrobials are preferred over narrow spectrum, whether a short course of antimicrobial can mask underlying infection of tuberculosis and whether a small difference in minimum inhibitory concentration and minimum bactericidal concentration indicate that the antimicrobial is bactericidal. The interns were asked about their drug of choice and alternative drug for the various causative agents like Enterococcus endocarditis, Methicillin susceptible and resistant *Staphylococcus aureus*, *Streptococcus pyogenes*, *Streptococcus viridans*, *Streptococcus/Peptococcus*, anaerobic, gram negative cocci and bacilli infections.

The last segment of the questionnaire was prepared to know the prescribing skill of an intern. Various clinical situations were listed, and interns were asked whether they would/not prescribe antibiotics for the same. If they would prescribe, then which antibiotic and in what dose. The various clinical situations were periapical pathology with no spread and patient is asymptomatic, periapical abscess localized and patient feels well, acute periapical infection before and after drainage, periodontal abscess, traumatic ulcer, denture stomatitis, acute necrotizing ulcerative gingivitis (ANUG), acute periodontitis, chronic periodontitis, extraction of third molar (asymptomatic), previous pericoronitis, current pericoronitis, dentigerous cyst asymptomatic, oroantral fistula, avulsion and reimplantation. The various medical conditions requiring antibiotic prophylaxis were also asked in the last segment of the questionnaire. This list comprised of previous bacterial endocarditis, prosthetic heart valve, mitral valve incompetence, atrial septal defect, immunocompromised patients, patent ductus arteriosus, head and neck radiotherapy, heart murmur, recent myocardial infarct, diabetes, stroke, orthopedic plate, old myocardial infarct, and kidney failure. The answer key to the knowledge part of the questionnaire was developed by authors based on established protocols that are consistent with appropriate practice but do not follow a single reference guideline.

These questionnaires were printed and handed over to the interns randomly, in two batches. 80 interns participated in June 2019 and 34 interns in Jan 2020. The questionnaire was administered as an anonymous survey form, and participants were assured of confidentiality of information. Out of 114 interns, 97 interns completed and returned the questionnaire. The data obtained was analyzed by using simple descriptive statistics and the parameters were expressed in percentages.

Results

97 interns participated in the above study, 13 were males and 84 were females. The average age of interns was 23 years (Figure 1).

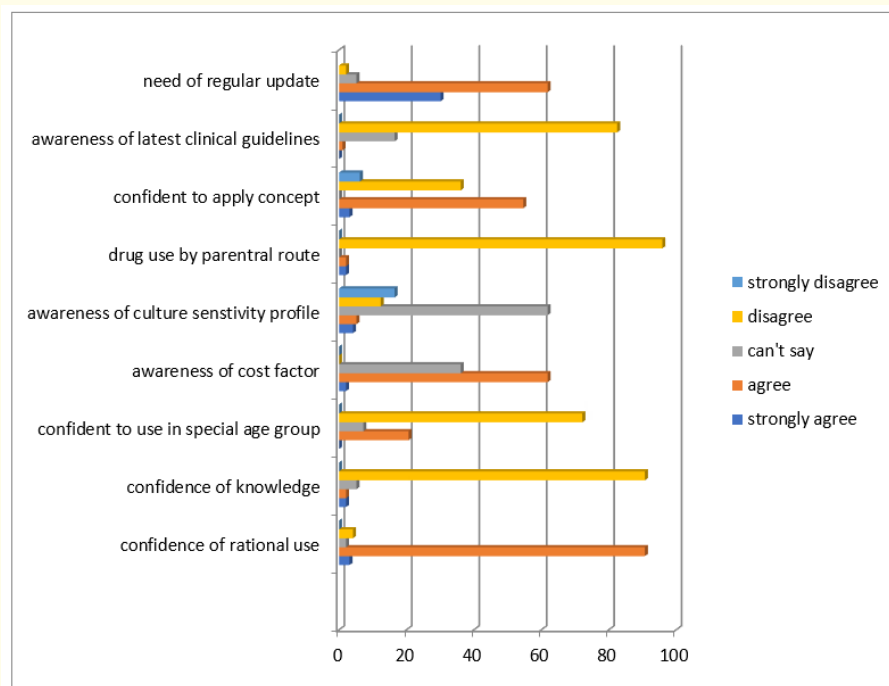


Figure 1: Depicting perception of interns on their prescription writing skills.

