PROMOTING ORAL HEALTH IN EARLY CHILDHOOD: THE ROLE OF THE FAMILY, COMMUNITY AND HEALTH SYSTEM IN DEVELOPING STRATEGIES FOR PREVENTION AND MANAGEMENT OF ECC

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Editorial: Promoting Oral Health in Early Childhood: The Role of the Family, Community and Health System in Developing Strategies for Prevention and Management of ECC

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Editorial on the Research Topic

Promoting Oral Health in Early Childhood: The Role of the Family, Community and Health System in Developing Strategies for Prevention and Management of ECC

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Early childhood caries (ECC), has been defined as the presence of one or more decayed, missing due to caries, or filled tooth surfaces in any primary teeth in children under 6 years of age and is recognised as a global public health problem (1), affecting almost half of preschool children around the world (2). If untreated, ECC can lead to negative health impacts including acute infection, need for emergency care, and economic impacts for the family and society (3).

Paediatric primary care practitioners including family physicians and paediatricians generally have much earlier contact with families of infants and preschool age children than do dental practitioners (4). This is due to uptake of immunisation services, and infant health checks, in both developed and developing countries. Across the health system these primary care practitioners, therefore, play a critical role in early childhood oral health including caries risk assessment, providing preventive care (if needed) with silver diamine fluoride and fluoride varnish, and referral to dental care providers. A recent review of oral interventions for expectant mothers and those with young children, found maternal oral health education, caries risk assessment and appropriate referrals by non-dental professionals, can lead to a sustained reduction in early childhood caries (5).

EDUCATION AND TRAINING

Policy statements from the American Academy of Paediatric Dentistry (AAPD) recommend: (1) referral by the child's primary care physician based on risk assessment, no later than 12 months of age, and (2) this assessment could be a routine component of new and periodic examinations by medical practitioners (6, 7). The World Health Organisation (WHO) also recommends that primary care teams and community health workers should understand the key risk factors for ECC, and how to identify them (3). However, in a recent review it was found that paediatricians frequently had limited knowledge of oral health and prevention in young children (8). The reasons given for this varied from barriers to education and training, time constraints, and lack of clear referral pathways.

Training should, therefore, involve early clinical signs of dental caries, recommended age of first dental visit, aetiology of dental caries and use of silver diamine fluoride and fluoride varnish. In a national survey of paediatric specialty trainees in the UK, it was found that although three quarters of the respondents agreed that paediatricians could assess oral health, nearly all felt that their training in oral health was insufficient (9). This indicates a need for oral health training in medical programmes, which enables competency in giving evidence-based preventive advice and support for families with preschool age children. Such training could be incorporated into the curriculum for general paediatric training. Inter-professional training at the undergraduate level may improve awareness of professional roles and facilitate interaction and communication between healthcare teams involved in child health. This requires development of competencies in knowledge and confidence in delivering oral health advice, for all paediatric primary care providers. Improvement in knowledge, confidence and practise towards children's oral health has been achieved through inter-professional education in graduate programmes (10). Sequentially, implementation includes awareness of the problem and proposed solutions, acceptance of information, application in practise and adapting to local health needs.

There is a perception still that attendance at a dental practise is more symptom-led than for medicine, which is more focused on preventive care for this age-group. It has been reported that most family physicians and paediatricians would refer a child with high caries risk for dental care but few would routinely refer a child at low risk for a first dental visit (11), suggesting some confusion regarding the importance of the dental home for young children. Dental teams also need to ensure clear and easy referral pathways from primary healthcare teams and non-dental health professionals. This has been achieved with children at high caries risk and in need of treatment (12).

RESEARCH TOPIC ARTICLES

In the context of the health system, two papers in this collection explored the effect of preventive oral care within state funded public health progammes. With a focus on fluoride varnish utilisation at medical well-child visits, Meyer and Danesh investigated inter-professional collaboration among dental and non-dental primary care providers and the impact of the COVID-19 pandemic on preventive care. They found quarterly fluoride utilisation rates and dental visits decreased significantly during the pandemic, highlighting the importance of inter-professional collaboration to provide access and preventive oral health services at physician offices.

Using machine learning pathways involving cluster analysis and cumulative dental cost curves, Peng et al. analysed utilisation patterns, service delivery models and cost effectiveness of preventive oral care among Medicaid insured children over 9 years. This revealed distinct clinical cost and utilisation patterns, and the need for preventive strategies that differentiate between specific subpopulations.

In the clinical setting, preventive oral care in early childhood is dependent on effective communication between the dental team and families with young children. In this context, Yuan et al. explored interactions between the dental professional-parent-child triad. Using conversation analysis, they identified three sequential phases of communications: social talking, containing worries, and task-focusing to develop strategic alliances for prevention and management of ECC.

In advocating for national upstream and downstream oral health promotion strategies Sitthisettapong et al. proposed a model for community-based prevention in Thailand. This model recommends an inter-professional, three-tiered approach to ECC prevention and management. The first tier is community education and use of fluoride toothpaste. The second tier is regular examination and early intervention. The third tier is the non-invasive use of atraumatic restorative treatment (ART, with or without silver diamine fluoride) all linked to effective monitoring systems.

The studies in this collection add to research that can inform the development of preventive strategies for ECC, as well as protocols/guidelines for all primary care teams that promote good outcomes for oral health in early childhood.

AUTHOR CONTRIBUTIONS

RNa and JN developed the manuscript, which was critically revised by RNi and BP. All authors contributed to the article and approved the submitted version.

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ORIGINAL RESEARCH
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A Machine Learning Approach to Uncovering Hidden Utilization Patterns of Early Childhood Dental Care Among Medicaid-Insured Children

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Background: Early childhood dental care (**ECDC**) is a significant public health opportunity since dental caries is largely preventable and a prime target for reducing healthcare expenditures. This study aims to discover underlying patterns in ECDC utilization among Ohio Medicaid-insured children, which have significant implications for public health prevention, innovative service delivery models, and targeted cost-saving interventions.

Methods: Using 9 years of longitudinal Medicaid data of 24,223 publicly insured child members of an accountable care organization (**ACO**), Partners for Kids in Ohio, we applied unsupervised machine learning to cluster patients based on their cumulative dental cost curves in early childhood (24–60 months). Clinical validity, analytical validity, and reproducibility were assessed.

Results: The clustering revealed five novel subpopulations: (1) early-onset of decay by age (0.5% of the population, as early as 28 months), (2) middle-onset of decay (3.0%, as early as 35 months), (3) late-onset of decay (5.8%, as early as 44 months), (4) regular preventive care (67.7%), and (5) zero utilization (23.0%). Patients with early-onset of decay incurred the highest dental cost [median annual cost (**MAC**) = $9,499, InterQuartile Range (**IQR**): $7,052–$11,216], while patients with regular preventive care incurred the lowest dental cost (MAC = $191, IQR: $99–$336). We also found a plausible correlation of early-onset of decay with complex medical conditions diagnosed at 0–24 months. Almost one-third of patients with early-onset of decay had complex medical conditions diagnosed at 0–24 months. Patients with early-onset of decay also incurred the highest medical cost (MAC = $7,513, IQR: $4,527–$12,546) at 0–24 months.

Conclusion: Among Ohio Medicaid-insured children, five subpopulations with distinctive clinical, cost, and utilization patterns were discovered and validated through a data-driven approach. This novel discovery promotes innovative prevention strategies that differentiate Medicaid subpopulations, and allows for the development

of cost-effective interventions that target high-risk patients. Furthermore, an integrated medical-dental care delivery model promises to reduce costs further while improving patient outcomes.

Keywords: pediatric dentistry, medicaid, public health, healthcare expenditures, health services research, early childhood dental care, early childhood dental caries, medical-dental integration

INTRODUCTION

Early childhood caries (ECC) has been a significant oral health problem in many countries, especially in socially disadvantaged populations. ECC is defined as the presence of one or more decayed, missing, or filled tooth surfaces in any tooth in a child under 6 (1). ECC can lead to various adverse outcomes, including toothaches, loss of teeth, sleep disturbances, low self-esteem, and poor school performance (2–5). Children with early childhood caries are at increased risk for future caries and subsequent restorative and surgical treatment that increases costs and risk for complications (6, 7). Nevertheless, dental caries may be largely prevented if preventive measures are applied early. Since early preventive dental visits are critical in preventing dental caries, the American Academy of Pediatric Dentistry recommends that all children have their first preventive dental visit and establish a dental home during the first year of life (8, 9).

We define early childhood dental care (ECDC) as all dental services between 24 and 60 months. ECDC can prevent dental caries and reduce the need for restorative and emergency dental care, therefore reducing dental costs among children (10–12). However, few children received ECDC regularly and even fewer among Medicaid-insured children whose social and economic capital is limited (13–15). Only 20% of Medicaid-insured children receive their eligible preventative dental care (15, 16).

