

Chair Time Is Access Time: Governed Artificial Intelligence, the CLEAR-Dent Framework and the Recovery of Dental Care Capacity for Underserved Americans

Fábio Luiz Ferreira da Silva

Specialist in Implant Dentistry, University Ibirapuera; São Paulo, SP, Brazil.
ORCID: 0009-0008-3735-7579 | Corresponding author's Email: paviolba75@gmail.com

Caroline Weinert Marçal

Specialist in Implant Dentistry, Instituto de Ensino Superior Blauro Cardoso de Mattos, Serra, ES, Brazil;
ORCID: 0009-0001-8786-7613

Luiz Augusto Ferreira de Medeiros

MBA in administration, PIO XII, Vitória, ES, Brazil;
ORCID: 0009-0000-5085-5849

Sabrina Gonella

PhD in Pediatric Dentistry, São Leopoldo Mandic, São Paulo, SP, Brazil;
ORCID: 0000-0002-8861-6496

Luciana Reinhardt

Graduated in Dentistry, Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil;
ORCID: 0009-0002-0625-0898

Yasmin Figueiredo Lacerda

Graduated in Dentistry, Federal University of Campina Grande – UFCG, Patos, PB, Brazil;
ORCID: 0009-0008-7348-0072

Luis Fernando Ferreira da Silva

Specialist in Orthodontics and dentofacial orthopedics, São Paulo, SP, Brazil;
ORCID: 0009-0004-3460-8222

Aline Colli de Lima Calniel

Graduated in Dentistry, University Positivo, Curitiba, PR, Brazil;
ORCID: 0009-0001-9232-3389

Abstract:

Background: U.S. dental clinics operate under a double constraint. On the supply side, 7,443 dental Health Professional Shortage Areas cover 63.7 million people, only 32.93% of dental need is met, and 91% of dentists recruiting hygienists describe it as very or extremely challenging. On the cost side, administrative complexity is the largest single category of waste in U.S. health care, estimated at US\$265.6 billion a year. Artificial intelligence (AI) is often presented as the answer, but most clinics adopt it tool by tool, without a management framework, governance or outcome measurement.

Materials and Methods: Narrative health-management review of PubMed-indexed studies on AI in appointment management, clinical documentation and diagnostic support; documentary analysis of federal frameworks (NIST AI Risk Management Framework, the Section 1557 rule on patient care decision support tools, ONC HTI-1) and of national dental workforce and expenditure data; integration of a series of recent IOSR-JBM studies on U.S. dental management; and an illustrative capacity-recovery model.

Results: Machine-learning no-show models reach areas under the curve of 0.72–0.76, but lack external validation. In a randomized trial, an ambient AI scribe reduced documentation time by 9.5%, and pilots report lower burnout. Diagnostic AI raised dentists' caries sensitivity from 0.72 to 0.81 but also increased invasive treatment decisions, leaving cost-effectiveness uncertain. On these grounds, the article proposes the CLEAR-Dent framework (Capacity, Ledger, Encounter, Assisted diagnosis, Reach), with a governance layer aligned with NIST AI RMF and federal anti-discrimination rules, a five-level maturity model and a balanced scorecard. If AI recovered two hours per week for 50,000 dentists, the freed time would equal about 2,875 full-time clinicians, or 26.8% of the national shortage-area deficit.

Conclusion: AI creates value in dental clinics only when it is managed as an operational system with governance and measurable targets. Used this way, it can act as an 'invisible hygienist', returning clinical time to underserved patients — a contribution of national importance.

Key Word: Dental practice management; Artificial intelligence; Management framework; AI governance; NIST AI RMF; Workforce shortage; Health Professional Shortage Areas; Administrative waste.

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I. Introduction

The U.S. dental care system spent US\$189 billion in 2024, 3.6% of all national health expenditure, according to CMS data analyzed by the American Dental Association Health Policy Institute ¹. Yet the system remains unable to reach a large part of the population. As of December 31, 2025, the Health Resources and Services Administration (HRSA) recorded 7,443 dental Health Professional Shortage Areas (HPSAs) affecting about 63.7 million people, with only 32.93% of dental need met and 10,744 additional practitioners required to close the gap ². Two-thirds of dental HPSAs are rural, while more than 98% of dental specialists practice in urban areas ².

