Review

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Review

Informed Consent in Artificial Intelligence-Augmented Dentistry: Clinical Care, Research, and the Dentist–Patient–AI Relationship: A Scoping Review

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Abstract

Artificial intelligence (AI) is increasingly integrated into dental diagnostics, treatment planning, documentation, and research. While ethical principles such as transparency and accountability are widely discussed, there is limited synthesis of how informed consent should be conceptualized and operationalized within the evolving dentist–patient–AI relationship. This scoping review aimed to map existing evidence on informed consent in AI-augmented dentistry and dental research, identify conceptual and practical gaps, and propose a structured framework to support ethically robust implementation; Methods: PRISMA-ScR guidelines was followed with review question formulated using the Population–Concept–Context (PCC) framework. A systematic search was conducted in PubMed, Web of Science, and ClinicalKey, complemented by grey literature screening; Results: From 2624 identified records, 30 studies were included after screening. The literature consistently emphasized disclosure of AI involvement, clarification of clinician accountability, communication of algorithmic limitations and bias, and separation between clinical and research consent. Based on thematic synthesis, we propose the ACCOUNT-AI framework, comprising structured domains addressing AI role clarification, clinician accountability, contextual differentiation, operational risks, secondary data governance, adaptive consent design, and transparency across the AI lifecycle. The framework integrates clinical use, research applications, and regulated data reuse as components of a unified accountability model; Conclusions: Informed consent in AI-augmented dentistry requires adaptation from traditional bilateral models to a triadic dentist–patient–AI framework grounded in human professional accountability. Standardized, context-sensitive consent structures are needed to ensure transparency, protect patient autonomy, and support ethically responsible AI integration in both clinical care and research.

Keywords: artificial intelligence; informed consent; dentistry; clinical decision support; dental research; bioethics; data governance; dentist–patient relationship

1. Introduction

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Artificial intelligence (AI) is rapidly transforming clinical practice across medicine and dentistry, with applications spanning diagnostic imaging, clinical decision support (CDS), natural language processing (NLP), automated documentation, and patient-facing digital health tools. In dentistry, AI-enhanced systems have demonstrated high diagnostic performance in radiographic interpretation—such as caries detection, periodontal bone loss assessment [1], CBCT segmentation and cephalometric landmark identification [2]—as well as in procedural planning, including implant placement and orthodontic treatment simulation [3–8]. In parallel, large language models (LLMs), ambient AI scribes, and conversational agents are increasingly being integrated into electronic health record (EHR) systems to support clinical documentation, workflow optimization, and patient communication, while mobile health (mHealth) applications and chatbots aim to assist with symptom triage, education, and self-management [9–12]. Despite the accelerating adoption of these technologies, there remains a critical gap in understanding how AI reshapes foundational elements of dental practice—particularly informed consent and the evolving dentist–patient–AI relationship [13,14].

Informed consent is a cornerstone of ethical healthcare practice, grounded in respect for patient autonomy, adequate understanding of risks and benefits, and shared decision-making [15]. Traditional consent frameworks are grounded in a bilateral interaction between clinician and patient, relying on the transparent communication of clinical information and the clinician's professional judgment. However, the introduction of AI as a third actor—whether visible (e.g., CDS systems, chatbots, AI-generated recommendations) or invisible (e.g., backend imaging algorithms influencing clinician interpretation)—fundamentally challenges this model. While existing literature in dentistry and medicine has addressed general ethical principles related to AI, such as transparency, accountability, explainability, and fairness [4,16–18], and has proposed high-level checklists or guidance for AI-related consent [19], no narrative or systematic review has yet explicitly examined informed consent through the lens of a dentist–patient–AI triad.

An emerging and largely overlooked dimension of AI integration in dentistry is the increasing use of generative AI and patient-facing health advisors by patients themselves for symptom interpretation, self-medication, and preliminary treatment planning prior to professional consultation. Such AI-mediated "preconsultation" decision-making has the potential to reshape patient expectations and autonomy, raising important questions about the validity and ethical robustness of informed consent in AI-augmented dental care.

Moreover, the literature has insufficiently explored how AI alters the structure, meaning, and practical execution of informed consent within routine dental workflows.

A further and increasingly consequential challenge is the growing mismatch between the speed of scientific and technical advancement in AI and the slower evolution of regulatory, legal, and professional governance frameworks. While AI systems are rapidly moving from research prototypes to real-world clinical deployment, regulatory guidance regarding their appropriate use, transparency requirements, liability attribution, and documentation standards remains fragmented, incomplete, or reactive rather than anticipatory [20–22]. In dentistry, this regulatory lag is particularly evident for emerging AI applications such as adaptive learning systems, LLM-based decision support, ambient scribes, and patient-facing conversational agents, many of which operate outside traditional medical device paradigms.