Understanding ECDC utilization patterns is the first step in developing future interventions to prevent early childhood caries and reduce dental costs. Prior studies that examined ECDC utilization patterns have relied exclusively on supervised machine learning methods (e.g., logistic regression) where target outcomes are predefined (e.g., preventive dental care use, yes or no) (17–19). While supervised machine learning is popular and useful in examining relationships between predefined variables, they are incapable of uncovering meaningful hidden patterns that cannot be detected using predefined variables. Unsupervised machine learning methods (e.g., cluster analysis) overcome this limitation by finding clusters within the data using some similarity metric. The objective of this study was to characterize using unsupervised machine learning methods the ECDC utilization patterns among a large cohort of Medicaid-insured children in Ohio. Medicaid-insured children are generally considered as a homogeneous population because they primarily come from low-income families. Breaking away from this usual approach, this study is the first to examine potential heterogeneity in ECDC utilization within a population of Medicaid-insured children.

MATERIALS AND METHODS

Data Source

Founded in 1994, Partners for Kids (**PFK**) is among the largest and oldest pediatric accountable care organizations (**ACOs**) in the United States. Through contracts with five private managed care plans, PFK covers most Medicaid enrolled children (∼330,000) in 34 counties in central and southeast Ohio. Forty percent of the children live in Franklin Country, the most urban county in the region, with the remainder spread throughout 33 other counties in Ohio, most of which are rural and many of them Appalachian (20).

In this study, 9 years (2009–2017) of PFK data were used for analysis. Eligible patients (6–60 months) were those who had continuous Medicaid enrollment. The continuous enrollment criteria ruled out a lack of insurance coverage as a barrier to dental utilization. PFK data were complete with no missing data in the variables we used for analysis. About 1% of paid amounts were in negative numbers all of which were converted to zero. All medical claims data (including emergency department visits) were included in our study. Pharmacy claims data were excluded.

A dental visit was defined as the use of any dental services during a single day. We used a combination of Current Dental Terminology (**CDT**), Current Procedural Terminology (**CPT**), and International Classification of Diseases (**ICD**) codes to assign each dental visit into one of the following four mutually exclusive categories.

(I) Treatment visit with operating room use (T + OR)
A treatment visit was identified as the presence of CDT codes D2000-2999 (restorative procedures), D3000-D3999 (root canal procedures), or D7000-D7999 (oral surgery procedures). Operating room use was identified as the presence of CDT codes D9420, D9219, D9220, D9221, D9223; or the presence of CPT codes (41899, 00170, or 0360) in combination with ICD diagnosis codes for dental disease (ICD-9 of 520-529 or ICD-10 of K00-K14 or M26-M27).

(II) Treatment visit without operating room use (T − OR)
A treatment visit was identified using the same codes in category (I), but no operating room use was identified.

(III) Preventive visit
Preventive care was identified using CDT codes D1000-D1999.

(IV) Other types of dental visits
Visits not falling into any of the above categories were identified as other types of dental visits.

In the category assignment process when more than one service was rendered on a given day, category I was given the highest

priority because treatment visits and operating room use are considered the biggest drivers of high dental costs. Category II was given the second-highest priority, followed by categories III and IV. For example, if services in both categories I and III were provided during the same visit, we assigned this dental visit to category I.

This study was approved by Nationwide Children's Hospital's Institutional Review Board.

Data Analysis

Data analysis was performed using Python version 3.6. Costs in dental claims for children between 24 and 60 months were analyzed. We first conducted the traditional segmentation analysis by calculating per member per year (**PMPY**) dental cost by gender. Two sample *t*-tests were performed to examine the significance of differences in PMPY by gender. A $P < 0.05$ was considered statistically significant. We then conducted a data-driven segmentation through cluster analysis.

A cost curve was defined as the cumulative cost of a patient over time. Assuming that a child had three dental visits by 40 months, which incurred dental cost C_1 at the first visit, C_2 at the second visit, and C_3 at the third visit, the cumulative cost of this patient at 40 months will be $C_1 + C_2 + C_3$. If this patient had another dental visit at the age of 45 months and incurred dental cost C_4, the cumulative cost by 45 months will accumulate to $C_1 + C_2 + C_3 + C_4$. We adjusted the dental expenses using the Personal Health Care index for Medicaid expenditures calculated by the Centers for Medicare and Medicaid Services (21); all amounts are given in 2017 dollars.

Each patient was represented by a concatenated vector of the cost curves of the following four categories: T + OR visits, T − OR visits, preventive visits, and other types of dental visits. We clustered the patients via k-means clustering with Euclidean distance measure (22). The distance between patients is calculated by finding the square of the distance between patients, where each patient is represented by a fixed-length vector. A useful clustering is defined as having a small average distance within a cluster while having a considerable average distance between clusters. We used the elbow method (23) and intuition to determine the optimal number of clusters. We used the silhouette score and Calinski-Harabasz score to compare the goodness of our clustering to a random clustering (24, 25). We used the Kruskal-Wallis test to examine whether the median and mean annual dental costs significantly differ across clusters.

We used three ways to validate the clusters identified via k-means clustering. First, we conducted a dental chart review of four randomly selected patients (two in the early-onset group, one in the late-onset group, and one in the regular preventive care group). Second, we investigated the medical and dental care characteristics at 6–24 months in patients of each cluster. We utilized the Pediatric Medical Complexity Algorithm (**PMCA**) to identify patients with complex chronic diseases (26). Using ICD codes, PMCA stratifies children into three levels of chronic disease: complex chronic disease, non-complex chronic disease, and without chronic disease. We anticipated seeing non-random patterns of medical complexity if the clusters were clinically valid. For example, patients within the same cluster exhibit similar medical complexity levels, while patients from different clusters have significantly different medical complexity levels. Third, we reproduced the analysis in a subset of eligible patients residing in an urban neighborhood (27). Residents from this urban neighborhood have similar socioeconomic status and access to dental care and resources (e.g., fluoride water), thereby ensuring that these variables do not account for the differences in clusters we observed. We anticipated that our urban analysis would reproduce the broader findings.

RESULTS

We identified 24,223 eligible patients who had continuous Medicaid enrollment between 6 and 60 months. The traditional segmentation by age and gender suggests some differences in dental costs in subpopulations (**Table 1**). Using k-means clustering, we identified five novel subgroups (**Table 2**): (1) early-onset of decay (0.5% of population), (2) middle-onset of decay (3.0%), (3) late-onset of decay (5.8%), (4) regular preventive care (67.7%), and (5) zero utilization (23.0%). Our clustering performed better than random clustering (**Table 3**) and provided more details than the traditional segmentation. Our clustering yielded a better silhouette score than random clustering (0.796 vs. −0.028). For silhouette score, the best value is 1 and the worst value is −1. Our clustering also yielded a better calinski harabasz score than random clustering (0.477 vs. 0.194). For calinski harabasz score, the higher the score, the better the performance.

We defined subgroups as early-, middle-, and late-onset of decay based on the age when patients had their first treatment visit with operating room use (T+OR). The representative patient from the early onset subgroup had his or her first T+OR visit at 28 months. In comparison, the representative patients from the middle- and late-onset subgroups had their first T+OR visit at 35 and 44 months, respectively (**Figure 1**). The representative patient from the regular preventive care subgroup had multiple periodic preventive dental visits and never had a T+OR visit from 24 to 60 months. Patients with early-onset of decay incurred the highest dental cost [median annual cost (**MAC**) = $9,499; InterQuartile Range (**IQR**): $7,052–$11,216], while patients with regular preventive care and those with zero utilization incurred the lowest dental costs (MAC = $191 and $0, respectively). Patients in the early-onset group incurred significantly higher dental costs than other subgroups ($p < 0.01$) (**Table 2**). Noticeably, the patients of early-, mid- and late-onset of decay only constituted 9.3% of the population but consumed 63% of the total annual dental cost to the ACO.

To validate the subgroups, we conducted a dental chart review of four randomly selected charts. The two patients in the early-onset group required dental rehabilitation under general anesthesia soon after their first dental visit indicating that early childhood caries was present. These patients required further dental treatment after the general anesthesia visit, typical with early childhood caries. In the late-onset group, the patient had dental decay diagnosed at 53 months, also requiring general anesthesia. No subsequent dental treatment was needed after the general anesthesia visit, and costs were lower than the

TABLE 1 | The mean of Per Member Per Year (PMPY) dental cost and the total cost of each demographic subgroup (Total $N = 24,223$).

	% of the population	24–36 months	36–48 months	48–60 months	24–60 months total
Overall	100%	$124.4	$266.4	$278.9	$669.6
Male	51.0%	$134.3	$275.9	$292.0	$702.2
Female	49.0%	$114.1	$256.4	$265.2	$635.7
T-test (*p*-value)	–	0.035	0.082	0.051	0.001

TABLE 2 | Median and mean annual dental cost by five subgroups of PFK children who had continuously enrolled in Ohio Medicaid from age 24–60 months (Total $N = 24,223$).

