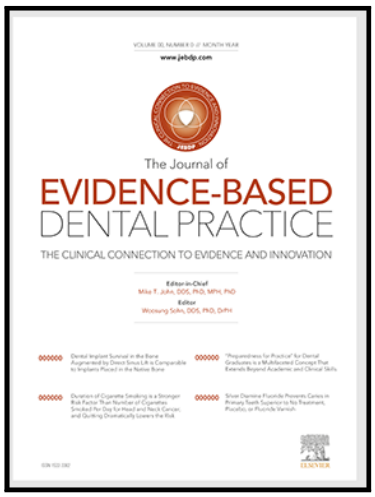

Evidence-Based Pediatric Dentistry: The First Twenty-Five Years of Transformation and the Next

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Evidence-Based Pediatric Dentistry: The First Twenty-Five Years of Transformation and the Next …

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Abstract

Over the past quarter-century, pediatric dentistry has shifted from an expert-opinion-driven craft-often extrapolated from adult dental care, to become a discipline anchored in rigorous, child-specific evidence. This transformation reflects the maturation of evidence-based dentistry (EBD): integrating the best available research with clinical expertise and the values and preferences of children and their families. As we celebrate the *Journal of Evidence-Based Dental Practice* at 25years of age, this article charts some milestones in pediatric EBD that show how clinical practice has led to scientific enquiry, research investigations and widespread changes in practice. The examples used are the Hall Technique, Atraumatic Restorative Treatment and pulp canal obliteration in dental trauma management. A pathway to improve research impact is proposed, stretching from ensuring research relevance and methodological rigor through to talking and listening to those who are stakeholders, planning implementation of findings, using core- and patient relevant- outcome sets, public communication and open science. Change does not have to be global to be important: locally tailored, context-aware research and its implementation can improve children's oral healthcare, reduce inequalities and deliver value. This article is part of the special issue "Celebrating 25 Years of the Journal of Evidence-Based Dental Practice".

1. Introduction

It is generally assumed that when a clinical problem is found, research is used to generate evidence, and this evidence naturally translates into improved patient outcomes. While this is a logical and appealing premise, suggesting a seamless flow from investigation to application at point of care, it does not always hold true[1]. Numerous factors can disrupt this pathway, including poor- research, misaligned priorities, lack of dissemination, and cultural or knowledge barriers to adoption in practice. A good dissemination plan, considering facets such as education, inclusion in living reviews, professional guidelines and regulatory policies are important. Implementation science hand in hand with clinical practice research in dentistry, are influenced by more than just evidence[2,3]. Innovations in materials and technology, like digital dentistry and tele-dentistry, also drive change. Patient preferences, cultural expectations, and practitioner experience can shape treatment choices. Continuing education and training opportunities affect how quickly new approaches are adopted. Added to this, public health priorities, such as preventive care and equity in access, often steer clinical focus. Together, these elements all work together and interact with evidence to shape the evolving landscape of dental practice, ensuring it remains responsive, practical, and patient-centered. Evidence-based dentistry (EBD) is not a recipe book or manual; it is a disciplined way to make better decisions with patients.

The American Dental Association defines EBD as "the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences."[4] This framing around the three pillars of: the best available evidence, clinical expertise, and patient needs and preferences has its basis in the evidence-based medicine movement articulated by Sackett and colleagues in their seminal 1996 paper.[5] It shapes how we pose questions, appraise research, and translate findings into care. It's also worth noting that the pillar around patient needs and preferences, is always talked about last and in the past has often been forgotten by clinicians. Now, the growing awareness and explicit use of *shared decision making* (the ongoing, collaborative process that involves patients and clinicians working together to make joint decisions about care) is bringing these more to the forefront and requires us to communicate evidence with patients to make those decisions.[6]

Twenty-five years on, the *Journal of Evidence-Based Dental Practice* has been central to cultivating EBD literacy, normalizing critical appraisal of research, and elevating the role of systematic reviews and clinical guidelines across specialties, including pediatric dentistry.