Few questions were asked to assess the knowledge of clinical pharmacology. In answer to question regarding preference of broad-spectrum antimicrobial over narrow spectrum in the treatment of mixed infection, 92.78% students gave a correct response as compared to 7.21 who gave a wrong response. 95.87% interns appreciated that short course of anti-microbial agent can mask underlying infection of tuberculosis. Majority of interns agreed that immunocompromised patient should not be given a bacteriostatic drug alone (Figure 2, table 1 and 2).

Discussion

Entry-to-practice competencies and comparison of dental school curriculum in context to pharmacology and prescription writing

Students interested in pursuing a BDS degree in India are required to complete the Higher Secondary Certificate (HSC), or 10+2 exam, in the science stream, with biology, chemistry, physics, and English, and attain a minimum of 50 percent marks in each course. Admission

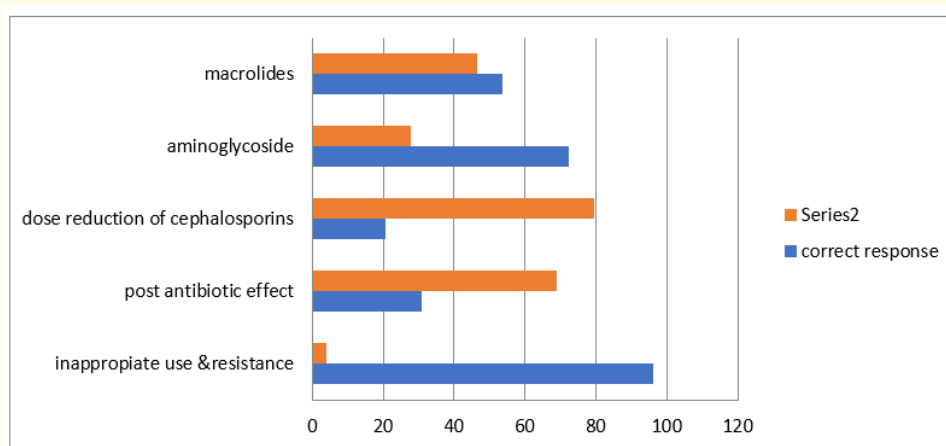


Figure 2: Depicting knowledge of interns on pharmacological aspects of antimicrobial use.

S no	Clinical Signs and symptoms	Yes (I shall give antibiotics)	No (I shall not give antibiotics)	Can't say
1	If patient complains of pain in tooth, fever, and malaise for the past three days.	98.96%	1.03%	-
2	If patient has a localized fluctuant swelling related with the tooth which is grossly carious.	63.91%	20.61%	15.46%
3	If patient comes with a gross diffuse swelling	95.87%	2.06%	2.06%
4	If the patient has restricted mouth opening	53.6%	13.40%	32.98%
5	If the patient experiences difficulty in swallowing	63.91%	20.16%	15.46%
6	The patient has a huge swelling which causes closure of the eye.	92.78%	3.09%	4.12%

Table 1: Responses of interns given (expressed in percentage) whether they would prescribe antibiotics in the case scenarios.