Subgroup	*N* (% of total population)	Median annual dental cost of each group* (Interquartile Range)	Mean annual dental cost of each group*	% of total annual dental cost to the ACO
Early onset of decay	122 (0.5%)	$9,499.2 ($7,052–$11,216)	$9453.6	8%
Mid onset of decay	731(3%)	$5,240.7 ($4,367–$6,006)	$5360.4	25%
Late onset of decay	1,405 (5.8%)	$2,989.5 ($2,483–$3,781)	$3331.4	30%
Preventive care	16,388 (67.7%)	$190.8 ($99–$336)	$357.6	38%
Zero utilization	5,577 (23%)	$0	$0	0%
Total	24, 223 (100%)	$151.2 ($40 - $360)	$669.7	100%

*$p < 0.01$, Kruskal-Wallis test.
Early, mid, and late onset of decay was defined based on the age when patients had their first treatment visit with operating room use.

TABLE 3 | Performance comparison of our clustering and random clustering.

	Silhouette score	Calinski harabasz score
Random clustering	−0.028	0.194
Our clustering	0.796	0.477

Silhouette score: The best value is 1 and the worst value is −1.
Calinski harabasz score: The higher the score, the better the performance.

early-onset group. In the regular preventive care group, the patient had multiple preventive dental visits but no restorative treatment visits.

As another approach to validate the subgroups, we investigated the resulting clusters' medical and dental care characteristics before 24 months. We observed non-random patterns of the five subgroups before 24 months, which further validated the five subgroups through cluster analysis (**Table 4**). Noticeably, the percent of patients with complex chronic disease (e.g., congenital heart disease) dropped from 31.2% (early-onset group) to 13.6% (zero-utilization group). The early-onset group had the highest medical cost (median = $7,513) before 24 months, while the zero-utilization group had the lowest medical cost (median = $5,744). The early-onset group came to their first dental visit at the oldest age (median age = 20 months), followed by the mid-onset group.

To further validate the subgroups, we reproduced the analysis in an urban subpopulation of eligible children. We observed a similar pattern of five subgroups (**Figure 2**), which consisted of 0.4% (early-onset), 2.5% (mid-onset), 4.5% (late-onset), 35.5% (preventive), and 57.1% (zero utilization) of the subpopulation, but consumed 12, 38, 39, 11, and 0% of the total dental cost, respectively.

DISCUSSION

Our study is the first to analyze pediatric dental claims data by calculating cumulative dental cost per person over multiple years (2009–2017). Our study is also the first to use unsupervised machine learning to characterize ECDC utilization among Medicaid-insured children. Using cluster analysis of accumulative cost curves, we identified five subgroups with distinctive clinical, cost, and utilization patterns among Ohio Medicaid-insured children: (1) early-onset of decay, (2) mid-onset of decay, (3) late-onset of decay, (4) regular preventive care, and (5) zero utilization. These subgroups are clinically meaningful and validated through patient chart review and characterization of each subgroup before 24 months. The five subgroups have also been reproduced in an urban subpopulation.

Comparison to Prior Studies

The five subgroups discovered in this study have not been previously reported. Nevertheless, our other results are comparable to findings from prior studies.

We found that the average cost for early-, mid- and late-onset groups were $9453.6, $5360.4, and $2,989.5 respectively (**Table 2**). This cost range is consistent with previous reports. In 2000, the average cost to Medicaid for dental treatment under general anesthesia was $2,009 per case in Iowa (28). In 2018, the average cost for dental treatment under general

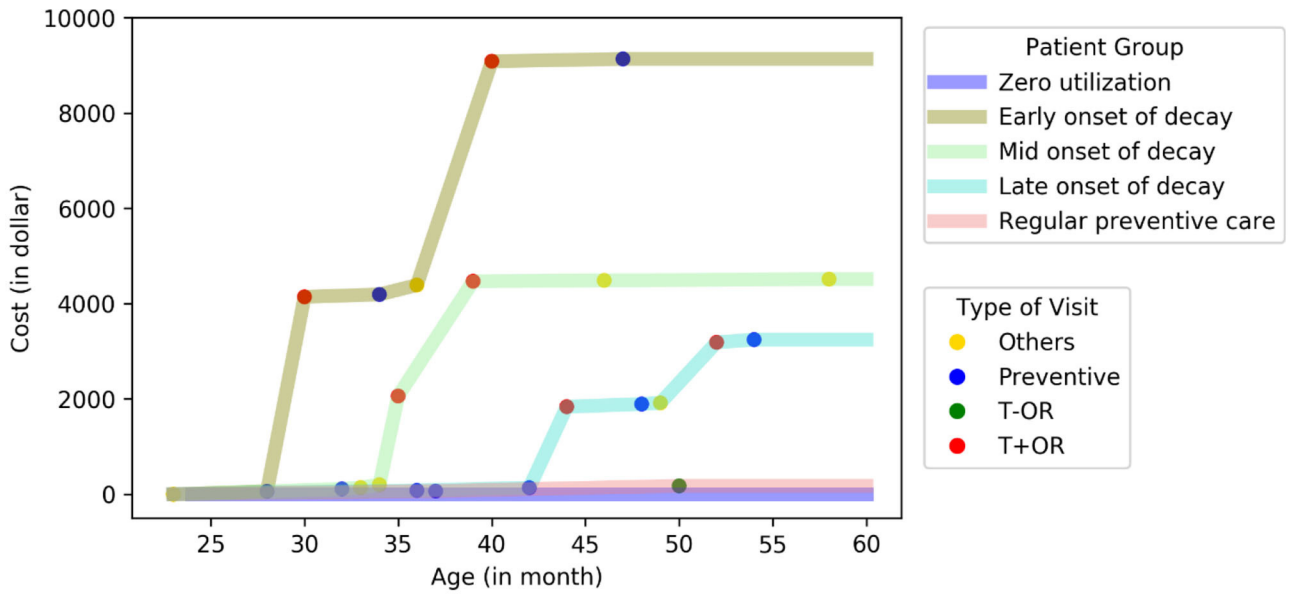

FIGURE 1 | Cost curve of five distinctive subgroups in PFK children who had continuously enrolled in Ohio Medicaid from age 24–60 months. A representative patient at the center of each cluster was plotted (total $N = 24,223$).

TABLE 4 | Medical and dental care characteristics of the five subgroups prior to 24 months old (Total $N = 24,223$).

Subgroup	Medical			Dental	
	Median cost of medical visits (Interquartile Range)	Median number of medical visits (Interquartile Range)	% classified as medically complex patients	% had a dental visit	Median age of first dental visit in months (Interquartile range)
Early onset of decay	$ 7,513 ($4,527–$12,546)	15 (10–28)	31.2%	29.5%	20 (14–19)
Mid onset of decay	$ 6,550 ($3,993–$11,210)	15.5 (9–24)	20.4%	30.5%	18 (10–20)
Late onset of decay	$ 6,399 ($3,957–$10,763)	16 (10–25)	21.8%	24.7%	16 (12–20)
Preventive care	$ 6,491 ($4,003–$10,824)	16 (10–25)	17.5%	22.3%	16 (12–20)
Zero utilization	$ 5,744 ($3,545–$9,710)	17 (11–27)	13.6%	10.4%	14 (12–20)
Overall	$ 6,300 ($3,892–$10,588)	16 (10–25)	17.0%	20.0%	16 (12–20)

Early, mid, and late onset of decay was defined based on the age when patients had their first treatment visit with operating room use.

anesthesia in a hospital setting was $9,833.79 (range = $2,062-$16,620) and $1,955.38 (range = $1,250-$3,525) in an office setting excluding professional fees (29). The use of general anesthesia for Medicaid-insured children is increasing and has significantly driven up Medicaid dental expenditures (30). Approximately 0.5% of Medicaid-insured children required general anesthesia at the cost of $68 million in 6 states, which extrapolates to $450 million nationally (31). Therefore, general anesthesia is likely the driving force of high dental costs for our three decay onset groups. Also, the recurrence of dental caries and restoration failure is exceedingly common among children treated under general anesthesia. When less durable restorations (e.g., composite restorations and strip crowns) are applied during general anesthesia, the failure rate is high, suggesting more treatments under general anesthesia (32). These additional treatments are likely another driver of the high cost for the three decay onset groups. Furthermore, atraumatic restorative techniques [e.g., silver diamine fluoride (SDF)] were not a covered benefit in Ohio Medicaid during our study period (2009–2017). This lack of covered benefit may have also contributed to the high dental costs observed in this study because repeated use of general anesthesia could have been potentially prevented if Ohio Medicaid covered SDF (33–35).