An additional and often underexplored dimension concerns informed consent for AI research, particularly when clinical data are reused for algorithm development, validation, or continuous learning. A conceptual distinction must be made between consent for the secondary use of patient data in AI research and model training and consent for the use of AI systems in clinical decision-making. Consent for data use—typically embedded within research protocols, institutional review board (IRB) approvals, or privacy notices—does not necessarily ensure that patients understand how their data contribute to AI model development, potential future reuse, data sharing across institutions, or the evolving nature of learning systems. Nor does it imply that patients are aware of, or agree to, downstream clinical deployment of AI tools trained on such data. In dentistry, where

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imaging datasets, intraoral scans, photographs, and salivary biomarkers or behavioral data, among others, are leveraged for AI research, this distinction becomes particularly salient and ethically consequential [12].

Conversely, informed consent in the context of AI-augmented clinical care must address the role of AI in diagnosis, risk prediction, treatment planning, documentation, and patient communication. It must also clarify the limits of AI performance, the presence of uncertainty, and the locus of responsibility for clinical decisions.

Emerging phenomena such as automation bias—where clinicians may over-rely on AI outputs—overthrust, in which patients may attribute excessive authority to algorithmic recommendations, and deskilling, reflecting the potential erosion of clinician expertise through sustained dependence on AI systems, further complicate the ethical landscape [23–25]. These dynamics raise critical questions about whether consent that is formally obtained is also ethically meaningful, particularly when AI influences decisions in opaque or indirect ways.

Current ethical and regulatory discussions frequently remain at the level of abstract principles and lack actionable frameworks tailored to dental practice and research contexts. There is a clear need for a conceptual and practical model of informed consent that explicitly incorporates the dentist–patient–AI triad and accounts for the heterogeneity of AI applications in dentistry, and AI-driven screening or population-health initiatives. Such a model must recognize a continuum ranging from "invisible AI," fully mediated by clinician judgment, to direct patient–AI interactions that may precede or bypass clinician involvement.

Accordingly, this review explores how informed consent processes in dentistry may need to evolve, addressing:

- explicit communication of AI's role in clinical reasoning, documentation, and research;
- clear statements regarding clinician oversight and ultimate decision-making responsibility;
- differentiation between consent for AI research and consent for AI-assisted clinical care; and
- the potential utility of dynamic or tiered consent models reflecting varying degrees of AI involvement.

Finally, although preliminary studies suggest that AI-generated consent documents may improve readability and completeness in certain clinical contexts [26–28], it remains unclear whether such approaches enhance or undermine patient understanding, trust, and the therapeutic alliance in dental care. This scoping review therefore aims to synthesize existing evidence on informed consent in AI-augmented dentistry and dental research, identify conceptual and practical gaps, and propose a structured framework to support ethically robust implementation of AI in both clinical and research settings. Figure 1 graphically summarizes the overarching aims of this scoping review, illustrating the integrative pathway from evidence synthesis to framework development for informed consent in AI-augmented dentistry.

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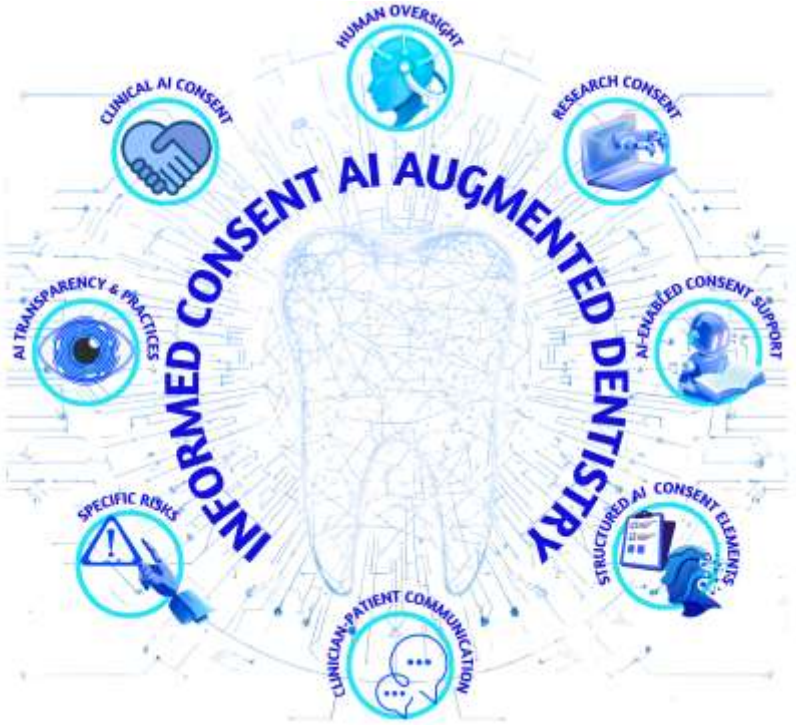

Figure 1. Conceptual framework of informed consent in AI-augmented dentistry, emphasizing that human oversight and clinician–patient communication remain the central ethical and legal anchors, ensuring that artificial intelligence functions as a transparent decision-support tool within both clinical care and research contexts rather than as an autonomous decision-maker.

