# Iatrogenic harm in dental practice – What can go wrong and how to prevent it?

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**Keywords:** Iatrogenic harm, iatrogenic complications, iatrogenic adverse events, cause, consequences, dentistry, ethical responsibility, prevention, patient safety, systems biology, stewardship.

## Executive summary

### *Clinical Relevance*

- The greatest threat to patient safety in dentistry is not the inevitable complication but the preventable one.
- Preventing iatrogenic harm is a defining indicator of quality, safety and professionalism in modern dentistry.
- A practical framework is proposed for reducing iatrogenic risk through prevention, minimally invasive care, evidence-based decision-making, biological and ethical stewardship.

## Key messages

- Iatrogenic harm encompasses far more than technical mistakes; it reflects preventable failures in clinical judgement, biological preservation and ethical responsibility.
- Every dental discipline carries unique risks, but all share a common obligation to minimise preventable harm through evidence-based practice and personalized care.
- The safest procedure is often the one that is unnecessary; intervention should always be justified by a favourable balance between expected benefit and potential harm.
- Preventing iatrogenic harm begins with sound clinical reasoning rather than technical execution alone.
- Ethical stewardship transforms "avoiding harm" into a proactive responsibility to preserve biology, support patient autonomy and deliver evidence-based care.
- Prevention requires deliberate thinking before, during and after treatment, supported by continuous reflection and quality improvement.
- Technology should support—not replace—ethical clinical judgement and biologically informed patient care.
- The future of safe dentistry lies not in performing more treatment, but in delivering the right treatment, for the right patient, at the right time, with the least possible biological cost.

## Practice pearls

- The safest procedure is not the one that is the easiest, but the one that brings the greatest benefit with the least harm.
- See the red flags early – protect biology, prevent harm and preserve trust.
- Technology should augment – not replace- clinical judgement and ethical responsibility.

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## Introduction: The Hidden Burden of Iatrogenic Harm

Every dental intervention is intended to improve health, yet every intervention also carries the potential to cause iatrogenic harm, thus breaking the oldest and most famous Hippocratic principle "Primum non nocere" or "above all, do no harm" [1]

This principle remains one of the most fundamental ethical principles and obligations in healthcare and the foundation of safe delivery of dental care, placing an obligation on dentists to avoid harm and protect patients from risks, which is directly relevant to iatrogenic risks.[2,3,4]

Dentistry has historically viewed iatrogenic harm as a technical or procedural complication.[5,6,7] This conventional and reductionist view is challenged in this review by a more provocative—and arguably more important—argument that 'the greatest iatrogenic risks in modern dentistry often arise from well-intentioned, evidence-based, and technically excellent care that is applied without sufficient biological, ethical, or contextual judgement'.

Modern dentistry is extraordinarily successful at restoring teeth. However, it is considerably less successful at preserving them biologically over a lifetime. Every restoration initiates what has been called the restorative cycle.

'Small restoration - Larger restoration – Endodontics – Crown – Post – Extraction- Implant. This sequence is so familiar that it is often accepted as inevitable.

Perhaps it should not be. The first preparation of a tooth may represent the beginning of decades of cumulative iatrogenic intervention.

Although modern dentistry has achieved remarkable advances in diagnosis, biomaterials, digital technologies, implantology and minimally invasive care, increasing therapeutic complexity has simultaneously expanded opportunities for iatrogenic injury. Such harm extends far beyond obvious procedural complications to include unnecessary treatment, diagnostic errors, biological disruption, medication-related adverse events, communication failures and inappropriate clinical decision-making. Many of these adverse outcomes are preventable and therefore represent an ethical challenge rather than an inevitable consequence of treatment. Clinical excellence should consequently be measured not only by technical proficiency but also by the ability to anticipate, minimise and prevent avoidable harm. Consequently, dental practitioners continuously have to balances therapeutic benefit against the possibility of iatrogenic harm. This is the ethical conundrum of modern clinical practice.

As treatment becomes increasingly sophisticated, the ethical challenge is no longer simply whether clinicians can intervene, but whether, when, and how they should. Preventing iatrogenic harm therefore requires a shift from a procedure-centred philosophy to one of evidence-based, patient-centred, biologically informed, and ethical stewardship. Dentists have a professional, ethical and legal obligation and duty to ensure that appropriate standards of quality and safety are applied in dental practice.[8] Promoting patient safety by avoiding preventable iatrogenic harms, adverse events, mishaps and errors, and limiting the negative consequences of those that are unpreventable, has become a key focal point in all health care professions.[9,10,11] Identifying and understanding iatrogenic risks and threats to patient safety is a key element in preventing iatrogenic harm[12] and improving dental patient safety.[13] Thus moving beyond discussing 'what can go wrong', to 'why iatrogenic harm occurs' and 'how ethical clinical decision-making can reduce it'. This shifts the discussion from isolated procedural errors to a broader ethical challenge facing modern dentistry.