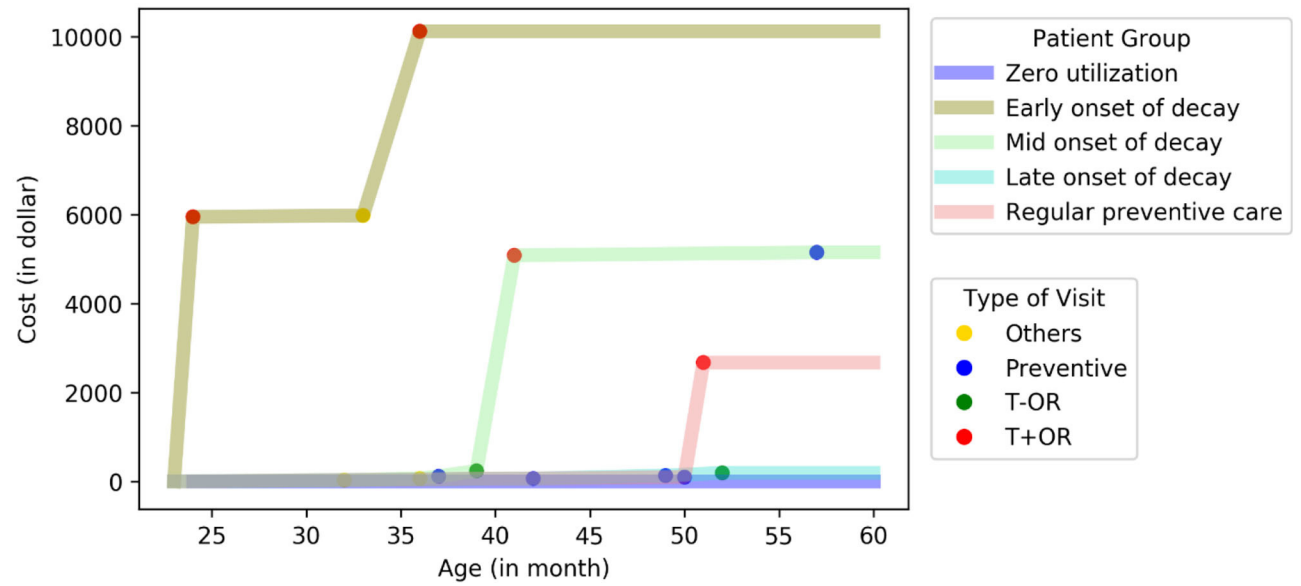

FIGURE 2 | Reproducibility of the five subgroups in an urban subpopulation. A representative patient at the center of each cluster was plotted. (total $N = 2,250$).

We also found that the early-onset group had their first dental visit at the oldest age and incurred the highest dental cost. This finding is consistent with prior studies that reported on ECDC utilization and costs. Nowak et al. found that children who started dental care at younger than 4 years of age had less restorative and surgical treatment than children who began dental care at an older age (11). Savage et al. also found that dental cost increases as the age at first preventive dental visit increases (10).

Furthermore, we found that the early-onset group had the highest percentage of patients with complex medical conditions (31.2%) and the highest medical cost (MAC = $ 7,513) before 24 months. This finding revealed an interplay between medical and dental conditions, which is consistent with previous findings. Craig et al. found that children with special healthcare needs (**SHCN**) had more caries and were less likely to use preventative dental care (19, 36). SHCN has been classified as a moderate risk for dental caries in children at 0–5 years (37). Chi and colleagues found that children with autism were less likely to utilize preventive dental care than those without autism (38). All those findings indicated that children with complex medical conditions tend to have more dental conditions.

Implications for Public Health Interventions

The early onset group included a small number of children (0.5% of the study population) but incurred disproportionately high costs (8% of the total dental cost to PFK). The early-onset group's representative patient had dental treatment under general anesthesia almost immediately after the first dental visit, indicating the child came to the dentist for the first time with severe dental caries (**Figure 1**). Caregivers of children in this early-onset group are likely to have low oral health literacy and few resources for finding dental care; and the children are not receiving any preventive dental care. Thus, the early-onset group's interventions should occur within their first 2 years of life and involve proactive outreach to their families. Support from primary care providers is essential but likely inadequate to connect those children with dental homes. An integrated medical-dental care delivery model may be a more viable and efficient approach to connect those children with dental homes. PFK has existing care coordination programs to help patients navigate and adhere to care with multiple healthcare providers. Dental care can be added as a critical component to the PFK care coordination program to proactively connect children with dental homes at an early age through home visits. This integrated care delivery model will further increase patient-centered care management and advocate for vulnerable children in many other ways.

The mid-onset group also included a small number of children (3% of the study population) and incurred disproportionately high costs (25% of the total dental cost to PFK). Compared to the early-onset group, we have a better chance of helping children in this group defer existing caries' progression and prevent subsequent caries. Primary care providers can play an essential role in preventing early childhood caries by incorporating oral health as a vital component of a routine well-child visit. Primary care providers can educate parents on healthy oral-health behaviors, provide fluoride varnish, and refer patients to establish a dental home by age one. Early Head Start programs can also support oral health by including dental screening and anticipatory guidance as a critical component of routine services such as child care (39, 40).

The late-onset group comprised 5.8% of the study population and incurred 30% of the total dental cost to PFK. Caregivers of children in this group likely have some oral health literacy level and necessary resources to access dental care; they may therefore have the potential to be caries free with early preventive

interventions. Primary care providers can play an essential role in helping those children by assessing their oral health and related behaviors at well-child visits. Primary care providers can educate parents on healthy oral-health behaviors, place fluoride varnish, and refer patients to a dental home. With the early establishment of a dental home, incipient caries can be treated with chemotherapeutic and minimally invasive restorative treatments which may avoid the need for general anesthesia (37). Early Head Start programs also can connect these families to dental care resources (39, 40).

The preventive care group comprised 68% of the study population. The preventive care group accounted for the largest share of the total annual dental cost to the ACO (38%) (**Table 2**). However, this group had the lowest associated median ($190.8) and mean ($357.6) annual dental cost among all the groups examined in this study. Future studies should examine this group in more depth to identify protective factors that can be encouraged in other groups.

The zero-utilization group comprised 23% of the study population. This percentage is consistent with previously published data where 28% of Medicaid-insured children in four states did not receive any dental services (41). We know little about the children in the zero-utilization group. These children will be older when they present to the dentist. Due to the lack of early preventive dental care, they are likely to have a high burden of dental disease. Despite the increased maturity, these children may still need general anesthesia as they have not developed the coping skills acquired during routine dental visits. At age 6, their permanent teeth will start erupting, and lack of ECDC may detrimentally impact their permanent dentition leading to a lifetime of dental compromise. The presence of a dental home should be assessed at well-child visits, and a referral made if the children have not seen a dentist. School-based dental programs may identify these children and connect them to dental care resources, but proactive care coordination at an earlier age would be ideal.

System-Level and Family-Centered Strategies

The costs observed in this study only reveal the tip of the iceberg of early childhood caries' impact on Medicaid-insured children and their families. Loss of a job, loss of income for time spent taking a child to dental appointments, missed school days, travel expenses, and mental and physical stresses are real and significant barriers to these families, exacerbated in today's chaotic economy (29, 42). System-level and family-centered strategies are warranted to mitigate those barriers and improve oral health for Medicaid-insured children.

Under the Early and Periodic Screening, Diagnostic and Treatment (**EPSDT**) benefit (43), state Medicaid programs must provide comprehensive and preventive health care services for Medicaid enrolled children under age 21. This provision includes dental care, regardless of whether such services are covered for adults or included in the state plan. Despite comprehensive coverage through EPSDT, access to dental care remains a barrier. Only 38 percent of dentists participate in Medicaid; low reimbursement rates are one reason cited by dentists for not participating (44). Although fluoride varnish in primary care has been promoted, oral health remains a low priority in Ohio Medicaid. To improve access to dental care among Medicaid enrolled children in Ohio, reimbursement incentives are needed to encourage dental care providers to participate in Ohio Medicaid. To integrate oral health into the overall health care system, national organizations, including the American Academy of Pediatric Dentistry, promote the establishment of a "health home." This health home would bring together the interaction of the child, parents, non-dental health professionals, and dental professionals to deliver medical and dental care in a coordinated, integrated, and family-centered way (45). Strategies are also needed to provide a sufficient and effective dental workforce and assure health professionals' appropriate training on ECDC management and parent education.

Beyond the healthcare system, oral health should also be coordinated with care systems supporting young children (e.g., childcare centers and schools). Childcare providers, teachers, and school administrators must be engaged as partners to promote early childhood oral health. They must know the origin and associated risk factors for tooth decay, be empowered to make appropriate decisions regarding timely and effective interventions, and facilitate dental care for young children (46, 47).

Fisher-Owens and colleagues proposed a model that recognizes the levels of influence on children's oral health and shows that child, family, and community interact with the biological factors impacting oral health (48). Drawing on this model, the Association of State and Territorial Dental Directors developed a strategic framework to prevent and control early childhood caries (45). The framework (**Figure 3**) includes four focus areas: Prevention, Disease Management, Access to Dental Services, and Systems of Integration and Coordination that are tied to the child, family, and community levels of influence on children's oral health. This framework can help plan and implement strategies, develop policies, conduct research, and allocate resources to prevent early childhood caries and improve early childhood oral health. Local, state, and national efforts should focus on these four areas to strengthen early childhood oral health.

