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# Oral Health Data Integration into Electronic Health Records (EHR): Opportunities and Challenges in Interoperability

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## ABSTRACT

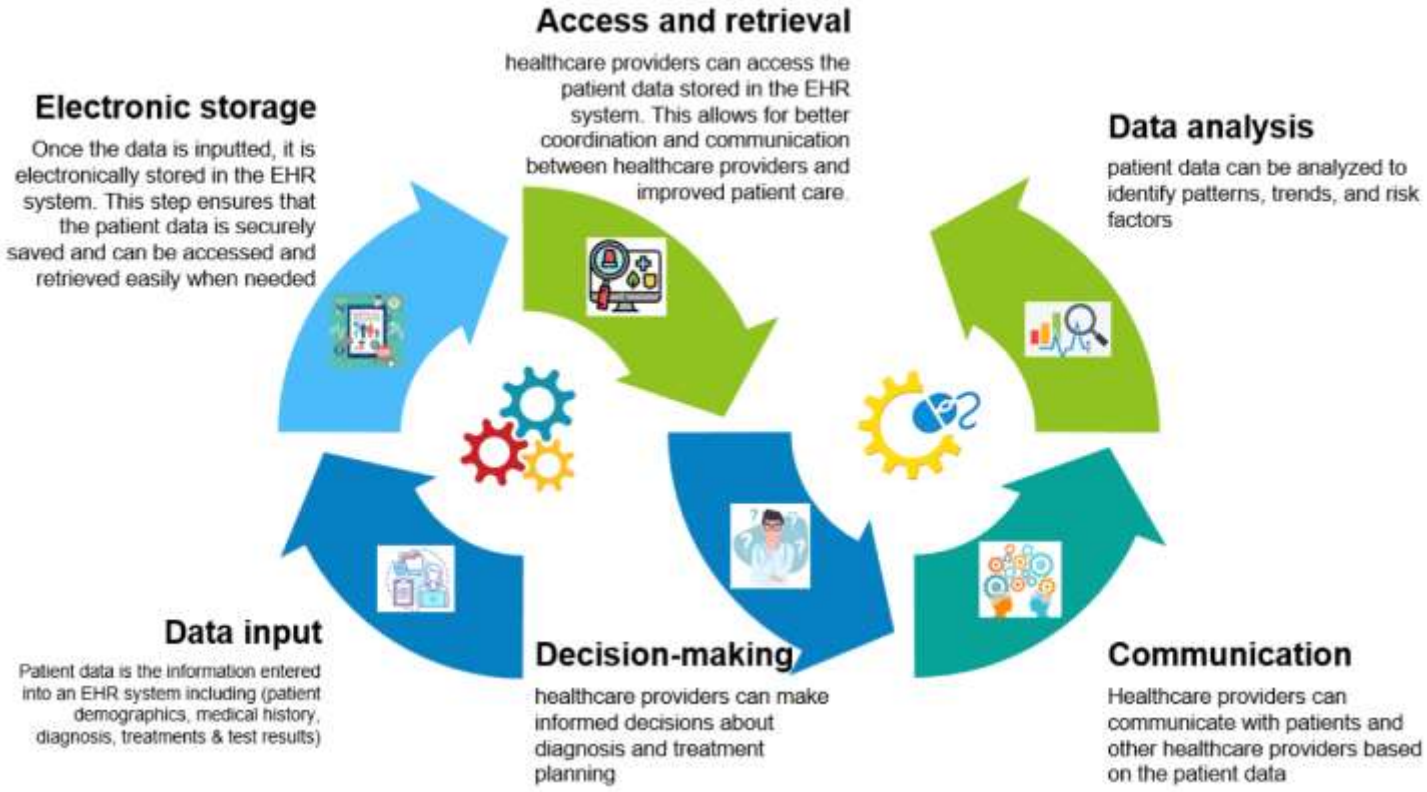
**The integration of oral health data into electronic health records (EHRs) presents a vital opportunity to advance comprehensive patient care by bridging the gap between dental and general health information systems. While EHRs have transformed the storage and exchange of medical data, the inclusion of dental records has lagged due to a lack of interoperability, differing clinical terminologies, and siloed data infrastructures. This paper investigates the potential benefits, barriers, and technical challenges associated with incorporating oral health data into EHRs. Drawing on existing literature, early implementation models, and interoperability standards, the study explores how integrated EHRs can improve diagnostics, treatment planning, and continuity of care. Particular attention is given to the challenges in data standardization, semantic harmonization, and provider workflows. The findings emphasize the need for collaborative policy development, unified health IT standards, and system architecture alignment to fully leverage integrated care delivery.**