The shortage is felt inside the clinic as much as on the map. In April 2026, only 60% of U.S. dentists reported having enough dental hygienists, and 91% of those recruiting described the search as very or extremely challenging, even though hygiene program enrollment rose 16% between 2020 and 2025 ³. More than one-third of practicing dentists are aged 55 or older, dental graduates carry average debts close to US\$300,000, and federal loan changes taking effect in July 2026 threaten the financing of future cohorts ⁴. At the same time, the business environment is shifting: the share of dentists affiliated with dental service organizations (DSOs) more than doubled between 2015 and 2024 ⁵, and practice finances remain exposed to fee-for-service reimbursement pressures, low Medicaid fees and Medicare's exclusion of routine dental care ⁶.

Across the U.S. health system, administrative complexity is the largest single category of waste, estimated at US\$265.6 billion a year ⁷, and administrative simplification has been estimated to offer savings of a similar order ⁸. Dental clinics carry their share of this burden through scheduling, insurance verification, claims, prior authorization, documentation and regulatory compliance — tasks that consume the time of the same scarce professionals who should be treating patients.

Artificial intelligence is increasingly offered as the solution. AI tools now support scheduling, marketing, claims processing, documentation and radiographic diagnosis ^{9,10}. However, adoption is fragmented: practices buy individual tools, rarely measure their effect and seldom apply formal governance. This article argues that the decisive variable is not the algorithm but the management system around it. Its objectives are (i) to synthesize the evidence on AI in the operational and clinical domains of the dental clinic, (ii) to propose an integrated management and governance framework for U.S. dental clinics, and (iii) to estimate the clinical capacity that well-managed AI could return to the national system. It builds on a series of recent studies on U.S. dental management covering geographic gaps and entrepreneurship ², workforce shortage ⁴, corporate consolidation ⁵, payment models ⁶ and strategic leadership ¹¹.

II. Material And Methods

Design. Narrative health-management review with documentary policy analysis and an illustrative capacity model. The design suits a field in which evidence is spread across dentistry, medical informatics, health economics and federal regulation, and in which the research question concerns organizational design rather than a single clinical effect.

Sources. PubMed was searched for studies on machine learning for appointment no-shows, ambient AI scribes and clinical documentation, AI-supported radiographic diagnosis, natural language processing and federated learning in dentistry, and AI in dental practice management. Systematic reviews and randomized trials were prioritized, and studies reporting null, mixed or unfavorable effects were retained. Federal frameworks were analyzed from primary sources: the NIST AI Risk Management Framework ¹², the Section 1557 regulation on patient care decision support tools ¹³ and the ONC HTI-1 final rule ¹⁴. National workforce and spending data

came from HRSA via a recent IOSR-JBM analysis ², the ADA Health Policy Institute ^{1,3} and the JAMA analyses of administrative waste ^{7,8}. Four recent IOSR-JBM studies on U.S. dental management were integrated as context ^{2,4,6}. Web sources were accessed on October 3, 2026.

Capacity model. The model converts hours of clinician time recovered by AI into full-time-equivalent (FTE) clinicians, assuming 46 working weeks and 1,600 clinical hours per FTE per year, and compares the result with HRSA's national deficit of 10,744 practitioners ². Scenarios vary the hours recovered (1, 2 or 3 hours per dentist per week) and the number of participating dentists (20,000, 50,000 or 100,000). The model is illustrative and is not a forecast of adoption.

III. Evidence Across The Operational And Clinical Domains

A. Front office: appointment failure

Missed appointments are especially costly in dentistry, where visits are long and chair time cannot easily be refilled. A study of dental appointments at a large clinic achieved an area under the curve (AUC) of 0.718 with machine-learning prediction of no-shows and proposed using predictions to reallocate or shorten bookings ¹⁵. At a U.S. dental school clinic, eight algorithms were compared; the best reached an AUC of 0.76 and identified confirmation status, age, prior failed appointments, lead time and medical alerts as key predictors ¹⁶. A 2026 systematic review confirmed the applicability of these models but noted small samples, single-center designs and a lack of external validation ¹⁷. The management implication is that no-show models are useful for triage — targeted reminders, overbooking rules or transport support — but should be validated locally before they drive decisions.