Sr. No	Questions on conditions of whether Interns would use antibiotics in the given condition	No	Yes
1	Periapical pathology (no spread, chronic asymptomatic)	62%	38%
2	Periapical abscess, localized swelling (patient feels well)	28%	72%
3(a)	Acute periapical infection (Before drainage)	33%	67%
3(b)	(After drainage)	82%	18%
4	Periodontal abscess	23%	77%
5	Traumatic ulcer	31%	69%
6	Denture stomatitis	80%	20%
7	Acute necrotizing ulcerative gingivitis	12%	88%
8	Acute periodontitis	23%	77%
9	Chronic periodontitis	36%	64%
10	Pericoronitis	21%	79%
11	Extraction of third molar(asymptomatic)	18%	82%
12	Previous pericoronitis	15%	85%
13	Current pericoronitis	9%	91%
14	Dentigerous cyst asymptomatic	41%	59%
15	Oro-antral fistula	15%	83%
16	Avulsion and reimplantation	41%	59%
17	Previous bacterial endocarditis	12%	88%
18	Prosthetic heart valve	08%	92%
19	Mitral valve incompetence	10%	90%
20	Atrial septal defect	11%	89%
21	Immunocompromised patient	02%	98%
22	Patent ductus arteriosus	08%	92%
23	Head and neck radiotherapy	28%	72%
24	Heart murmur	10%	90%
25	Recent myocardial infarct	18%	82%
26	Diabetes	05%	95%
27	Stroke	09%	91%
28	Orthopedic plate	16%	84%
29	Old myocardial infarct	18%	82%
30	Kidney failure	12%	88%

Table 2: Questionnaire to know the prescribing practice of antimicrobial use in the interns.

requirements vary between institutions and only about 15,000 students are admitted annually. It is also important to get a high rank in the entrance examination as the number of applicants for combined medical and dental entrance could be more than 150,0000.

There are certain basic pre-dental education courses (math and sciences) that must be completed before enrolment in dental school in US and Canada. Moreover, Dental schools in US usually require students to complete a bachelor’s degree before submitting their applica-

tion. Depending on GPA and references, certain institutions may accept applications during the final year of undergraduate program. All dental schools require applicants to take the DAT (Dental Admission Test) as a part of the comprehensive admission process.

The framework of dental education is similar in India, US, UK, Japan. However American Dental School takes a minimum of four academic years and leads to one of two equivalent degrees based on the university one attends: Doctor of Dental Surgery (DDS) or Doctor of Dental Medicine (DMD) [21].

Based on the recommendations of dental council of India (DCI), dentists are required to prescribe medications for the management of several oral conditions. Prescription writing is taught in pharmacology course with a much-needed integration with other basic biomedical sciences taught in the first year and with microbiology, and pathology in the second year. The vertical integration of prescription writing skills and rational use of antibiotics is required in medicine and surgery of third year and dental clinical subjects in fourth year. Interns write prescription based on the knowledge gained in previous years. This competency is required for their lifelong skill for future clinical practice. However dental students learn various subjects in compartment or in isolation, so in-depth integrated learning does not take place as students are unable to see the clinical applicability immediately. A dentist should be competent to write prescription based on the integration of knowledge, and not mechanically write whatever is in vogue. Interns write prescription under supervision of seniors, so the errors are usually rectified before the prescription is handed to the patients.

There are approximately 69 accredited dental schools in United States. At Detroit Mercy Dental, i.e. University of Detroit Mercy's School of Dentistry, the second-year dental students are introduced to core pharmacokinetic and pharmacodynamic principles and autonomic pharmacology. These concepts and principles are reinforced for all drug classes. In addition, mechanism of action, clinical applications and an overview of the therapeutic and adverse actions, precautions, contraindications, and drug interactions for each major drug category/class and their implications to dental patient management are discussed.

The overarching goal is to increase the student's comfort level with pharmacological information, to provide them with a background of knowledge to enable them to make appropriate decisions involving the use of dental medications in patient care and instill in them the curiosity that will encourage them to stay current in this ever-changing field.

At the next level, students learn the details pertaining to the use of antimicrobials, immunosuppressants and pain control medications. The goals are set to increase the student's comfort level with the knowledge of drugs of abuse and common alternative medicinal products and their implications. They also gain thorough understanding of the systemic and oral impact of common drugs used for respiratory and GIT diseases, anticoagulants, endocrine and CNS drugs used by the dental patient. All through, an emphasis is laid on horizontal integration of other biomedical sciences with pharmacology and on highlighting their applications in clinical dentistry.

