

Awareness and Management of Local Anaesthetic Complications Among Undergraduate Dental Students: A Narrative Review

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ABSTRACT

Background: Local anaesthesia is fundamental to dental care, but its administration may cause local, neurological, ophthalmic, allergic, and systemic complications. Undergraduate dental students begin administering local anaesthetics while their technical ability and clinical judgement are still developing. **Objective:** To synthesise evidence regarding undergraduate dental students' awareness of local anaesthetic complications, their knowledge and preparedness for managing these events, and the educational factors associated with clinical readiness. **Methods:** PubMed/MEDLINE, Google Scholar, journal repositories, and reference lists were searched using terms related to dental local anaesthesia, complications, undergraduate students, emergency management, and dental education. Cross-sectional surveys, educational studies, clinical reviews, case reports, and contextual evidence involving recent graduates were narratively synthesised. **Results:** The evidence indicated uneven knowledge across complication domains. Students were generally more familiar with common local complications than with maximum dose calculations, neurological and ophthalmic events, allergy differentiation, or local anaesthetic systemic toxicity. Management knowledge frequently appeared weaker than recognition knowledge. Seniority and clinical exposure were associated with greater confidence, although confidence did not consistently correspond to objective knowledge or competence. Simulation, case-based learning, repeated emergency training, and accessible emergency resources may strengthen preparedness. **Conclusion:** Undergraduate dental students demonstrate variable readiness to recognise and manage local anaesthetic complications. Curricula should integrate complication-focused teaching, objective scenario-based assessment, and repeated emergency-management training throughout clinical education. **Keywords:** Local anaesthesia; dental students; complications; dental education; patient safety; systemic toxicity.

INTRODUCTION

Effective pain control is fundamental to contemporary dental practice, and local anaesthesia is routinely used during restorative, endodontic, periodontal, prosthodontic, and oral surgical procedures. The development of injectable amide local anaesthetics, including lidocaine, articaine, mepivacaine, prilocaine, and bupivacaine, has made most dental procedures safer and more tolerable for patients. Although these agents have a favourable safety profile when appropriately selected and administered, their use requires accurate knowledge of pharmacology, maximum recommended doses, vasoconstrictor

concentrations, anatomical landmarks, injection techniques, patient-related contraindications, and emergency management principles (1-3).

Complications associated with dental local anaesthesia range from common, transient events to uncommon but potentially serious emergencies. Local complications include injection-site pain, haematoma, trismus, needle breakage, soft-tissue injury, infection, prolonged anaesthesia, and paraesthesia. Neurological and anatomically mediated complications may include transient facial nerve palsy, cranial nerve disturbance, diplopia, ptosis, extraocular muscle dysfunction, and other sensory or motor deficits resulting from direct nerve trauma, diffusion through adjacent anatomical spaces, or inadvertent intravascular deposition (2,4,5). Ophthalmic complications are rare but clinically important because transient visual disturbance and permanent vision loss have been documented following intraoral local anaesthetic injections (6,7). Systemic complications include psychogenic reactions, vasovagal syncope, hyperventilation, allergic or hypersensitivity reactions, methaemoglobinaemia, seizures, cardiovascular disturbances, and local anaesthetic systemic toxicity. Many of these events are preventable or manageable when the clinician applies appropriate dose calculations, aspiration techniques, patient assessment, early recognition, and structured emergency responses (2,8).

Undergraduate dental students occupy a particularly important position in relation to local anaesthetic safety because they begin administering injections to patients while their technical skills, clinical judgement, and confidence are still developing. The transition from preclinical training on models or simulation devices to injections in conscious patients is challenging and may be accompanied by substantial anxiety. Students must simultaneously identify anatomical landmarks, communicate with the patient, control the syringe, aspirate appropriately, monitor the patient's response, and recognise signs of an adverse event. Training that concentrates primarily on needle placement may therefore leave insufficient attention for dose selection, medical risk assessment, complication recognition, documentation, referral, and emergency management (9,10).

Existing studies indicate that undergraduate dental students frequently demonstrate uneven knowledge of local anaesthetic administration and its complications. Students may recognise familiar local events, such as pain, haematoma, or trismus, while showing weaker understanding of maximum safe doses, neurological complications, ophthalmic events, allergic reactions, and systemic toxicity. Cross-sectional surveys have also reported differences according to academic year, postgraduate status, and clinical exposure, although findings are difficult to compare because questionnaires, scoring systems, participant groups, and competency definitions vary considerably between studies (11,12). Broader investigations of medical-emergency preparedness similarly suggest that senior students and recent graduates often report greater confidence than junior students, but increasing confidence does not invariably correspond to equivalent gains in theoretical knowledge or objectively demonstrated competence (13,14). Evidence from house officers and general dentists further indicates that knowledge gaps may persist during the transition to more independent clinical practice, although these populations should be interpreted as supplementary rather than direct evidence concerning undergraduate education (15).