- ***Consequences for patients***

The risk of iatrogenic harm for patients is of great significance because of the potential morbidity, cost burden, and negative consequences associated with the unintended biological, physical (trauma, injury), functional, aesthetic, psychological, and/or systemic harm arising directly or indirectly from professional care in all fields of dentistry.[10,14,15]

- ***Impact on the dental profession***

Iatrogenic harm also affects the dental profession directly and indirectly due to its socio-economic (financial burden),[10,16] psychological (distress),[14] medico-legal,[8,17,18] damage to the reputation of dental professionals,[19] professional and emotional impact on dental professionals[20] and healthcare systems at large.[21] In addition, it can impair the doctor-patient relationship, reduce patient trust, negatively impacting on patients' willingness to seek care or to comply with treatment recommendations. Ultimately this may lead to medico-legal disputes/litigation resulting in loss of revenue, burnout, and emotional and psychological burden on the practitioner.[11,22,23]

- ***Importance of mitigating harm and promoting safety***

Iatrogenic harm remain a persistent and serious concern in healthcare systems worldwide[16,24,25] while information and clinical guidelines on mitigating iatrogenic harm and promoting patient safety, especially in the dental practice

setting, remain limited.[21,26] It is thus imperative that dental practitioners worldwide acknowledge this reality to mitigate patient harm and to promote patient safety.[24]

- ***Purpose***

This review examines the causes of iatrogenic harm, explores its underlying biological and human mechanisms, and proposes an ethical stewardship framework for preventing iatrogenic harm, thereby promoting safer contemporary dental practice.

## Defining Iatrogenic Harm

- ***Definition of iatrogenesis***

Iatrogenesis is derived from the Greek roots iatros (physician/healer) and genesis (origin/caused by) – It fundamentally describes a condition that is "healthcare provider made" rather than cause by natural progression of the patients primary underlying disease or condition. Thus, iatrogenic literally means "caused by the healer." Today, this term applies to all healthcare professionals, including specialists, dentists, and oral hygienists. Iatrogenesis is a very common, often preventable, hazard of treatment and is related with considerably increased patient morbidity and cost.[27]

Iatrogenesis refers to harm experienced by patients resulting from dental care, whereas negligence can be conceptualized more narrowly as "failure to use reasonable care, due to "departures from accepted standards of care." Therefore, while all harm that results from negligence is iatrogenic, not all iatrogenic injury is negligent.[28] Iatrogenic adverse events differs from negligence as long as the dental practitioner treats a patient with reasonable care. Intentional, unjustified or unexcused iatrogenic harm is a breach of a doctors ethical duty of non-maleficence.[29,30]

- ***Definition of iatrogenic harm***

Iatrogenic harm, also referred to as iatrogenic adverse events, is defined as any unintended, unfavourable, undesired, or unnecessary harmful outcome, adverse event, injury, complication, mishap or error induced in a patient as a result of medical or dental diagnostic, clinical decision-making, intervention, treatment, medication, advice or manner by a health care practitioner, despite the intention to benefit the patient.[9,11,31,32,33,34]

Iatrogenic harm refers to any preventable adverse biological, functional, psychological or social consequence resulting directly or indirectly from professional healthcare. In dentistry, harm may arise through acts of commission, such as over-instrumentation or inappropriate prescribing, or acts of omission, including failure to diagnose disease, inadequate monitoring or delayed referral. Harm may also originate from system failures, communication breakdowns, inadequate documentation or commercial pressures that influence treatment decisions.

Importantly, iatrogenic harm should not be viewed solely as procedural error. It frequently reflects deficiencies in judgement, planning or ethical decision-making that precede treatment. Moreover, the absence of overt complications does not necessarily indicate that care has been biologically or ethically optimal. Excessive removal of healthy tooth structure, unnecessary replacement of restorations or indiscriminate antibiotic prescribing may appear clinically successful while simultaneously compromising long-term patient health.

Consequently, iatrogenic harm encompasses far more than technical mistakes; it reflects preventable failures in clinical judgement, biological preservation and ethical responsibility.

- ***Characteristics of iatrogenic harm***

Iatrogenic harm or adverse events are characterized by the following: (i) In most cases they are unintentional as a result of error or mishap in clinical judgement or procedure[13,24;] (ii) it can occur at any phase of care and any field of dentistry[15,26,35]; (iii) is a significant source of therapeutic risk, morbidity and cost to the patient[11,15, 26,35,36]; (iv) its manifestations can be immediate or delayed[11,26,35]; and (v) it can be anticipated/avoidable and thus preventable (e.g., antibiotic overprescribing), or unanticipated /unavoidable, despite appropriate, evidence-based care (e.g., a rare allergic reaction to a local anaesthetic).[9,11,15,24,35] Errors and mishaps are inevitable despite experience and talent, which impacts patient safety.[37]

The prevalence of adverse events (AEs) associated with dental care is estimated at 1.4%, of which at least two-thirds are preventable.[15]

## Drivers of iatrogenic harm

The causes of iatrogenic harm are multifactorial and rarely attributable to a single event. Rather, adverse outcomes emerge from interactions among biological/clinical complexity[11,38,39,] human factors[24,37,40,41,] technological advances [37,42,43,44,] and organisational influences.[24,41,45]

Patients increasingly present with ageing dentitions, multiple chronic diseases, polypharmacy and complex restorative histories, making clinical management more demanding. Human factors—including fatigue, cognitive bias, overconfidence, inadequate communication and