2. Changing practice through evidence

2.1 From mini-adult (kiddy-cons) to child-specific evidence

Historically, pediatric dentistry has borrowed heavily from adult dentistry. Examples of this include the use of complete caries removal, surgical restorative approaches, managing immature teeth suffering trauma in the same way as permanent teeth and the use of medicaments whose benefits and harms were not well quantified in young patients (e.g. formocresol). The EBD era challenged these assumptions with evidence accumulating from well-recorded observations and clinical trials, being incorporated into systematic reviews, living guidelines and making practice standards. The growth of Evidence-based medicine and EBD, the rise of the Cochrane Oral Health Unit and establishment of evidence-based dentistry centers, have made critical appraisal a core professional skill, reducing reliance on eminence-based practice. The Cochrane Oral Health Group, in particular, has been instrumental in setting global benchmarks for methodological rigor and transparency. Its systematic reviews have not only synthesized high-quality evidence but also driven the development of international clinical guidelines, and provided clinicians with accessible, trustworthy summaries to inform everyday decisions. Cochrane has championed living systematic reviews and promoted open science, aligning with best practices worldwide.

2.2 Changing practice through evidence in pediatric dentistry; one size doesn't fit all

The process of accumulating evidence to change practice isn't a pre-planned standard formula. Here are three examples of different evidence-accumulation that have led to clear changes in practice in pediatric dentistry.

2.2.1. The Hall Technique

The first, the Hall Technique, is a striking example of pediatric-specific practice change, exemplifying a paradigm shift towards minimally invasive clinical practice.[7] The Hall Technique, called after Dr Norna Hall, a dentist working in Scotland, in the UK in an area with high levels of dental caries[8]. Dr Hall kept meticulous records and through her clinical vigilance and then auditing her records[9], she noted that when she placed preformed metal crowns over a tooth where some caries had been left in a cavity, the outcome for the tooth was no worse than for teeth where she had completely removed caries to reach hard dentine. The Hall Technique involves placement of preformed metal crowns to encapsulate carious lesions in primary molars, notably without the administration of local anesthesia, removal of carious tissue, or any tooth preparation. By entirely sealing the carious lesion, the Hall Technique introduced a fundamental divergence from conventional restorative approaches

where complete excision of decayed tissue was a priority, regardless of the effect on the dental pulp or tooth structure integrity.

A robust body of clinical evidence, has accumulated from multiple randomized controlled trials, demonstrating the efficacy and safety of the Hall Technique in managing carious primary teeth. Both the recently updated Cochrane review[10] and a systematic review and meta-analysis evaluating success rates of the HT within pooled study types,[11] including 15 Randomized control trials and 10 Non-randomized intervention studies, found that the HT compared favorably with traditional restorative interventions. It outperformed standard restorations or matched outcomes for conventional crowns consistently.

The success of the Hall Technique has challenged long-standing dogmas regarding the necessity of caries removal for effective management, thereby prompting a critical re-evaluation of established clinical protocols. Importantly, these insights have informed the development and broader acceptance of minimally invasive strategies in other domains of dentistry. In particular, the evidence supporting the non-removal of carious tissue in primary teeth has provided a scientific rationale for the adoption of selective caries removal techniques in the management of permanent teeth in adults. This evolution in clinical practice underscores a growing emphasis on the preservation of tooth structure, the reduction of patient discomfort, and the maintenance of favourable long-term outcomes.

Despite the robust evidence supporting the effectiveness of sealing in caries to arrest its progress, and the place of the Hall Technique in national and international clinical practice guidelines, it has not been universally adopted.[12,13] In some areas, the concept of sealing in caries continues to face resistance and is not universally accepted as a viable treatment option.[14,15] This ongoing reluctance highlights the need for continued implementation of evidence to facilitate broader acceptance and implementation of minimally invasive caries management strategies. The Hall Technique not only signifies a transformative change in pediatric dental practice[16] but also serves as a foundational model for the ongoing refinement of caries management strategies across the lifespan.

2.2.2. Pulp canal obliteration

The next example is a compelling case study in how high-quality evidence can be generated outside the traditional framework of randomised control trials and concerns the evolution of clinical practice in dental trauma in the management of pulp canal obliteration (PCO). Historically, PCO, often observed in young permanent teeth following trauma, was regarded as a harbinger of pulp necrosis. The prevailing clinical response was routine prophylactic root canal treatment upon radiographic detection of PCO, a practice rooted in expert opinion and case reports rather than robust longitudinal data.

Over the past 25 years, this paradigm has shifted dramatically, driven by the accumulation of prospective observational evidence. Central to this transformation has been the work of Dr. Jens Andreasen, whose meticulous long-term follow-up of dental trauma cases resulted in a unique and invaluable database.[17] Rather than relying on randomised control trials, Andreasen's research combined large, well-designed cohort studies with rigorous longitudinal follow-up. In a 1996 paper, reporting on 82 traumatised permanent incisors with pulp PCO, followed for an average of 16 years (range 7–22 years), 51% of teeth responded normally to electric pulp testing, while an additional 40% were clinically and radiographically healthy despite not responding to testing. Only 8.5% developed periapical lesions suggestive of pulp necrosis during the observation period. The calculated 20-year pulp survival rate was 84% without intervention.[18] These insights challenged the prevailing assumption that PCO was inherently pathological, instead reframing it as a healing response to trauma.

