Review Article

Ensuring Patient Safety in Pediatric Dental Care

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Abstract

This review aims to examine safety concerns in pediatric dental care and underscore the need for comprehensive patient safety initiatives within the Korean Academy of Pediatric Dentistry. Drawing insights from the prevailing patient safety policies of the American Academy of Pediatric Dentistry, case reports, and systematic reviews, this review elucidates issues such as dental fires during sedation, ocular complications from local anesthesia, and surgical emphysema. This review highlights the significance of safety toolkits encompassing infection control, medical error reduction, dental unit waterline infection, and nitrous oxide safety in pediatric dental settings, underscoring the need to foster a safety culture. Furthermore, this study explores the curriculum for pediatric dentistry residency programs, emphasizing concepts such as high-reliability organizations and mortality and morbidity conferences. The study suggests the need for initiatives to enhance patient safety, including establishing safety committees, expanding reporting systems, policy development, and supporting research related to patient safety. In conclusion, this study underlines key messages, emphasizing the utmost priority of patient safety, acknowledging the inevitability of human error, promoting effective communication, and cultivating a patient safety culture. These principles are vital for advancing patient safety in pediatric dental care and improving outcomes among pediatric patients. [J Korean Acad Pediatr Dent 2024;51(2):109-131]

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Introduction

Similar to any other medical procedure, dental treatment carries inherent risks. Despite the core principle of "Do no harm" outlined in the Hippocratic Oath[1],

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human error remains an inevitable factor[2], which raises significant concerns about patient safety in dental settings, particularly among vulnerable populations such as children.

1. Need for patient safety initiatives in Korean pediatric dentistry

The presence of patient safety acts and cultural awareness varies between regions in Korea and globally and is influenced by various factors including healthcare systems, government policies, education, and institutional culture[3]. Generally, countries with advanced healthcare systems, whether developed or developing, have more advanced legal frameworks and cultural awareness regarding patient safety[4]. These countries are more likely to have various systems and programs in place to enhance patient safety. However, compared with other countries, Korea still has room for development in these aspects. In recent years, awareness of patient safety has increased in Korea, with growing interest from the government and healthcare institutions[5,6]. Nonetheless, there may still be inadequacies compared to global standards[7]. This review aims to address patient safety issues by reviewing the latest patient safety policies of the American Academy of Pediatric Dentistry (AAPD)[8], safety toolkits[9], and pediatric dental residency programs[10]. This review is expected to provide basic data for policy development and program improvements to enhance patient safety in Korean pediatric dentistry.

2. Advancement in patient safety initiatives within the Korean Academy of Pediatric Dentistry and South Korea

The Sedation Education Research Committee of the Korean Academy of Pediatric Dentistry (KAPD) was established in January 2014 and has been conducting annual sedation-related conferences and simulation training. Since 2019, it has been reorganized into the Sedation Training Institute, which offers basic education, practical training, and simulation courses targeting KAPD members. Basic (theoretical) education has been conducted online since 2020, while practical and simulation training were planned to be held twice a year. Furthermore, a reporting system for complications arising from pediatric dental sedation was developed in 2015 to evaluate adverse events. Guidelines related to pediatric dental sedation were extensively updated by the KAPD in 2017 and distributed to pediatric dentists[11]. The clinical guidelines established by the KAPD in 2016 cover various topics related to patient safety, including the administration of antibiotics, management of pediatric patients receiving chemotherapy and radiation therapy, emergency management protocols, child abuse and neglect, medical record keeping, and obtaining informed consent[12].

Patient safety concerns are being tackled not only at the academic level but also at the national level, with South Korea implementing various legislative measures and initiatives as part of its patient safety policy:

1) **Healthcare Facility Accreditation System:** Implemented by the Healthcare Accreditation Institute since 2011, this system ensures patient safety by requiring healthcare facilities to meet specific standards for accreditation. This enhances the establishment and operation of systems focusing on patient safety[13].

2) **Patient Safety Act:** Enacted in 2016, this law establishes standards and systems aimed at enhancing patient safety within healthcare institutions[5].

3) **Patient Safety Reporting and Learning System:** Introduced by the Ministry of Health and Welfare in 2020[14], this system within healthcare institutions reports and monitors patient safety incidents promptly, facilitating appropriate responses and providing patient safety alerts[15].

4) **Comprehensive Patient Safety Plan:** Following the implementation of the Patient Safety Act, the Ministry of Health and Welfare formulated the first comprehensive plan (2018-2022) to oversee patient safety[6]. This plan has led to the implementation of various policies and programs related to patient safety. The plan includes the implementation of specific policies, programs, and initiatives designed to prevent medical errors, improve communication

between healthcare providers and patients, enhance reporting systems for adverse events, and promote a culture of safety within healthcare settings. The current second plan (2023–2027) is underway[16], and it is anticipated that the third plan (2028–2032) will be implemented in the future.

5) **Central Patient Safety Center:** The Central Patient Safety Center, established under the Patient Safety Act on July 30, 2020, is responsible for implementing measures to safeguard patients and improve healthcare quality. Additionally, South Korea designated five organizations as the first Regional Patient Safety Centers, including the Korean Medical Association, Korean Nurses Association, Korean Pharmaceutical Association, Samsung Seoul Hospital, and Kangwon National University Hospital, to collaborate with the Central Patient Safety Center on tasks aimed at enhancing patient protection, healthcare quality, and safety incident education, prevention, promotion, and support.

6) **Publication of the first standardized Dental Healthcare Facility Infection Control Manual in Korea:** Established by the Korean Dental Association and Ministry of Health and Welfare in 2020[17], this manual provides guidelines for infection prevention and management in dentistry.

3. Potential risks regarding patient safety issues in pediatric dentistry

1) Dental fire during dental sedation

Table 1 presents uncommon complications that may occur in pediatric dental clinics. A fire could potentially occur while a patient undergoes dental treatment. Although such incidents are rare in dentistry, they are plausible[19]. A 72-year-old woman sustained second-degree facial burns from a fire near the nasal hood, delivering a nitrous oxide-oxygen mixture, likely ignited by heat generated during the preparation of a titanium post using a high-speed, irrigated carbide bur. After evaluation for potential pulmonary complications, she was discharged from the local emergency department and later trans-

ferred to a regional burn unit, where she was discharged with second-degree burns. If the fuel source cannot be removed, the dentist should cease the open flow of oxygen or nitrous oxide-oxygen mixtures to the patient for one minute before using a potential ignition source. Additionally, intraoral suction should be employed to clear the ambient atmosphere of oxidizer-enriched exhaled gas[18,42].

