Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.47750/jptcp.2022.843

Pharmacology teaching in dental education in India: Time for a reappraisal

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Submitted: 13 November 2021; Accepted: 5 June 2022; Published: 8 July 2022

ABSTRACT

India has a unique position with its vast population and rapidly increasing healthcare demand. Dental health is integral to a holistic health care need, and a robust dental education system is necessary. Dental education in India is mainly regulated by the Dental Councilof India, setting broad guidelines. Universities having dental colleges and institutes develop fine curriculum development and evaluation details. General and Dental Pharmacology and Therapeuticsis a crucial subject taught to undergraduate dental students during the second year of a 4-year duration course. A dental graduate should be well trained in general and systemic pharmacology and rational therapeutics principles. This has been set as an objective by the Dental Council of India. Sound knowledge of the drug action mechanisms, indications, adverse drug reactions, drug interactions and contraindications, evidence-based medicine, and rational use of adrug is core to the allopathic system. The practical exercises on human simulation or computer-assisted learning are critical for understanding pharmacology. The subject of pharmacology for dental graduates has been allotted 70 hours of theory and 20 hours of practicals with almost the same syllabus as medical graduates. This article highlights the areas of concern concerning the deficiency of teaching hours and needed improvement in the curriculum to make it competent to achieve its objective. The authors bring this much-needed topic for discussion among academicians and for the attention of regulatory authorities.

Keywords: *Dental education, medical teaching, and learning methods, pharmacology teaching*

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INTRODUCTION

Formal Dental education in India was started in the 1920s, with the establishment of the first dental college in Calcutta by Dr. Rafiuddin Ahmed.[1] The Dental Council of India is responsible for the regulation of dental education and the profession of dentistry in India is a statutory body constituted on April 12, 1949, by an Act of Parliament, the Dentists Act, 1948 (XVI of 1948).[2]

CURRENT STATUS OF DENTAL EDUCATION IN INDIA

The number of dental institutions overgrew in the recent decade, with private institutions contributing a major portion. At present, there is a total of 315 colleges and institutes, with 311 colleges offering Bachelor of Dental Surgery (BDS) courses and 252 colleges offering the Master of Dental Surgery (MDS) coursein branches of Prosthodontics and Crown & Bridge, Conservative Dentistry and Endodontics, Periodontology, Orthodontics & Dentofacial Orthopedics, Oral & Maxillofacial Surgery, Oral & Maxillofacial Pathology and Oral Microbiology, Oral Medicine & Radiology, Pediatric Dentistry, Public Health Dentistry.[3,4]

There is no official data available regarding India's current dentist population, but largely, it is getting saturated.[5,6]

Regarding the total number of BDS seats in Government-run dental colleges and private colleges, the Ministry of Health and Family Welfare, in a reply dated March 23, 2018, to question No. 4650, informed the Lok Sabha (lower house of the Indian Parliament) about the MBBS & BDS seats available in each Indian state. The reply states that, presently, there are a total of 27,060 BDS seats in India (2930 seats in government institutionsand 24,130 seats in private), whereas the MBBS seats were 30,455 in government institutions and 36,040 in private. It was also informed during the reply that a total of 4450 BDS seats and 437 MBBS seats remained vacant all over India in 2017–18.

If we look into the distribution of BDS seats, there is uneven distribution among the different regions of India. BDS seats in private colleges play a significant role in this uneven distribution as they are concentrated mainly in south Indian states, i.e., BDS seats in Karnataka (3360), Maharashtra (3250), Tamil Nadu (2760), Kerala (1730), Andhra Pradesh (1300) although some of the north Indian states, such as Uttar Pradesh (2400), Rajasthan (1460), also contribute good proportion.[7]

DENTAL EDUCATION REGULATION IN INDIA

Dental education involves attaining many technical skills along with the required theoretical knowledge. The dental colleges' curriculum and standard of education in India areregulated by the Dental Council of India (DCI), constituted on April 12, 1949, by an Act of Parliament, the Dentists Act, 1948 (XVI of 1948).[8]