2. Materials and Methods

This scoping review was conducted in accordance with the PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines [29] and was registered with the Open Science Framework (OSF) 10.17605/OSF.IO/U9Y67 (accessed on 21.02.2026). The review question was formulated using the Population–Concept–Context (PCC) framework, focusing on dental patients, dental clinicians, and dental research participants (Population); informed consent and ethical, legal, and relational implications of artificial intelligence (Concept); and AI-augmented dental care and dental research settings (Context).

A systematic literature search was performed in PubMed, Web of Science, and ClinicalKey, complemented by a grey literature search in Google Scholar. Reference lists of the included studies were also manually reviewed to identify additional relevant publications. Search terms combined controlled vocabulary and free-text keywords related to artificial intelligence, dentistry, and informed consent. The search strategy in the three main databases is provided in Anex 1.

2.1. Eligibility Criteria

2.1.1. Inclusion Criteria

Studies, reports, or documents were eligible for inclusion if they met all of the following criteria:

Population / Stakeholders: dental patients, dental clinicians (e.g., general dentists, specialists, dental radiologists, oral surgeons), or participants in dental research; studies addressing patient–clinician–AI interactions in dentistry.

Concept: Informed Consent and AI: Explicit discussion of informed consent, patient information, autonomy, transparency, or shared decision-making in the context of AI; ethical, legal, or governance implications of AI use in clinical dentistry or dental research. Consent for Clinical AI Research (added explicitly): Articles addressing consent for AI research, including: secondary use of dental data (imaging, intraoral scans, photographs, salivary or behavioral data); consent for

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algorithm training or continuous learning systems; governance of AI research under GDPR, EU AI Act, WHO, or equivalent frameworks; IRB/ethics committee considerations for AI-based dental research.

Context: AI-Augmented dentistry or dental research: AI applications in dentistry, including but not limited to: diagnostic imaging (e.g., OPT, CBCT, caries detection); clinical decision support systems (CDS); AI-assisted treatment planning; ambient AI scribes or automated clinical documentation; patient-facing AI tools (chatbots, mHealth, wearables); AI systems used for research purposes, including model development, validation, training, or secondary data use; settings encompassing clinical care, academic dentistry, or dental AI research environments.

Types of Sources: Peer-reviewed journal articles (original research, reviews, ethical analyses); legal or regulatory documents (e.g., GDPR, EU AI Act, policy statements); professional guidelines or position papers (e.g., WHO, FDI); Relevant grey literature (white papers, authoritative reports).

Language and Timeframe: publications written in English, published from January 2015 to January 2026, reflecting contemporary AI applications in dentistry.

2.1.2. Exclusion Criteria

Studies or documents were excluded if they met any of the following criteria: lack of relevance to dentistry; AI studies conducted exclusively in medicine or healthcare without dental applicability; engineering or computer science papers with no discussion of clinical, ethical, or consent implications; absence of informed consent or ethical dimension; articles describing AI performance, accuracy, or technical development without reference to: informed consent, patient communication, ethical, legal, or governance considerations; studies focused solely on algorithm architecture, training performance, or validation metrics; AI benchmarking or simulation studies without patient involvement or ethical discussion; AI applications unrelated to clinical dental care or dental research (e.g., administrative AI without patient interaction); educational AI tools without patient data or consent implications; opinion pieces without ethical analysis; editorials, commentaries, or opinion articles lacking substantive ethical, legal, or conceptual analysis of informed consent; full texts unavailable for review. Robotic surgical systems performing autonomous operative procedures without a primary focus on informed consent in dental AI-assisted decision-making were excluded, as they represent a distinct technological and ethical domain beyond the scope of this review.

All references identified through database were imported into Zotero reference management software (Zotero, Corporation for Digital Scholarship, USA), and duplicate records were identified and removed before the screening process.

Titles and abstracts were screened for relevance by two reviewers (M. T. and C. M. C.) using the Rayyan platform (https://www.rayyan.ai/ accessed on 28.01.2026). Any discrepancies were resolved through discussion and consensus, followed by full-text review of the selected records.

Data were charted using a clinician-oriented extraction framework designed to capture consent elements directly relevant to dental practice, including disclosure of AI involvement, clinician oversight, AI-specific risks, data governance, and distinctions between clinical and research consent.

The PRISMA-ScR checklist and the detailed search strategies for the main databases (PubMed, Web of Science, and ClinicalKey) are provided as Supplementary materials.