Dental facilities must implement appropriate fire preparedness and safety measures to prevent burns. The risk of fire arises when the fuel, oxidizer, and ignition source converge to form a fire triangle[8] (Fig. 1). Sparks originating from burs, lasers, and electrosurgical units can also act as ignition sources[19]. Various combustible agents, such as dry gauze, throat packs, paper and cotton products, hair, petroleum-based lubricants, alcohol-based products, rubber dams, and nitrous masks, can serve as fuel[19]. The administration of oxidizers such as nitrous oxide or oxygen can generate an atmosphere enriched with oxidizers (OEA).
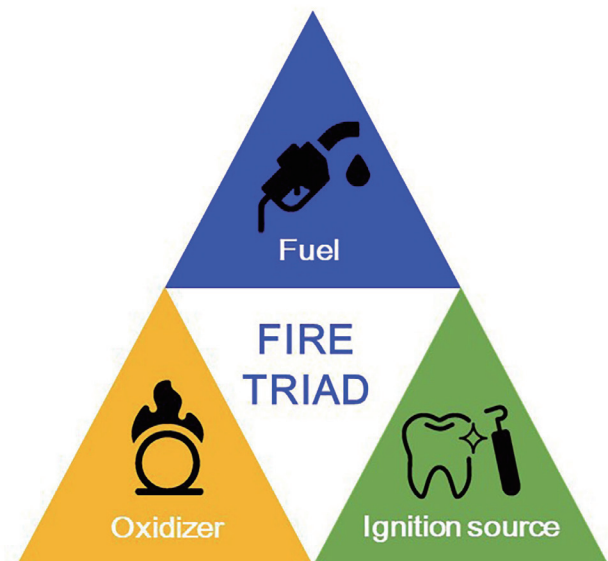

Fig. 1. The dental fire triangle.
Note: This triangle refers to the three essential components necessary for the occurrence of a dental fire: an ignition source, a fuel source, and an oxidizer.

Table 1. Uncommon complications that may occur in pediatric dental clinics

Situation Description	Risk/Complication	Prevention/Action Required	Reference
During dental treatment, a patient experienced a fire.	Risk: - Fire triad (oxidizer, ignition source, and fuel.) Complication: - Burn injuries, smoke inhalation, and trauma such as falls or collisions, psychological trauma, damage to dental equipment, and delayed dental treatment.	Prevention: 1. Avoid having all components of the fire triad at the same time during sedation. 2. Do not dry cut. 3. Use high-power suction during the entire sedation treatment. 4. Discuss the fire risks with your anesthesiologist before starting treatment, and review possible emergency protocols if one happens. Action required: 1. Stop the source of oxygen or nitrous oxide, remove the ignition source, evacuate the patient and staff, and assess & treat injuries. 2. Investigation of the cause, documentation, and review and revision of the safety protocol.	Review [18] Case report [19]
An ocular complication arose due to local anesthesia.	Risk: - Intra-arterial spread of local anesthesia - Local diffusion of anesthesia through tissue planes - Autonomic dysregulation - Intravenous spread of local anesthesia Complication: - Diplopia, ptosis, ophthalmoplegia, mydriasis, and amaurosis, etc.	Prevention: 1. Mandatory aspiration techniques should be practiced in at least two planes. 2. Additionally, the minimum permissible dosage of the anesthetic solution must be considered. Action required: 1. If early signs of complications arise during dental anesthesia, it is crucial to monitor the patient until the anesthetic effect subsides. 2. Covering the affected eye with gauze can prevent contamination. However, if the complication is deemed irreversible, prompt referral to an ophthalmologist and/or neurophysician is essential for further management.	Systematic reviews [20] Reviews [21,22] Case reports [23,24]
Surgical emphysema ensued from a routine tooth extraction or root canal treatment.	Risk: - Air-driven handpieces during dental extractions - Drying of root canals with pressurized air - Irrigation with hydrogen peroxide and - Air-water spray produced by handpieces - Laser-produced spray and ozone gas infiltration - Patient-related factors, such as vigorous mouth rinsing, nose blowing, or sneezing with a closed mouth. Complication: - Typically non-fatal and self-limiting - Severe cases of pneumomediastinum require immediate medical care because they may rarely lead to pericardial tamponade, airway obstruction, or mediastinitis.	Prevention: 1. Drying of the root canals by air under pressure must be avoided; paper points or micro-suction tips could be used instead. 2. Using electric motors or safe-exhaust handpieces instead of standard air motors for access cavity preparation could also reduce the risk. 3. The air-water spray produced by various types of handpieces should not be directed toward areas with mucosal discontinuity. 4. There is very little justification for the use of hydrogen peroxide and ozone gas as disinfectants, as they also do not seem to provide any advantage over Sodium hypochlorite. 5. Rubber dam may be able to prevent the introduction of air subcutaneously through the periodontal sulcus or mucosal lacerations. 6. Patient-related factors may be avoidable with clear and concise post-operative instructions following dental treatment. Action required: Its management remains empirical and may involve antibiotics and analgesics/NSAIDs, local application of ice packs or compresses, administration of oxygen, and hospitalization.	Systematic reviews [25,26] Case report [27]

Table 1. (Continued) Uncommon complications that may occur in pediatric dental clinics