*Figure 1: Systems model of Iatrogenic Harm: From risk factors to Clinical Outcomes*

time pressure—remain among the leading contributors to preventable errors. Simultaneously, rapid adoption of digital workflows, artificial intelligence, cone-beam computed tomography, CAD/CAM technologies and laser therapies has increased diagnostic and technical complexity while introducing new opportunities for error when inadequately understood. Organisational factors such as productivity targets, commercial incentives, time pressures, understaffing, fragmented interdisciplinary care and insufficient quality assurance further increase vulnerability to harm. These interacting influences highlight that iatrogenic harm is fundamentally a systems problem rather than simply an individual operator failure. (**Figure 1**)

## Biological mechanisms of iatrogenic harm

Every dental intervention interacts with an intricate biological ecosystem comprising mineralised tissues, oral biofilms, saliva, immune responses and host tissues. Harm occurs when treatment disturbs this equilibrium beyond the tissues' capacity for adaptation and repair.[46] Examples include excessive removal of sound tooth structure during restorative procedures[47,48], tissue trauma[49,50] disruption of the periodontal attachment apparatus through traumatic instrumentation[51,52], unnecessary alteration of the oral microbiome by repeated antimicrobial exposure and prolonged inflammation resulting from poorly planned interventions.[46,53-56] Medication-related complications,[57-59] biomaterial-related interactions[60,61] altered wound healing and immune dysregulation[62,63] further illustrate that local dental procedures may have systemic biological consequences.

A systems biology perspective emphasises that the oral cavity functions as an integrated ecosystem rather than a collection of isolated teeth.[63,64]

Consequently, preserving biological integrity should become a primary therapeutic objective alongside disease elimination. Therapeutic strategies therefore should move beyond pathogen-centered models to a systems-level perspective, aiming to restore ecological balance and recalibrate host responses rather than merely reducing the pathogenic burden.[64] Therefore, effective dentistry should preserve biological homeostasis while treating disease, recognising that unnecessary biological disruption is itself a form of iatrogenic harm.

## Clinical Categories of Iatrogenic Harm

Iatrogenic harm permeates all fields and aspects of primary dental care.[10] A summary of typical iatrogenic harms or risks, their cause, and preventive strategies by clinical fields in dentistry are summarized in **Table 1.**

Hidden causes of iatrogenic harm or risks can be attributed to: (i) diagnostic uncertainty; (ii) cognitive bias; (iii) time pressure; (iv) financial incentives; (v); technological overconfidence; (vi) incomplete medical histories; (vii) poor communication; (viii) fragmented care; (ix) failure to monitor outcomes; and (x) stress and fatigue. Obadan and co-workers identified delayed treatment, unnecessary treatment, or disease progression after misdiagnosis as the largest type of reported iatrogenic harm in dental adverse events.[24] In this context it is emphasized that human factors frequently outweigh technical deficiencies.

**Table 1: Iatrogenic risks across clinical dentistry – An ethical stewardship perspective**

| Clinical discipline | Typical iatrogenic risk (harm) | Underlying cause(s) | Preventive strategies | Refs |
|---|---|---|---|---|
| **Diagnosis & Treatment planning** | • Wrong diagnosis and treatment<br>• Delayed diagnosis and treatment<br>• Missed diagnosis and under-treatment<br>• Inappropriate treatment<br>• Overtreatment | • Inadequate investigations<br>• Inadequate assessment<br>• False positive test<br>• Inadequate risk stratification<br>• Cognitive bias<br>• Radiographic artifacts<br>• False diagnosis<br>• Patient values & preferences<br>• Inadequate informed consent & maintenance | • Comprehensive history & thorough examination<br>• Appropriate imaging<br>• Early risk factor identification<br>• Personalized treatment protocols<br>• Long-term maintenance protocol<br>• Second opinions when indicated<br>• Proper case selection, treatment planning, informed consent and execution<br>• Shared decision-making | 10, 65 ,75 |
| **Preventive Dentistry** | • Enamel abrasion<br>• Gingival trauma<br>• Dysbiosis<br>• Bacteremia<br>• Infective endocarditis | • Over-polishing<br>• Excessive instrumentation<br>• Indiscriminate antimicrobial use | • Risk-based prevention<br>• Minimally invasive techniques<br>• Ecological biofilm management<br>• Patient education | 76 - 79 |
| **Restorative Dentistry** | • Loss of healthy tooth structure<br>• Restoration leakage & failure<br>• Pulpal injury<br>• Occlusal dysesthesia (phantom bite syndrome)<br>• Immunotoxicity,<br>• Autoimmune condition | • Extensive irreversible procedures<br>• Aluminium-oxide air abrasion<br>• Overtreatment<br>• Poor isolation<br>• Inadequate adhesive protocols<br>• Occlusal errors<br>• Mercury exposure (dental amalgam) | • Minimal intervention dentistry<br>• Preservation of health tooth structure,<br>• Evidence-based adhesive principles<br>• Meticulous isolation (e.g., rubber dam)<br>• Occlusal assessment<br>• Regular monitoring & early complication detection<br>• Ongoing maintenance, repair, replacement | 20, 67-69, 80 - 88 |
| **Endodontics** | • Untreated canals<br>• Persistent symptoms<br>• Root canal failure<br>• Accidental aspiration<br>• Severe pain & tissue trauma<br>• Tooth abscess<br>• Tooth fracture<br>• Tooth extraction/loss<br>• Re-intervention<br>• Chronic fungal sinusitis<br>• Systemic infection | • Pulp chamber & canal (root) perforation<br>• Instrument separation (file fracture)<br>• Over instrumentation<br>• Overfilling<br>• Canal transportation<br>• Untreated canals<br>• Sodium hypochlorite accidents,<br>• Persistent symptoms<br>• Inadequate imaging<br>• Inaccurate working length<br>• Procedural errors<br>• Lack of rubber dam usage<br>• 'Wrong tooth' therapy<br>• Extrusion of endodontic filling material in sinus | • CBCT when indicated<br>• Magnification, electronic apex locators<br>• Irrigation protocols<br>• CPD improve skills & competence<br>• Use of rubber dam<br>• Good communication & informed consent<br>• Use Evidence-based protocols,<br>• Adopt new diagnostic technologies, (Microscopy, Guided endodontics, Dynamic Navigation System)<br>• Patient monitoring and maintenance& early complication detection | 10, 19, 23, 81, 82, 89- 99 |