3. Results

A total of 2,624 articles were initially identified through searches of three primary databases, and two additional eligible articles were retrieved from Google Scholar. As illustrated in Figure 2, after the removal of duplicates and completion of title/abstract screening and full-text eligibility assessment, 28 articles from the main databases and 2 from website sources were included, resulting in a total of 30 studies. The inter-rater reliability between the two reviewers during the screening process was excellent (ICC = 0.95).

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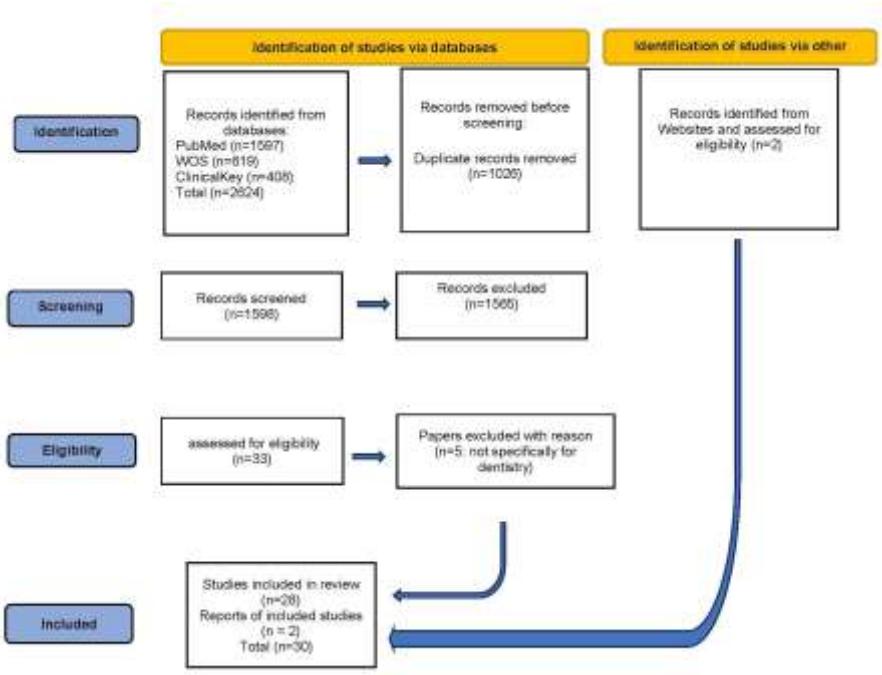

Figure 2. PRISMA 2020 flow diagram illustrating the study selection process for this scoping review.

Table 1 presents a clinician-oriented synthesis of the essential informed consent elements reported in the included literature on AI-augmented dentistry. The table organizes evidence across key domains relevant to dental practice, including disclosure of AI involvement, professional responsibility, AI-specific risks, consent structure, and patient understanding. This synthesis provides a practical overview of consent requirements that may inform the development and implementation of AI-adapted consent forms in dental settings.

Table 1. Clinician-oriented synthesis of the essential informed consent elements reported in the included literature on AI-augmented dentistry.

Domain	Key Consent Element	What Must be Communicated to the Patient (Dentist / Oral Surgeon Perspective)	Clinical & Ethical Relevance	Key References
AI Disclosure Practices	Disclosure of AI involvement	Explicitly inform the patient when AI contributes to diagnosis, treatment planning, imaging interpretation, documentation, or decision support	Prevents hidden automation and supports informed decision-making	Roganović (2024) [19,30]; Rokhshad et al. (2023) [31]; Rokhshad et al. (2024) [32]
	Nature of AI output	Explain whether AI outputs are deterministic or probabilistic, and whether the system is validated or experimental	Sets realistic expectations and mitigates overreliance	Roganović (2024) [30]; Rokhshad et al. (2023) [31]
	Documentation of disclosure	Record AI disclosure in the clinical file, including AI role and clinician review	Supports medico-legal traceability	Roganović (JADA 2024)
Clinician Accountability & Oversight	Final responsibility	Clearly state that the dentist retains ultimate clinical responsibility for decisions	Reinforces professional	Rokhshad et al. (2024) [32]; Ducret et al. (2024) [33]