The Dental Council of India defines the following objectives: (i) Maintenance of uniform standards of dental education—both at undergraduate and postgraduate levels; (ii) it envisages inspections/visitations of dental colleges for permission to start dental colleges, increase seats, and start new PG courses (as per provisions of section 10A of the Act); (iii) prescribe standard curricula for training dentists, dental hygienists, dental mechanists, and the conditions for such training; (iv) Prescribe the minimum standards of examinations and other requirements to be satisfied to secure for qualifications recognition under the Act; and (v) Supervision over all dental institutions to ensure that they maintain the prescribed standard.[9]

Undergraduate Dental Course Duration and Examination System

The duration of the undergraduate dental course in India is 5years including 1year of compulsory

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rotatory internship. Formative evaluation is done throughout the session under the heading of internal assessment. Weightage for the internal assessment shall be 10% of the total marks (separately in theory and practice) of the university examination. Universities conduct a summative evaluation by holding examinations at the end of each academic year through written, practical, patient-based, and oral exams.

PHARMACOLOGY IN MEDICAL AND DENTAL EDUCATION

Previously known as '*Materia Medica*' in the nineteenth century, pharmacology as a subject has advanced manifold. Pharmacology is a highly dynamic subject that has witnessed many advancements since its inceptionas a course subject. The advent of antibiotics in the mid-1900s with synthetic and semisynthetic products opened the door for rapid discovery of drugs. With the advent of technology, understanding drug-receptor interactions, signal transduction mechanisms at the molecular level, and knowledge of the pathological, genetic, and biochemical basis of diseaseidentified new targets for advanced drug discovery, leading to better elucidation and understanding of drugs.

Pharmacology Domains in Undergraduate Medical and Dental Syllabus

Broadly, pharmacology for undergraduate medicine and dentistry courses comprise three domains:

1. Principles of drug therapy covered under the section of general pharmacology, which includes topics related to pharmacokinetics, pharmacodynamics, factors modifying drug action, molecular interactions, and adverse reactions, including the concept of tolerance.
2. Systemic pharmacology related to drugs used in diseases in different systems.
3. Clinical pharmacology covering topics of rational use of drugs, pharmacotherapeutics, the process of development of new drugs, drug regulatory aspects, and bioethics.

PHARMACOLOGY IN DENTAL CURRICULUM

The Dental Council of India, in its BDS regulation 2007, has mentioned General and Dental Pharmacology and Therapeutics as a course subject to be taught in the second year of the BDS curriculum alongwith General Pathology and Microbiology, Dental Materials. Pharmacology is a major paraclinical subject in the secondyear of the BDS program. Students mustclear a university-based theory examination (3 hours' duration) and a practical examination separately as a mandate. General Pathology and Microbiology (one paper) and Dental Materials will also have a university-based theory and practical examination in the secondyear, whereas Preclinical Conservative Dentistry, preclinical Prosthodontics & Crown & Bridge, and Oral Pathology & Microbiology will not have theory papers, but only practical viva voce in the second year examination.[10]

GOALS SET BY DCI FOR PHARMACOLOGY TEACHING[11]

DCI regulation sets the following goals for General and Dental Pharmacology teaching.[11]

The broad goal of teaching pharmacology to undergraduate students is to inculcate a rational and scientific basis of therapeutics, considering the dental curriculum and professional requirements.

At the end of the Pharmacology course the student should be able to: (i) describe the pharmacokinetics and pharmacodynamics of essential and commonly used drugs in general practice as well as in dentistry; (ii) list the indications, contraindications; drug-drug interactions, drug-food interactions, and adverse drug reactions of commonly

TABLE 1. Second year subject-wise distribution of hours and University Exams by the Dental Council of India.