## KEYWORDS

**Oral health, Electronic Health Records, Interoperability, Health IT, Dental informatics, Data integration, Semantic interoperability, Clinical workflows**

## INTRODUCTION

The role of oral health in systemic wellbeing is increasingly acknowledged across the medical community. Conditions such as diabetes, cardiovascular diseases, and adverse pregnancy outcomes have established links with poor oral health. Yet, despite these associations, oral health data remains largely disconnected from the broader healthcare ecosystem, particularly within electronic health records (EHRs). EHRs have revolutionized healthcare delivery through improved accessibility, record-keeping, and communication among stakeholders.



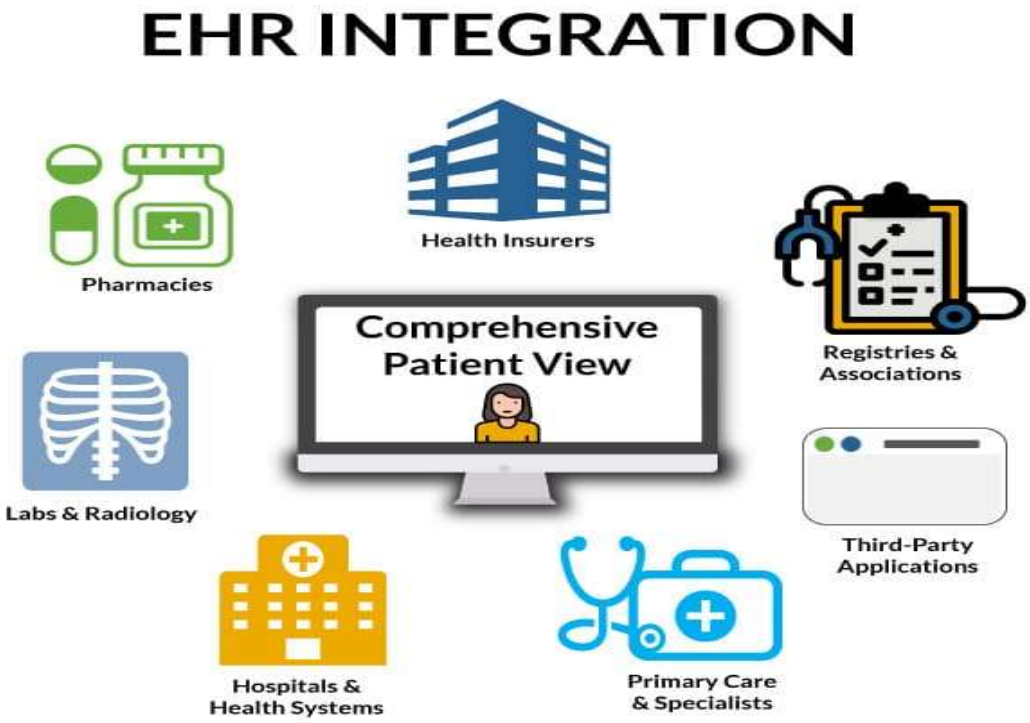

***Source: https://www.mdpi.com/2227-9032/11/12/1762***

However, the integration of dental and oral health data into EHRs remains an underexplored and underutilized dimension of comprehensive patient care.

The health informatics landscape has focused heavily on the interoperability of general medical data, often sidelining dentistry due to its historically isolated IT systems and distinct clinical documentation standards. The exclusion of oral health records from EHRs limits the potential of coordinated care and leads to information silos, redundant testing, and fragmented treatment plans. For example, a physician unaware of a patient's periodontal status may miss systemic inflammatory connections, which could otherwise inform treatment for comorbid conditions.

This paper investigates the technical, operational, and systemic dimensions of integrating oral health data into EHR systems. It aims to outline the potential benefits of this integration, including improved patient safety, holistic treatment, and data-driven decision-making. The manuscript also examines the structural barriers such as incompatible data schemas, lack of consensus on standardized vocabularies (e.g., SNODENT, LOINC, and ICD), and divergent workflow models between dental and medical practices. By understanding these challenges and

exploring the current state of interoperability initiatives, the study aims to chart a practical path forward for inclusive, integrated healthcare records.




