Mapping the Evidence: Efficiency of Systematic Reviews, Meta-Analyses, and Network Meta-Analyses in Contemporary Dentistry

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Abstract: Evidence-based dentistry relies on rigorous synthesis methods to inform clinical decision-making. Systematic reviews (SRs), meta-analyses (MAs), and network meta-analyses (NMAs) sit atop the evidence hierarchy, yet their methodological efficiency and practical impact in dental research warrant critical appraisal. SRs employ a structured, transparent process to identify, appraise, and synthesize all relevant studies addressing a focused question; MAs statistically pool comparable outcomes to generate summary effect estimates; NMAs extend conventional MAs by comparing multiple interventions simultaneously, even when head-to-head trials are lacking. Recent audits of high-impact dental journals reveal exponential growth in SR output, but only 15–25% meet Cochrane risk-of-bias and PRISMA adherence criteria, raising concerns about redundancy and variable quality. Well-conducted MAs have demonstrably influenced clinical guidelines, reducing unwarranted practice variation—for example, clarifying the superiority of powered over manual toothbrushes and the caries-preventive benefit of resin infiltrants. NMAs, though fewer, efficiently rank competing restorative materials, endodontic irrigants, and periodontal adjuncts, guiding cost-effective care where direct evidence is sparse. However, heterogeneity, publication bias, and inconsistent outcome reporting constrain their certainty. Strengthening protocol registration, core outcome sets, and advanced bias-adjustment methods will further enhance the efficiency and credibility of evidence syntheses in dentistry.

Keywords: Dental Research; Evidence-Based Dentistry; Meta-Analysis; Network Meta-Analysis; Systematic Review

Definitions and Conceptual Framework

A systematic review is "a review of a formulated question that uses systematic and explicit methods to identify, select and critically appraise relevant research, and to collect and analyse data from the studies included in the review"[1-3]. A meta-analysis is "the statistical combination of results from two or more separate studies addressing the same question" and is often embedded within an SR to increase power and precision[4]. A network meta-analysis extends MA by "integrating direct and indirect evidence across a network of randomized trials to compare three or more interventions simultaneously" and to generate treatment rankings[2].

Growth and Quality of Evidence Syntheses in Dentistry

Bibliometric surveys of PubMed indicate that dental SR publications rose from fewer than 50 in 2000 to over 1,200 in 2024, paralleling medicine's evidence-based movement[1]. Despite this surge, methodological appraisals using AMSTAR-2 show that only one-quarter achieve high or moderate confidence, largely due to incomplete protocol registration, inadequate search strategies, and failure to explore publication bias[1]. Consequently, efficiency-defined as the ratio of high-quality, decision-changing reviews to total output—remains modest.

Impact of Meta-Analyses on Clinical Decision-Making

High-quality MAs have translated into tangible practice shifts. For instance, a 2020 Cochrane MA pooling 17 trials (n = 36,000) demonstrated that oscillating-rotating powered toothbrushes reduce plaque by 11% and gingivitis by 6% compared with manual brushes at three months[3]. These findings underpin current European Federation of Periodontology (EFP) recommendations. Similarly, an MA of nine randomized trials confirmed the caries-preventive effect of resin infiltration for non-cavitated lesions, prompting its inclusion in minimally invasive caries management guidelines[5-7]. Such examples illustrate MA efficiency when rigorous methodology aligns with clinically relevant questions.

Added Value of Network Meta-Analyses

Dentistry often faces multiple competing interventions—for example, irrigants in endodontics or scaffolds in regenerative periodontology-yet direct comparative trials are scarce. NMAs bridge this gap. A 2023 NMA of 42 trials compared eight endodontic irrigants, revealing sodium hypochlorite + EDTA as the most effective for smear-layer removal, while citric acid ranked highest for biocompatibility[4]. By leveraging indirect evidence, the analysis provided a

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clinically actionable hierarchy, facilitating cost-utility assessments without awaiting exhaustive head-to-head studies—an efficiency gain unique to NMA methodology.

Limitations and Future Directions

Heterogeneity from variable case definitions, operator expertise, and outcome measures plagues dental MAs/NMAs, reducing certainty. Publication bias persists, as positive small studies in implantology or esthetic dentistry outnumber negative trials[1]. Adoption of prospective protocol registration (PROSPERO), core outcome sets (e.g., COMET initiative), and GRADE certainty assessment can curtail redundancy and improve interpretability. Statistical advances—including Bayesian hierarchical models and bias-adjusted treatment ranking—promise to refine NMAs' efficiency further.

Conclusion

Systematic reviews, meta-analyses, and network meta-analyses are indispensable for evidence-based dentistry, yet their efficiency hinges on methodological rigor and relevance. While MAs have already shaped guideline recommendations, NMAs offer unparalleled comparative insight where direct evidence is limited. Strengthening quality assurance, transparency, and methodological innovation will maximize the return on investment of these evidence-synthesis tools, accelerating translation of robust research into optimal dental care.

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