Subject	Theory	Practical	University exam for the subject
General Pathology & Microbiology	55 (pathology) 65 (Microbiology)	55 (pathology) 50 (Microbiology)	Combined theory exam of Pathology and microbiology (100 Marks each for theory and practical)
Dental Pharmacology & Therapeutics	70	20	100 marks each for theory and practical
Dental Material	60	200	100 marks each for theory and practical
Preclinical Prosthodontics and Crown & Bridge	25	200	Only practical and viva voce in the second year
Preclinical Conservative Dentistry	25	200	Only practical and viva voce in the second year
Oral Pathology & Oral Microbiology	25	50	No university exam in the second year, but conducted in the 3rd year

prescribed drugs with justification; (iii) tailor the use of appropriate drugs in disease with due consideration to the socioeconomic aspects of a patient, i.e., cost, efficacy, and safety. Choice of drugs based on above parameters if **mass** therapy is required; (iv) indicate special precaution/care while prescribing drugs in special medical situations such as pregnancy, lactation, old age, renal insufficiency, hepatic damage, and immune-compromised patients; (v) integrate and exercise rational pharmacotherapy in clinical pharmacology, and (vi) indicate the principles underlying the concepts of "Essential drugs."

TEACHING HOURS ALLOTTED FOR PHARMACOLOGY IN MEDICAL AND DENTAL EDUCATION

To fulfill these objectives/goals, DCI regulation has allotted total of 90 hours of Pharmacology teaching, with 70 hours for theory and 20 hours for practicals (Table 1). The comparison of MBBS and BDS syllabus specified by MCI and DCI respectively has almost the same objectives and syllabus but with a huge difference in the allotted time of teaching hours for pharmacology. The MCI regulation has allotted 300 hours of Pharmacology teaching without any Theory and practical break up in its syllabus, leaving the issue to universities. Kerala University of Health Sciences, in its syllabus, has divided these 300 hours into theory; **Lectures 125 hours and Practicals 75 hours;** Innovative sessions & Internal Assessments 100 hours.

The other Health university in the country, Rajiv Gandhi University of Health Sciences (RGUHS), has made the following breakup in its pharmacology syllabus, Theory; **Lectures 120 hours and Practicals 144 hours;** Integrated teaching 36 hours. The Maharashtra University of Health Sciences has divided the 300 hours into Theory; **Lectures 109±5 hours, Tutorials 17+5 hours and Practicals 120+5 hours; Revision and evaluation 60 hours.**

TOPIC-WISE MEDICAL AND DENTAL SYLLABUS

Going through the topic-wise syllabus of BDS, it was found that it contained almost the same topics and subtopics as in MBBS. Only a few topics, e.g., male and female sex hormones, and anti-arrhythmic drugs, are not mentioned in the BDS syllabus. Although, at times, it becomes challenging for a teacher to deal with anticancer drugs without providing knowledge of sex hormones. In addition to an almost similar syllabus as MBBS, the BDS syllabus

has some additional topics like Dental Pharmacology, including fluorosis.It is to be noted that the MBBS syllabus does not include Dental Pharmacology.

Dissecting the individual topic-wise allocation of time, we find a major difference in allocated time for the same topics in MBBS and BDS among different universities.[12–15]

PRACTICAL TOPICS OF DENTAL PHARMACOLOGY SYLLABUS DEVOID OF CLINICAL PHARMACOLOGY TOPICS

Let's go through the practical topics of the MBBS syllabus. It covers a wide range of topics of experimental pharmacology that reinforce the knowledge of the autonomic nervous system (ANS) and peripheral nervous system (PNS). The topics covered under Clinical Pharmacology are critically important and mainly include rational use of drugs, principles of pharmacotherapy, problem-based learning (PBL) activities, i.e., clinical problems and simulations, Biomedical Ethics, Informed Consent, ADR monitoring, i.e., pharmacovigilance.

The Importance of Clinical Pharmacology and the BDS Syllabus

Clinical pharmacology is important for dental students as they need to be updated on drug therapy and information related to their clinical practiceand knowledge of relevant adverse effects and interactions, e.g., the most important class of drugs prescribed by dentists include local anesthetics, analgesics, and antibiotics.[16] There is a trend of polypharmacy in older patients; therefore, knowledge of drug interactions and adverse effects that cause dental problems isvery important.[17] Further,

TABLE 2. Comparison of allocation oftheory hours between MBBS and BDS between Kerala University of Health Sciences (KHUS) and Rajiv Gandhi University of Health Sciences (RGUHS).