**Table 1(contd): Iatrogenic risks across clinical dentistry – An ethical stewardship perspective**

| Clinical discipline | Typical iatrogenic risk (harm) | Underlying cause(s) | Preventive strategies | Refs |
|---|---|---|---|---|
| **Periodontology** | • Treatment failure / Relapse<br>• Gingival recession<br>• Root sensitivity<br>• Tooth loss<br>• Attachment loss<br>• Accidental trauma,<br>• Systemic infection<br>• Poor healing<br>• Inadequate informed consent & maintenance | • Poor case selection<br>• Poor surgical planning<br>• Uncontrolled systemic conditions<br>• Aggressive instrumentation<br>• Inappropriate surgery<br>• Procedural errors<br>• Poor maintenance<br>• Poor follow-up | • Tissue preserving instrumentation<br>• Patient specific therapy<br>• Supportive periodontal care<br>• Personalized monitoring and maintenance protocols | 35, 51, 52, 74, 77, 79, 94, 100, 101, 107 |
| **Oral Surgery** | • Nerve injury, paraesthesia, impairment,<br>• Excessive bone loss, bleeding, site infection<br>• Neuropathic pain<br>• Wrong site/tooth surgery<br>• Medication-related osteonecrosis of the jaw (MRONJ) (c)<br>• Sinus perforation after extraction (a)<br>• Trigeminal neuropathy<br>• Bleeding<br>• Allergy<br>• Antimicrobial resistance<br>• Surgical site infections<br>• Bacteremia<br>• Infective endocarditis | • Inadequate diagnosis & surgical planning<br>• Misdiagnosis<br>• Inadequate radiographic assessment (CBCT) and investigations (Biopsy and blood tests)<br>• Inadequate medical history<br>• Uncontrolled systemic conditions<br>• Inadequate anatomical assessment<br>• Traumatic technique<br>• Surgical errors<br>• Patients taking antiresorptive drugs<br>• Inappropriate antibiotic prescribing<br>• Inadequate informed consent & maintenance | • Careful case selection<br>• Appropriate use of pre-operative imaging<br>• Informed consent<br>• Atraumatic surgery<br>• Skills development | 76 - 79 |
| **Implant dentistry** | • Inferior alveolar nerve injury<br>• Peri-implantitis<br>• Implant failure,<br>• Prosthetic complications<br>• Neurosensory alterations<br>• Foreign body reactions<br>• Bleeding<br>• Allergy<br>• Antimicrobial resistance<br>• Foreign body reaction | • Diagnostic errors<br>• Surgical errors<br>• Prosthetic errors<br>• Poor case selection<br>• Poor surgical planning<br>• Systemic conditions<br>• Improper implant positioning<br>• Sub-optimal peri-implant soft tissue<br>• Unfavourable prosthetic factors<br>• Bovine bone xenografts<br>• Inadequate informed consent<br>• Inadequate maintenance | • Appropriate risk assessment<br>• Comprehensive planning<br>• Personalized treatment protocols<br>• Informed consent<br>• Guided surgery when appropriate<br>• Prosthetically driven placement<br>• Continued maintenance & close monitoring<br>• Personalized supportive therapy protocols | 17, 22, 52, 70, 72, 100 - 105 114 - 117 |