Situation Description	Risk/Complication	Prevention/Action Required	Reference
A pediatric patient developed a nontuberculous mycobacteria infection.	Risk: - Mycobacterium abscessus infections. - Legionella pneumophila infections. Complication: - Pain, osteomyelitis, facial swelling, lymphadenopathy, pulmonary nodules, and fever. - Nontuberculous mycobacteria infection and pneumophilia.	Prevention: 1. Enhanced dental water quality standards are needed. 2. During surgical procedures, it is recommended to use sterile water and opt for equipment such as a bulb syringe or sterile disposable products. Action required: 1. Infections may require various antibiotic treatments depending on the type and grade. 2. Proper inspection and disinfection of the dental unit waterline.	Case reports [28-31]
Intraocular gas complications occurred associated with the use of nitrous oxide.	Risk: - Vitrectomy technique (intraocular gas) Complication: - Gas bubble in the anterior chamber, elevated intraocular pressure, corneal decompensation, retinal detachment, cataract formation, and loss of vision	Prevention: Temporary identification bracelet to warn anesthesiologists of the presence of an intraocular gas bubble and the risk of using nitrous oxide. Action required: Immediate emergency intervention, consultation with an ophthalmologist or eye specialist, and documentation.	Case reports [32-34]
Risk of ocular injury during dental treatment.	Risk: - Type of fluid entry, foreign bodies, splash of biological fluids, or conjunctivitis Complication: - Corneal abrasions, conjunctivitis, subconjunctival hemorrhage, traumatic iritis, and hyphema.	Prevention: Protection of the eye: a protective shield or patch. Action required: Immediate assessment, irrigation and cleaning, management of symptoms, referral to an ophthalmologist, and documentation	Systematic review [35]
Inadvertent inhalation/ ingestion of a foreign body during treatment.	Risk: - Endodontic file, screwdriver, crown and bridge, bur & drill, and rubber dam clamp. Complication: - Airway obstruction, aspiration pneumonia, atelectasis, bronchial injury, pulmonary abscess, and systemic infection. - Gastrointestinal obstruction, internal bleeding, and perforation of the esophagus or other structures	Prevention: 1. Patient education to minimize necessary movements, such as sudden swallowing or talking. 2. Use of a dental isolation device 3. Proper instrument handling 4. Maintaining a clean treatment environment Action required: Having protocols in place, immediate observation, notification of medical staff, medical diagnosis, appropriate treatment, emergency intervention, patient management and referral, and documenting.	Reviews [36,37] Case reports [38-41]

NSAID: nonsteroidal antiinflammatory drug.

2) Ocular complications due to local anesthesia

An ocular complication arose due to local anesthesia during dental treatment[23]. Joshi et al.[20] emphasize the potential occurrence of ocular complications resulting from local anesthesia (LA) or the spread of odontogenic infection. The complications observed included diplopia, ptosis, ophthalmoplegia, mydriasis, and amaurosis, with outcomes ranging from temporary to permanent, including permanent blindness. The review found that lidocaine and articaine were the most common anesthetic agents associated with ocular complications, particularly when administered via the inferior alveolar nerve block and posterior superior alveolar nerve block techniques. Boynes et al.[21] suggested that articaine

may be associated with a higher risk of ocular complications due to its increased tissue diffusion ability, although conclusive evidence is lacking. Peñarrocha-Diago and Sanchis-Bielsa[24] reported 14 cases of ophthalmic complications following posterior maxillary anesthesia with articaine, suggesting that the symptoms appeared shortly after administration and resolved over time, likely because of solution diffusion to the orbital region. Hence, it is crucial to meticulously practice LA block techniques and ensure infection control to avoid potential morbidity, mortality, and legal implications. Understanding the anatomical considerations and pathophysiology of complications is crucial, and the implementation of appropriate preventive measures is essential.

3) Subcutaneous emphysema

Subcutaneous emphysema (SE) can occur regardless of surgical or nonsurgical treatment, irrespective of the use of air-driven motors[26,27]. Jones's systematic review study[25] examines the factors contributing to SE following dental procedures between 1993 and 2020. It identifies dental extractions, particularly surgical extractions, as common precursors to SE, with the posterior mandibular teeth being the most affected. Iatrogenic factors, notably air-driven handpieces, contributed to most cases, showing a significant increase in SE occurrence over time. This study suggests that air-driven handpieces should be avoided during dental extraction to mitigate SE risks and the associated morbidity. Adherence to regulated protocols during the use of medical devices and tools is imperative to prevent such occurrences.

4) Dental unit waterline infection

A pediatric dental patient contracted a nontuberculous mycobacteria infection due to contamination from the Dental Unit Waterline (DUWL)[29-31]. Effective management of DUWL contamination is crucial because it is a preventable issue. Cases of pneumonia caused by airborne Legionella pneumophila have also been reported. [28]. This case highlights the risk of contracting diseases from DUWLs during standard dental procedures, with aerosolized water from high-speed turbine instruments identified as the probable infection source. Specifically, DUWL contamination has been documented among young patients undergoing pulpotomy treatment in the United States, prompting concerns regarding waterline safety[30,31]. Consequently, meticulous oversight and management are deemed necessary in this domain. According to the standards established by the Organization for Safety, Asepsis, and Prevention (OSAP)[43] and the Centers for Disease Control and Prevention (CDC)[44] in the United States, water deemed safe for drinking should contain fewer than 500 CFUs (colony-forming units) of bacteria per 1 mL. This standard is cited as the globally accepted minimum requirement for managing DUWLs used for cooling and rinsing in nonsurgical dental procedures. The American Dental Association (ADA) has set a recommendation limit of ≤200 CFU/mL on the heterotrophic bacterial load in water from DUWLs[45]. The Korean Dental Association recommends that the water used in routine dental procedures should not exceed 100 CFU of general bacteria per 1 mL, which is stricter than the internationally accepted guidelines, based on water quality regulations established by the Ministry of Environment[44]. It is recommended to avoid using water from dental units during surgical procedures such as pulpotomy and supernumerary tooth extraction, opting instead for sterile water along with equipment such as a bulb syringe or sterile, single-use disposable products[46]. Therefore, it is imperative to minimize contamination in dental unit waterlines to prevent the exposure of both patients and staff to this bacterium.

5) Intraocular gas complications associated with the use of nitrous oxide

Identifying patients with intraocular gas is crucial when considering nitrous oxide anesthesia[32-34]. Nitrous oxide inhalation sedation is commonly used in dental and other surgical procedures. However, there have been reported cases of patients with intraocular gas experiencing sudden elevations in intraocular pressure and subsequent blindness due to nitrous oxide anesthesia[32-34]. Intraocular gases are frequently employed in the surgical management of retinal diseases like retinal

detachment. However, their presence serves as a significant contraindication to the use of nitrous oxide. These gases can persist in the eye for up to three months following surgery. During this period, nitrous oxide inhalation, whether administered during general anesthesia or sedation for dental procedures, can trigger a rapid expansion of intraocular gas bubbles, leading to sight-threatening elevations in intraocular pressure.