B. Encounter: documentation burden

Documentation is one of the main sources of clinician burnout. At Stanford Health Care, a three-month pilot of an ambient AI scribe with 48 physicians produced large reductions in task load and burnout scores and improved usability ¹⁸. A systematic review of eleven implementation studies found improvements in at least one efficiency measure in nine of ten studies reporting them and positive effects on clinician wellness in seven, while noting variable accuracy and the need for manual edits ¹⁹. The first randomized trial, with 238 outpatient physicians, found that one of two commercial scribes reduced time spent writing notes by 9.5% compared with usual care, while both were associated with signs of lower burnout; clinically significant inaccuracies were reported occasionally ²⁰. Dental evidence is still emerging, but natural language processing and speech recognition are recognized as the most promising AI applications for dental administration, provided that data scarcity and evaluation challenges are addressed ²¹.

C. Assisted diagnosis: accuracy is not the same as value

Diagnostic AI is the most mature dental application. In a cluster-randomized trial, dentists using AI to detect proximal caries on bitewing radiographs achieved a higher AUC (0.89 vs. 0.85), mainly because sensitivity rose from 0.72 to 0.81 without loss of specificity ²². However, the same higher sensitivity led to more invasive as well as non-invasive treatment decisions, and a subsequent cost-effectiveness analysis found that AI and non-AI detection produced practically identical tooth retention and lifetime costs ²³. This is a central management lesson: a more accurate algorithm can increase activity without increasing value unless the clinic also governs what happens after detection. For a sector shaped by fee-for-service incentives ⁶ and by productivity-based compensation in some corporate settings ⁵, this risk is not theoretical.

D. Data, privacy and governance

Dental AI depends on data that are scattered across practices and protected by privacy rules. Federated learning, which trains models without moving patient data, has been proposed as a scalable, privacy-preserving route for dental AI ²⁴. Reviews converge on the same conditions for value: tangible benefit for access, quality or efficiency; human oversight; explainability; and protection of patient rights ^{9,10}. These conditions are now reflected in U.S. federal policy, discussed below.

IV. The Regulatory And Governance Context

Three federal instruments shape responsible AI use in U.S. clinics. The NIST AI Risk Management Framework organizes AI risk management into four functions — Govern, Map, Measure and Manage — and is the reference voluntary standard for trustworthy AI ¹². The Section 1557 regulation requires covered health programs to make reasonable efforts to identify patient care decision support tools that use variables related to race, color, national origin, sex, age or disability, and to mitigate the risk of discrimination arising from their use ¹³. The ONC HTI-1 rule introduced transparency requirements for decision support interventions in certified health information technology ¹⁴. Together with HIPAA, these instruments mean that a dental clinic deploying

AI is not only buying software but assuming governance obligations — a task for which few practices are organized.

V. The CLEAR-Dent Integrated Management Framework

To translate the evidence into practice, this article proposes CLEAR-Dent, an integrated framework that organizes AI adoption around five management domains, a cross-cutting governance layer, a maturity model and a balanced scorecard. Its premise is that every AI tool must be attached to a management objective, an owner, a measurable indicator and a risk control (Table 1).

Table no 1: The CLEAR-Dent framework: domains, example AI applications, management objectives and primary indicators.

Domain	Example AI applications	Management objective	Primary indicator
C — Capacity (front office)	No-show prediction, smart reminders, dynamic scheduling ¹⁵⁻¹⁷	Fill chair time; protect access for high-need patients	Chair utilization; no-show rate
L — Ledger (revenue cycle)	Eligibility verification, claim scrubbing, denial prediction, prior-authorization drafting ⁹	Reduce administrative waste and payment delay ^{7,8}	First-pass claim acceptance; days in accounts receivable
E — Encounter (documentation)	Ambient scribes, voice periodontal charting, structured notes ^{20,21}	Return clinician time to patients; reduce burnout	Minutes of documentation per visit; burnout score
A — Assisted diagnosis	Radiographic caries, periodontal and lesion detection ²²	Improve accuracy without inducing overtreatment ²³	Invasive-to-non-invasive treatment ratio; audit agreement
R — Reach (population)	Recall targeting, Medicaid outreach, teledentistry triage ²	Extend care to underserved and shortage areas	Visits per 1,000 Medicaid patients; HPSA patients served
Governance layer	NIST AI RMF; Section 1557; HTI-1; HIPAA ¹²⁻¹⁴	Safety, equity, transparency, privacy	Tools inventoried and bias-checked; incidents

Source: proposed by the author on the basis of the cited evidence.