**Table 1(contd): Iatrogenic risks across clinical dentistry – An ethical stewardship perspective**

| Clinical discipline | Typical iatrogenic risk (harm) | Underlying cause(s) | Preventive strategies | Refs |
|---|---|---|---|---|
| **Prosthodontics** | • Pulpal trauma<br>• Occlusal dysfunction, food impaction & retention,<br>• Prosthetic & TMJ complications,<br>• Dysesthesia (phantom bite syndrome)<br>• Aesthetic dissatisfaction<br>• Functional dissatisfaction<br>• Prosthetic failure<br>• Marginal leakage & Restoration/prosthesis failure | • Inadequate informed consent<br>• Excessive preparation<br>• Poor impressions/ intra-oral scanning<br>• Inaccurate occlusion<br>• Inadequate follow-up maintenance | • Conservative tooth preparation<br>• Precise digital/conventional workflows<br>• Occlusal verification, regular follow-up & maintenance & supportive care | 80, 84, 106, 117 |
| **Orthodontics** | • Apical root resorption<br>• Enamel demineralization<br>• White spot lesions<br>• Periodontal recession<br>• Tooth devitalization<br>• Periodontal damage | • Excessive force<br>• Prolonged treatment<br>• Inadequate oral hygiene facilitated by orthodontic appliances<br>• Inadequate monitoring and adjustment | • Controlled biomechanics<br>• Regular monitoring<br>• Preventive oral hygiene programmes,<br>• AI-driven dynamic orthodontic treatment management | 118 – 127 |
| **Paediatric Dentistry** | • Altered tooth development<br>• Pulpal injury<br>• Dental fluorosis<br>• Post-traumatic dental care anxiety (PTDA)<br>• Behavioural trauma | • Poor diagnosis<br>• Overtreatment<br>• High-concentration fluoride varnish, gels & mouthrinses<br>• Inappropriate behaviour management<br>• Traumatic dental experience | • Child-centered care,<br>• Minimally invasive, preventive philosophy<br>• Parental engagement | 20, 128, 129 |
| **Oral Medicine & Oral pathology** | • Delayed diagnosis of serious disease<br>• Medication-related harm<br>• Xerostomia<br>• Gingival hyperplasia<br>• Dysgeusia<br>• Candidiasisa | • Failure to recognise pathology<br>• Delayed referral<br>• Inadequate medical assessment<br>• Microbial dysbiosis<br>• Epithelial toxicity<br>• Immune mediated reaction | • Early recognition<br>• Biopsy/ referral when indicated<br>• Multidisciplinary collaboration | 26, 130 |
| **Dental Radiology** | • Missed pathology,<br>• Overdiagnosis & overtreatment<br>• Unnecessary radiation exposure<br>• Ionizing radiation, | • Inappropriate imaging selection<br>• Interpretation errors<br>• Radiographic artifacts,<br>• False positive diagnosis | • Optimize radiation safety protocols- ALARA/ALADA principles<br>• Justification of imaging,<br>• Continuous training in interpretation<br>• Regular radiographic monitoring & early detection of complications<br>• Use alternative ionizing radiation-free modalities (ultrasonography) | 26, 71, 73, 82, 131-135 |

**Table 1(contd): Iatrogenic risks across clinical dentistry – An ethical stewardship perspective**

| Clinical discipline | Typical iatrogenic risk (harm) | Underlying cause(s) | Preventive strategies | Refs |
|---|---|---|---|---|
| **Occlusion & TMJ Management** | • Chronic pain<br>• Occlusal instability<br>• Irreversible tooth alteration | • Misdiagnosis<br>• Unnecessary occlusal adjustment<br>• overtreatment | • Comprehensive functional assessment<br>• Reversible therapies first<br>• Evidence-based management | 84, 136, 137 |
| **Pharmacology** | • Adverse drug reactions<br>• Antibiotic resistance<br>• Medical emergencies (toxicity, allergy, systemic effects)<br>• Antimicrobial resistance, bleeding in anticoagulated patients<br>• Infections in immune-suppressed patients<br>• Osteonecrosis in patients taking antiresorptive drugs<br>• Thromboembolic events & haemorrhagic risks<br>• Systemic toxicity<br>• Medication-related osteonecrosis of the jaw (MRONJ) | • Inappropriate prescribing, use and misuse of antibiotics, drug interactions<br>• Inadequate medical history, local anaesthesia<br>• Polypharmacy | • Antimicrobial stewardship<br>• Medication review<br>• Evidence-based prescribing<br>• Medical consultation when required<br>• Pharmacovigilance | 26, 58, 78, 111, 138 - 152 |
| **Infection Prevention Control** | • Cross-infection<br>• Waterborne microbial diseases | • Sterilisation failures<br>• Poor compliance with protocols<br>• Inadequate infection control<br>• Contaminated dental unit waterlines | • Strict infection-control standards<br>• Sterilisation monitoring<br>• Waterline management<br>• Staff training | 21, 138, 153, 154 |
| **Procedural Safety Protocols** | • Ophthalmological complications<br>• Pathological fracture<br>• Fractured needle<br>• Ingestion or inhalation of foreign objects (teeth fragments, burs, endodontic files | • Procedural-related, errors, mishaps<br>• Non-adherence to safety protocols | • Strict adherence to safety protocols<br>• Eye protection<br>• Rubber dan<br>• Anatomical awareness | 155, 156 |
| **Digital Dentistry & Artificial Intelligence** | • Misdiagnosis<br>• Under- & overdiagnosis<br>• Ill-fitting restorations<br>• Overtreatment<br>• Detached & mechanistic dentist-patient relationship | • Non-use of CBCT<br>• Inaccurate digital data<br>• Software limitations<br>• Automation bias<br>• Over-reliance on AI | • Verification of digital outputs<br>• Clinician oversight<br>• Calibration<br>• Continuous education | 43, 157 - 159 |