A third-year student is introduced to the principles of practical therapeutics in clinical dentistry. This involves instruction in the method(s) of prescription writing. The commonly prescribed chemotherapeutic agents and analgesics are reviewed with the help of case discussions. A variety of clinical scenarios are offered to aid the students in developing prudent decision-making. This might appear repetitive but is necessary to make sure students develop a rationale for effective use of antibiotics for dental infections and other oral infective lesions in patients suffering from acute or chronic medical conditions. Students also gain confidence regarding the knowledge of best practice guidelines for prophylactic use of antibiotics and conditions where such use is indicated.

In addition to above, students are required to pass a medication review competency. This competency assesses the dental student's ability to document an accurate, complete patient medication and recreational drug history, explain whether these medications have a significant adverse effect on the patient that may impact care and treatment and demonstrate how the patient's medications may interact with medications that a dentist may prescribe. Simultaneously, student learns to extract the relevant information from the drug database.

The end goal is dental student's preparedness to prescribe effectively, correctly, and safely while considering all variables like height, weight, race, age, sex, existing medical conditions, drug interactions and medication intolerance.

In the fourth year, dental student's prescription writing skills are assessed through a prescription writing competency by utilizing case-based scenario of a dental patient suffering from complex medical condition(s).

Prescription is a legal document and must be free from all errors for good clinical practice and for effective and safe treatment. Once interns graduate and start their clinical practice, they take independent decisions regarding prescription medications, hence they should be competent in writing a correct, legible, and rational prescription. Competency in prescription is a dynamic process which changes with knowledge, practical experience, and change in antimicrobial resistance pattern. Rational use of antimicrobial drugs in dentistry requires regular update on the existing guidelines on antimicrobial use, essential drug use, list of drugs in the formulary and evidence of safety and efficacy of drugs. Writing irrational prescription results in an increased burden to the society in terms of economics, loss of effectiveness of antimicrobials and development of bacterial resistance to these drugs. Many studies have pointed out the lacunae in prescription writing [22,23].

L Teoh, M] Mc Cullough, G Moses are of the opinion that most dentists report they have very little education on *how* to prescribe. As a result, it is a skill they pick up 'on the fly' during their final year at the university or in their first post-graduate year under the tutelage of senior staff. It is therefore likely that dental prescribing is highly prone to medication errors and adverse events [24]. Evidence demonstrates it as a universal challenge as even newly graduated medical students feel unprepared to safely prescribe medications in the early years of residency and consider it as their weakest area of practice [25].

Prescription writing skills and rational use of antibiotics

There have been calls over the years for dentists to minimize their prescription of antibiotics and only to prescribe when regional or systemic spread of the infection poses a significant risk. Growing antibiotic resistance threatens the effectiveness of antibiotics now and in the future. There are an estimated 25,000 deaths in Europe every year due to antibiotic resistant infections, and related costs of €1.5bn in healthcare expenses and productivity losses. Wide-spread antimicrobial resistance (AMR) threatens to push us back into the pre antibiotic era and it should therefore be a wake-up call for all healthcare personnel, including dentists. The fear of a major public health crisis is looming large.

In 2020, the center for strategic and international and international studies (CSIS), issued a brief regarding antimicrobial resistance in United States as *resistant infections afflict more than 2.8 million people a year, resulting in at least 35,000 deaths annually* [26].

Various guidelines have been laid down which intend to provide guidance over judicious antibiotic use. Studies done in the past show that antibiotic prophylaxis is not necessary in healthy patients for minor oral surgeries, implants, and periodontal surgeries [27]. In Contrast to these guidelines, in the present study, interns prescribed antibiotics for dental abscesses, post root canal treatment, post dental extraction and after most minor surgical procedures with no mention on the systemic counterpart.