The available literature also differentiates inadequately between awareness, knowledge, confidence, preparedness, and clinical competence. Awareness reflects recognition that a complication may occur, whereas management knowledge concerns the ability to identify appropriate immediate actions. Confidence is a self-perceived judgement and may not accurately reflect actual performance. Preparedness additionally depends on institutional factors, including supervision, access to emergency protocols, availability of drugs and equipment, and opportunities to rehearse emergency responses. Simulation and case-based teaching may improve technical familiarity and decision-making by allowing students to practise uncommon clinical events in a controlled environment, but the degree to which these educational gains transfer to real-patient emergencies remains uncertain (16-18).

The evidence base is further limited by the predominance of single-centre cross-sectional surveys, heterogeneous questionnaires, self-reported outcomes, variable reporting of response rates, and limited use of objective performance-based assessments. Rare but severe events are also more frequently documented through clinical reviews and case reports than through student-based educational studies. Consequently, direct evidence concerning undergraduate knowledge must be distinguished from contextual evidence describing the clinical manifestations and management of complications.

This narrative review therefore aimed to synthesise the available evidence regarding undergraduate dental students' awareness of local and systemic complications associated with dental local anaesthesia, their knowledge and preparedness for managing these events, and the educational and institutional factors associated with clinical readiness. Evidence involving house officers and recently qualified dental practitioners was considered only where it clarified the transition from supervised undergraduate training to early independent practice. The review additionally examined limitations in current teaching and assessment approaches and identified evidence-informed priorities for improving undergraduate dental education and patient safety.

MATERIALS AND METHODS

This study was conducted as a narrative review using a structured, non-systematic approach to identify and synthesise literature concerning awareness and management of dental local anaesthetic complications among undergraduate dental students. A narrative design was selected because the available evidence included heterogeneous cross-sectional surveys, educational studies, clinical reviews, case reports, case series, textbooks, and medical-emergency preparedness studies that differed substantially in their populations, assessment instruments, outcome definitions, and methods of reporting. The review was organised around four principal questions: what undergraduate dental students know about local and systemic local anaesthetic complications; how well they understand the management of these complications; which educational, clinical, psychological, and institutional factors influence their preparedness; and which teaching and assessment approaches may strengthen clinical readiness.

Electronic literature searches were conducted through PubMed/MEDLINE, Google Scholar, and relevant journal repositories. Search terms were used individually and in combinations and included “local anaesthesia,” “local anesthesia,” “local anaesthetic complications,” “local anesthetic complications,” “dental students,” “undergraduate dental students,” “house officers,” “dental interns,” “awareness,” “knowledge,” “confidence,” “competence,” “management,” “systemic toxicity,” “local anaesthetic systemic toxicity,” “neurological complications,” “ophthalmic complications,” “medical emergencies,” “simulation,” and “dental education.” Publications from approximately the preceding two decades were prioritised to reflect contemporary dental education and clinical practice. Earlier sources were retained when they provided foundational information on pharmacology, neurological complications, ophthalmic complications, allergy, or emergency management that remained relevant to the review question. Reference lists of retrieved publications were also examined to identify additional eligible sources.

Direct evidence comprised observational or educational studies involving undergraduate dental students and assessing at least one relevant domain, including knowledge of local anaesthetic agents, maximum recommended doses, cartridge calculations, injection-related complications, recognition of adverse events, immediate management, medical-emergency preparedness, confidence, or objectively assessed performance. Studies involving postgraduate students were considered when undergraduate findings were reported separately or when the comparison provided relevant information on the influence of educational seniority. Evidence involving house officers, dental interns, recent graduates, dental officers, or general dentists was retained as contextual evidence when it informed the transition from

undergraduate education to early independent practice, but it was not treated as equivalent to direct undergraduate evidence.

Clinical reviews, case reports, and case series were included to characterise uncommon neurological, ophthalmic, otological, allergic, and systemic complications that were insufficiently represented in student surveys. Dental-education studies examining preclinical models, manikins, virtual simulation, mixed-reality systems, student-to-student injection training, case-based learning, or simulated medical emergencies were included when they addressed the development of relevant knowledge, technical performance, confidence, or emergency decision-making. Textbooks and clinical practice resources were used to support established pharmacological, anatomical, and emergency-management principles. Sources that did not address dental local anaesthesia, associated complications, student education, patient safety, or emergency preparedness were not used to support the thematic conclusions.