**Table 1(contd): Iatrogenic risks across clinical dentistry – An ethical stewardship perspective**

| Clinical discipline | Typical iatrogenic risk (harm) | Underlying cause(s) | Preventive strategies | Refs |
|---|---|---|---|---|
| **Dental Materials** | • Allergenic & cytotoxicity risk<br>• Restoration failure and secondary decay<br>• Foreign body reaction | • Residual monomer (incomplete polymerization) composite resins<br>• 3D printing resin-based material<br>• Allergy to latex, acrylic, local anaesthetics, metal alloys, dental amalgam<br>• Polymerization shrinkage & microleakage<br>• Bovine bone xenograft | • Evidence-based oversight and use | 62, 105 160 - 163 |
| **Administrative processes, Maintenance & recall** | • Disease recurrence<br>• Unmet expectations<br>• Patient dissatisfaction | • Inadequate risk assessment,<br>• Poor communication<br>• Inadequate consent<br>• Incomplete records<br>• Poor follow-up<br>• Generic recall intervals<br>• Patient values & preferences | • Individualised recall schedules<br>• Risk-based maintenance<br>• Minimally invasive monitoring<br>• Early intervention<br>• Education<br>• Documentation<br>• Shared decision-making | 26, 70, 72, 75, 82, 83<br><br>100, 117, 164 |

Iatrogenic harm resulting in dental patient safety incidents can occur across preoperative, intraoperative, and postoperative stages, with the majority occurring intraoperatively.[26] A study analysing base root-cause of iatrogenic harm identified pain, nerve injury, hard tissue injury (e.g., tooth perforation), and soft tissue injury (e.g., lacerations) as the most common harmful adverse events (AEs).[165] The most frequent contributing factors to harmful adverse events included person (training, supervision, fatigue), patient (noncompliance, low health literacy), and professional-professional collaboration.[165] Perea-Pérez and co-workers classifies adverse events in dentistry, which are related to iatrogenic risks, into three categories: errors (40%), complications (40%), and accidents (20%).166 High-risk dental fields that were most associated with unnecessary harm to patients, were implant dentistry first, followed by endodontics, oral surgery, prosthodontics, and orthodontics. [166]

Across all disciplines, several recurring themes underpin preventable harm. (**Table 2**). Across every discipline, iatrogenic harm most commonly arises from four interconnected factors:

1. Errors in clinical judgement (diagnosis and treatment planning).
2. Excessive or insufficient intervention (failure to achieve the appropriate balance).
3. Technical and procedural shortcomings (execution of care).
4. Failure to preserve biological integrity (healthy tissues, host response, and the oral microbiome).

This reinforces a fundamental principle of ethically responsible dentistry. The goal of excellent clinical care is not simply to treat disease successfully, but to achieve the greatest possible health benefit while causing the least possible biological harm. This principle encapsulates the modern shift from a procedure-centred model of care to one of biological stewardship, where preservation of natural tissues, maintenance of ecological balance, and long-term patient wellbeing become the primary measures of clinical success.

## The intervention paradox of iatrogenic harm

The intervention paradox recognises that every treatment intended to improve health simultaneously introduces new biological and procedural risks with the potential to cause unintended harm. While technical excellence has advanced considerably, many iatrogenic complications or adverse events arise not from inadequate skill but from clinical decision-making, overtreatment, cognitive bias, fragmented care, and failure to respect biological systems.

This intervention paradox lies at the heart of ethically responsible dentistry – 'failure to treat disease may allow its progression, while unnecessary or overly aggressive treatment may initiate a cycle of cumulative biological damage'. Every restoration removes irreplaceable tooth structure, every periodontal procedure alters supporting tissues, every extraction sacrifices a natural organ, every indiscriminate prescription has the potential to influence the oral microbiome, immune response, or systemic health, and overtreatment driven by technological enthusiasm and profit rather than patient need. Each intervention consumes

**Table 2: Recurring themes and clinical impact associated with iatrogenic harm**

| Theme | Clinical Impact | References |
|---|---|---|
| **Poor diagnosis/ Misdiagnosis (Diagnostic iatrogenesis)** | Wrong, delayed, or missed treatment | 65, 167 - 169 |
| **Excessive intervention, overtreatment (Procedural iatrogenesis)** | Loss of healthy tissues and overtreatment | 66 – 69, 81, 85, 93 |
| **Technical errors (Procedural iatrogenesis)** | Procedural complications and failures | 170, 171 |
| **Biological disruption (Biological iatrogenesis)** | Pulpal, periodontal, occlusal and microbial imbalance | 79, 172 - 174 |
| **Human factors (Professional iatrogenesis)** | Communication failures, shared decision-making, failure to obtain informed consent, fatigue and cognitive bias, poor record keeping, profit before patient benefit | 24, 66, 67, 91 |
| **Inadequate monitoring & maintenance (Administrative iatrogenesis)** | Early detection of complications, recurrence of disease and restoration failure, patient reported treatment outcome | 70, 82, 94, 117, 122, 164 |
| **Medication & Local anaesthesia-related harm (Systemic iatrogenesis) (Pharmacological iatrogenesis)** | Adverse reactions and antimicrobial resistance<br>Medical complications | 139, 152,<br>175 – 178 |
| **Insufficient patient-centered care (Administrative iatrogenesis)** | Inadequate treatment planning, failure to educate, Lack of early referral, reduced adherence, and dissatisfaction, failure to follow-up and maintain care. | 75, 80, 164 |

biological capital by removing tissues, altering host-microbial relationships or exposing patients to cumulative risk.