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			accountability and legal clarity	
	Human oversight	Confirm that AI outputs are reviewed and may be overridden by the clinician	Prevents automation bias and unsafe delegation	Weerakoon et al. (2025) [34]; Ducret et al. (2024) [33]
	Clinician competence	Ensure the clinician understands AI system limits and performance	Ethical obligation to avoid misuse of AI	Rokhshad et al. (2024) [32]
Clinical Care vs. Research Consent	Separate consent pathways	Distinguish consent for AI-assisted clinical care from consent for AI research	Prevents ethical conflation of care and research	Shah (2024) [35]; Brinz et al. (2025) [36]; Roganović (2024) [30]
	Secondary data use	Explicit opt-in required for reuse of clinical data in AI training or validation	GDPR and research ethics compliance	Shah (2024) [35]; Brinz et al. (2025) [36]
	Data protection	Inform patients about anonymization, de-identification, and privacy safeguards	Addresses data governance concerns	Brinz et al. (2025) [36]
AI-Specific Risks	Algorithmic bias	Explain that AI may perform differently across populations or clinical contexts	Supports fairness and risk awareness	Rokhshad et al. (2023) [31]; Ducret et al. (2024) [33]
	Diagnostic errors	Disclose risks of false positives/negatives and model limitations	Aligns AI risks with conventional clinical risk disclosure	Pethani (2021) [37]; Rokhshad et al. (2023) [31]
	Explainability limits	Inform patients when AI decisions are not fully interpretable	Ethical transparency requirement	Ducret et al. (2024) [33]
	Right to refuse AI	Offer non-AI alternatives where feasible	Preserves patient autonomy	Rokhshad et al. (2023) [31]
Consent Formats	Structured AI consent elements	Include AI role, benefits, risks, clinician oversight, and data use	Standardizes AI disclosure across dental practice	Rokhshad et al. (2023) [31]; Roganović (2024) [30]
	Tiered / layered consent	Adapt depth of explanation to level of AI involvement and risk	Improves comprehension without overburdening patients	Rokhshad et al. (2024) [32]; Roganović (2024) [30]
	AI-specific acknowledgment	Use a separate checkbox or signature line for AI use	Makes AI consent explicit and auditable	Rokhshad et al. (2023) [31]
Patient Understanding & Trust	Communication quality	Clinician explanation strongly influences patient trust in AI	Maintains therapeutic alliance	Roganović et al. (2023) [38]; Weerakoon et al. (2025) [34]
	Clinician confidence	Dentist uncertainty about AI undermines patient understanding	Highlights need for professional training	Rokhshad et al. (2023) [31]

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	Monitoring understanding	Assess patient comprehension during early implementation	Moves beyond formalistic consent	Weerakoon et al. (2025) [34]
AI-Generated Consent Documents	Use of AI to draft consent	AI-generated consent may improve readability but lacks validation	Prevents uncritical reliance on AI-generated text	Shah (2024) [35]; Brinz et al. (2025) [36]
	Mandatory human review	AI-drafted consent must be reviewed and approved by a clinician	Ensures ethical and legal accuracy	Brinz et al. (2025) [36]
	Data provenance	Protect patient data used in generating consent text	Prevents secondary misuse of sensitive data	Shah (2024) [35]

To further contextualize these findings, Table 2 maps consent requirements according to the clinical, research, and hybrid contexts in which AI systems are deployed in dentistry.

Table 2. Context-dependent consent requirements for AI use in dentistry.

AI Context	AI Role	Consent Focus	Consent Requirements	Key References
Routine clinical care (low-risk AI)	Administrative support, image enhancement, scheduling	Transparency	General disclosure of AI use; no separate written consent required	Rokhshad et al. (2023) [31]; Ducret et al. (2024) [33]
Clinical decision support (moderate risk)	Diagnostic suggestions, treatment planning assistance	Autonomy & oversight	Explicit disclosure of AI role, limitations, and clinician responsibility; inclusion in written consent	Roganović (2024) [30]; Rokhshad et al. 2023
High-impact clinical AI	AI significantly influences diagnosis or treatment decisions	Risk & accountability	Explicit, documented consent; explanation of AI uncertainty, bias, and alternatives; right to refuse AI	Roganović (2024) [30]; Ducret et al. (2024) [33]
Hybrid care–research AI	Deployed AI still undergoing validation or learning	Dual-purpose transparency	Disclosure of developmental status; separate explanation of care vs research functions	Roganović (2024) [30]; Brinz et al. (2025) [36]
AI-based research	Model training, validation, algorithm development	Research ethics	Separate research consent; purpose, data use, withdrawal rights, data sharing	Shah (2024) [35]; Brinz et al. (2025) [36]
Secondary data use	Retrospective data reuse for AI improvement	Data governance	Explicit opt-in consent; explanation of anonymization and sharing	Brinz et al. (2025) [36]; Roganović (2024) [30]
Dynamic / learning AI systems	Continuous model updating	Ongoing autonomy	Tiered or dynamic consent; possibility to modify preferences over time	Roganović (2024) [30]; Rokhshad et al. (2024) [32]
AI-generated consent tools	AI assists consent drafting or explanation	Meta-consent	Mandatory human review; disclosure of AI-generated content	Shah (2024) [35]; Brinz et al. (2025) [36]

Based on the thematic synthesis of included studies, we propose the ACCOUNT-AI Framework (Table 3), a structured, operational model for informed consent in AI-augmented dentistry that integrates clinical care, AI research, and secondary data reuse under a unified human-accountability paradigm.

The framework is organized into seven structured domains, designed to be directly translatable into consent documentation and clinical workflows.