***Source: https://www.smartlinkhealth.com/resources/ehr-integration-definitive-guide/***

## LITERATURE REVIEW

### 1. Importance of Integrating Oral Health with Primary Care

The importance of integrating oral health with primary care has been emphasized by several public health entities. The U.S. Surgeon General's Report on Oral Health described oral diseases as a "silent epidemic" and advocated for the recognition of oral health as a component of overall health. A systematic review by Mouradian et al. (2003) illustrated how early diagnosis of systemic conditions is possible through oral examinations, thereby reinforcing the need for integrated medical-dental data systems.

Incorporating dental data into EHRs supports continuity of care and fosters bidirectional communication between physicians and dentists. Studies such as by Beazoglou et al. (2004) have noted that integrated health records could help identify patterns in systemic-dental relationships, such as correlations between periodontal disease and

diabetes mellitus. The fragmentation of care caused by the current separation of medical and dental records stands in the way of these insights.

**2. The Current State of Dental Informatics Systems**

Dental practices typically use stand-alone dental software such as Dentrix, Eaglesoft, and Open Dental. These systems were primarily developed for practice management and billing, not for interoperability or data sharing with EHRs. In contrast, general medical records are increasingly governed by HL7 standards and use integration mechanisms such as Continuity of Care Documents (CCDs). These fundamental differences in data architecture, coding systems, and application programming interfaces (APIs) create obstacles to seamless integration.

Further complicating integration is the limited use of standardized dental terminologies. The Systematized Nomenclature of Dentistry (SNODENT) and the Dental Diagnostic System (DDS) are two notable efforts in standardizing dental vocabulary. However, their adoption remains inconsistent across dental institutions. Without a shared semantic framework, EHR systems cannot easily interpret or utilize dental data.

**3. Interoperability Standards and Efforts**

Health Level 7 (HL7), Fast Healthcare Interoperability Resources (FHIR), and Clinical Document Architecture (CDA) have formed the backbone of medical data exchange. While HL7 has released dental-specific extensions, they are not widely adopted. Efforts by the Integrating the Healthcare Enterprise (IHE) initiative have aimed at harmonizing dental and medical IT systems, yet implementations have remained limited due to infrastructure and cost constraints.

Some integrated health delivery systems, such as Kaiser Permanente and the Veterans Health Administration (VHA), have made early progress in integrating dental data with broader EHR systems. For example, VHA has implemented a limited but functional integration using VistA, allowing primary care providers to access dental records as part of comprehensive care planning.

**4. Technical Barriers to Integration**

From a technical perspective, one of the foremost challenges lies in mapping dental data to standardized formats. The lack of consensus on which dental terminologies to adopt—ICD vs. SNODENT vs. CDT—impairs automated translation and exchange. Further, many dental software systems lack application programming interfaces (APIs) compatible with HL7 or FHIR, necessitating expensive middleware or custom development.

Another key issue is data granularity. Dental data often includes image-heavy content such as radiographs and intraoral scans, which are storage-intensive and require specialized viewers and storage solutions not typically present in medical EHRs. As a result, even if integration is achieved on a textual level, it may exclude critical clinical imagery.

**5. Operational and Human Factors**

In addition to technical hurdles, operational challenges such as differences in workflows, documentation practices, and care delivery models hinder integration. Dental practitioners may not see the value in entering data into a broader EHR, particularly when reimbursement incentives are not aligned with integrated reporting. Similarly, medical professionals may not be trained to interpret dental information and may not use it even when available.

Furthermore, the user interface of EHRs is a common source of frustration among clinicians. Poorly designed interfaces reduce the likelihood of accurate data entry and utilization. When EHR systems attempt to incorporate dental data without adapting to dental workflows, they risk increasing the burden on providers rather than streamlining care.

**6. Policy and Regulatory Landscape**

While various U.S. federal programs, such as the Health Information Technology for Economic and Clinical Health (HITECH) Act, promoted EHR adoption in medical settings, dental providers were largely excluded from these initiatives. As a result, dental practices have lower EHR adoption rates and lack financial incentives for integration.

However, policy shifts are underway. The Patient Protection and Affordable Care Act (ACA) emphasized pediatric dental coverage as part of essential health benefits, pushing for some degree of interoperability. Additionally, organizations such as the Office of the National Coordinator for Health IT (ONC) have called for inclusion of dental records in the broader health information exchange (HIE) ecosystem.

## METHODOLOGY

This research adopts a qualitative and exploratory methodology focused on synthesizing existing literature, implementation case studies, and policy documents related to oral health-EHR integration. The study design includes three core phases: systematic literature selection, thematic coding, and synthesis.