Potentially relevant publications were initially assessed according to their titles and abstracts, followed by examination of the full text when the source appeared applicable to the review objectives. Duplicate reports were considered as a single source, and reference-list searching was used to supplement the electronic search. During synthesis, information was organised according to publication year, country, study design, participant group, educational level, sample characteristics, assessment approach, complication domain, outcome type, principal findings, and reported limitations.

The synthesis distinguished five related but non-equivalent outcome constructs. Awareness referred to recognition that a particular complication could occur. Knowledge referred to factual understanding of causation, clinical presentation, prevention, or management. Confidence represented participants' self-perceived ability to respond appropriately. Preparedness incorporated knowledge, confidence, access to protocols, emergency equipment, medications, and supervisory support. Competence referred to demonstrated performance in a clinical, simulated, or scenario-based assessment. Findings based on objective testing or direct performance assessment were interpreted separately from self-reported confidence.

Evidence was grouped thematically into local anaesthetic pharmacology and dose calculation; local complications; neurological, ophthalmic, and otological complications; allergic and hypersensitivity reactions; local anaesthetic systemic toxicity; broader medical-emergency preparedness; educational and institutional determinants; simulation and case-based teaching; and priorities for future research. Studies specifically assessing undergraduate students' knowledge or management of local anaesthetic complications were given interpretive priority. Broader emergency-preparedness studies and evidence involving house officers or practising dentists were used to provide contextual support and were identified as indirect evidence when appropriate.

Because of substantial heterogeneity in study populations, questionnaires, scoring systems, outcome definitions, and educational settings, statistical pooling was not undertaken. Findings were synthesised narratively by examining the consistency, direction, directness, and clinical relevance of reported results. No formal risk-of-bias or methodological-quality appraisal tool was applied because the purpose of the review was thematic synthesis rather than systematic estimation of an intervention effect or pooled prevalence. Consequently, conclusions were framed cautiously, and greater interpretive weight was placed on findings supported by multiple studies, clearly defined outcomes, and direct assessment of undergraduate dental students.

RESULTS

The identified evidence was geographically diverse but methodologically dominated by cross-sectional questionnaires, institution-based surveys, educational evaluations, clinical reviews, and case reports. Direct evidence involving undergraduate dental students consistently suggested that knowledge of local anaesthetic complications was incomplete and uneven. Students were generally more familiar with

common local events, including pain, haematoma, trismus, and soft-tissue trauma, than with uncommon neurological, ophthalmic, allergic, or systemic complications. In one survey, fewer than one-quarter of participants correctly identified transient amaurosis as temporary blindness, while only a minority correctly identified the safe number of cartridges of 2% lidocaine with adrenaline for a healthy adult (11).

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Table 1. Principal studies examining knowledge, confidence, and preparedness related to local anaesthesia and medical emergencies

