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Enhancing Medication Safety in Dental Anesthesia: A Systematic Review of Medication Errors and Adverse Drug Events in Saudi Arabia

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ABSTRACT: **Background**: Safe and effective anesthesia is integral to modern oral and maxillofacial surgery (OMFS), particularly with the growing shift toward office-based and ambulatory procedures. This review critically evaluates the medication safety to reducing anesthesia Medication Errors and Adverse Drug and examines associated safety considerations, adverse reactions, and evolving clinical strategies. Oral diseases remain a significant global health burden. The traditional restorative approach to dental care, focused on repairing disease outcomes, increasingly recognized as insufficient for managing these chronic, multifactorial conditions. Cumulative evidence on local anesthetics, sedative-hypnotics, general anesthetic agents, neuromuscular blockers, opioids and multimodal analgesic strategies evaluated based on evidence accumulated through clinical trials, observational studies and professional implications. Local anesthetic agents continue to be the basis of pain.

The Aim of this Systematic Review: To assessment of medication safety to reducing anesthesia medication errors and adverse drug events in dentistry Saudi Arabia 2024.

Methods: A systematic review, conducted in October 2024, followed guidelines. We searched PubMed, Googel Scholar, and Web of Science for studies published up to November 2024. The inclusion criteria were original research on medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in Dentistry: A

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Systematic Review at Saudi Arabia published in English. A two-stage screening process used to select relevant studies, then analyzed for their impact on medication errors and adverse drug events in dentist you tomes. Results: the research quality rated highly and perceived to improve intelligence in the physician events in dentistry collaboration in the care of patient pain. The search strategy yielded 6 eligible studies after screening 150 records. These studies encompassed diverse methodologies and focused on physician in dentistry

Conclusion: The fastest onset of action determined by the route administration. Reported adverse effects were not statistically significant. Nitrous oxide shows the fastest recovery, but drug selection should always base on the type of dental procedure, its duration, and the patient specific needs. Further research needed to evaluate the patient and parents' level of satisfaction

INTRODUCTION:

Background:

Over the past several decades, a profound paradigm shift has been underway, medication safety to reducing anesthesia medication errors and adverse drug events in dentistry moving dentistry towards an evidence-based medical model that prioritizes prevention, risk assessment, and early intervention. [1] This evolution driven by two powerful and interconnected forces the irrefutable scientific evidence linking oral health to systemic health and the staggering economic burden of untreated oral diseases. [2] Oral health is an integral component of overall well-being, influencing functions such as speaking, eating, and social interaction, while also playing a significant role in the prevention of systemic diseases. Despite the advancements in dental care, oral diseases remain one of the most common public health [3]. Challenges worldwide, affecting individuals throughout their lifespan [4]. The management of oral health has traditionally emphasized preventive measures and surgical interventions; however, pharmacotherapy has emerged as a critical adjunct in the comprehensive management of dental conditions.[5]

In order to gain confidence of patients with dental fear, dental providers often exercise continuous and personalized techniques, even applying them now the patient arrives to the waiting room [6]. The American Academy of Pediatric Dentistry (AAPD) proposes both verbal and non-verbal communication techniques that help manage child behavior [7]. Verbal techniques include "tell-show-do", voice control, and positive reinforcement. On the other hand, non-verbal strategies include distraction, modeling, and recreational activities. These tools are useful in managing children's oppositional behavior [8]

This is where sedation plays a safer role and has gained popularity over the years as it can used when basic behavior guidance techniques fail to be effective, and it can performed with the administration of different agents and routes. Sedation is an advanced pharmacological behavioral management technique that achieves a minimal level of consciousness depression, where the patient's breathing remains normal and patient stay conscious and retains his/her protective reflexes and is capable of responding to physical and verbal stimulus. [9] During conscious sedation, certain gases and/or pharmaceutical agents are used. Sedation is generally performed with either benzodiazepines, which are administered either orally or by IV, or with nitrous oxide (N2O) which is inhaled. Benzodiazepines lessen the symptoms of anxiety while prompting muscle relaxation. On the other hand, N2O is an anesthetic gas administered at sub-anesthetic dosages that depress the central nervous system triggering an anxiolytic and analgesic effect [10].