Table 3. The ACCOUNT-AI Framework: Structured Domains and Consent Requirements for AI-Augmented Dentistry in Clinical Care and Research.

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ACCOUNT-AI Framework	Framework Domain	Required Patient Disclosure and Consent Elements	Purpose and Ethical Justification
A	AI Role Clarification (Functional Transparency)	Patients must be clearly informed: • Whether AI is used in diagnosis, treatment planning, documentation, or risk prediction • Whether AI outputs are assistive, probabilistic, or deterministic • Whether the AI system is validated, adaptive, or still under refinement	This domain addresses hidden automation and prevents algorithmic opacity in clinical reasoning.
C	Clinician Accountability and Oversight	Consent must explicitly state that: • The dentist retains ultimate decision-making authority • AI outputs are reviewed and may be overridden • Responsibility for clinical outcomes remains human	This reinforces that AI functions as a decision-support instrument, not an autonomous agent.
C	Context Differentiation (Care vs. Research vs. Hybrid Use)	Consent must clearly distinguish between: • AI use for direct patient care • AI use within research protocols • Hybrid systems (clinical tools undergoing validation or continuous improvement)	Separate or tiered consent pathways are recommended to avoid conflating treatment with experimentation.
O	Operational Risks and Limitations	Patients should be informed of AI-specific risks, including: • False positives/false negatives • Algorithmic bias • Explainability limits • Automation bias risks • System performance variability	This aligns AI disclosure with traditional risk–benefit communication in dentistry.
U	Use and Reuse of Data (Secondary Data Governance)	Consent should clarify: • Whether clinical data (radiographs, CBCT, intraoral scans, photographs, e.g.,) may be reused for AI development • Whether reuse is anonymized or pseudonymized • Whether data may be shared across institutions • Whether patients may opt-in or opt-out	Reuse of high-quality clinical data contributes to improving AI accuracy, robustness, bias mitigation, and clinical safety by enabling model validation, recalibration, and population representativeness.
N	Navigable and Adaptive Consent Structure	Consent should be structured using: • Tiered or layered explanations • AI-specific acknowledgment sections • Dynamic consent options for continuous-learning systems	This ensures proportionality between AI impact and disclosure burden.
T	Transparency Across the AI Lifecycle	Structurally integrate: • Disclosure • Data reuse • Continuous learning • Performance recalibration • Governance oversight	This domain consolidates the triadic dentist–patient–AI model by ensuring that AI systems operate within defined

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	accountability boundaries. Transparency across the lifecycle transforms data reuse into an ethically governed feedback loop that enhances system reliability while preserving patient autonomy and trust.

The ACCOUNT-AI framework proposed is grounded in a triadic dentist–patient–AI structure, with human oversight as the normative center. AI operates within clearly defined accountability boundaries, while transparency across the AI lifecycle ensures that patients are informed not only about the system's role in decision-making but also about its development, validation, data reuse, and potential continuous learning.

Within this structure, secondary data reuse functions as a regulated feedback loop: responsibly governed reuse of clinical data enables algorithm validation, recalibration, bias mitigation, and population representativeness, thereby enhancing diagnostic accuracy and safety over time. Transparency regarding this process transforms data reuse from a purely privacy concern into an ethically justified mechanism for improving clinical reliability and decision quality.

Thus, accountability anchors decision-making, transparency safeguards autonomy, and structured data stewardship supports the iterative refinement of AI systems within ethically defined limits.

4. Discussion

This scoping review demonstrates a clear and persistent gap between the rapid integration of artificial intelligence into dental practice and the development of robust, operationalized informed consent frameworks. While the ethical necessity of informed consent for AI-augmented dentistry is widely acknowledged across the literature [19,30,31,39,40], most publications remain conceptual, offering high-level ethical principles without providing concrete guidance for clinical implementation. Transparency, autonomy, accountability, and data protection are repeatedly emphasized as foundational values [39]; however, their translation into actionable consent processes suitable for routine dental care remains limited and inconsistent.

The evidence mapped in this review indicates that informed consent in AI-augmented dentistry is currently fragmented, variably interpreted, and often inadequately adapted to the unique characteristics of AI systems. In particular, the literature highlights deficiencies in standardized terminology, clarity regarding clinician responsibility, differentiation between clinical care and research consent, and communication of AI limitations and uncertainty [30,31,33,38]. These shortcomings risk reducing consent to a formalistic exercise rather than a meaningful process that supports patient understanding and trust.

4.1. Informed Consent Beyond Disclosure: From Ethical Principles to Clinical Practice

A central finding of this review is that informed consent for AI in dentistry cannot be reduced to simple disclosure of AI use. Traditional consent models, developed for stable, human-driven clinical interventions, are poorly suited to AI systems that may operate probabilistically, evolve over time, and rely on large-scale data processing [7,9,22]. Although many studies emphasize the ethical obligation to inform patients when AI is involved in their care, few specify what information is

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essential, how it should be communicated, or how clinician oversight should be documented in practice.