The governance layer applies the four NIST functions to every tool. **Govern** assigns an accountable owner and a written policy for each AI application. **Map** documents the tool's purpose, data, users and affected patients, including whether it uses protected characteristics within the meaning of Section 1557¹³. **Measure** sets baseline and follow-up indicators, including subgroup performance. **Manage** defines thresholds for human review, incident reporting and decommissioning¹².

A. The maturity model

Table no 2: CLEAR-Dent maturity levels for U.S. dental clinics.

Level	Description	Typical characteristics
0 — Manual	No AI; paper or basic practice software	High administrative load; no performance data
1 — Tool adoption	Isolated AI tools purchased by vendor offer	No owner, no baseline, no governance
2 — Managed	Each tool has an owner, objective and indicator	Monthly KPI review; staff training
3 — Integrated	Tools linked across domains and to the scorecard	NIST-aligned governance; bias and accuracy audits
4 — Value-based	AI outputs tied to quality, access and payment contracts	Shared savings with payers; public reporting

Source: proposed by the author.

Most independent practices today sit at Level 0 or 1, while larger DSOs may reach Levels 2–3 because they have the capital and administrative infrastructure to do so⁵. This asymmetry matters: if only consolidated organizations can manage AI well, the technology may widen rather than close the gap between corporate and independent practice, and between urban and rural care^{2,5}. The framework is therefore designed to be applicable by small practices, community health centers and group purchasing networks, not only by large organizations.

B. The balanced scorecard

CLEAR-Dent links AI to a four-perspective balanced scorecard: (1) **patient and access** — wait time to first appointment, Medicaid and shortage-area patients served; (2) **clinical quality** — preventive-care rates, appropriateness of invasive treatment after AI detection^{22,23}; (3) **workforce** — documentation time, overtime, burnout and retention of hygienists and assistants^{3,20}; and (4) **financial** — first-pass claim acceptance, collection cycle and administrative cost per visit⁷. Each AI tool must demonstrate improvement in at least one perspective without deterioration in the others before moving from pilot to routine use.

VI. Capacity Recovery: An Illustrative National Estimate

The strongest public argument for AI in dental clinics is not cost reduction in isolation but the conversion of administrative time into clinical capacity. Table 3 estimates the full-time-equivalent clinicians that would be freed if AI, managed under CLEAR-Dent, recovered one, two or three hours per week per participating dentist. The two-hour scenario is consistent with the magnitude of documentation-time reductions reported for ambient scribes^{19,20}, but it should be treated as an assumption to be tested.

Table no 3: Clinical capacity recovered by AI, expressed as full-time-equivalent (FTE) clinicians and as a share of the national dental HPSA deficit of 10,744 practitioners².

Participating dentists	1 h/week recovered	2 h/week recovered	3 h/week recovered
20,000	575 FTE (5.4%)	1,150 FTE (10.7%)	1,725 FTE (16.1%)
50,000	1,438 FTE (13.4%)	2,875 FTE (26.8%)	4,312 FTE (40.1%)
100,000	2,875 FTE (26.8%)	5,750 FTE (53.5%)	8,625 FTE (80.3%)

Note: FTE = hours/week × 46 weeks × dentists ÷ 1,600 clinical hours. Percentages refer to the HRSA deficit. Recovered time closes the gap only if it is redirected to patients in shortage areas or underserved groups. Author's calculation.

Under the central scenario — two hours per week for 50,000 dentists — the time freed would equal about 2,875 full-time clinicians, more than a quarter of the national shortage-area deficit. This capacity is created without new dental schools, without additional student debt and in a matter of months rather than the years required to train new professionals⁴. The estimate depends on a critical management condition: recovered time must be redirected to patients, particularly Medicaid and shortage-area patients, rather than absorbed by additional administrative work or by higher volumes of low-value treatment^{6,23}.