While most reported cases involving nitrous oxide inhalation and vision loss following intraocular gas instillation have been in elderly patients with retinal detachments or other retinal diseases[32-34], it is essential to consider this potential risk in pediatric patients as well[47,48]. Although children visiting pediatric dental clinics generally do not suffer from age-related retinal diseases like retinal detachments, they may have other ocular conditions that could place them at risk. Therefore, dentists should maintain a high level of vigilance when evaluating pediatric patients, particularly those with a history of eye trauma or intraocular surgery. Therefore, medical and dental personnel administering nitrous oxide inhalation should be aware that this procedure is contraindicated in patients receiving intraocular gas.

6) Ocular injury during dental treatment

There is a risk of ocular injury during dental treatment[23,35]. This highlights the potential hazards during dental procedures that necessitate compliance with appropriate safety equipment and procedures to ensure patient safety. Jordi and Méndez's systematic review[35] identifies associated factors, such as occasional use of ocular protection, age, sex, and years of practice, that contribute to ocular injuries primarily caused by the entry of liquids and foreign bodies. These findings emphasize the importance of compliance with eye protection protocols for mitigating ocular injuries in dental settings.

7) Foreign body aspiration or ingestion

During dental treatment, foreign bodies can be ingested inadvertently or aspirated[36,37]. If an object is swallowed and passes into the stomach, there is a high probability, particularly for small blunt objects under 2 cm, that it will naturally move through the gastrointestinal tract without complications due to peristaltic movement[36]. Conservative management involves regular radiographic monitoring and checking stools for the object's passage. However, sharp or pointed objects pose a higher risk of perforation, especially in areas such as the esophagus, pylorus, duodenum, duodenojejunal flexure, and ileocecal region. In such cases, early endoscopic removal is recommended. Symptoms such as pain, nausea, vomiting, tenderness, or abdominal guarding may indicate perforation, and if the object remains lodged for more than two weeks, surgical intervention is necessary[36].

On the preventive side, employing precautionary measures is the most effective approach to minimize instances of dental instrument aspiration[37]. First, dental personnel should incorporate the possibility of such emergencies into their standard operating procedures and undergo regular training to recognize and mitigate adverse events promptly. Delegating individual responsibilities ensures clear organization and swift support in cases of emergency. Having access to the contact details of an endoscopist and a fully equipped hospital is imperative. Second, a thorough review of the patient's medical and dental history is essential, especially for high-risk populations, and scheduling short morning appointments is recommended for them. Third, patients should receive comprehensive pre-operative education with the dental staff ensuring active involvement and cooperation. Fourth, instruments should undergo periodic checks for signs of wear or fatigue before use, and any worn-out instruments should be promptly replaced. For example, burs should be securely fastened into the handpiece, and dental mirrors should be tightly screwed in place. Broken instruments should be carefully retrieved and matched with any retained fragments to ensure complete recovery. Finally, standard operating procedures with precautionary measures must be followed during all practices. These measures include appropriate anesthesia and treatment selection, proper positioning of the body and head, adequate lighting,

and four-handed dentistry with attentive assistance and high-speed evacuation. Routine use of a rubber dam and properly fitting clamp, as well as the use of a protective barrier such as a 4 × 4-inch gauze distal to the working area, can further enhance safety. Additionally, tethering small instruments, cast posts, cores, and crowns with a ligature can improve grip strength and reduce the risk of dropping.

4. Challenges in understanding global patient safety in pediatric dentistry

Obtaining a clear picture of patient safety in pediatric dentistry is a global challenge. Although data on incidents are crucial, they are likely to be underreported and inconsistent across countries[49]. This is due to fear of liability lawsuits, a lack of standard reporting systems, and varying definitions of what constitutes an error. Despite these challenges, adverse event studies have provided glimpses into potential problems. Dental patient adverse event research is primarily conducted through three main methods. The first involves deriving insights from case reports, which, although limited, provide detailed information on each case, aiding in a substantive understanding of adverse events (AEs)[49]. Obadan et al.[49] investigated the safety of dental patients by reviewing reported AEs. Researchers have found that misdiagnosis leading to delayed or unnecessary treatment was the most common issue. Although deaths have been reported in some cases, permanent harm was more frequent. These findings highlight the need for a better understanding of dental AEs and their causes.

The second method entails researching AEs experienced by dental practitioners through surveys[50]. However, issues, such as respondent participation rates and sample selection bias, may arise. Nicola et al.[51] surveyed pediatric dentists in the United States regarding adverse events during dental care for children. Between October and December 2019, an anonymous online survey was conducted with 11 percent of AAPD members. Of the respondents, 91% reported experiencing at least one AE in a child during dental treatment. The two most

prevalent AEs, each reported by 82% of respondents, were self-inflicted trauma to soft tissues after local anesthesia and nausea and vomiting. The annualized estimates for these events were 7,816 and 7,003, respectively. Major AEs (respiratory depression, cardiovascular depression, neurological damage, death) during pediatric dental treatment were reported by 14% of respondents (annualized estimate=443). "Wrong" errors (wrong tooth/wrong procedure/wrong patient) were reported by 24% of respondents (annualized estimate=600).

Finally, trigger tool-based adverse event detection in electronic health records (EHRs) provides another avenue for studying dental adverse events[52-54]. The trigger tool was initially designed as a manual method for healthcare professionals to review patient records[55,56]. Kalenderian et al.[57] explored the use of EHRs to improve the detection of AEs in dentistry. However, there has been growing interest in semi- or fully automated adverse event detection methods utilizing EHRs, which require less time and personnel resources for identifying AEs[58]. Currently, most dental institutions rely on manual chart reviews to identify AEs, which is inefficient[59]. Implementing prospective AE-detection through automated surveillance systems using EHR data can provide real-time feedback to healthcare professionals, enabling timely intervention[60]. Although not perfect, trigger tool-based automated adverse event detection showed promise as a more efficient way to detect AEs compared to manual methods.

5. Defensive dentistry

Hellyer and Radford[61] have observed a growing trend in "defensive dentistry" over the past decade. Their study reported that experienced dentists may increasingly choose to perform only low-risk or risk-free procedures. Dentists are shifting their practices due to concerns about patient safety, often prioritizing risk reduction to prevent complications. The fear of facing legal action is a driving force behind treatment decisions as dentists navigate complex medico-legal considerations[62,63]. Additionally, concerns regarding the health and safety of both

staff and patients are prompting adjustments in practical approaches, particularly to minimize the risks of exposure to infections or injuries. This could have negative potential consequences on the overall oral health of the population, as experienced dentists may limit their scope of practice[64].