Several authors argue that consent processes must explicitly address the AI system's role in clinical reasoning, the nature of its outputs, and its limitations, including potential bias and uncertainty [12,30,33,41]. Importantly, the literature converges on the principle that dentists must retain ultimate responsibility for AI-assisted decisions, even when AI systems significantly influence diagnostic or treatment recommendations [33,40]. However, how this responsibility is exercised, communicated, and recorded remains insufficiently defined, creating ambiguity for both clinicians and patients.

4.2. Clinical Care Versus Research: A Persistent Ethical Fault Line

One of the most significant challenges identified in this review is the blurred boundary between AI-assisted clinical care and AI-based research. While traditional ethical frameworks draw a clear distinction between treatment and research, AI systems frequently occupy a hybrid space, particularly when clinical data are reused for algorithm training, validation, or continuous improvement [36,42]. The literature consistently emphasizes that consent for clinical care does not automatically authorize secondary data use for AI development and that separate or tiered consent mechanisms are ethically preferable [19,30].

Despite this consensus, practical solutions for managing dual-purpose data use in dental practice remain underdeveloped. Regulatory frameworks such as GDPR and the EU AI Act [43] impose transparency and consent requirements but offer limited dental-specific guidance on how to operationalize these obligations [36]. As a result, dentists may unknowingly rely on inadequate consent processes, exposing patients to unrecognized data uses and undermining trust in AI-assisted care.

4.3. Emerging Consent Models: Promise Without Validation

The review identifies growing interest in adaptive consent models—particularly tiered, layered, dynamic, and risk-based approaches—as potential solutions to the limitations of traditional consent frameworks [19,30,44]. These models aim to tailor consent requirements to the level of AI involvement and risk, thereby balancing patient autonomy with clinical practicality. Tiered consent allows patients to choose different levels of AI participation or data sharing, while layered consent seeks to improve comprehension by presenting information progressively [19,28].

Dynamic consent, enabled by digital platforms, offers ongoing patient control over data use and consent preferences, which is particularly appealing for continuously learning AI systems [44]. However, the evidence base supporting these approaches in dentistry is largely theoretical. Empirical studies evaluating feasibility, patient understanding, clinician workload, and long-term impact on trust are notably absent. As such, while these models are conceptually attractive, their real-world applicability in busy dental practices remains uncertain.

4.4. Patient Understanding, Trust, and the Dentist–Patient–AI Relationship

Patient understanding and trust emerge as central, yet underexplored, dimensions of informed consent in AI-augmented dentistry. Several studies suggest that transparency about AI use can strengthen trust when accompanied by clear clinician explanation and reassurance of human oversight. Conversely, inadequate communication or overreliance on AI may erode the dentist–patient relationship, particularly if patients perceive AI as replacing human judgment.

Moreover, despite the expanding literature regarding AI's applications in dentistry, just a few authors emphasize the necessity of disclosing potential conflicts of interest to ensure transparency and maintain patient trust in artificial intelligence (AI) [45]. However, empirical studies evaluating the integration of such disclosures into the informed consent process remains absent. While transparency is recognized as essential for maintaining patient trust in AI-driven tools, the absence

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of data regarding conflicts of interest disclosure represents a critical research gap. This deficiency carries significant/profound ethical and legal implications for patient autonomy and the integrity of AI-assisted clinical decision-making.

Notably, the literature reveals that clinician uncertainty about AI systems directly affects the quality of consent communication [12,19]. If dentists lack confidence in explaining how AI works, its limitations, and its role in decision-making, meaningful patient understanding is unlikely. This finding underscores the importance of professional education and training as a prerequisite for ethically sound consent processes, rather than an optional adjunct to technological adoption [38].

4.5. AI-Generated Consent Documents: A Recursive Ethical Challenge

An emerging and particularly complex issue identified in this review is the use of AI itself to generate or assist consent documents. Preliminary studies suggest that AI-generated consent materials may improve readability and completeness; however, empirical evidence regarding their safety, acceptability, and impact on patient understanding remains extremely limited [26,46]. The use of AI to explain AI introduces a recursive ethical challenge, raising questions about accuracy, accountability, and transparency.

The literature consistently cautions against uncritical reliance on AI-generated consent without human review and oversight [46]. From an ethical perspective, patients should be informed not only about AI use in their care but also about AI involvement in the consent process itself. This highlights the need for what has been described as higher-order or meta-level consent governance, in which patients can express preferences regarding how consent decisions are made and managed over time.

4.6. Implications for Dental Practice and Policy

Taken together, the findings of this review suggest that informed consent for AI-augmented dentistry must evolve from a static, document-centered process to a dynamic, relationship-centered practice. Dentists should be supported by clear professional guidelines, standardized consent elements, and practical communication tools that reflect the realities of AI-assisted care. Regulatory frameworks provide an important foundation, but dental-specific implementation guidance remains urgently needed.