The impact of this non-traditional evidence base is evident in the 2020 International Association of Dental Traumatology (IADT) guidelines,[19] which synthesise data across both primary and permanent dentitions to standardise diagnosis, initial management, and follow-up. The guidelines, which have been made freely available, have accelerated global uptake and harmonised care standards. Notable changes in practice include shorter splinting durations, more precise endodontic timing after avulsion, and the adoption of innovations such as guided endodontics and external bleaching. In the specific context of PCO, current best practice now supports a conservative, evidence-informed approach: asymptomatic teeth are monitored clinically and radiographically, with intervention reserved for cases demonstrating clinical or radiographic signs of pathology.[20]

The Dental Trauma Guide, developed from Andreasen's data, continues to shape global clinical decision-making and exemplifies the value of longitudinal, patient-centred evidence in improving outcomes. This case illustrates how impactful research can arise from well-designed cohort studies and real-world data, particularly when RCTs are impractical or unethical. The ongoing refinement of dental trauma guidelines underscores the importance of embracing diverse forms of evidence to inform practice and optimise patient care.

2.2.3. Atraumatic Restorative Treatment

The next example is Atraumatic Restorative Treatment (ART). Developed in the 1980s, ART was specifically designed to address the needs of populations in resource-limited settings, where access to conventional dental infrastructure and electricity-dependent equipment was severely constrained. The technique involves the careful removal of carious tissue using only hand instruments from the periphery of the cavity, thereby preserving as much healthy tooth structure as possible whilst achieving a seal with the material. The resulting cavity is then restored with a high-viscosity glass ionomer cement.[21]

Over the past several decades, a substantial body of evidence, including randomized controlled trials and systematic reviews, has established the clinical efficacy and safety of ART.[22] These studies have consistently demonstrated that ART achieves survival rates for single-surface restorations in both primary and permanent teeth that are comparable to those of conventional amalgam and composite resin restorations. The technique's effectiveness, combined with its simplicity and low cost, has made it an invaluable tool in the delivery of dental care to underserved populations worldwide.

Importantly, ART also marked a significant step forward in child-centred dental care. By eliminating the need for electrically powered drills and local anaesthetic injections, a side benefit was that ART greatly reduced the fear, discomfort, and anxiety often associated with traditional dental treatments for children, hence the name, Atraumatic.[23] Its less invasive approach is felt as less threatening and makes dental care more accessible and acceptable for young patients, fostering positive dental experiences and improving cooperation. This focus on the comfort and psychological well-being of children aligns closely with the principles of patient-centred and minimally invasive dentistry and has influenced the design of subsequent pediatric dental interventions.

Although initially conceived as a solution for communities with limited resources, ART has demonstrated clinical and economic benefits, facilitating its adoption in a wide range of settings, including high-income countries. In these contexts, ART has proven particularly advantageous for many patient groups who may not tolerate conventional restorative procedures well, such as young children, older adults, and individuals with dental anxiety or special healthcare needs.[24] Its gentle, non-threatening approach aligns closely with the principles of patient-centred care.

Community-based oral health programs have employed ART due to its cost-effectiveness, ease of implementation, and minimal infrastructure requirements.[25] The technique is also increasingly utilized in private practice settings, reflecting its alignment with contemporary trends toward preventive and minimally invasive dental care.[21]

In summary, Atraumatic Restorative Treatment exemplifies how innovations developed to address the challenges of low-resource environments can transcend their original context to become integral elements of global dental practice. Its widespread adoption from paediatric dentistry to other groups, including the elderly, anxious patients and those with additional needs or medically compromised, underscores the place of paediatric dentistry in producing adaptable, evidence-based approaches to advance overall dental care and oral health for diverse populations.

The evolution of clinical practice in pediatric dentistry has not followed a single, linear path. Instead, it has taken decades of accumulating diverse forms of evidence, through a wide range of research programs, which were not pre-determined but evolved in response to clinically notable findings. These forms of evidence range from randomized controlled trials to observational studies. The Hall Technique, ART, and trauma management guidelines each illustrate how innovation, persistence, and a combination of evidence sources have gradually shifted policy and practice. Despite strong evidence, adoption has often been uneven, highlighting that even compelling data may take years to influence widespread clinical behavior. These examples underscore that change is complex, requiring not just evidence, but also advocacy, accessibility, and alignment with broader healthcare values.