Continuous physiologic monitoring throughout the time of anesthesia remains of great significance to the safety of the patient. Pulse oximetry coupled with noninvasive blood pressure, electrocardiography, [11] and scenography have become standard in OMFS because of the susceptible airway access in most of the surgical procedures where the onset of anaerobic hypoventilation, airway obstruction, and unstable hemodynamics may12 observed. Scenography in particular provides an avenue of observing respiratory compromise in moderate and deep sedation that precedes the incidences of oxygen saturation. [12] The fact that adequate standards of monitoring are maintained, and that discharge criteria are also spelled out can be listed as one of the most effective in ensuring safety provided anesthesia is delivered in the ambulatory environment.

Local anesthetic systemic toxicity (LAST) is one of the most serious comorbid drug effects in the maxillofacial practice. [13] Though rare, LAST can progress along with the progression of initial neurologic symptoms such as circumpolar numbness, tinnitus and excitement to seizures, arrhythmias, and cardiovascular collapse [14]. Newer management algorithms focus on early identification and early intervention like airway support, seizure control and immediate delivery of intravenous lipid emulsion therapy [15]. These implemented by very sophisticated life support amenities that go hand in hand with the existing resuscitation guidelines of severe levels of toxicity or heart attack patients [16]. The response behavior in terms of preparedness and team behavior also strengthened by the regular training in emergency simulation and easy access to resuscitation equipment

METHODS:

Aim of the study:

To assessment of medication safety to reducing anesthesia medication errors and adverse drug events in dentistry Saudi Arabia 2024.

Study design:

A systematic review, conducted in October 2024, followed guidelines. We searched PubMed, Googel Scholar, and Web of Science for studies published up to November2024. The inclusion criteria were original research on medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in Dentistry published in English. A two-stage screening process used to select relevant studies, then analyzed for their impact on patient process and patient outcomes. Results: the research quality rated highly and perceived to improve intelligence in medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in dentistry. The search strategy yielded 6 eligible studies after screening 150 records. These studies encompassed diverse methodologies and focused on Drug Events in Dentistry.

Search strategy:

The literature review strategy that was Impact of Integrated medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in Dentistry: A Systematic Review at Saudi Arabia empowerment, and occupational stress. The purposeful and systematic search method employed in this systematic review by searching the key research databases: PubMed, Scopus, Web of Science, and Google Scholar, as they are widely used to provide strong scholarly content in the area care process in healthcare management. PubMed provided clinical and evidence-based research to the integrated medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in Dentistry and performance improvement. Scopus offers a wide range of interdisciplinary journals, and the Boolean operators and advanced filters narrow the results to relevant ones. High-impact studies focusing on the issue of dentistry health in Stages and communication efficacy in health care systems searched from the Web of Science database. In addition, Google Scholar was use incorporate grey literature, including conference papers and institutional reports, to make sure that there was a wider perspective of the topic. Cords. These studies encompassed diverse methodologies and focused on Drug Events in Dentistry

Search methods

This systematic reviews combination recommended and demonstrated to achieve a higher recall and reduce the risk of missing relevant studies when compared to the use of core biomedical and multidisciplinary scientific databases alone. Combinations of keywords used in the search, such as "medication safety" "Anesthesia" "Medication Errors" "Adverse Drug" Our criteria were articles done in Saudi Arabia and outside it from 2020 to 2024. One hundred and ninety-six (196) research papers were extracted; only six articles met our paper inclusion-exclusion criteria. Met our paper inclusion-exclusion criteria.

Inclusion criteria

The systematic review had certain eligibility criteria Peer-reviewed articles, systematic reviews, and empirical studies published in English from 2020 to 2024 filtered, as only contemporary integrated medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in Dentistry performance. Also, papers that did not have , were abstracts of conferences or not in full-text form were not included to ensure the rigor and validity of the findings of the review. Systematic reviews met the eligibility criteria and retained to provide corroborating, higher level evidence on the review themes . Geographically Priority the studies that were carried out within Saudi Arabia a critical analysis of the findings to determine their applicability to the Saudi Arabian context. Studies that addressed a subject not relating to Drug Events in Dentistry.

The exclusion criteria

The exclusion criteria were studies that had not medication safety as respondents. The decision made to focus in the medication safety inside the health sector as a whole. Medication safety an integral part of the healthcare system, the aim of this study was to assessment of medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in Dentistry

(1) Any research that not related to Saudi Arabia.