The importance of antibiotic use for surgical wound healing is very low. The incidence of wound infection following extraction is less than 3%, so one is attempting to prevent low and minor risk of infection [28]. Similarly, clinical need of antibiotics for asymptomatic periapical pathology and periapical abscess is very low. Use of antibiotic for acute or chronic periodontitis is vogue, even though clinical evidence shows none or minimal benefits.

Several surveys that show that both general dentists and endodontists routinely prescribe antibiotics for patients with dental pain [29,30]. Evidence from randomized clinical trials and systematic reviews to indicates that supplemental antibiotics following adequate debridement and drainage in cases of localized endodontic infections are ineffective [31].

Our study showed interns using antibiotics for conditions like traumatic ulcers which could be treated by oral rinses and by removing the cause. Denture stomatitis could easily be managed by leaving the denture out for a few days, but our results showed interns prescribing antibiotics for the same. The recommended protocol for managing Oro-antral fistula is closing the fistula by suturing, but our study showed interns prescribing antibiotics for its treatment.

A US survey in 2015 revealed that dentists were responsible for more than 2.9 million antibiotic prescriptions, exceeding those of several other medical and allied healthcare provider specialties [32]. The underlying reasons being the desire to avoid clinical complications or the tendency to put professional experience before guidelines [33,34].

Observations from the Swedish strategic program against antibiotic resistance (STRAMA) point to an overall decrease in antibiotic prescriptions over the last 10 - 15 years, with a decrease in total prescriptions in dental practices from 35 to 27 per 1000 inhabitants between 2007 and 2016, probably due to the revised prophylaxis guidelines. Yet, significant differences in the prescription patterns were still noticeable between dental practices in greater cities and rural provinces [35]. This trend is also observed in the US, where prescriptions in dental practice accounted for 77.5 per 1000 inhabitants, with a two-fold geographical variability in some instances [36].

Our study shows that 82.47% interns were not aware of the latest ADA guidelines [37] which recommends prophylactic use of antibiotics only for few selected conditions. Either the study participants did not understand the guidelines or not adhere to them. The national bodies have not laid down specific dental guidelines for antibiotic use although general guidelines have been framed by Government of India, which 80% of the study participants were not aware of.

Ivana Šutej, Matej Par, Dragan Lepur, did a national survey study on 348 Croatian dentists to investigate their practice and compliance with current guidelines of infective endocarditis prophylaxis. An appropriate answer on antibiotic choice and first-line prescription at the right schedule for IE AP was given in significantly higher frequency by dentists working in a hospital/university setting compared to the dentists working in public or private practice ($p = 0.007$). There was a significant negative linear correlation ($R^2 = 0.97$, $p < 0.001$) between the work experience and an improper prescription of prophylaxis. The main misapplication was the choice of antibiotic and discordance in the regime of antibiotic use [38].

Dentist should follow certain general principles like not prescribing antibiotics for viral infections, culture, and sensitivity tests before prescribing antimicrobials, using appropriate antibiotic in proper dosages, considering narrow spectrum antibiotics in simple infections, preserving broad spectrum for more complex infections, and use of higher generation of antibiotics. Though this is taught in second year onwards, but internship is the golden period and last opportunity for the reinforcement of these concepts. In this study interns did appreciate the importance of rational use of antibiotics and 93% of them agreed that they were aware of principles of rational use of antibiotics; however, only 4% were confident on their ability to use recommended protocol for antimicrobial prophylaxis. While 94% of the interns agreed that antibiotics should be used judiciously to prevent antimicrobial resistance, and 98% of them agreed on the need to choose most safe and efficacious drug; however, they were unable to show similar results in practice. Thus, there is urgent need for reinforcement of the concepts they had learnt in previous classes during internship period.

Aminoglycosides are used for gram negative enteric bacteria especially when resistance is suspected and are used with beta lactam antibiotic to achieve synergism and cover Gram positive pathogens as well. Aminoglycosides have concentration dependent killing, that is increased concentration leads to more proportion of bacteria being killed at rapid rate. They also have significant post antibiotic effect; such that antibacterial activity persist beyond the time during which measurable drug is present. While toxicity of Aminoglycosides is both time and concentration dependent, these properties allow once daily dosing in various clinical situations which is of potential practical advantage to dentist [39,40].