Limitations and Future Studies

This study had several limitations. First, our findings were based on data from one state and may not be generalizable to other states. Each state operates its own Medicaid program within federal guidelines. Because the federal guidelines are broad, states have a great deal of flexibility in designing and administering their programs. As a result, Medicaid eligibility and benefits often vary widely from state to state. Also, similarities in training and practice patterns among Ohio dental providers may limit our findings' generalizability to other states. Future studies are warranted to assess whether our results can be replicated in other states. Second, we limited our study population to those with continuous Medicaid enrollment from 6 to 60 months of age. Although some potentially high-cost patients may be excluded due to discontinuous enrollment, continuous enrollment criteria

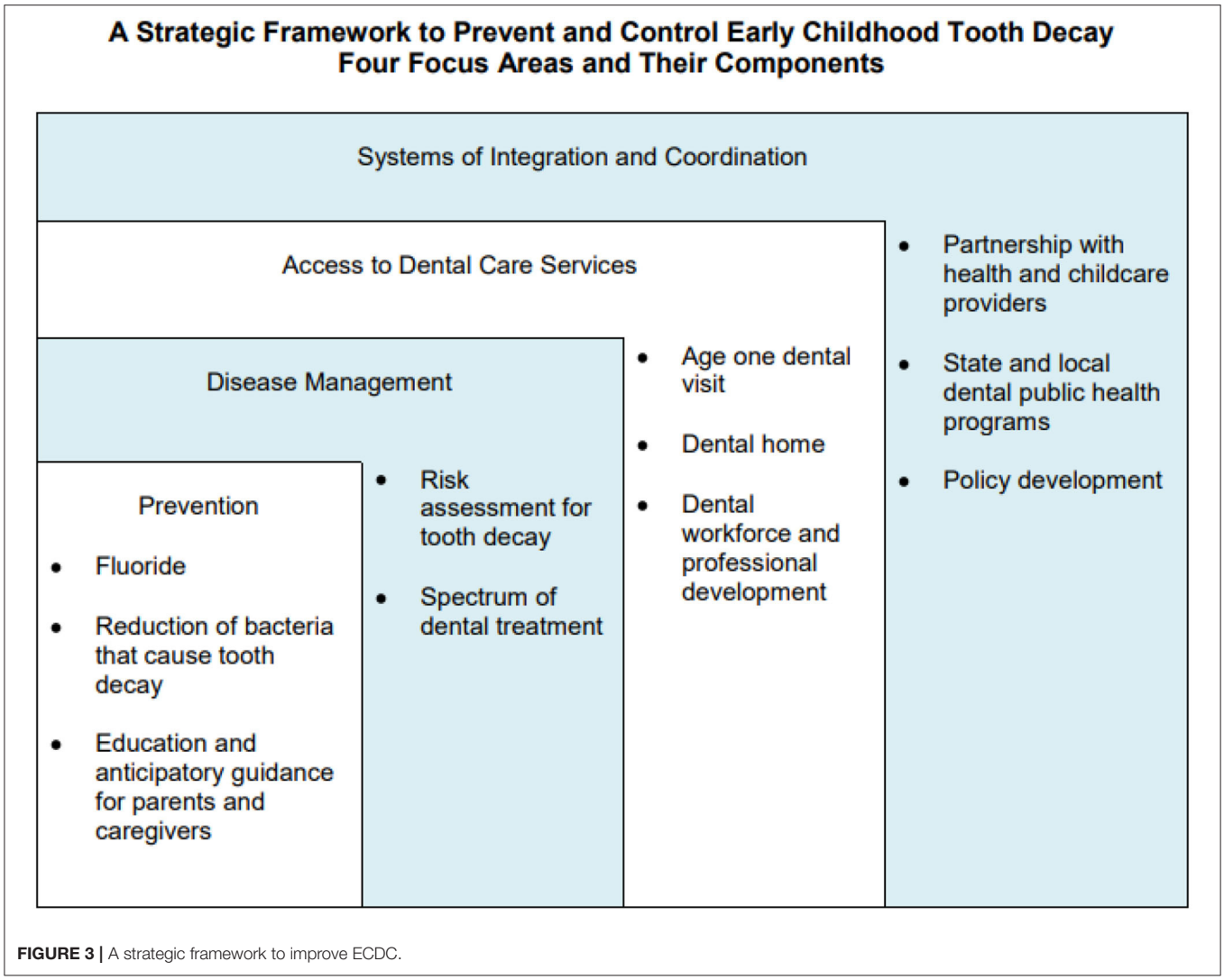

FIGURE 3 | A strategic framework to improve ECDC.

have been widely used in the literature to obtain complete longitudinal data to enable sound data analysis (49). Third, no race and ethnicity information were available in our data. Dasanayake et al. examined dental care utilization among Alabama Medicaid-insured children and found significant racial disparities in dental service utilization among those children (50). Future studies should further explore racial disparities in ECDC utilization among Medicaid-insured children. Fourth, although our data revealed an interplay between complex medical and dental conditions, we were not able to explore this topic in-depth in the current study. Frank et al. suggested that the extent of caries varies among different subgroups of children with SHCN (36). Future studies should further explore the relationship between SCHN and early-onset of dental caries. Furthermore, future analysis is warranted to identify geographical barriers to optimal oral health including lack of dental providers, lack of fluoridated water, or lack of access to healthy foods in some geographical areas. Targeted interventions such as mobile dental clinics, increased fluoride varnish applications by medical providers, or access to bottled fluoridated water may be cost-effective in a managed care population. Once we can predictably identify these groups, surveys can be implemented to understand better behavioral risk factors such as sugar intake or oral hygiene habits.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: Researchers must sign a data use agreement to use the dataset. Requests to access these datasets should be directed to https://partnersforkids.org.

AUTHOR CONTRIBUTIONS

JP: contributed to data acquisition, study design and results interpretation, and drafted and critically revised the manuscript. XZ: contributed to study design, results interpretation, and performed all data analyses. JT: contributed to results

interpretation, performed medical chart review, and drafted and critically revised the manuscript. GL: contributed to results interpretation and critically revised the manuscript. YH: critically revised the manuscript. SL: contributed to conception, study design and results interpretation, and critically revised the manuscript. All authors: gave final approval and agreed to be accountable for all aspects of the work.

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The Impact of COVID-19 on Preventive Oral Health Care During Wave One

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Introduction: Early childhood caries burdens children, their families, and the health care system. Utilizing fluoride varnish at medical well-child visits with non-dental primary care providers can be an interprofessional strategy to combat early childhood caries. The COVID-19 pandemic dramatically altered preventive health care delivery and the effects on preventive oral health care delivery have not been previously described.

Methods: This analysis used descriptive statistics and non-parametric Wilcoxon Mann-Whitney tests to compare preventive oral health utilization among 1 to 5-year old children in two state Medicaid agencies before and during the pandemic. Fluoride utilization rates at dental visits and medical well-child visits were calculated as number of users per 1,000 enrolled children. Additionally, the proportion of well-child visits that included fluoride application was calculated for each state.

Results: During the pandemic, the quarterly fluoride utilization rate significantly decreased at dental visits (pre-pandemic = 153.5 per 1,000 enrolled children; pandemic = 36.1 per 1,000 enrolled children, $p < 0.001$) and signficantly decreased at medical well-child visits (pre-pandemic = 72.2 per 1,000 enrolled children; pandemic = 32.3 per 1,000 enrolled children, $p = 0.03$) during the pandemic.

Conclusions: The findings highlight the importance of interprofessional collaboration among non-dental primary care providers and dental providers to provide access to preventive oral health services, particularly when access to dentists is limited. Future directions might include rigorous evaluations of co-located medical and dental services or the use of interprofessional telehealth technologies.

Keywords: Medicaid, dental public health, primary care, fluoride, pediatric dentistry, health services research, coronavirus, early childhood

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INTRODUCTION

Early childhood caries (ECC) is an age-defined condition of dental caries in children younger than 6 years old (1). For more than 25 years, professional guidelines have recommended establishing a dental home by age one (2). However, translating this recommendation into dental practices has lagged, so alternative venues have been explored. Children have significantly more medical visits than dental visits prior to age three (2). Accordingly, one intervention policymakers used

to increase the proportion of early oral health visits was to reimburse physicians for oral health screening, counseling, and prevention (i.e., fluoride varnish) during medical well-child visits (3).

Many researchers have evaluated oral health prevention provided at early ages of life. Early evidence demonstrated clear increased access to care following implementation of reimbursement for preventive oral health services at well-child visits in physician offices (3, 4). Increased reimbursement also increased utilization of preventive services in dental offices, but it created gaps and exacerbated disparities for certain groups requiring comprehensive care (5–8). For example, children with autism or intellectual and developmental disability had lower preventive care utilization than their peers (8, 9).

Well-child visits can help improve the utilization of preventive oral health services among young children (10). Compared to children who received preventive oral health services during medical well-child visits, children who received preventive care from a dentist had greater caries related treatment (4). Recent analysis questions the long-term benefits of physician provided preventive oral health services because over long follow-up periods, differences in caries related treatment and expenditures tend to attenuate (4, 11–13).

Beyond the application of fluoride varnish, medical well-child visits include personalized anticipatory guidance for general health and safety topics. Both well-child visits and early dental visits provide an opportunity to improve parental oral health knowledge and practices for their children (14). Additionally, these early visits offer chances to coordinate care and referral to dentists for high risk children with extensive and severe disease (15, 16). Well-child visits play an important role in the oral health care system, especially when access to a dentist is severely limited (17).