Although these interventions are often clinically justified, each represents a biological cost that must be balanced against its anticipated benefit. The ethical challenge is therefore not simply deciding how to treat, but whether, when, and to what extent treatment is truly necessary. The optimal therapeutic pathway lies between the extremes of undertreatment and overtreatment, guided by accurate diagnosis, individual risk assessment, minimally invasive principles, and long-term biological preservation.[16]

In this context, clinical success is measured not by the number or sophistication of procedures performed, but by achieving the greatest possible improvement in oral health while preserving healthy tissues, maintaining ecological balance, and minimising avoidable iatrogenic harm. This principle reinforces the philosophy of minimally invasive dentistry, where preserving healthy tissues and supporting natural biological adaptation frequently provide superior long-term outcomes compared with increasingly aggressive intervention.

## Clinical Decision-Making: Where Most Harm Begins

Many adverse outcomes originate long before treatment commences. Making choices is a challenging undertaking - Diagnostic reasoning and clinical judgement largely determine whether appropriate interventions are selected.[43,179,180]

Cognitive biases—including anchoring, confirmation bias, availability bias and premature diagnostic closure—may distort clinical reasoning despite excellent technical skills.[181,182] Similarly, failure to consider patient expectations and preferences, systemic health, long-term prognosis or uncertainty may result in inappropriate treatment decisions. [43]

More treatment is not always better treatment. Healthcare systems often reward activity - More procedures, more technology and more intervention. Furthermore patients may equate intervention with quality, therefore clinicians may feel compelled to act. Yet one of the most difficult professional decisions is deciding not to intervene. Sometimes careful monitoring is the most ethical treatment.

Decisions regarding prescribing medications, probiotics

and antimicrobial mouthrinses should be individualized according to patient-specific risk factors, underlying medical conditions, and the available clinical evidence, particularly among immunocompromised patients. Drug interaction monitoring requires coordinated communication among health care professionals regarding the potential for microbiome-mediated alterations in medication efficacy and safety.

Medications and systemic conditions impact directly and indirectly on dental caries and periodontal disease risk and progression. Xerostomia inducing medications and systemic conditions such as diabetes alter salivary function and microbial balance, resulting in dysbiosis, increasing susceptibility and risk and the potential for iatrogenic harm. Therefore incorporating medical history in risk assessment enables targeted prevention, optimized risk management, and improved treatment outcomes.[183]

High-quality decision-making requires[1] deliberate reflection, comprehensive risk assessment, shared decision-making and willingness to reconsider initial assumptions. Structured diagnostic pathways, multidisciplinary consultation and continuous professional education further reduce cognitive error. Ultimately, the quality of treatment rarely exceeds the quality of the clinical judgement that precedes it.

## Ethical Stewardship: A New Clinical Paradigm

The fundamental ethical principle on 'Non-maleficence' (do no harm) is the foundation of safe delivery of dental care, placing an obligation on dentists to avoid harm and protect patients from risks, which is directly relevant to iatrogenic risks and harm.[2,3,4,18,91]

Although the traditional ethical principle of non-maleficence ("do no harm") remains fundamental, it is insufficient for contemporary dentistry. Dentistry is unique because almost every intervention (procedure) intentionally alters healthy or diseased tissues in pursuit of a better clinical outcome.

- Every bur removes irreplaceable enamel.
- Every extraction removes a functioning organ.
- Every periodontal procedure alters supporting tissues.
- Every implant or prosthesis replaces a biological structure with an artificial one.
- Every prescription influences the patient's microbiome and immune system.

Dentistry being complex and manual, has a high risk for iatrogenic harm, error and mishaps, and refusal to acknowledge this vulnerability compromises patient safety and limits professional performance.[37] Therefore, modern practice demands active ethical stewardship—a proactive commitment to "actively minimise avoidable harm" while maximising patient benefit.

Ethical stewardship integrates the fundamental ethical principles of beneficence, non-maleficence, patient autonomy and justice into everyday clinical decision-making. It encourages minimally invasive treatment, preservation of healthy tissues, evidence-based interventions, transparent communication and shared decision-making that respects patients' values and informed preferences. Importantly, stewardship extends beyond individual procedures to encompass responsible use of antibiotics, biomaterials, radiation exposure and healthcare resources. It recognises that clinicians are custodians not only of oral tissues but also of patients' long-term biological wellbeing.

The prevention of iatrogenic harm extends beyond technical proficiency to the ethical responsibility of making judicious clinical decisions that maximise patient benefit while minimising biological cost. Ethical stewardship represents a paradigm shift from procedure-centred care to the preservation of the patient's biological capital, recognising that healthy tooth structure, pulpal vitality, periodontal attachment, alveolar bone, oral microbiome homeostasis, and functional integrity are finite resources that should be conserved whenever possible.

Every clinical intervention should therefore be justified by a favourable balance between anticipated benefit and potential harm, guided by the principles of beneficence, non-maleficence, patient autonomy, and evidence-based practice.[18,184] This approach requires clinicians to ask not only – "Can this procedure be performed?" but more importantly, "Can prevention replace intervention?" "Should it be performed, is it necessary now, and is there a less invasive alternative?" , and "Will the benefit outweigh the biological cost?"