The efficacy of once daily dosing for endocarditis (*Enterococcus*, *Streptococcus* and *Staphylococcus*) in pregnancy and in neonatal group is not well defined. Interns hesitated to use parenteral antibiotics as none of them was confident to use the antibiotic by parenteral route.

Though studies have depicted an alarming use of combination antibiotics and self-medication for dental problems in India, there is scarcity of data demonstrating parenteral antibiotic usage for dental infections in the country or in other studies the routes of drug administration have not been clearly depicted. William J Connors, Heidi H. Rabie, Rafael L. Figueiredo., *et al.* reported that based on the overall severity of dental infections presenting to acute medical care, 49% required parenteral antibiotics and an outpatient parenteral antimicrobial therapy (OPAT) referral. It is a common practice to give a single dose of an antibiotic with a longer half-life (i.e. ceftriaxone) to patients appropriate for oral step down at initial OPAT assessment [41].

During clinical training, dental students in Saudi Arabia are authorized to prescribe antibiotics. To evaluate dental students' knowledge and attitudes regarding antibiotic prescription a cross-sectional study based on a validated questionnaire was distributed amongst dental students in five leading dental colleges in Riyadh. When comparing junior and senior dental students, it was found that there was no significant difference in antibiotic prescription frequency between the two groups. When questioned with regards to specific conditions, such as localized intraoral swelling, juvenile diabetes, and congenital cardiac abnormalities, there was significant difference between the prescription tendencies of juniors and seniors. Regarding dental students' attitude towards prescribing antibiotics, it was found that the vast majority of dental students (88.4%) choose to prescribe Amoxicillin as their first-choice and a minority of students, 36 (11.5%), choose to prescribe ofloxacin with ornidazole, cephalexin, and clindamycin. The most common duration of an antibiotic course chosen was 3 - 5 days (69.2%), more than five days (17.6%), or for three days (13.2%) [42].

Prior studies evaluating the average duration of antibiotic course prescribed by dentists in Canada found that dental practitioners prescribe antibiotics for an average of 6.92 days [43].

Antibiotics are not routinely indicated in endodontics, unless there is fever and or gross swelling in the localized area. Endodontists in the USA prescribed antibiotics for 7.58 days [30]. According to the British National Formulary (BNF), an antibiotic course of two to three days is advocated for the treatment of acute dento-alveolar infections [44].

Indeed, several reports have shown that patients improved significantly after two to three days of antibiotic therapy, thus proving that prolonged courses may not confer additional benefits. Another important finding is that several students would prescribe antibiotics for viral infections, noted to be 33.3% of the sample, when in cases of viral infections, such as herpes simplex infection, symptomatic relief is the treatment of choice [44].

Our findings showed that dental students may prescribe antibiotics inappropriately to manage various oral and systemic conditions when they are not indicated. Furthermore, demonstrating a clear defect in education and awareness of students with regards to antibiotic guidelines.

Most prescribed drug was beta lactam group (Amoxicillin) followed by Fluoroquinolone group. This is similar to the finding of other studies done in dentists. There was overall excess use of antibiotics which is similar to study results by Debb [45].

Rebecca M. Roberts, Monina Bartoces, Sydney E. Thompson, and Lauri A. Hicks., *et al.* investigated antibiotic prescribing by general dentists in the United States, 2013. The most prescribed antibiotic agent was Amoxicillin at a rate of 43.6 per 1,000 persons (13.8 million prescriptions), representing 56% of all antibiotics. Other commonly prescribed antibiotics were Clindamycin (3.6 million prescriptions, 14.4% of all antibiotics); Penicillin VK (3.2 million prescriptions; 13.2% of all antibiotics), Cephalexin (1.2 million prescriptions; 4.9% of all antibiotic prescriptions) and Azithromycin (1.1 million prescriptions; 4.7% of all antibiotic prescriptions). Amoxicillin-potassium

clavulanate, doxycycline, ciprofloxacin, erythromycin and trimethoprim/sulfamethoxazole were also often prescribed by general dentists [46].