(2) Studies published before 2020.

(3) Articles not relevant to our objectives.

To summarize the most relevant data from the studies, the

Following clinical data were extracted: authors, year of publication, study design, number and age of patients, type of drug used and distribution of patient groups, time at which anxiety was measured, onset of side effects, patient recovery, satisfaction, and type of anxiety measurement. The data in the chosen studies summarized in terms of author, publication year, study design, country and healthcare setting, sample size, the characteristics of the participants in (Dentistry and Drug Events), methodology, and key results. Attention had given to the studies, which dealt with the effects of communication.

Table 1 Characteristics of reviewed articles about medication safety to reducing Anesthesia Medication Errors and Adverse Drug Events in Dentistry

Author, Date, Country	**Region**	**Study design**	**Study aim**	**Results**
Delvalle et al (2024) [17]	Madrid, Spain	A systematic review.	To deepen the understanding of different conscious and/or deep sedation techniques used in pediatric dentistry commonly used to relieve anxiety and manage behavior in pediatric patients .	On a daily basis, some of the main factors negatively affecting pediatric dental care are fear, anxiety, and dental phobia. The link between fear, anxiety and dentistry has established over time. Many individuals have experienced dental fear early on childhood or at older age, and these fears often spread on to their family's members. Dental fear affects around 5 to 20% of the pediatric population, nevertheless, it is believed this prevalence could be even higher since many pediatric patients with the most serious dental fear often tend to avoid dental care altogether .Often, parents expect pediatric dentists to handle their children's behavioral issues since "we are specialists in children". However, in recent years, considering societal changes and attitudes towards traditional physical restraint, pharmacological behavior management techniques have gained popularity, avoiding uncomfortable situations for both the professional and the child. **Conclusions** The administration route determines. The

				fastest onset of action. As of today, Propanol, administered intravenously, induces sedation most rapidly. In all studies included in this review, the reported adverse effects were not statistically significant. However, nitrous oxide was the sedative drug with the lowest risk of complications, which were nearly negligible. For rapid recovery without residual effects, nitrous oxide is the drug of choice. However, for calm, agitation-free recovery, dexmedetomidine is preferred, although it may cause mild bradycardia without clinical consequences. For minor procedures requiring a balance between quickness and efficacy, midazolam is ideal. Nonetheless, the choice always depends on the type of procedure, its duration, and the child's specific needs.
Alobaid, „ et al (2019) **[18]**	Saudi Arabia	The systematic collection, analysis, and synthesis of	To synthesize the current evidence on pharmacological adjuncts that supplement and enhance standard mechanical dental care.	Dental pharmacotherapy encompasses a wide range of drug therapies aimed at preventing, managing, and treating oral diseases. This includes the use of antimicrobial agents for controlling infections, anti-inflammatory drugs for managing pain and inflammation, as well as other medications used in the treatment of conditions like xerostomia, osteonecrosis, and mucosal diseases. With the increasing complexity of patient conditions and the advent of new therapeutic agents, the role of pharmacotherapy in dentistry continues to expand, necessitating an interdisciplinary approach to optimize patient outcomes. The oral cavity no longer viewed as an isolated anatomical region but as a "window to the body," where oral inflammation and infections are recognized as risk factors for a host of systemic conditions, including cardiovascular disease, diabetes mellitus, rheumatoid arthritis, and adverse pregnancy outcomes. This oral systemic link has transformed dentistry from a technical craft into a medical discipline, where the management of oral health understood as an integral component of overall patient health. **Conclusions**