Ethical stewardship promotes comprehensive diagnosis, shared decision-making, minimally invasive treatment, antimicrobial stewardship, and long-term maintenance as the foundations of ethically responsible care. Rather than measuring success solely by procedural outcomes or technological sophistication, this paradigm defines excellence by the preservation of healthy tissues, support of biological resilience, maintenance of ecological balance within the oral microbiome, and sustainable improvements in oral health and quality of life. In an era of rapidly advancing




*Figure 2: Ethical stewardship framework : A Five-Step Clinical Checklist for Preventable Iatrogenic Harm*




*Figure 3: Clinical red Flags for Preventable Iatrogenic Harm: Early Recognition, Timely Intervention and Continuous Learning*

technologies and expanding therapeutic options, the highest standard of dental practice is achieved not by doing more, but by consistently exercising the knowledge, restraint, and clinical judgement required to intervene only when the expected long-term benefits clearly outweigh the risks of iatrogenic harm. Dental practitioners have a duty to minimize the risks to their patients, which includes refraining from harming the patient and choosing the lesser of two harms when some level of harm is unavoidable in treatment.[2]

## A Five-Step Ethical Stewardship Framework for Preventing Iatrogenic Harm (Risk)

Preventing iatrogenic harm requires five questions before every intervention (**Figure 2**). The core question at every stage is focussed on: "Will this decision improve long-term health while preserving the patients biological capital?" Where biological capital includes:

- Health tooth structure
- Pulp vitality
- Periodontal attachment
- Alveolar bone
- Oral microbiome balance
- Functional dentition
- Patient well-being and quality of life

Clinical decisions should progress through five sequential stages, visualised in **Figure 2**:

The key clinical decision rules are:

**Step 1**: Think and justify before you intervene. Confirm that treatment is genuinely necessary and supported by evidence.[66–69,84,85,91,92,110,134]

**Step 2:** Assess risks comprehensively before you act. Evaluate patient factors, systemic health, biological complexity, operator competence and procedural risk.[16,52,72,91,92]

**Step 3:** Preserve biological function to minimise biological cost. Conserve healthy tissues, protect the oral microbiome, minimise inflammation and favour minimally invasive approaches wherever possible.[68,80,81,84,85,93,185]

**Step 4:** Execute with precision. Careful planning, effective communication, meticulous technique, appropriate documentation and adherence to evidence-based protocols reduce procedural complications.[70,82,186-193]

**Step 5:** Periodic review of treatment outcomes and maintenance. Early recognition of complications, structured follow-up, outcome auditing and reflective practice transforms adverse events into opportunities for continuous quality improvement.[52,70,71,82,83,91,94,117,122]

This framework promotes patient-centered evidence-based care while preserving healthy tissues, supporting the oral ecosystem resilience, and reducing avoidable iatrogenic harm. (**Figure 3**)

The safest dental intervention is not necessarily the most conservative or the most advanced – it is the intervention that delivers the greatest long-term health benefit with the least biological cost. Together these principles create a culture of patient safety that extends beyond individual procedures to the entire continuum of care.

## Future Directions

Future strategies for reducing iatrogenic harm will increasingly integrate precision medicine, systems biology and digital

technologies. Artificial intelligence may assist diagnosis, risk prediction and clinical decision support, while personalised treatment planning based on genetic, microbial and systemic health profiles promises more individualised care.

However, technology and AI cannot replace professional judgement or ethical responsibility. Algorithms lack the contextual understanding, empathy and moral reasoning required for patient-centred decision-making. Instead, technological innovations should augment clinicians' ability to make safer, more informed and biologically respectful treatment decisions. Developing AI assisted models learning healthcare systems that continuously evaluate outcomes and incorporate emerging evidence will further strengthen patient safety.

## Conclusion

Iatrogenic harm remains one of the most important yet under-recognised challenges in contemporary dentistry. As treatment options become increasingly sophisticated, opportunities for preventable harm inevitably expand. Improving patient safety therefore requires more than technical excellence; it demands sound clinical judgement, biological understanding, ethical stewardship and continuous professional reflection.

The true challenge of iatrogenic risk in dentistry is not simply avoiding technical mistakes. It is recognising that every intervention carries a biological cost, and that this cost may accumulate silently over a patient's lifetime. The most ethically responsible clinician is therefore not the one who performs the greatest number of technically flawless procedures, but the one who consistently exercises sound judgement, preserves healthy tissues, respects biological systems, and intervenes only when the anticipated benefits clearly outweigh the inevitable biological consequences.

This perspective shifts the profession from a paradigm of intervention to one of ethical stewardship. In that paradigm, the highest standard of care is not measured by what the clinician is capable of doing, but by the wisdom to know when less treatment achieves more health. Such a philosophy does not diminish the value of modern dentistry; rather, it elevates it by aligning technical excellence with ethical responsibility, long-term biological preservation, and patient-centred care. By embracing evidence-based decision-making, minimally invasive principles and systems-oriented thinking, dental practitioners can substantially reduce preventable harm while strengthening professional accountability and patient trust.

## Acknowledgement:

ChatGPT (OpenAI, San Francisco, CA, USA) was used during manuscript development to assist with conceptual structuring, section organisation, and language refinement. The tool was not used to generate original data, perform literature searches, or determine interpretations. All scientific content, analysis, referencing, and final editorial decisions were independently developed, reviewed, and approved by the author, who assumes full responsibility for the manuscript. The conceptual figures were developed by the author through an iterative design process with the assistance of ChatGPT (OpenAI) as a visualisation and language-support tool. The author conceived the underlying scientific framework, directed all figure development, critically evaluated and revised each illustration, and accepts full responsibility for the scientific content, clinical interpretation and final presentation.

## References

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