Topic and Subtopic (Theory)	Kerala University of Health Sciences (KUHS) (hours)		Rajiv Gandhi University of Health Sciences (RGUHS) (hours)	
	MBBS	BDS	MBBS	BDS
General Pharmacology and basic concepts of clinical Pharmacology	16	9	12	9
Autonomic nervous system	12	7	15	7
Autacoids and related drugs	3	2	6	2
Central nervous system including local anesthetics	24	12	20	12
Cardiovascular system including diuretics	15	5	17	5
Drugs affecting blood and blood formation	6	6	5	7
Respiratory system	2	1	2	1
GIT	3	3	5	3
Drugs acting on endocrine system	9	4	15	4
Chemotherapy	17	13	25	15
Dental pharmacology and emergencies in dental practices	0	5	0	5
Chelating agents,	1	1	1	1
Miscellaneous including immunosuppressants, gout, and rheumatoid arthritis	4	2	6	0

few younger populations on psychotropic drugs may need dental consultations for oral hygiene, which is compromised directly or indirectly through behavioral problems.[18] Patients on nutritional and herbal medicine, who are seeking dental treatment, may likely face herbal, allopathic drug interactions, e.g., warfarin, with an increased risk of bleeding.[19] Thus, Clinical Pharmacology is important for dentists, and there is a need to frame an optimal education strategy.

TABLE 3. Comparison of allocation of Practical hours between MBBS and BDS among KHUS and RGUHS.

Topic (Practical)	**KUHS**		**RGUHS**	
	MBBS (Practical and Innovative session (Total 175 hours)	**BDS (20 hours)**	**MBBS**	**BDS (20 hours)**
Pharmacy introduction and preparation Introduction—equipment used in dispensing pharmacy, prescription—parts and model prescription.	—	14	40	14
Dosage form	—	02	—	02
Medical prescription	—	02	—	02
Dental prescription	—	02	—	02
Experimental pharmacology 1. Frog heart preparation to show the effect of autonomic drugs on ions. 2. Frog rectus preparation to show neuromuscular drug action. 3. Mammalian smooth muscle (rabbit, guinea pig, rat) to show drug effects and drug antagonism. 4. Mydriatic and meiotic effects on rabbit pupils. 5. Drug action on the ciliary movement of frog esophagus. 6. Anesthesia: Frog plexus, surface anesthesia in rabbits, infiltration in the guinea pig. 7. Demonstration of the animal experiment using computer-aided demonstrations may be included as part of experimental pharmacology." Experiments on whole animals may be included in place ofisolated tissue wherever feasible, for example: • Effect of drugs on rabbit eye. • Induction of catalepsy in rats/mice. • Sleeping time in mice. • Effects of drugs on spontaneous motor activity & exploratory behavior. • Skeletal muscle relaxants. • Effects of analgesics	Total 175 hours have been allotted for practical and innovative sessions having sessions on computer-assisted learning (mainly on experimental pharmacology), Seminars, Projects, demonstrations, etc.	Not at all in the syllabus for BDS students	40	Not at all in the syllabus for BDS students.

(continues)

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TABLE 3. Continued.

Topic (Practical)	KUHS		RGUHS	
	MBBS (Practical and Innovative session (Total 175 hours)	**BDS (20 hours)**	**MBBS**	**BDS (20 hours)**
Clinical pharmacology: • Clinical problem-solving exercises oriented toward drug interaction, and rational drug therapy. • Prescription writing for common clinical conditions. • Criticize, correct and rewrite the given prescriptions (Therapeutic & drug interactions oriented). • Case studies to study rational therapeutics. • Analysis of rationality of fixed-dose combination. • Critical evaluation of promotional drug literature. • Getting conversant with the source of drug information. • Cost comparison of branded preparations.	Included in the above hours (175 hours)	Not at all in the syllabus for BDS students	64	Not at all in the syllabus for BDS students.