Study	Population and context	Assessment focus	Principal findings	Interpretation
Kumar Mangal and Ravindran (11)	Undergraduate and postgraduate dental students in India	Dosage, administration, and complications	Overall knowledge was moderate, postgraduate participants performed better than undergraduates, fewer than one-quarter correctly identified transient amaurosis, and only a minority correctly identified the safe number of lidocaine cartridges	Demonstrated specific deficits in dose calculation and recognition of uncommon ophthalmic complications
Karthikeyan (12)	Undergraduate dental students in Tamil Nadu, India	Awareness of local anaesthetic complications	Gaps were identified in knowledge of local and systemic complications	Supported the presence of uneven complication-related knowledge among undergraduates
Felipe et al. (19)	Dental students	Local anaesthetics and associated complications	Knowledge varied across pharmacological and complication-related domains	Reinforced the need to separate general knowledge from management competence
Vanconcellos et al. (20)	Undergraduate dental students in Brazil	Selection of local anaesthetics for patients with special medical considerations	Students demonstrated inconsistencies in selecting appropriate agents for medically compromised patients	Indicated limitations in applying pharmacological knowledge to patient-specific decision-making
Tadin et al. (21)	Practising dentists in Croatia	Knowledge, practice, and self-reported confidence	Knowledge, clinical practice, and confidence varied among respondents	Provided indirect evidence that knowledge gaps may persist after graduation
Solanki et al. (13)	Dental students from four dental schools in the United States	Readiness to manage medical emergencies	Scores varied substantially between participants and institutions, with senior students generally performing better than junior students	Suggested that educational seniority improves preparedness but does not ensure uniform competence
Sng et al. (14)	Dental students and dental officers in Singapore	Competence and confidence in managing medically compromised patients and acute emergencies	Confidence increased with clinical seniority, whereas theoretical knowledge did not demonstrate an equally consistent gradient	Demonstrated that confidence and knowledge are related but non-equivalent outcomes
Anwar et al. (15)	Dental house officers and general dentists in Pakistan	Knowledge, skills, and perceived emergency competency	Meaningful deficits persisted despite greater clinical exposure than undergraduate students	Supported the need for reinforcement during the transition to independent practice
Alolayan et al. (18)	Dental students in Saudi Arabia	Preparedness for medical emergencies	Preparedness and confidence were variable, and limitations in emergency resources were identified	Highlighted the combined influence of individual knowledge and institutional readiness
Knipfer et al. (9)	Undergraduate dental students progressing from models to patients	Local anaesthesia training and transition to clinical practice	The transition from simulation to live-patient administration represented a substantial educational step	Supported staged teaching and supervised clinical exposure
Chandrasekaran et al. (10)	Dental students receiving their first local anaesthetic injection	Perception and anxiety	Students experienced appreciable anxiety during their first injection experience	Suggested that psychological stress may affect recall and clinical performance
Thelen et al. (16)	Dental hygiene students	Simulation compared with traditional local anaesthesia teaching	Simulation and traditional methods produced differing educational experiences and performance outcomes	Supported the use of simulation as an adjunct rather than an assumed

Study	Population and context	Assessment focus	Principal findings	Interpretation
Manton et al. (17)	Dental practitioners participating in a simulation curriculum	Medical-emergency management	Scenario-based training was feasible for rehearsing emergency recognition and response	replacement for clinical practice Provided contextual support for simulation-based emergency education

Table 2. Evidence synthesis by complication and competency domain

Domain	Evidence base	Synthesised finding	Educational implication
Maximum dose and cartridge calculation	Pharmacological reviews and student or dentist surveys (2,3,8,11,23)	Knowledge of maximum recommended doses and safe cartridge numbers was inconsistent, despite its direct relevance to prevention of systemic toxicity	Weight-based dose calculation and cartridge conversion should be repeatedly assessed during preclinical and clinical training
Selection for medically compromised patients	Student surveys and clinical reviews (20,24)	Students showed difficulty translating pharmacological knowledge into appropriate agent selection for medically complex patients	Teaching should integrate medical history, vasoconstrictor considerations, drug selection, and patient-specific risk assessment
Common local complications	Student surveys and clinical reviews (2,11,12,19)	Pain, haematoma, trismus, and soft-tissue injury were generally more familiar than uncommon complications	Common complications should be linked to prevention, documentation, follow-up, and referral criteria rather than taught only as definitions
Neurological complications	Clinical reviews and educational surveys (4,5,11,12)	Facial nerve palsy, paraesthesia, and other neurological events were less consistently recognised than common local complications	Anatomical mechanisms and immediate management should be taught through cases and anatomical correlation
Ophthalmic complications	Case reports, reviews, and dentist surveys (6,7,22)	Diplopia, ptosis, amaurosis, and vision loss were uncommon but clinically significant and frequently under-recognised	Rare ophthalmic events should be included in high-stakes case discussions and referral algorithms
Otological complications	Case-based evidence (25)	Tinnitus and hearing disturbance have been described following specific mandibular block techniques	Students should understand that complications may extend beyond the immediate injection site
Local anaesthetic systemic toxicity	Clinical reviews and case-based evidence (2,8,26)	Early neurological features may progress to seizures, arrhythmia, and cardiovascular collapse; rapid recognition is essential	Students should rehearse immediate cessation, airway support, oxygenation, seizure management, emergency escalation, and awareness of lipid-emulsion protocols
Allergy and hypersensitivity	Reviews, practitioner surveys, and case reports (27-29,33)	True allergy to amide agents is rare, and vasovagal, anxiety-related, epinephrine-related, or preservative-related reactions may be misclassified as allergy	Training should emphasise differential recognition, emergency treatment of genuine anaphylaxis, and appropriate referral for allergy assessment
Medical-emergency preparedness	Multicentre and institutional surveys (13-15,18,30,31)	Knowledge and confidence were variable, and preparedness was influenced by access to emergency drugs, equipment, protocols, and training	Competency assessment should combine knowledge testing, simulation, and verification of emergency-resource availability
Anxiety and psychogenic responses	Student and clinical studies (10,32)	Anxiety may affect cardiovascular responses, concentration, and recall during local anaesthetic administration	Graduated exposure, communication training, supervision, and simulation may reduce cognitive overload
Simulation and case-based training	Educational studies (9,16,17)	Simulation supported rehearsal of injection and emergency-management skills, although transfer to real clinical performance could not be assumed	Simulation should supplement supervised patient care and should include objective scenario-based assessment