The AAPD Safety Toolkit: A Review of Key Practice Tools

The AAPD offers a Safety Toolkit on its website with the aim of creating a safe environment in pediatric dental practice[9]. This toolkit provides a comprehensive set of resources for 12 key issues, including practice tools, scientific documentation, training tools, and library materials. The present review focuses on the core practices and training tools that can be effectively used in clinical settings. The following section provides descriptions, practice, and training tools for each of the 12 key issues:

1. Developing a culture of safety

The concept of safety culture originated from studies conducted outside healthcare, focusing on high reliability organizations (HROs) that consistently minimize adverse events despite engaging in complex and hazardous work[65]. These organizations prioritize safety across all levels, from frontline providers to upper management. Research has shown significant differences in perceptions of safety culture across various organizations and job roles[66]. Surveys are commonly used to measure safety culture, with validated options including the Agency for Healthcare Research and Quality's (AHRQ) Surveys on Patient Safety Culture™ (SOPS®)[67] and the Safety Attitudes Questionnaire (SAQ)[68]. The AAPD's patient safety policy prioritizes fostering a culture wherein staff members feel empowered to address patient safety concerns[8]. This includes encouraging team members to voice their concerns and take the necessary actions to ensure patient safety.

2. Infection control

The AAPD issued a comprehensive policy statement addressing infection control measures in dental settings. First, they endorsed the CDC guidelines for infection control[69,70], sterilization, and management of hepatitis B infection, recognizing them as vital resources for maintaining safety in dental practices. Second, the AAPD urges dental practitioners to stay updated with current literature and meticulously implement infection control measures to minimize the risk of disease transmission. This includes heat sterilization of all dental handpieces between uses, including low-speed motors and reusable prophylaxis angles. Furthermore, the AAPD emphasizes the importance of proactive infection control practices among dental providers and their teams. Additional training may be beneficial for staff members to effectively address parental concerns regarding infection control practices within treatment facilities. This policy also highlights the necessity of developing a water management plan for dental unit waterlines to ensure that routine maintenance procedures are followed to maintain low bacterial counts. Additionally, practitioners are advised to use irrigants for operative and surgical procedures in line with the CDC recommendations. Conventional dental units may not reliably deliver sterile water; therefore, single-use disposable syringes should be used to dispense irrigants during pulpal therapy and oral surgical procedures. Finally, the AAPD stresses the need for clinicians to take necessary precautions to prevent potential backflow associated with the use of saliva ejectors, further safeguarding patient safety in dental settings.

3. Medical error reduction

This topic discusses an approach that directs attention to systemic weaknesses that facilitate errors rather than attributing faults to isolated incidents. The systems approach to error analysis in healthcare, pioneered by Reason[71], emphasizes that errors often result from flaws in the overall system rather than from individual failings. This approach views errors as inevitable and seeks to

identify the underlying system flaws to prevent or minimize their impact on patients. Errors are classified into active errors, typically made by frontline personnel, and latent errors, which stem from organizational or design failures. Techniques such as root cause and failure mode effect analyses are used to analyze errors and develop solutions with a focus on redesigning protocols, devices, and work environments to reduce the risk of slips and mistakes[72]. Creating a culture of safety in which reporting errors is encouraged and frontline workers are not punished for slips is crucial for improving patient safety. Preventing pediatric medication errors through the use of such systems is a prime example of avoiding individual mistakes[73].

4. Waterline safety

Many healthcare facilities and dental practices adhere to recommended guidelines for regularly monitoring and maintaining the quality of DUWL to enhance patient safety. There are several checklists and recommendations in the United States for complying with DUWL standards, primarily based on the guidelines published by the ADA[74], OSAP[75], and CDC[76]. These checklists and recommendations include the following:

1) Regular monitoring of water quality in DUWL systems.
2) Flushing and disinfection protocols for DUWL systems.
3) Use of appropriate treatment products and maintenance of DUWL systems.
4) Training for dental personnel on DUWL maintenance and infection control.
5) Compliance with manufacturer recommendations for DUWL equipment and products.

These guidelines aim to ensure the safety and quality of water used in dental procedures, thereby reducing the risk of infection for both patients and staff.

5. Sedation and general anesthesia safety

Recent research has examined the safety of deep seda-

tion in outpatient pediatric dentistry (2017-2019 records) [77]. Although convenient, outpatient deep sedation may have unpredictable risks; 8.6% of children experienced issues (AEs) such as dizziness, breathing problems, or allergic reactions. The AAPD suggests the "Use of anesthesia providers in the administration of office-based deep sedation/general anesthesia to the pediatric dental patient" as a best practice recommendation. This best practice is intended to assist dental practitioners who choose to employ a currently licensed anesthesia provider to deliver deep sedation/general anesthesia to pediatric dental patients in a dental office or non-hospital, non-ambulatory surgical center setting. This best practice emphasizes the need for thorough documentation and procedures for ensuring safe and high-quality care for pediatric dental patients undergoing deep sedation or general anesthesia. The key components include documenting the reasons for sedation, obtaining informed consent, providing clear instructions to patients and parents, conducting preoperative health evaluations, maintaining detailed anesthesia records, and recording recovery notes. It also underscores the importance of implementing risk management and quality assurance measures. Additionally, utilizing in-office anesthesia providers can offer safe and compassionate care alternatives, particularly when access to traditional surgical facilities is limited.

6. Nitrous oxide safety

Nitrous oxide, which is extensively used in pediatric dental clinics, plays a vital role in assisting certain patients. However, the inadvertent inhalation of excessive nitrous oxide by staff can lead to adverse health outcomes. First, it is crucial to carefully evaluate the patient selection criteria (e.g., tolerance of the nasal hood, ability to breathe through the nose, cooperative potential, recent illnesses, indications, and contraindications) before administering nitrous oxide. Several studies have suggested that the use of nitrous oxide in patients with intraocular gas tamponade following vitreoretinal surgery may induce blindness[32-34].