3. How EBD Drives Better Decisions for Children and Families

At its core, EBD reduces uncertainty. It reframes clinical encounters as shared decisions that balance effect sizes, certainty, child/family preferences, and feasibility. In pediatric settings, where the child's tolerance for procedures and caregiver logistics matter, EBD's insistence on patient-centered outcomes (pain, quality of life, function, school attendance) is important.

The GRADE framework has been widely adopted in dentistry and medicine. It helps transparency going from evidence profiles to recommendations (strong vs weak/conditional recommendations), taking into consideration benefits/harms, values, and resource use.[26]

Reporting guidelines, the best known of which are probably CONSORT[27] and PRISMA[28] and clinical-area–specific checklists curated by the EQUATOR Network[29] have improved the clarity and replicability of pediatric trials and reviews, enabling clinicians to judge applicability to their local context.

4. Research Waste and Value in Pediatric Dentistry

Despite progress over 25 years, a sobering proportion of biomedical research is avoidably wasted through asking the wrong questions, suboptimal design and analysis, inefficient regulation, inaccessible results, or unusable reporting.[27] The Lancet's 2014 series estimated that up to 85% of research investment may be squandered across the pipeline and proposed targeted reforms for funders, institutions, journals, and investigators.[30]. The metascience critique in these papers remains relevant: small studies, flexible analyses, selective reporting, and inaccurate outcome predictions inflate false positives and hamper replication. Pediatric dentistry is not immune: heterogeneity of outcomes, underpowered trials, and limited transparency make synthesis and implementation difficult. The research waste position was updated in a 20[31] series of six papers in the Lancet, the most pertinent to pediatric dentistry addresses **"**Strengthening the paediatric clinical trial ecosystem to better inform policy and programmes"[32] with a call to action in the Lancet Global Health reaffirmed that there is an even greater urgency in seriously addressing these.[33]

Dentistry has responded by strengthening systematic reviews (e.g., Cochrane Oral Health) and promoting dental specific core outcome sets (COS)[34] and patient reported outcome measures (PROMS) to reduce heterogeneity [35]and selective reporting, with recent work, some led by pediatric cariology groups, and the COMET Initiative-designing COS for caries management in children and improving outcome reporting in dental research. Stronger expectations from journals and funders: pre-registration, adherence to CONSORT/PRISMA/TIDieR, open data where feasible, COS adoption,

not allowing "spin" in interpretation of results[36] and explicit GRADE judgments are some of the ways we can direct quality improvement, curbing research waste and accelerating impact for children.

The ethical and economic stakes are high: waste not only misallocates scarce funds; it delays or distorts care for children. Value-for-money in research demands relevance, rigor, transparency, and a pathway to implementation.[37]

5. Change That Matters: Local, Context-Specific Implementation

Not all evidence needs global roll-out to make a difference; locally tailored, proportionate-universal programs can substantially improve outcomes.

Implementation frameworks like i-PARIHS remind us that uptake is a function of the innovation, recipients, and context, actively facilitated. Their emphasis on facilitation, context diagnostics, and adaptation provides a language and toolkit for translating pediatric evidence into routine care-whether in community programs or clinic workflows[38,39]

6. What Makes Research Impactful? A Practical Guide for Pediatric Dentistry

The examples presented above show that evidence can be moved into practice and change patient care. However, if we are to avoid waste in testing treatments and innovations, we need to be aware of the end goal; impact, and drive towards that as the key aim. Impact is rarely accidental. So, how best to achieve impactful, research? Studies that change practice-locally or globally-tend to score highly across a number of dimensions. Examples of these and suggestions as to how they can be identified and used across the evidence production ecosystem to help achieve impact are listed below.

6.1. Real-world relevance (aligned to clinical need)

We should start with questions that matter to children, parents, clinicians, and payers; prioritize uncertainties identified via systematic reviews and stakeholder priority-setting; funders should require prior evidence mapping before approving new trials.[33]

6.2. Patient-centered outcomes

We should always measure what matters: pain, function, oral-health-related quality of life, school absence, aesthetics/acceptability-alongside lesion- and tooth-level endpoints.[34,35,40-42] These aren't always the easiest things to measure but adopting or helping develop *core outcome sets* reduces heterogeneity and enables meta-analysis. [31]

6.3. Methodological rigor and clear reporting

There are a few basic but important rules we should consistently adopt here: pre-register trials; power them adequately; minimize bias; use appropriate comparators; plan analyses; report completely using dental-specific checklists (see EQUATOR network[29]). For complex, multi-component interventions, using TIDieR describes what was done, by whom, where, and with what fidelity-so others can replicate or adapt[43].