The coronavirus pandemic exacerbated and created significant access to care issues, especially for young children and those who already had limited access to oral health care. The pandemic disrupted daily life and significantly altered health care delivery. Access to dental care was severely hampered when many offices were forced to shut down or reduce operations to non-aerosolizing, non-emergent procedures according to state regulations and federal guidelines (18). The guidance for routine pediatric medical care was less imposing. The CDC posted guidance emphasizing the importance of routine well-child visits and immunization shortly after the national emergency response was declared in March 2020 (19). As the pandemic progressed, well-child visits returned to 90% of historic averages through 6 months of the pandemic (20).

Preventive oral health services at dental visits and medical well-child visits during the pandemic has not been described. The objective of this analysis was to compare preventive oral health utilization before and during the pandemic. Specifically, fluoride varnish utilization rates at dental visits and well-child visits were compared using data from the Medicaid programs in Ohio and North Carolina.

METHODS

The Ohio State University IRB determined this to be non-human subjects' research. Aggregate data from administrative claims were obtained from both North Carolina Medicaid and Partners for Kids, a pediatric accountable care organization managing the Medicaid program in southern and southeastern Ohio. For context, North Carolina Medicaid covers more than 1.2 million children, and Partners for Kids manages the Ohio Medicaid program for more than 325,000 children. North Carolina self-manages a fee-for-service dental program, and Ohio Medicaid primarily contracts with dental managed care organizations to operate its dental program which report to Partners for Kids. The Into the Mouths of Babes initiative in North Carolina was one of the first public health programs to reimburse physicians for preventive oral health services (3). At Partners for Kids, the program is comparatively newer, and physicians are encouraged to participate through the organization's quality improvement program. North Carolina limits reimbursement to physicians for preventive oral health services up to age 42 months, whereas Ohio continues reimbursement up to age 60 months, which aligns with the United States Preventive Health Services Task Force recommendation (21).

Monthly data summaries were requested for 1 to 5-year old children from January 2019 to June 2020. Limited to preventive visits, data for each age included:

- Number of dental visits with fluoride application.
- Number of well-child visits with fluoride application in physician offices.
- Total number of well-child visits.

Enrollment estimates for 1 to 5-year old children were approximately 76,000 in Ohio and 335,000 in North Carolina. Quarterly and monthly fluoride utilization rates were calculated separately for dental visits and well-child visits as the number of visits per 1,000 enrolled children per time period (i.e., quarter or month). The proportion of well-child visits that included fluoride application was also calculated. Although pandemic-imposed restrictions began in mid-March 2020, for analysis, the pandemic was defined as April–June 2020. Analysis relied on descriptive statistics and non-parametric Wilcoxon Mann-Whitney tests to compare utilization rates before and during the pandemic within each state. The level of significance was set at alpha equals 0.05, and all analysis was completed using Stata v.16.1 (STATACORP, LLC., College Station, TX, USA).

RESULTS

Overall, the quarterly fluoride utilization rate at dental visits significantly decreased by 117.4 per 1,000 enrolled children during the pandemic (pre-pandemic = 153.5 per 1,000 enrolled children; pandemic = 36.1 per 1,000 enrolled children; $p < 0.001$). Quarterly fluoride utilization rate at medical well-child visits significantly decreased by 39.9 per 1,000 enrolled children during the pandemic (pre-pandemic = 72.2 per 1,000 enrolled children; pandemic = 32.3 per 1,000 enrolled children; $p = 0.03$). However, the proportion of well-child visits that included

fluoride application did not significantly change (pre-pandemic = 26%; pandemic = 20%; $p = 0.2$).

Quarterly utilization rates for each state are summarized in **Figure 1**. North Carolina had higher fluoride utilization rates at dental visits and well-child visits than Ohio. The proportion of well-child visits that included fluoride application was more than double in North Carolina than in Ohio (40 vs. 18%, respectively). During the pandemic, fluoride utilization rates at dental visits significantly declined in both states. In Ohio, the difference was 116.8 per 1,000 enrolled children ($p < 0.001$) and in North Carolina, the difference was 118 per 1,000 enrolled children ($p < 0.001$). Changes in fluoride utilization rates at well-child visits differed in each state. In Ohio, fluoride utilization rate at well-child visits significantly decreased by 45 per 1,000 enrolled children per quarter ($p = 0.007$). In North Carolina, fluoride utilization rate at well-child visits decreased by 34.8 per 1,000 enrolled children per quarter ($p = 0.3$). The proportion of total well-child visits that included fluoride was not significantly different during pre-pandemic and pandemic periods. In Ohio, there was a 4 percentage point decrease ($p = 0.3$) and in North Carolina, there was a 0.1 percentage point decrease ($p = 0.9$).

The patterns of monthly utilization are shown in **Figure 2**. The two states had similar patterns of fluoride utilization rates at dental and well-child visits overall and across age strata. Fluoride utilization rates at dental visits essentially went to zero during March and April 2020, but has since rebounded. Consistently over the study period, 1-year-old children were the age group with the greatest proportion of recipients of fluoride varnish at well-child visits (**Figure 2**). The major source of professionally applied fluoride during the onset of the pandemic occurred in medical, rather than dental, settings.

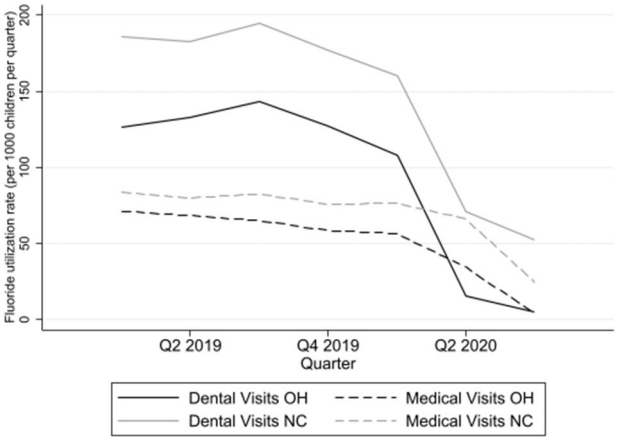

FIGURE 1 | Quarterly fluoride utilization rates at dental visits and medical well-child visits in Ohio (OH) and North Carolina (NC) among Medicaid-enrolled children from January 2019 to June 2020. Q1: January–March. Q2: April–June. Q3: July–September. Q4: October–December. In this figure, the pandemic begins during Q2 2020.

DISCUSSION

The results of this exploratory analysis highlight the importance of physician offices within the preventive oral health care safety net in two states during the first wave of the pandemic. For very young children, a physician's office may be the only source of professional oral health prevention. The sharp decrease noted in fluoride utilization rate at dental visits (75%) is especially dramatic when compared against the decline in vaccination visits among 0–2 year old children (25%) during the pandemic (22). When dental offices were closed or open only for emergency care during the early stages of the pandemic, physicians continued to provide preventive oral health care, albeit at a reduced rate, especially for 1- and 2-year old children.

Across the United States, only 8% of young children receive preventive oral health services at medical well-child visits (23). Additionally, recent analysis demonstrates that preventive oral health delivered at well-child visits complement, rather than replace, preventive dental visits (24). The two states examined in the present analysis compare favorably to the 8% reported average for preventive oral health delivered at well-child visits (Ohio = 6%; North Carolina = 8%) (23). Preventive oral health services at well-child visits have come a long way since their inception. While their use is increasing, a number of barriers and facilitators have provided insight to implementation. Lack of training during medical school, limited time with each patient, low reimbursement, poor implementation support, and non-integrated medical and dental records have prevented more widespread implementation, while having an office champion, implementation teams, good reimbursement policies from state public health programs, and a leader with a clear vision for how oral health will be included in the practice facilitate implementation (10, 25, 26).

The barriers noted above point to opportunities that can maximize delivery of preventive oral health services to very young children. The push toward interprofessional education and practice, as well as medical and dental integration has been well described (27–30). In addition to training physicians to provide oral health screening and apply fluoride varnish, two ideas that have been implemented at local and state levels include co-located services and care coordination. Colocation can facilitate many aspects of care coordination, particularly if the staffing model is optimized to use each workforce member to the highest level of their degree. Several versions of colocation models are available depending on state regulations governing the practice of dentistry and dental hygiene. Proposed models would include (1) the medical office hires a dental hygienist, (2) the dental hygienist practices independently, or (3) the dental hygienist serves as a spoke from a dentist-operated hub clinic (29). Colocation also demands full time staff from both professions so patients have continuous access to the elements of the medical and dental home. With the right staffing model and referral relationships, teledentistry workflows can farther facilitate colocation and care coordination (18). These innovative delivery models need support from reimbursement mechanisms, and as an accountable care organization, Partners for Kids may be able to engage its participating providers in different incentive plans based on performance against benchmark quality measures.