Additionally, scavenging waste anesthesia gases is cru-

cial[78]. Scavenging refers to the process of suctioning and eliminating the waste nitrous oxide exhaled by a patient during a procedure performed under nitrous sedation. Waste anesthesia gases consist of small quantities of volatile anesthetic gases that escape from the patient's anesthesia breathing circuit into the air in operating rooms during anesthesia delivery[78]. Double-chamber mask delivery systems outperform single-chamber masks with scavenging caps in removing excess nitrous oxide gas[79,80]. Employing a properly fitted double-chamber mask along with the recommended scavenging system flow rate can effectively reduce occupational exposure to nitrous oxide gas.

7. Medical emergencies in the dental office

Non-dental medical emergencies may occur when families visit pediatric dental facilities. It is necessary to document observable symptoms, signs, and management strategies[81], for potential emergencies that may occur in dental clinics. Additionally, documentation of the indications and dosages of medications available for use in emergencies is required. Preparing protocols in advance and ensuring that all staff members undergo training are crucial steps to promptly address emergencies that may arise in dental practice.

8. Comprehensive informed consent

The provision of a patient consent form is mandatory. Beyond simply preparing a patient consent form, it is essential to consider how to provide information to patients effectively and empower them to make informed choices. This safety toolkit section offers various training tools for professional societies, universities, and companies to facilitate this process. The AAPD provides recommendations for informed consent in their best practice section[82]. Consent forms should be tailored to the procedure, use straightforward language, and avoid broad statements. When practitioners use an informed consent form, the following items should be included: 1. Legal name and date of birth of patient; 2. Legal name and re-

lationship with the pediatric patient/legal basis on which the person is granting permission on behalf of the patient; 3. Patient's diagnosis; 4. Nature and purpose of the proposed treatment in simple terms; 5. Potential benefits and risks associated with the treatment in simple terms; 6. Professionally recognized or evidence-based alternative treatment – including no treatment – to recommended therapy and the risk(s) of each treatment modality in simple terms; 7. Place for the parents to indicate that all questions have been asked and adequately answered; and 8. Places for the signatures of parents, dentists, and office staff members as witnesses.

9. Dental records and record keeping

Documentation and patient records are essential components of a successful dental practice[83]. They contain crucial details regarding the patient's treatment plan and the care they received. Dental records play a significant role when submitting dental benefit claims or responding to legal matters, such as lawsuits. Although these records serve as a form of insurance, it is important to only include information relevant to dental care. Adhering strictly to your established record-keeping format is vital, as anything documented can potentially be presented in a court of law. Information that should not be noted in dental records includes[84]:

1) **Financial information:** This includes ledger cards, insurance benefit breakdowns, insurance claims, and payment vouchers. Financial records are separate from clinical records and should be maintained independently.

2) **Personal opinions or criticisms:** It is important to refrain from documenting the subjective opinions or criticisms of patients. While it is acceptable to document instances such as a patient's refusal of recommended treatment or information about canceled appointments, any disparaging comments or informal notes should be avoided, as they may need to be disclosed in the event of a lawsuit.

3) **Patients' personal information:** Personal information should be kept separate from medical and den-

tal records. Creating a separate form for collecting personal information will facilitate the maintenance of separate files. Team members can use this form to record each patient's special interests, hobbies, and activities.

10. Office design safety

Office design safety encompasses a range of topics in pediatric dental practices, from safety-promoting office design to toy safety. These factors represent the physical attributes of the interiors of dental clinics that either facilitate or impede the provision of a safe environment. It is important to prepare a toy safety checklist, especially for toddlers and young children because they may be particularly vulnerable to risks[85,86]. Choking is the fourth leading cause of unintentional death, the primary cause of infantile mortality, and the fourth leading cause of death among preschool children[87]. The most frequently implicated objects in choking incidents are food items, coins, balloons, and toys. According to a review by the CDC on nonfatal choking incidents among children treated in emergency departments, 13% of cases were linked to coins, while 19% were attributed to candy or gum ingestion. Among the aspirated foreign bodies resulting in fatalities, latex balloons were the most common, accounting for 29% of deaths due to foreign body aspiration between 1972 and 1992. During the same period, hot dogs emerged as the most lethal food item causing aspiration, accounting for 17% of food-related aspiration fatalities. Following are some tips to ensure toy safety[85]:

1) **Check the Label:** Most toys on the market are safe, but it is still crucial to check the labels for age recommendations. Toys designed for children aged 3 - 6 years may pose choking hazards to younger children.

2) **Consider Age and Development:** The age recommendation for a toy considers physical and mental abilities and safety aspects. Toys should always be chosen appropriately for a child's age and developmental stage.

3) **Prevent Choking:** Avoid small toys and parts for children under 3 years of age, as they may mouth objects and risk choking. Toys should be regularly checked for loose parts to ensure that they are sturdy. Beware of items including latex balloons[88-90], bean bag chairs, and small batteries or magnets[91].

4) **Avoid Falling:** Keep riding toys away from stairs and bodies of water. Supervise children on riding toys and ensure proper fit.

5) **Prevent Suffocation and Strangulation:** Discard plastic wrapping immediately and keep strings away from cribs and playpens[92]. Be cautious of strings, ropes, or cords that could strangle a child. Watch out for loose or long clothing parts and remove hood cords from playground equipment.

6) **Prevent Other Injuries:** Be wary of toys that shoot projectiles or make loud noises, as they can cause eye and hearing injuries. Electric plug-in toys and hobby kits may cause burns or shocks if misused. Chemistry sets and similar kits should be used with caution because of the presence of toxic substances and fire hazards. Toy chests can pose risks of pinching, bruising, or suffocation.

11. Personnel security

Occupational violence is universally deemed unacceptable in professional settings. Within the healthcare sector, including dentistry, safeguarding workers' well-being is paramount. Healthcare workers face various forms of violence, ranging from physical assault to nonphysical acts such as shouting, bullying, threats, and even sexual harassment[93]. Violence can significantly impact workers, leading to decreased quality of work, psychological issues, and, in rare cases, resignation from their positions. The increasing incidence of occupational violence against oral healthcare professionals underscores the urgent need for improved protective measures to establish safe working environments for dental practitioners.