Recognition knowledge was generally stronger than management knowledge. Students could often identify that paraesthesia, trismus, syncope, or allergic reactions may occur but were less consistently able to describe a complete immediate response, including cessation of treatment, patient positioning, airway assessment, oxygen administration, emergency medication, documentation, follow-up, and referral. This gap was particularly relevant for local anaesthetic systemic toxicity, for which early symptoms such as perioral numbness, tinnitus, dizziness, or visual disturbance may progress rapidly to seizures and cardiovascular compromise (2,8,26).

Awareness of allergy also appeared conceptually limited. The literature indicated that true immunoglobulin E-mediated allergy to amide local anaesthetics is uncommon, whereas anxiety, vasovagal reactions, epinephrine effects, sulfite sensitivity, and other adverse responses may be incorrectly labelled as anaesthetic allergy (27-29,33). Appropriate management therefore requires both emergency recognition and accurate differentiation of the likely mechanism.

Academic seniority and clinical exposure were associated with improved confidence and, in several studies, stronger performance. However, confidence increased more consistently than objective

knowledge. Surveys involving students, recent graduates, and dental officers demonstrated that more experienced participants often felt better prepared, although knowledge scores did not always improve in parallel (13-15). These findings indicate that self-reported confidence should not be used as a substitute for demonstrated competence.

Institutional preparedness also influenced clinical readiness. Broader medical-emergency surveys identified variation in the availability of emergency drugs, oxygen, equipment, and structured protocols in dental teaching and practice settings (18,30,31). Preparedness was therefore not determined solely by individual knowledge. Even a knowledgeable student or recent graduate may be unable to deliver effective emergency care when essential resources are unavailable or unfamiliar.

Educational studies supported the use of simulation, case-based teaching, and graduated clinical exposure. Model-based and simulation-supported training could improve familiarity with equipment, injection steps, and emergency decision-making, while supervised patient care remained necessary to address anatomical variability, patient anxiety, communication demands, and real-time clinical judgement (9,16,17). Anxiety during early injections may further increase cognitive load and interfere with the application of knowledge, reinforcing the value of repeated rehearsal and structured supervision (10,32).

DISCUSSION

This narrative review indicates that undergraduate dental students possess partial but uneven knowledge of complications associated with dental local anaesthesia. Familiarity appears strongest for common local complications and weakest for maximum dose calculations, uncommon neurological and ophthalmic events, differentiation of allergic reactions, and recognition or management of local anaesthetic systemic toxicity. The evidence also suggests that the ability to recognise a complication does not necessarily imply the ability to manage it, and that self-reported confidence should be interpreted separately from objectively demonstrated competence.

Deficits in dose calculation are particularly important because systemic toxicity is often preventable. Safe administration requires the clinician to integrate the concentration of the anaesthetic solution, quantity per cartridge, patient body weight, maximum recommended dose, medical status, concurrent medication, injection-site vascularity, and use of vasoconstrictors (1-3,8). A student who can identify the name of an anaesthetic but cannot calculate a safe dose has not achieved clinically sufficient pharmacological competence. Dose-calculation exercises should therefore be incorporated repeatedly into teaching and assessment rather than confined to an isolated pharmacology lecture.

The relative weakness in recognising neurological and ophthalmic complications may reflect their low frequency in routine teaching clinics. Students are more likely to observe pain, haematoma, trismus, or transient soft-tissue injury than diplopia, facial nerve palsy, amaurosis, or systemic toxicity. Rare exposure, however, does not reduce the need for prompt recognition because these events may be distressing, disabling, or life-threatening (4-7). Case reports and anatomical reviews are valuable in this context because they demonstrate how inadvertent vascular injection, diffusion through fascial spaces, direct nerve trauma, or deposition near adjacent structures can produce complications remote from the injection site.