The implications of these findings must be considered in the context of barriers that families face as a result of the pandemic. In the dental office, many practices are asking

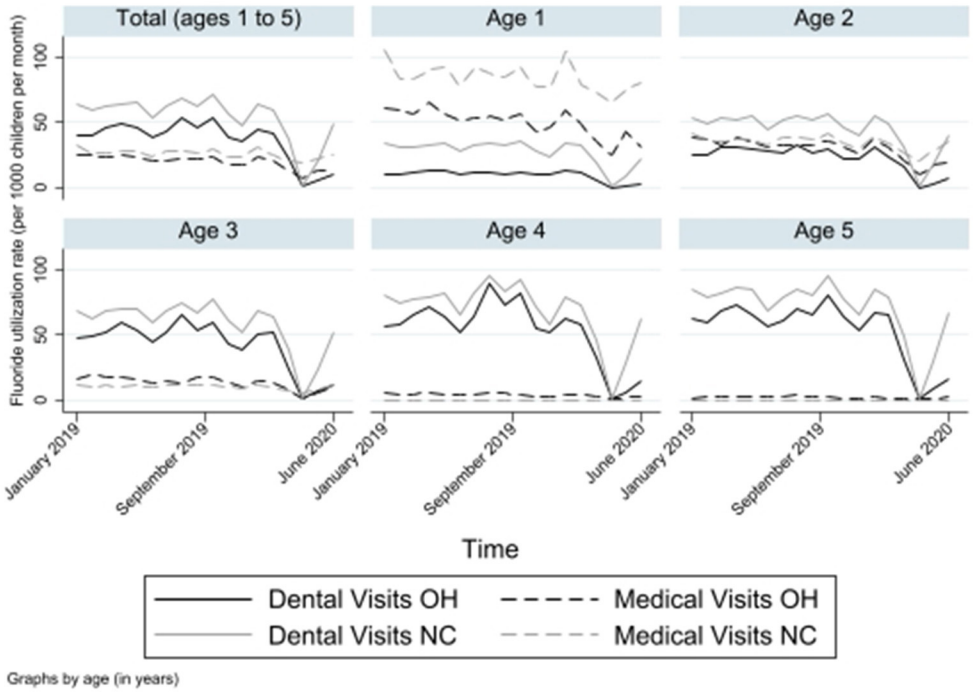

FIGURE 2 | Monthly fluoride utilization rates at dental and medical well-child visits in Ohio (OH) and North Carolina (NC) among Medicaid-enrolled children from January 2019 to June 2020. Rates are plotted in total and by age from 1- to 5-years old. In this figure, the pandemic begins in March 2020.

fewer family members attend dental visits to maintain physical distancing recommendations. This may mean families with multiple children have to spread appointments over multiple days which can be cumbersome and subject the family to additional barriers. Whether individuals have new fears of getting sick, are burdened by school closures or looking after high-risk family members, or have become unemployed, the pandemic has altered how we interact with the health care system. For oral health, these changes are paradigm altering, and building collaborative relationships and care networks whether through referrals or telehealth consultations will become increasingly important. Interprofessional collaboration between non-dental medical and dental providers is critical. If infant oral health is to become the next great dental public health achievement (31), medical and dental collaborations, likely at well-child visits, will become a backbone of progress.

The present analysis was limited in scope. Differences in Medicaid administration, provider participation, training, and reimbursement, as well as state regulatory responses to the pandemic could partially explain the results. This analysis compared two different state-run health care systems, with system-level factors affecting medical well-child visits, dental visits, and preventive oral health service delivery. The pre-pandemic time period (January 2019–March 2020) also differs from the pandemic time period (April 2020–June 2020). Although visit utilization rates per 1,000 children per quarter were used for analysis, well-child visits and family engagement with medical and dental care may differ between the two time periods. The data and subsequent analysis could not assess the impact of the pandemic on dental outcomes or the quality of preventive oral health services provided at well-child visits. As aggregate data, the specific characteristics of the children receiving fluoride at dental visits and well-child visits could not be compared. The cost of personal protective equipment may play a more critical role in economic evaluations of early preventive oral health visits, but costs were not included in the present analysis. Conclusions from claims analysis are limited to system users, both participating providers and beneficiary users. The present analysis did not include specific provider or beneficiary data. Despite these limitations, the findings presented here underscore the importance of well-child visits in the preventive oral health safety net. Among the chaos imposed by the pandemic, fluoride utilization at well-child visits served as the primary source of preventive oral health for many young children.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

BM was responsible for the study design, data collection, analysis, and interpretation, and manuscript preparation. DD was responsible for the data interpretation and manuscript preparation. BM and DD agree to be accountable for the content of the work. All authors contributed to the article and approved the submitted version.

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frontiers in Public Health

ORIGINAL RESEARCH
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Communicating With Parents and Preschool Children: A Qualitative Exploration of Dental Professional-Parent-Child Interactions During Paediatric Dental Consultations to Prevent Early Childhood Caries

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The aim of this study was to explore communication interactions and identify phases adopted by dental professionals with parents and their young children and to examine the hypothesis that successful social talking between the actors together with the containment of worries allows the formation of a triadic treatment alliance, which leads to achieving preventive dental treatment goals. Conversation analysis of the transcribed data from video recordings of dental professionals, parents and preschool children when attending for preventive dental care was conducted. The transcriptions were read, examined and analysed independently to ensure the trustworthiness of the analysis. The transcriptions were explored for interactive patterns and sequences of interaction. Forty-four individual consultations between dental professionals, parents, and preschool children were recorded. The number of communication behaviours was 7,299, with appointment length ranging from 2 min 10 s to 29 min 18 s. Two patterns of communication were identified as dyadic (between two people) and triadic (between three people) interactions within a continuous shifting cycle. The three phases of communication were social talking, containing worries and task-focusing. Social talking was characterised by shifts between dyadic and triadic communication interactions and a symmetry of communication turns and containing worries. This typified the cyclical nature of the triadic and dyadic communication interactions, the adoption of talk-turn pairs, and triadic treatment alliance formation. Task-focusing pattern and structure were different for dentists and extended-duty dental nurses. For dentists, task-focusing was characterised by a dyadic interaction and as an asymmetrical communication pattern: for extended-duty dental nurses, task-focusing was typified by symmetrical and asymmetrical communication patterns within dyadic and triadic interactions. Empathy and understanding of the young child's emotional needs during containing worries

allowed the formation of the triadic treatment alliance and with this treatment alliance, the acceptance of interventions to prevent early childhood caries during "task-focusing." This qualitative exploration suggests that dyadic and triadic communication interactions are of a dynamic and cyclical quality and were exhibited during paediatric dental consultations. The communication phases of social talking, containing worries and task-focusing were evident. Successful social talking signalled the entry to containing worries and triadic treatment alliance formation which permitted the preventive goals of the consultation to be achieved (task-focusing). Future work should generate additional data to support the hypotheses created here namely that, social talking and containing worries triggers an integral pathway to task-focusing and the achievement of preventive dental goals.

Keywords: communication, conversational analysis approach, paedodontics, dental professional, parent, pre-school child, utterances, cues

INTRODUCTION

The United Nations Convention on the Rights of the Child (UNCRC) Article 12 secured children's rights and influenced policies for children to be included and to be heard in their healthcare (1, 2). Children aged as young as 4 years of age, when accessing health services with their caregivers, are said to be able to recall information, would like more involvement in the discussions concerning their health and wish to have a say about their treatment (3, 4). Some evidence suggests that young children can engage with the health professional, although their participation in the consultation is limited (5). Nonetheless, children do experience barriers in their understanding and voicing their opinions (6). The proposed asymmetrical interaction between caregivers and the health professional contributes to a dilemma for the health professional when attempting to engage with the child patient in active treatment (7). The paediatric dental appointment is no different.

The paediatric dental consultation, in addition to the above, is fraught with worries and concerns. For the dental professional, the interaction with parents and children may be troublesome because of the relationship between parental and child dental anxiety and the wish, on the part of the dental professional, to maintain a two-person interaction with the parent, unwittingly, at the expense of the child (8, 9). For the parent there are worries that the child will accept treatment and will be able to manage the encounter with the dental professional. For the child all is strange and unfamiliar. It is in this setting that dental professionals must provide dental care using their communication and behavioural management skills to reduce the dental anxieties and other parental and child concerns. Effective communication is, thus, essential for successful dental care outcomes in the paediatric clinic.

To achieve this goal, dental professionals must ensure that both the parent and the child are involved and have the opportunity to contribute and speak during the treatment appointment. This is an important step since effective communication strategies will contain implicit or explicit parental and child dental anxieties and permit through sensitive enquiries the formation of a special type of treatment alliance. This treatment alliance is different from that between the adult patient and dental professional which may be thought of as an adult-to-adult interaction in which the patient accepts the treatment the health professional is offering. The dental professional, however, when caring for children must form the treatment alliance with the child through the parent (9). This treatment alliance may be referred to as a triadic treatment alliance and the interaction, within the alliance, categorised as triadic communication between health professional, parent and child (10, 11). The dental professional by promoting and maintaining this three-way conversation upholds the treatment alliance with the child that can enable successful treatment outcomes. However, with the pre-school child, communication is complex. This is strongly related to the stage of the child's cognitive and emotional development. Therefore, the dental professional needs first, to establish rapport with both parent and child, secondly, engage in information gathering and respond to questions from the parent and thirdly, acknowledge the complexity of the verbal and non-verbal exchanges between the three "actors" (i.e., the dental professionals, parents and the young children). Intrinsic, thus, to the treatment alliance is effective verbal and non-verbal communication together with the containment of patient worries and concerns by the health professional.