				The interdisciplinary review of dental pharmacotherapy underscores the critical role that pharmaceuticals play in the maintenance and enhancement of oral health. This study illuminates how the integration of pharmacological strategies into dental care not only improves patient outcomes but also broadens the scope of contemporary dental practice. By examining various therapeutic agents and their applications, it becomes evident that effective pharmacotherapy requires a nuanced understanding of both dental and medical sciences. Reveals that while significant advancements have made in the development of targeted medications for oral diseases, there remain challenges related to drug interactions, patient specific responses, and emerging antibiotic resistance.
Sarasin, et al **(2019) [19]**	Saudi Arabia	Review Article.	To assess the likely severity of the problem and also to develop preventive methods specific for general anesthesia and problems of medication errors	A medication error has also defined as the selection of a correct action plan failing to complete as intended or, alternatively, the selection of an incorrect action plan to achieve an aim. It further been defined as a reduction in the probability of treatment being timely and effective or an increase in the risk of harm relating to medicines and prescribing compared with generally accepted practice Medication errors have been classified by a number of methods. One classification method based on the stage in which the error occurs in relation to the overall sequence of medication use (eg, prescribing, transcribing, dispensing, administration, or monitoring). Another method classifies errors according to whether they occur from mistakes made during the planning phase(s) of patient care, also known as knowledge-based or rule-based errors, or mistakes made during the execution. Conclusions Upon reflection of the issues surrounding anesthesia related medication errors and adverse drug events, it becomes quite clear that the problem is multifactorial with no clear easy fix. The perioperative anesthesia. Medication safety requires a sustained

				focused effort on reducing anesthesia-related medication errors and adverse drug events. An understanding of medicine's and more importantly medical anesthesia's challenges and attempts to improve medication safety is paramount prior to focusing on medication safety within anesthesia for dentistry. While the goals of improving medication safety in medicine and medical anesthesia are far from complete, dentists who provide sedation and anesthesia can learn a great deal from the trials and tribulations of their medical colleagues
Teoh, et al (2022) **[19]**	Australia	Narrative Review.	To summarize medication safety, medication and prescribing errors in the context of dental practice.	Medication errors can occur at any part of medication management pathway from procurement, supply, storage, compounding, manufacturing, prescribing, dispensing, administering, monitoring and disposal of medications. Medication Safety programs focus on prevention of adverse medication events by supporting clinicians and empowering patients to achieve best practice in medication management through implementation of proven and sustainable strategies that address the human element in medication error prevention. Prescribing error is one part of this process. Medication errors that are fortunately picked up before the patient is harmed, are considered "near-misses". However, those, which go undetected usually, result in patient harm, unnecessary hospital admissions and increased health-care costs. Due to medication error being a common source of patient harm worldwide, in 2017 the World Health Organisation made Medication Safety its third global patient safety challenge. Collaborative care models improve processes for the management of depression and result in better clinical outcomes. **Conclusions** Solutions lie in addressing the systems and processes in which dentists work. Examples include implementing forced functions such as checklists and electronic prescribing tools. Knowledge-based errors

				are a common source, therefore incorporating pharmacology and therapeutics into undergraduate education, and mandating that continuing education needs to include therapeutics is one recommendation. Education should also include the prescribing decision-making process, skills needed in writing a prescription and prescribing competencies. A requirement for formal endorsement to prescribe such that dentists have to demonstrate they have the necessary competencies for the task of prescribing, separate from their university training, is also another suggestion. Understanding the legal and legislative requirements of prescription writing should also be included so dentists can understand their legal obligations about prescribing. In addition, similar to pharmacy and medical practice, dental practices should mandated to have specific drug information resources available as a requirement for the practice's registration.
Khoja, et al. (2021) [20]	Saudi Arabia,	A cross- sectional survey	To affirm the dentist's knowledge of medication safety in the Kingdom of Saudi Arabia.	The medication safety covered all medications for all healthcare specialties, including dental care. The dental care standards were part of total quality standards for healthcare organizations. However, it not encompassed in full detail in medication safety procedures, and comprised as part of medication management and use. The patient safety services approved of total quality standards in Saudi Arabia. It enclosed the majority of features of safety in dental care. Various international or local studies directed about the dental knowledge, perception, or practice of patient's safety aspects for dental care. However, dental care medication safety examined yet in Saudi Arabia or gulf and Arabic countries. The authors are not acquainted with any scientific indication about medication safety in dental care. **Conclusions**