**1. Literature Collection and Inclusion Criteria**

A systematic search of peer-reviewed journals, government health IT policy papers, and white papers was conducted using databases such as PubMed, Scopus, and IEEE Xplore. Keywords included "oral health interoperability," "dental EHR integration," "SNODENT," "health information exchange," and "clinical data standards." Only documents published prior to August 2016 were included.

**2. Thematic Coding Approach**

The selected literature was coded based on emergent themes such as:

- Technical interoperability standards
- Adoption barriers
- Clinical workflow impact
- Benefits of integrated EHR
- Data vocabulary and structure challenges
- Case study insights from integrated health networks

Using NVivo software, thematic clustering and frequency analysis were performed to identify dominant barriers and opportunities.

**3. Case Study Analysis**

In addition to literature review, case-based insights were drawn from:

- The Veterans Health Administration (VHA) integration strategy
- Kaiser Permanente's shared health IT ecosystem
- University-based pilot programs evaluating SNODENT and HL7 CDA

These cases were evaluated to determine practical success metrics, limitations, and replicability potential across other healthcare systems.

**4. Expert Interviews (Secondary Data)**

The research drew upon published expert interviews and roundtable discussions available from organizations such as HIMSS, ADA, and ONC to understand on-ground sentiment and adoption resistance.

## RESULTS

The results derived from the synthesis of literature and case studies indicate the following patterns and outcomes in integrating oral health data into EHR systems:

### 1. Identified Opportunities

| Category | Opportunities Observed |
|---|---|
| Clinical Decision Support | Improved diagnosis via shared data (e.g., diabetes–periodontitis link) |
| Patient Engagement | Shared records enable continuity and informed choices |
| Public Health Surveillance | Better tracking of oral-systemic comorbidities |
| Reduced Redundancy | Eliminated repeat imaging or lab work due to record fragmentation |
| Billing and Insurance Alignment | Potential for unified claims across medical and dental fields |

The use of interoperable formats like HL7 CDA and SNODENT for structured dental records showed promise when piloted in academic environments and health systems with internal IT control.

### 2. Challenges Identified

| Challenge Type | Specific Issues Identified |
|---|---|
| Technical Barriers | Lack of standard APIs between EHRs and dental software; lack of image interoperability |
| Vocabulary Incompatibility | SNODENT and CDT not aligned with ICD or LOINC; coding ambiguity for shared conditions |
| Workflow Misalignment | Medical EHR systems not adaptable to dental-specific procedures |
| Policy Exclusion | Lack of dental incentives in Meaningful Use; absence from HITECH funding |
| Training Deficits | Medical professionals unsure how to interpret dental indicators |

In case studies from the VHA and Kaiser Permanente, structured integration using custom-developed middleware allowed partial inclusion of dental data. However, efforts remained limited to text-based data; rich media formats (radiographs, intraoral scans) continued to be stored separately.

### 3. Stakeholder Sentiment

Across professional associations and provider-level documentation, the sentiment toward integration was cautiously optimistic. While providers appreciated the vision of holistic care, operational burdens and training needs often dampened enthusiasm for implementation. Many dentists were concerned that EHR modifications would disrupt established workflows.

**4. Semantic Gaps and Data Fragmentation**

Semantic dissonance between medical and dental record systems was a major finding. For instance, the same oral lesion could be coded differently under SNODENT and ICD-10, making automated mapping error-prone. Furthermore, dental EHRs often stored notes as unstructured free text, limiting the potential for data reuse in clinical analytics or decision support.

## CONCLUSION

Integrating oral health data into EHRs is a critical yet underrealized advancement in patient-centered care. The literature and case analysis indicate that while technical and policy-level frameworks for interoperability exist, they remain underutilized in the dental domain. The benefits of such integration are clear—ranging from improved diagnostic coordination to enriched population health management. However, realization of these benefits is contingent on overcoming entrenched barriers in data standards, workflow harmonization, and provider training.

To enable successful integration, health systems must commit to adopting dental-friendly interoperability standards such as HL7 CDA, SNODENT, and FHIR extensions tailored for oral health. Policymakers must revise funding models and incentive programs to include dental practices. Furthermore, EHR vendors must collaborate with dental software providers to build robust APIs and shared data models. Only through coordinated technical, institutional, and regulatory efforts can the vision of a unified health record that includes oral health be fully achieved.

Integrated care is no longer a futuristic goal—it is an immediate necessity for delivering safe, effective, and equitable healthcare. Oral health, being a foundational element of overall wellness, deserves to be at the center of this integration strategy.

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