THE ISSUE OF RATIONAL DRUG USE

The act of indicating one or more drugs to be taken by the patient, its dosage, and the treatment interval is known as prescribing.[19] Rational drug prescription is defined as obtaining the best possible effect using the least number of drugs to, in the short period and at a reasonable cost to the patient.[20–22] Rational drug prescribing is a dynamic and individualized clinical process. Many factors, e.g., social, economic status, cultural background, and drug promotional factors, can influence the prescription pattern. Thus, knowledge of Pharmacology is the most important component of the undergraduate dental teaching curriculum, where students learn about the art of prescription writing and different drug and dose formulations. It is essential for dental students to know about the proper therapeutic guidelines.[23,24]

Toothache is generally the most important reason for prescribing medication to dental patients. Therefore, NSAIDs arethe most important class of drugs prescribed by dentists. Dental students commit errors during prescription due to wrong posologies for different age groups and special groups, e.g., pregnancy. Other commonly prescribed drugs in dentistry are the local anesthetics used during dental procedures and antibiotics. Due to the varying characteristics of these drugs, it is mandatory to determine accurate doses and be aware of any adverse or toxic effects before prescribing. These drugs may cause harm to the patient if not prescribed correctly.[25,26]

CONCOMITANT MEDICATION/ POLYPHARMACY ISSUES

Although dentists prescribe less than 10% of all available drugs, patients may take many other drugs for medical reasons. Polypharmacy is the norm these days, especially in India, it is critical to every practice setting today. Dentists need to explore drug history and medical history before prescribing drugs to avoid possible drug interactions.

It is very important to take into account drug history about allopathic medications, herbal products, over-the-counter drugs, and supplements the patient is taking at that time, and accordingly, the dentist has to decide whether a prescribed drug is compatible with the drugs the patient is already taking.

CHALLENGES IN TEACHING PHARMACOLOGY

It is challenging for a teacher to cover pharmacokinetics (2 hours), Pharmacodynamics (2 hours), and the entire cardiovascular system (4 hours), whereas the students of MBBS getthree semesters (first semester 16 weeks, second semester 16 weeks, and final semester 24 weeks). It is a great challenge for a teacher as well as for a dental student.

DIFFICULTIES FACED BY STUDENTS

Dental students face similar difficulties as faced by pharmacology teachers due to short hours allocation for pharmacology. Pharmacology being a major subject, the DCI curriculum emphasizes dental students to be as expert as medical students in a minimal number of hours, which is practically impossible because of time constraints. Students feel stressed out due to the vast syllabus to be completed and learned thoroughly. Students feel the difficulty applying practical pharmacology in a clinical setting due to inadequate subject knowledge. Thus, they sometimes feel less confidentand frustrated while prescribing drugs to patients, which is not acceptable in a patient setting.

CONCLUSIONS

It is time for reappraisal so that the pharmacology syllabus content and duration should match the course objective.

1. Basic pharmacological principles are equally important for BDS students as for MBBS.
2. It is difficult to cover in such a short time whole syllabus is almost equivalent to an MBBS Pharmacology course
3. If it is felt that knowing a drug for a particular system is not necessary, its deletion can be considered.
4. But if any drug for a particular system isto be incorporated in the BDS syllabus, then there must be teaching hours corresponding to minimum requirements.
5. Practically, there is no trend of making medicines in pharmacology laboratory, e.g., Mandle's throat paint, astringent mouth wash, Whitfield's ointment, Oral rehydration salts, tooth powder, toothpaste, etc., as the laboratory reagents may be substandard quality and moreover undergraduate lab is not standardized for such formulations and preparations. In addition, all these preparations are available in the market. Making these preparations in a lab should be obsolete and should be replaced by simulations, CAL, and Clinical Pharmacology exercises for a better understanding of applied Pharmacology.
6. Present hour allocation leads to half knowledge to dental students despite teachers' best efforts because of restricted hours to complete syllabus.

AUTHORSHIP

It is certified that all authors meet the following four criteria of authorship.

1. Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
2. Drafting the work or revising it critically for important intellectual content; AND
3. Final approval of the version to be published; AND

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4. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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