Incidents of violence within medical institutions continue to occur in South Korea. The Korean Dental Association strives to protect dental healthcare professionals

by distributing a "Violence and Threat Response Manual" [94] and a "Dental Healthcare Provider Violence Prevention Poster"[95]. Ongoing worksite analyses and hazard identification are crucial for the effectiveness of a comprehensive workplace violence prevention program[96]. Risk factors for workplace violence in healthcare settings encompass various aspects, including those related to patients, clients, and settings, as well as organizational factors[97].

12. IT security

Cyberattacks have been persistently occurring in the international dental community recently[98,99]. IT security in the dental field involves safeguarding digital systems, networks, and data against unauthorized access, use, or modification. Not only industrial sectors, but also organizations possessing personal patient information, have fallen victim to such cyber threats. The US Department of Health and Human Services Office for Civil Rights is currently providing a list of hacking incidents under investigation[100]. With the escalating sophistication of cyberterrorism, the importance of protecting personal information has become increasingly important. The use of programs utilizing patient imaging or treatment data has rapidly increased among medical professionals in the AI era[101-106]. With various diagnostic and treatment programs utilizing patient data, ensuring the safe and effective use of systems in the medical field requires addressing security and privacy threats related to AI.[107,108]. The Cyber Essentials Toolkit consists of modules aimed at simplifying the Cybersecurity and Infrastructure Security Agency (CISA) Cyber Essentials into manageable actions[109]. This enables C-suite leadership in the healthcare sector to progressively prepare for each Cyber Essential.

Curriculum for Pediatric Dentistry Residency Programs

In 2021, a survey of US pediatric dentistry residency directors found a gap between recognizing the importance of patient safety training and how it is delivered[110]. While most directors perceive this as crucial, residents often enter programs with weak safety knowledge. The programs primarily use lectures and clinical experience; however, the lack of familiarity with specific safety tools suggests the need for more comprehensive training. The directors expressed interest in providing additional support to strengthen their safety education. In 2021, a comparable survey on the status of sedation training for pediatric dental residents in training hospitals was conducted in South Korea[111]. This study also reported that sedation training was conducted in all training institutions; however, disparities were noted in the residents' experiences across various aspects.

In December 2023, the AAPD Research and Policy Center established the 2023 Pediatric Dental Residency Program[10]. It targets both new dentists and experienced professionals and provides them with the knowledge and tools to create a safe environment for everyone involved. The key points of the curriculum are as follows:

1. **Focus on safety:** Teaches foundational safety principles and fosters a culture of safety in pediatric dental practices.
2. **Up-to-date and tailored:** Uses the latest healthcare safety knowledge while offering resources specific to dentistry. The curriculum can be adapted to different settings such as hospitals and dental schools.
3. **Flexible learning:** Users can choose the learning materials most relevant to their needs, rather than mastering everything.
4. **Supplements existing training:** This program complements existing safety tools by focusing on pediatric dentistry specifics.
5. **Expert-developed:** Safety specialists designed the curriculum, and program directors reviewed it for relevance in both classroom and clinical settings.

1. What are HROs?

The excerpt from "Human Error" delineates two primary perspectives on error management[71]. The Person Approach holds individuals accountable for errors, cit-

ing factors such as forgetfulness, inattention, and inadequate skills as the causative elements. In contrast, the Systems Approach attributes errors to systemic issues, such as ineffective communication, insufficient training, or ambiguous procedures. This advocates for designing systems that mitigate the risk of human error and facilitate safer task performance.

HROs are examples of the systems approach in action. HROs, such as nuclear power plants and air traffic control systems, operate in complex environments with high risks, but maintain exceptional safety records. Their success is attributed to a culture that prioritizes safety and acknowledges human variability as a fact of life, even using it as a safeguard. HROs achieve this by anticipating problems, promoting communication, and adapting to challenges. By focusing on the system as a whole, rather than blaming individuals, HROs create a safer environment for everyone involved. The distinction between the individual and systems approaches is an important concept not only in human factors engineering but also in patient safety within the healthcare field.

2. What is the safety culture?

Table 2 presents the key points and benefits of the three safety cultures[71]. Just culture centers on promoting sincere reporting of safety concerns within an organization. Its key aspects include incentivizing and acknowledging individuals for reporting safety issues and distinguishing between inadvertent mistakes and intentional negligence. This approach yields benefits such as fostering an environment where staff can openly report errors without apprehension of reprisal, thereby facilitating the early detection and resolution of potential issues. Reporting culture emphasizes the establishment of an environment wherein individuals feel at ease reporting errors and near-misses. The key to this is reporting incidents, regardless of how minor a regular and anticipated practice is. These benefits include gathering valuable data for learning from past incidents and fostering a collective sense of responsibility toward safety. A learning culture prioritizes the active utilization of safety reports to enhance organizational practices. Key components include the organization's readiness to analyze safety data and enact significant changes if needed to enhance safety. This approach offers benefits, such as fostering ongoing enhancements in safety performance and showcasing a dedication to patient safety and risk mitigation. These three safety cultures complement each other to establish a robust safety environment. To summarize, a just culture encourages reporting, a reporting culture captures data, and a learning culture uses data to

Table 2. Key points and benefits of the three safety cultures

	Focus	Key Points	Benefits
Just Culture	- Encouraging honest reporting of safety issues	- People are encouraged and even rewarded for reporting safety concerns. - It emphasizes differentiating between human error and deliberate recklessness.	- Creates a safe space for staff to report mistakes without fear of punishment. - Allows for the early identification and correction of potential problems.
Reporting Culture	- Creating an environment where people feel comfortable reporting errors and near misses (close calls).	- The organization has the willingness and ability to analyze safety data and learn from it. - A strong learning culture is prepared to implement significant changes if necessary to improve safety.	- Provides valuable data for understanding and preventing future incidents. - Fosters a sense of shared responsibility for safety.
Learning Culture	- Actively using information from safety reports to improve practices.	- The organization has the willingness and ability to analyze safety data and learn from it. - A strong learning culture is prepared to implement significant changes if necessary to improve safety.	- Leads to continuous improvement in safety performance. - Demonstrates a commitment to patient safety and risk reduction.

drive improvement, ultimately enhancing overall safety performance and risk-reduction efforts.