Despite substantial advances in dental public health over the past century, recent trends in the United States and Canada reveal increasing rates of emergency department (ED) visits and hospitalizations for acute dental infections (ADI). A parallel trend has been documented in Europe with Germany, Britain and Finland showing similarly increased ED visits for ADI. A recent study in the United States found that 56% of emergency room dental visits from a statewide sample received antibiotic prescriptions [47].

Perception of prescription writing skills

The observations from this study suggest that interns perceived knowledge of antibiotics as very important in their course, but they were unable to apply the knowledge in solving clinical problems. Since pharmacology is an extremely volatile subject, interns felt that most of the knowledge they gained in earlier years had evaporated. Reinforcement of most prescribed drugs and incorporation of pharmacology during internship, is needed to promote rational prescribing of antibiotics. There is also a need for regular discussions or journal clubs regarding newer guidelines on drug usage. Apart from making prescription writing a part of internship training curriculum, more effective team-teaching strategies among basic science professors and clinical dentists are needed to promote self-learning and to build the confidence of dental students. Other observations include lack of confidence in prescribing dose in special populations like geriatric, pregnant and pediatric age group. Hence, more dose calculation exercises, and practical training on prescription writing through case-based scenarios during internship is recommended.

Conclusion

At undergraduate level, prescription writing is an inherent part of dental curriculum in India. There is a gap between the perceptions of knowledge and its application in clinical dentistry among interns. Revisiting prescription writing and reinforcement of biomedical pharmacology during internship can help in filling the observed knowledge gap. Interns have a low self-awareness of prescribing errors and would likely benefit from frequent assessments and professional training by faculty with specialist qualification in pharmacology.

When a dentist perceive prescription writing as a powerful therapeutic tool and is able to understand the relevance and risks associated with prescription errors, only then practice for the same will be implemented.

Currently, it appears that antibiotics are being underused for crucial infections or for dental chemoprophylaxis, overused in surgical prophylaxis and used empirically either in sub therapeutic doses or for prolonged duration which amounts to their substantial misuse. Prudent use of antibiotics is essential to counter the significant threat of antibiotic resistance, which is already having a serious impact on patient care. In dentistry, there are usually interventions that can be used as first-line treatments rather than the prescription of antibiotics.

Dental professionals must take responsibility to use the best evidence-based practice available, and to educate patients about the available choices and the reasons for doing so.

Suggestions for dental student's preparedness for antibiotic prescriptions

Teaching pharmacology of drug groups with the help of case vignettes to second year dental students and utilizing this foundational knowledge in third year to identify core therapeutic principles in applied clinical pharmacology can help the students develop critical thinking skills which are necessary for pharmacologic reasoning.

Clinical seminars for fourth year dental students must emphasize integration of basic sciences knowledge, skills, and values. There is a need of frequent self-evaluation of knowledge of clinical pharmacology, and this could be achieved through discussions around medica-

tion prescriptions during seminars. Retention of pharmacology knowledge can be a challenge as the subject involves certain amount of memorization which can be quickly forgotten with breaks between the courses.

Limitations and Future Studies

This study captures perceptions and practices of interns in one center only, a higher number of participants and multicentric data would give a broader and clearer picture. Some of the open-ended questions were only answered by few participants, thus leaving some questions unanswered.

To assess the stepwise learning approach to pharmacology, it would be wise to do similar assessment surveys among dental students and residents at dental schools in United States and Canada. It is important to gauge if there are any coping strategies used by prescribers to relieve them of the emotional stress resulting from prescription errors. Similar studies will provide with student achievement data that can support future instructional decision making and can also bring to light how the recognition of minor or serious mistakes subsequently impact the prescribing practices.

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