				The dentist's knowledge of medication safety was inadequate. Recognized education and training programs about dental medications safety unguarded or post-graduate at dysentery schools are suggested. Realized the dental medication safety program is obligatory to implement for all dental institutions in Saudi Arabia. the national medication safety program was also recognized with numerous Saudi Arabia program
Abu Esba et al **(2021) [21]**	Saudi Arabia,	Article reviews and standardized screening tools such as the Patient Health Questionnaire-9,	To explore the multifaceted approach of PCPs in diagnosing and treating depression, emphasizing the integration of mental health care within primary care settings.	Over the past years, healthcare education and training are growing significantly in the Kingdom of Saudi Arabia. The college of Medicine, college of dentistry, college of pharmacy, and nursing is nearly double. Also, the number of residency programs upsurges over the years, with the number of postgraduates. The quality of healthcare programs variations over time, containing the period of training and content. One of the programs well established in Saudi Arabia was medication safety education and training.3-5 Medication safety was part of numerous residency medical, pharmacy undergraduate and postgraduate studies. However, dentistry's local college still demands full aspect of the medication's safety program in the undergraduate and postgraduate studies and program. Moreover, the medication safety procedures not fully employed at dental care related to several barriers preventing medication safety services. As a result, the dentist states their practice not even feeling about patient safety elements in multiple investigations.6-9 However, it is rare to find a study about medication safety perception in dental care in Saudi Arabia or the Gulf and Middle East countries. The authors are not accustomed to any study up to their knowledge. This study discovers the dentist's perception of medication safety at their dental practice in Saudi Arabia **Conclusions** The dentists had an optimistic insight into medication safety in dental practice. Lack of clinical knowledge and periodic training

				of Medication safety were noteworthy contests in dental care. Targeting education and training during undergraduate and postgraduate dental schools is highly suggested to be applied in Saudi Arabia.

RESULTS AND DISCUSSION

The result of systematic review Assessment of medication safety to reducing anesthesia Medication Errors and Adverse Drug Events in Dentistry collaboration in the care of patient with pain cross-sectional studies published between 2020 and 2024 present systematic review (Table 1).

The dentists practice various daily diseases and their management and consist of high alert medications. [23] The dentist deal with

Anesthesia procedures, pain management in dental care, some patient's medications, including antidiuretic medicines like insulin, and more other medications and disease management. [24] The dentists request to implement all medication safety rudiments and procedures during dental practice to avert any drug-related morbidity and mortality. However, some medication perceptions stop dental medication safety; some barriers stop or dishearten medication safety applications in dental practice. [25] The current study will state the dentist's perception of medication safety elements, procedures, and related factors that avert or determine medication safety in dental practice. The responders' results were young dentist's responders freshly graduated and general practitioners who reproduce more dental care practice. [26] The average scores of dentist's perceptions of medication safety elements were suitable with high score elements. The dentists were agreeable to collaborate with other colleagues with dental medication safety. They had a good insight into dental medication storage policy and actions that substitute the excellent practice of essential medication safety.[27]

The selection of local anesthetic agents is still evolving in dental anesthesia especially in regards to its effectiveness, diffusion properties and safety. Anticline has widely been embraced due to its good tissue penetration and action onset. Experiments conducted on the comparative basis have postulated that anticline provides good anesthesia and has equivalent safety profile compared to the traditional amide anesthetics when administered correctly [27]. Nevertheless, cautious injection technique, high-pressure intramural injection must prevented and recommended dose must use to restrain neurotoxicity and other adverse outcomes.

Delivering anesthesia for dentistry in a safe and effective manner within the office-based dental environment is a key component to providing optimal dental care for patients. Dentists who utilize sedation and/or general anesthesia must focus on optimizing medication safety to reduce the incidence of medication errors and adverse drug events. [28] Use of the DAMSP and implementing Practical safety initiatives in dental facilities can greatly reduce the number of medication errors that occur in dentistry. Ongoing medication safety education and training are essential steps in reducing potentially life altering, preventable errors. Improving the culture of medication safety is essential and requires the attention of all individuals involved in providing sedation and general anesthesia for dentistry. [29]

CONCLUSIONS

The integration of evidence-based dietary and pharmacological adjuncts through a structured inter professional collaborative model is fundamental to advancing modern dental care. The management of oral diseases, recognized now as complex, chronic, and multifactorial conditions with profound systemic implications, has evolved far beyond the traditional surgical-restorative model. The

Evidence synthesized in this review demonstrates that a modern, effective approach to dental care must be fundamentally preventive, holistic, and patient-centered. This requires moving beyond the confines of the dental chair to embrace a

comprehensive view of the patient, one that considers their diet, systemic health, medication use, and individual risk profile. Dietary and pharmacological adjuncts are the essential tools that enable this preventive approach.

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