3. Why is leadership important for fostering a safety culture?

Leaders must enforce policies and communicate them clearly to all team members[112]. The Joint Commission document outlines an 11-step approach to creating a strong safety culture within an organization[113]:

1) **Encourage Open Reporting:** Be transparent and nonpunitive when staff report mistakes, close calls, and unsafe conditions. This allows for learning and improvement.
2) **Distinguish Blame from Errors:** Develop fair systems to separate human error from poorly designed systems and intentionally unsafe acts.
3) **Leaders Set the Tone:** Leaders must champion safety and eliminate bullying behaviors to build trust within the organization.
4) **Communicate Safety Policies:** Clearly communicate policies that support a culture of safety and encourage incidents reporting.
5) **Recognize Safety Efforts:** Acknowledge and reward staff who report issues, identify risks, or suggest safety improvements.
6) **Measure Safety Culture:** Utilize surveys such as the Agency for the AHRQ Hospital Survey on Patient Safety Culture (HSOPS) or alternative tools such as the Safety Attitudes Questionnaire (SAQ) to establish a starting point and monitor advancements in fostering a secure environment.
7) **Analyze Data, Identify Opportunities:** Analyze safety data to identify areas for quality improvement and patient safety.
8) **Implement Safety Initiatives:** Develop and implement targeted actions to improve the safety culture within each unit.
9) **Integrate Safety Training:** Embed safety training into quality improvement projects and everyday processes.
10) **Proactively Assess Systems:** Identify and address weaknesses in systems such as medication management and EHRs.
11) **Continuously Monitor Progress:** Regularly assess the organization's safety culture to track progress (every 18 - 24 months) and ensure long-term improvement.

4. What is the SBAR tool?

Effective communication between healthcare providers and patients is crucial for patient safety and shared decision-making[114]. The Situation-Background-Assessment-Recommendation (SBAR) technique offers a structured approach to communication among healthcare team members regarding a patient's condition[115]:

S = Situation (a concise statement of the problem)
B = Background (pertinent and brief information related to the situation)
A = Assessment (analysis and consideration of options — what you found/think)
R = Recommendation (action requested/recommended — what you want)

The SBAR serves as a practical tool for framing critical conversations and facilitating immediate attention and action from clinicians. It aids in setting communication expectations among team members and promoting teamwork and a patient safety culture. Practicing communication strategies with dental teams and patients, fostering safe environments, and ensuring effective communication between providers and patients is crucial for patient safety and shared decision-making[116].

5. What is a mortality and morbidity session?

Mortality and morbidity (M&M) sessions are regular meetings held in healthcare settings, typically in hospitals or medical institutions, where healthcare professionals gather to review and discuss cases involving patient deaths or adverse events (morbidity)[117]. These sessions serve as a forum for clinicians to reflect on clinical outcomes, identify factors contributing to adverse events, and explore opportunities for improvement in patient care practices, procedures, and systems[118]. The prima-

ry goal of M&M sessions is to promote continuous learning, quality improvement, and patient safety within the healthcare organization[119]. Dental hospitals, similar to medical institutions[120], also need to integrate M&M sessions into dental resident education[121].

Enhancing patient safety in pediatric dental care: proposed initiatives and strategies

At present, there is a need to comprehensively address patient safety issues throughout pediatric healthcare, extending beyond dental sedation. Consequently, the author proposes implementing the following nine initiatives related to patient safety:

1. **Establishing a safety committee within the KAPD:** The creation of safety committees within professional societies dedicated to pediatric dentistry will facilitate ongoing monitoring and improvement of safety protocols.

2. **Enhancing and broadening the utilization of the pediatric dental patient safety reporting system:** Expanding beyond dental sedation and establishing reporting systems for adverse events in pediatric dental safety will enable swift detection of issues and support ongoing improvement endeavors.

3. **Policy development on patient safety:** The committee should institute patient safety policies to outline standards and procedures aimed at reducing risks and enhancing safety in pediatric dental practice.

4. **Clinical guidelines and best practice development:** Revising clinical guidelines and best practices regarding safety issues, including consent form formats, surgical checklists, infection control checklists, and equipment maintenance checklists, will standardize practices and minimize errors.

5. **Establishing resident education and training programs:** Implementing educational initiatives, such as webinars and modules, will equip pediatric dental residents with the necessary knowledge and skills to prioritize patient safety.

6. **Designation of pediatric dental patient safety awareness day:** Designating a specific day (or week) to highlight pediatric dental patient safety will boost awareness and foster ongoing education and improvement, exemplified by initiatives like "World Patient Safety Day" on September 17, as designated by the World Health Organization.

7. **Dissemination of safety alert notes:** Sharing safety alert notes through professional organizations, such as the Joint Commission, will facilitate the swift distribution of essential safety updates to pediatric dental practitioners.

8. **Support for patient safety-related research:** Society should provide support and resources for research aimed at advancing patient safety practices and outcomes in pediatric dentistry.

9. **Developing pricing models for pediatric dental patient safety insurance coverage:** Policy collaboration among relevant stakeholders is crucial to developing pricing models for pediatric dental patient safety insurance coverage that accurately reflect the value of patient safety initiatives and incentivize investment in safety measures.

By implementing these initiatives, pediatric dentistry can strive toward achieving the highest standards of patient safety, ultimately improving outcomes and enhancing the quality of care provided to pediatric patients.

Conclusion

Here are the key take-home messages for readers:

1. **Prioritize "Do no harm":** Above all else, prioritize the principle of "do no harm" in healthcare practices and policies.

2. **Leadership's role:** Leadership within healthcare organizations plays a pivotal role in shaping the culture of safety. Leaders should prioritize patient safety, provide support and resources for safety initiatives, and lead by example.

3. **Cultivate patient safety culture:** It is inadequate to simply enforce safety acts and regulations; fostering a patient safety culture is essential to prevent distortion of their original meaning over time.

4. **Embrace human error:** Recognize that human error is inevitable and refrain from blaming individuals for it. Establish a "just culture" that focuses on learning and improvement rather than punishment.

5. **Promote effective communication:** Effective communication with both patients and staff members is crucial for establishing and maintaining patient safety. Encourage a "reporting culture" where concerns and errors can be openly discussed.

6. **Learn from mistakes:** View mistakes as valuable opportunities for growth and improvement. Embrace a "learning culture" where errors are reported, analyzed, and used to implement changes that enhance patient safety.

Conflict of Interest

The authors have no potential conflicts of interest to disclose.

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