From a policy perspective, the absence of standardized consent frameworks risks variability in practice, legal uncertainty, and erosion of patient trust. The development of consensus-based consent models, informed by empirical research and aligned with evolving regulations, represents a critical next step for the dental profession.

The ACCOUNT-AI framework proposed in this review directly responds to the fragmentation identified in the literature by translating abstract ethical principles into structured, operational consent domains. By integrating AI role clarification, clinician accountability, contextual differentiation, operational risk disclosure, secondary data governance, adaptive consent design, and lifecycle transparency, the framework provides a coherent structure capable of accommodating both current AI applications and emerging continuous-learning systems. Importantly, it reframes secondary data reuse not solely as a privacy concern but as a governance-regulated mechanism for improving algorithmic calibration, bias mitigation, and diagnostic accuracy. In doing so, the framework seeks to align patient autonomy with collective clinical benefit while preserving the centrality of human professional responsibility within the dentist–patient–AI relationship.

4.7. Human Accountability in AI-Augmented Dental Care: Implications for Informed Consent

A late 1970s statement attributed to IBM — “A computer can never be held accountable, therefore a computer must never make a management decision” — remains strikingly relevant in the era of artificial intelligence in healthcare. While contemporary AI systems far exceed the computational capabilities of earlier technologies, the ethical premise underlying this statement persists: AI systems cannot bear moral, professional, or legal responsibility for clinical decisions.

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In AI-augmented dentistry, algorithms may analyze radiographs, predict caries risk, recommend orthodontic treatment plans, or stratify patients for implant success. However, AI outputs remain advisory tools rather than autonomous decision-makers. Accountability for diagnosis, treatment planning, and patient outcomes remains with the licensed dental professional (Figure 3). This distinction is not merely technical but foundational for informed consent.

Figure 3. Human Accountability in AI-Augmented Dental Care: Implications for Informed Consent.

4.8. Review Limitations

This scoping study is limited by language restrictions to English publications, the predominance of conceptual rather than empirical studies, and the inherent methodological constraints of scoping reviews, which map existing evidence but do not formally assess study quality or provide quantitative synthesis.

4.9. Future Directions

This review highlights several priorities for future research, including empirical studies on patient preferences and understanding, comparative evaluations of different consent models, and implementation research in real-world dental settings. Particular attention should be paid to vulnerable populations, health literacy, and equity, as AI systems and consent processes may differentially affect diverse patient groups.

Ultimately, informed consent in AI-augmented dentistry should be understood not merely as a regulatory obligation but as a core expression of patient-centered care. As AI becomes increasingly embedded in dental practice, the profession has both an ethical responsibility and a practical imperative to ensure that consent processes are meaningful, transparent, and responsive to the evolving dentist–patient–AI relationship.

Emerging fully autonomous robotic interventions may introduce additional consent complexities, but these fall outside the present review's focus on AI-augmented clinical decision support and data-driven systems.

5. Conclusions

In conclusion, this scoping review identifies a persistent gap between the rapid integration of artificial intelligence into dental practice and the development of operationalized, context-sensitive informed consent structures. While transparency, clinician accountability, and respect for patient

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autonomy are consistently recognized as foundational principles, their practical translation into structured consent processes remains fragmented and inconsistent.

The evidence supports a transition from a traditional bilateral clinician–patient model toward a structured triadic dentist–patient–AI framework grounded in explicit human oversight and lifecycle transparency. In response to the conceptual heterogeneity identified in the literature, this review proposes the ACCOUNT-AI framework, which operationalizes informed consent into seven structured domains encompassing AI role clarification, clinician accountability, contextual differentiation between care and research, AI-specific risk disclosure, secondary data governance, adaptive consent formats, and transparency across the AI lifecycle.

Importantly, responsible secondary data reuse—when governed transparently and ethically—may contribute to improving algorithmic calibration, bias mitigation, and diagnostic accuracy, thereby enhancing clinical safety. However, empirical validation of consent models in real-world dental settings remains limited. Future research should prioritize implementation studies, patient comprehension assessment, clinician education, and evaluation of dynamic consent mechanisms to ensure that informed consent in AI-augmented dentistry remains meaningful, ethically robust, and firmly anchored in human professional responsibility.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org. Supplementary material 1 - Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist; Supplementary material 2 – Search strategy.

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Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial intelligence
CDS	Clinical decision support
NLP	Natural language processing
CBCT	Cone Beam Computed Tomography
LLM	Large language models
EHR	Electronic health record
mHealth	mobile health
OSF	Open Science Framework
PCC	Population–Concept–Context
GDPR	General Data Protection Regulation
EU	European Union
FDI	World Dental Federation
WHO	World Health Organization
IRB	Institutional review board

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