The findings further demonstrate the importance of distinguishing knowledge from confidence. Senior students and recent graduates frequently reported greater confidence than junior students, but theoretical knowledge and demonstrated competence did not always show an equivalent increase (13-15). Clinical exposure may reduce anxiety and improve procedural fluency, yet repeated performance of routine injections does not guarantee preparedness for rare emergencies. Educational programmes should consequently avoid relying exclusively on self-assessment and should incorporate objective

structured clinical examinations, case-based oral assessments, dose-calculation tasks, and simulated emergency scenarios.

Management knowledge appeared less developed than awareness. This distinction is clinically important because recognising that syncope, anaphylaxis, paraesthesia, or systemic toxicity may occur is insufficient unless the student can initiate an appropriate response. Teaching should define the sequence of immediate actions for each complication, including interruption of treatment, patient assessment, positioning, airway support, oxygenation, medication, emergency-service activation, documentation, monitoring, follow-up, and referral. Local anaesthetic systemic toxicity warrants particular attention because its progression may be rapid and because students may have limited familiarity with lipid-emulsion treatment protocols (26).

Allergy-related teaching should also be refined. The rarity of true amide allergy and the frequency with which psychogenic, vasovagal, epinephrine-related, or preservative-related reactions are labelled as allergy create risks of both overtreatment and undertreatment (27-29,33). Students should be able to distinguish expected sympathomimetic symptoms from urticaria, angioedema, bronchospasm, hypotension, and other features of immediate hypersensitivity. They should also understand that definitive evaluation of a suspected allergy may require specialist assessment rather than permanent avoidance of all local anaesthetic agents.

Psychological factors may contribute to the observed gap between classroom knowledge and clinical performance. Students commonly experience anxiety when progressing from simulation to their first patient injections, while patient anxiety may itself produce cardiovascular and behavioural responses that complicate interpretation of an adverse event (10,32). Simulation, repeated supervised practice, structured communication, and graded exposure may reduce cognitive overload. Nevertheless, simulation cannot reproduce every anatomical, interpersonal, and emotional feature of a genuine patient encounter and should complement rather than replace supervised clinical training (9,16).

The review also indicates that preparedness is partly an institutional responsibility. Surveys of dental students and practitioners have documented variation in emergency equipment, medications, oxygen availability, and familiarity with response protocols (18,30,31). Curricular improvement should therefore be accompanied by routine inspection of emergency kits, clearly assigned responsibilities, accessible algorithms, and regular multidisciplinary drills. Training students in a setting where emergency resources are absent or inaccessible limits the practical value of theoretical instruction.

An integrated educational model is warranted. Complication-focused teaching should begin alongside pharmacology and anatomy, continue through preclinical simulation, and be reinforced during supervised patient care. Common complications should be assessed through prevention and follow-up planning, whereas rare high-consequence events should be addressed through scenario-based learning. Students should demonstrate competence in dose calculation, risk assessment, recognition, immediate management, documentation, and referral before graduation. Refresher training during internship or house-officer practice may help preserve skills during the transition to greater clinical independence.

The principal strength of this review is its integration of pharmacological, anatomical, emergency-management, and dental-education evidence while distinguishing direct undergraduate findings from contextual evidence involving recent graduates and practising dentists. It also separates awareness, knowledge, confidence, preparedness, and competence rather than treating them as interchangeable constructs. The conclusions should nevertheless be interpreted in light of the predominance of cross-sectional and self-reported evidence, heterogeneity in questionnaires and scoring systems, institutional variation, limited objective performance testing, and the absence of formal methodological appraisal. The narrative search approach may also have introduced selection and publication bias.

Future research should use multicentre longitudinal designs that follow students from preclinical training through graduation and early practice. Standardised and validated assessment instruments are needed to permit comparison between institutions and countries. Educational trials should compare lecture-based, case-based, simulation-supported, and blended approaches using objective performance outcomes rather than confidence alone. Research should also examine whether improved knowledge and simulated performance translate into safer clinical behaviour, more accurate emergency responses, and fewer preventable adverse events.

CONCLUSION

Available evidence suggests that undergraduate dental students have variable and frequently incomplete knowledge of local anaesthetic complications, with the greatest weaknesses involving dose calculations, rare neurological and ophthalmic events, allergy differentiation, and local anaesthetic systemic toxicity. Management knowledge often appears less developed than recognition, while increasing clinical seniority improves confidence more consistently than objective competence. Dental curricula should therefore integrate pharmacology, anatomy, complication recognition, emergency management, simulation, and supervised patient care throughout undergraduate training, supported by objective scenario-based assessment and accessible emergency resources.

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