VII. Implementation Roadmap For Clinics

- **Months 0–3: diagnose.** Map administrative workflows, measure baseline indicators (no-show rate, claim acceptance, documentation minutes, staff overtime) and create an inventory of any AI already in use.
- **Months 3–6: govern.** Appoint an AI owner, adopt a written policy aligned with NIST AI RMF, review vendor documentation for Section 1557 and HIPAA compliance, and define human-review rules^{12,13}.
- **Months 6–12: pilot one domain.** Start where evidence is strongest and risk lowest — typically scheduling (Capacity) or documentation (Encounter) — with a before-and-after comparison^{16,20}.
- **Months 12–24: integrate.** Add revenue-cycle and assisted-diagnosis tools, link them to the balanced scorecard, and audit treatment appropriateness after AI detection^{22,23}.
- **Months 24–36: reach outward.** Redirect recovered capacity to Medicaid and shortage-area patients through extended hours, satellite sites, teledentistry triage and partnerships with community health centers, and negotiate value-based contracts that reward access^{2,6}.

The same roadmap can be used as the operational core of a clinic business plan, because it specifies investments, milestones and the indicators by which return on investment and social impact will be demonstrated¹¹.

VIII. Discussion And Limitations

The evidence supports a measured conclusion. AI can reduce some administrative burdens and improve some diagnostic tasks, but its benefits are inconsistent across tools and settings, and accuracy gains do not automatically translate into value^{20,22,23}. The difference between success and disappointment lies in management: clear objectives, local validation, governance and measurement. CLEAR-Dent is offered as a structure for that management, compatible with independent practices, DSOs and safety-net clinics alike.

The study has limitations. Much of the documentation evidence comes from medicine rather than dentistry; the no-show models have not been externally validated; the capacity model rests on assumptions about hours recovered and their redeployment; and the framework itself has not yet been tested empirically. The four IOSR-JBM studies integrated here are recent narrative reviews, and their findings should be read together with the primary sources they cite.

IX. National Interest And Significance

The endeavor addressed in this article has substantial merit and national importance for five reasons. **First, scale:** 63.7 million people live in dental shortage areas and only one-third of their dental need is met²; any intervention that adds capacity without new training pipelines responds directly to a federally documented national problem. **Second, workforce:** the hygienist shortage and the aging, indebted dentist workforce are national labor-market problems that will not be solved by training alone in the short term^{3,4}. **Third, public expenditure:** administrative complexity costs the U.S. health system about US\$265.6 billion a year⁷, and dental

care, at US\$189 billion, is a significant part of national health spending¹; reducing administrative waste protects public and private payers alike.

Fourth, safe innovation: federal policy now expects health organizations to manage AI risk, transparency and discrimination¹²⁻¹⁴, but most dental practices lack the capacity to do so; a practical framework that translates these expectations into clinic routines advances national goals for trustworthy AI. **Fifth, market structure:** without accessible management models, AI may accelerate consolidation and leave independent and rural practices behind⁵; a framework designed for small practices and community health centers helps preserve a diverse, competitive and geographically distributed dental care system. The endeavor is replicable in every state and requires professionals who combine clinical dentistry, experience in large public primary-care systems and expertise in health management and digital innovation — a combination that makes contributions of this kind valuable to the United States.

X. Conclusion

The United States does not lack dental technology; it lacks dental capacity where it is needed and the management systems to turn technology into capacity. AI can act as an 'invisible hygienist' — removing administrative work, supporting diagnosis and returning clinical time to patients — but only when it is governed and measured. The CLEAR-Dent framework links each AI tool to a management objective, an indicator and a risk control, aligns adoption with NIST and federal anti-discrimination rules, and provides a maturity path that independent practices, DSOs and community health centers can follow. Under plausible assumptions, the capacity recovered could offset a meaningful share of the national shortage-area deficit, making well-managed AI a practical contribution to access, workforce sustainability and responsible use of health care resources in the United States.

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