6.4. Certainty and recommendations made explicit

We should be constantly adopting GRADE to assess certainty across outcomes and to explain the strength and direction of recommendations, including how family preferences and resources influenced decisions improves transparency which speeds uptake and contextualization[26].

6.5. Stakeholder engagement from the outset

Involve families (including children where appropriate), primary-care dentists, hygienists/therapists, school/nursery staff, commissioners, and policy-makers not only in defining questions, and outcomes, but in the implementation plans and the "how to" investigate. This improves recruitment, adherence, and relevance, and helps pre-empt inequities in access.

6.7. Implementation and scale-up planning (from day one)

Design with implementability in mind; use frameworks (e.g., i-PARIHS) and pragmatic trial designs where appropriate; report fidelity and adaptations; consider clinical workflows, training load, costs, and cultural acceptability; build in plans for audit and feedback.

6.8. Equity and context

Anticipate social gradients in disease and care. Build proportionate universalism into study design and implementation stratify analyses by deprivation, ethnicity, and geography.

6.9. Open science, data sharing, and dissemination

Publish protocols, datasets (where ethical), and lay summaries; register and report all trials to reduce publication [44]. Use accessible formats (chairside guides, infographics) and continuing education to speed translation, as seen in American Dental Association's EBD program.[45] Dissemination plans should include the public.

6.10. Policy and System-Level Support

Align with research and national health priorities to maintain relevance and help with embedding.

6.11. Demonstrate cost-effectiveness

There are many ways of doing this, whether through formal economic evaluation and value-based care methodologies, pairing of clinical endpoints with costs to deliver or carrying out budget-impact analyses. Cost-effectiveness though, must align with emerging oral-health value-based care models that reward prevention, minimally invasive care, and outcomes over activity-an area gaining traction in public programs and safety-net settings.

6.12. Across-the-life-course integration

Consider links to maternal, antenatal, and general health services (e.g., immunization visits, health visitor checks) to reach families earlier and more equitably.

6.13. Education and Training

Have materials ready to support updates in curricula; provide CPD courses and practical workshops for clinicians and educators.

7. Looking Ahead: The Next Decade of Evidence-Based Pediatric Dentistry

7.1. Smarter synthesis, faster learning

Living guidelines and better evidence infrastructures will shorten the bench-to-chairside lag. The ADA's living guideline program and the broader move towards rapid, transparent evidence synthesis promise timelier, practice-relevant recommendations-especially when combined with GRADE and robust reporting standards.[45]

7.2. Digital tools and data linkage

Data linkage at population level has the potential to enable real-world effectiveness and equity monitoring. Registries and records could be used to support risk-based recalls, proactive prevention, and evaluation of delivered dental care items. However, even if the data is collected (which it often isn't), it can't be accessed, is not in the right format, or is simply not linked.

7.3. Personalized Pediatric Dentistry:

The future of clinical care supported by evidence-based dentistry is towards personalized care, where genetic and individual risk profiles inform treatment decisions.

7.4. Value-based, prevention-first models

Payment reform is beginning to reward outcomes gained over procedures carried out, aligning incentives with EBD's preventive, minimally invasive ethos. As in many countries, the US, Medicaid/managed care and Federally Qualified Health Centers expand alternative payment models, pediatric dentistry has an opportunity to define meaningful outcome measures and demonstrate savings via reduced operative interventions and improved quality of life[46].

8. Conclusion

Pediatric dentistry has undergone a profound EBD-driven transformation: from extrapolation of adult techniques and surgical default to child-specific, prevention-first, minimally invasive, and shared-decision-making care. The Hall Technique, Atraumatic Restorative Treatment and standardized trauma protocols exemplify how rigorous evidence can shift practice and improve outcomes that matter to children and families. Yet the job is unfinished: too much research still fails to deliver value, and inequalities persist. The path forward is clear. Prioritize relevance, center patient-important outcomes, quality, design and report with rigor and transparency, plan for implementation and equity, and embrace open science and value-based care. When evidence meets facilitation and policy, management of children's oral health problems can improve quickly and fairly.

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