In addition, health professionals must focus on the task at hand and exchange information with the parent to ensure that all clinical safeguards are maintained (6). This is echoed in Kelly et al.'s work with a warning, that "when the emphasis moves to parents as consumers of paediatric healthcare, children are at risk of being objectified or even marginalised" (12). Empirical work, has suggested, that when dental nurses are trained in communication skills, they can provide effective oral health interventions for and with the young child and their caregiver (13). More recent research supports this finding. It has revealed that when caregivers/parents are actively involved in their child's dental health care, their interventions promote the transfer of knowledge (14). Nevertheless, when parents unwittingly become an "interpreter" for their child, translating the dental professionals' words into a clear, understandable form, there is the danger that parental utterances may hinder rather

than enable child patient-centred care (15, 16). It is known that when children are unintentionally excluded from the interaction between practitioner and parent, they interrupt and interject with talk and gestures. Jenkins et al. (17) describe these encounters as "instigating talk" to attract the attention of the parent to contribute to the conversation. This demonstrates a number of interactive processes, such as for example social talk, that occur during the appointment with the child patient. Following Tannen's formulation, this talk may be conceptualised as "communication scripts" which Tannen proposes are important for the different phases of the paediatric appointment between professional, parent and child. The significance of these different communication scripts we suggest, is that they enable the professional to respond and to assist the child and parent to navigate from examination to treatment. Our previous work (18), limited to the immediate effects of the dental professional's words on the child's behaviour, would support this interpretation of Tannen's thesis (19). However, what remains unclear, is the relevance of such communication interactions and phases and how they affect children's engagement and acceptance of treatment in the dental setting. While we acknowledge the salient work of Bridges et al. (16) and Wong et al. (14) we believe that it is the nuances of the communication interactions and subsequent phases that are of central importance. The aim of this study, therefore, was to explore communication interactions and identify phases adopted by dental professionals with parents and their young children and to examine the hypothesis that successful social talking between the actors together with the containment of worries allows the formation of the triadic treatment alliance, which leads to achieving preventive dental treatment goals.

METHODS

Study Design

The present study is an analysis of the video recordings from the BEHAVE2 study (18, 20). The BEHAVE 2 study, video recorded 44 individual paediatric dental appointments between dental professionals, preschool child patients and their parents. In total the number of communication verbal and non-verbal behaviours recorded was 7,299. All turns had been given a unique behavioural code in the original primary analysis. The rate of all communication instances was: 5.92 instances/min for the dental professional; for the parent 3.22 instances/min and for the child 1.06 instances/min. The length of the appointments ranged from 2 min 10 s to 29 min 18 s. We adopted a qualitative exploration of the transcriptions of the video recordings and used a conversation analytic approach to scrutinise the data.

Setting

The Childsmile Programme is funded by the Scottish Government, whose purpose is to reduce child dental health inequalities using the proportionate universalism approach (21). As part of the programme, parents of children aged as young as 2 years, are encouraged to access primary dental care for fluoride varnish applications twice a year to prevent early childhood caries. During such appointments, the dentist or the Extended Duty Dental Nurse (EDDN) will apply fluoride varnish to the child and discuss toothbrushing regimes and healthier diets with the parent/caregiver. Since the type of treatment as well as the age of the child affects the relationship between parental and child dental anxiety (8), the relative non-invasive nature of the Childsmile appointment provides a perfect occasion to examine communication processes in the paediatric dental appointment.

Participants

Purposive sampling was used to identify dental professionals who participated in the Childsmile programme in general dental practises located in East of Scotland. Four general dental practises were approached and agreed to take part, which included urban and rural practises in affluent and deprived areas. Five dental professionals working in these practises agreed to participate in the study and completed the written consent form. Fifty child-parent dyads were approached and invited to take part with the following six pairs being excluded due to: (i) two pairs of twins were treated with their twin siblings; (ii) one child was the sibling of the participating child and was invited by the parent to receive fluoride varnish application during the video observation; (iii) one child was excluded due to observed learning difficulties; and (iv) two children declined to take part.

Data Collection

Paediatric dental consultations were video recorded to capture both the verbal and non-verbal communication. Each consultation included, toothbrushing with fluoride toothpaste and dietary advice, and a fluoride varnish application. All the video recordings were collected during May – September 2017 (20).

Data Analysis

Conversation analysis was used to analyse the transcribed video data (22–24). The conversation analysis approach is particularly well-suited to video recordings within real-life scenarios of clinical interactions where wide variation of both content and participation of "actors" is apparent. Bridges et al. (16) suggest that conversational analysis is an appropriate form of qualitative analysis in the dental setting since it permits "the specific qualities of patient-centred care" to be realised and the "sequential patterns of activity" during the dental visit to be identified. High definition quality video clips of a series of appointments enabled detailed transcripts of the verbal and non-verbal content and behaviour to be prepared as the data corpus for members of the research team to apply conversational analysis.

The transcriptions were investigated for interactive patterns and sequences of interaction. The analytical purpose was to examine how the "actors" interacted, rather than an in-depth examination to explain choice of communication behaviours (22). Therefore, in this instance conversation analysis focused on the "talk-in-interaction" in the dental setting. Conversation analysis was used to capture the details of the turns taken in the conversation in terms of the timing, the subtleties of the utterances between the speakers including the phrasing, the patterns of stress, the intonation as well as non-verbal behaviours.

TABLE 1 | The three basic models of the health professional-patient interaction of Szasz and Hollender (28).

Model	Health professional role	Patient role	Application	Prototype of the model
Activity passivity	Does something to the patient	Accepts and receives the treatment	Treatment	Parent to child
Guidance cooperation	Listens to the patient; tells the patient what to do; makes the treatment decisions	Speaks with the health professional but accepts the treatment decisions	Examination appointment	Parent to child
Mutual participation	Advises and negotiates treatment decisions	Patient in equal partner care	Negotiation of treatment or preventive plans	Adult to adult

In this analysis, for each paediatric dental consultation, the sequential structure, turn-taking, and patterns of turns of the communication were analysed using Finset and Ørnes' (25) theoretical understanding of clinical encounters. Garrod and Pickering outline a helpful framework to understand some of the subtle phenomena that can be identified in many clinical interactions. They highlight patterns of interactions within the consultation that go very smoothly and "speakers apply largely automatic and unconscious processes of interactive alignment in the process of speaking and listening in conversations" (26). Communication in these instances according to Finset and Ørnes "becomes more symmetrical and with a higher degree of mutuality" (25). These patterns are identified from close attention to the individual turns taken by the actors. Many of these turns are linked to exhibit these key phenomena within consultations. For clarity, we adopted the definition of turn-taking as, "the single speech turn (i.e., continuous speech by [*the actors*] that is preceded and followed by the other's speech) can therefore contain more than one utterance" (27).

The phase of the communication was informed by the hypothetical model of clinician-patient interaction of Szasz and Hollender (28). In their theoretical paper Szasz and Hollender proposed three different models of the clinician-patient interaction (**Table 1**). The first of these is the activity-passivity model in which the health professional does something to the patient and the patient receives and accepts the care provided. The activity-passivity model reflects the paternalistic model of the dentist-patient interaction in which the dentist is active and the patient passive (29). The second model is guidance-cooperation. Within this interaction the health professional tells the patient what to do and the patient obeys accordingly. The guidance-cooperation model is evocative of the dental check-up visit in which to quote Coleman and Burton (30) "the patient knows something; dentist knows something." Therefore, there is joint knowledge in the guidance-cooperation model, and while the health professional listens to the patient, it is the health professional who makes the final treatment decision. The last part is mutual-participation model in which the health professional and patient are joint partners. This is distinctive since the patient is active in the choices and decisions with the health professional regarding their health care (28). Hence, we applied in parallel through conversation analysis the close examination of turns to identify features of various aspects of interactive alignment across possible phases of the consultation as described by Szasz and Hollender.

The process of conversation analysis, adopted here, included (31):

1. Selecting relevant interactions

During the initial viewing of the video data interesting moments or "noticings" relevant to the research question were logged by SY and RF, separately. These are also referred to as "connexions" by Finset and Ørne (25). This was a slow and arduous process as the videos were examined frame-by-frame. Following, this first tranche of the video data, the identified incidents were watched, and the process repeated. During this time SY and RF watched, shared and discussed the choices made (31). Finally, the incidents or "episodes" transcribed were those which focused on the question under investigation. Viewing the videos frame-by-frame permitted the video data in the form of "stills" (e.g., positioning of the child and parent during the appointment) to supplement the transcribed data.

2. Identifying recurrent interactional patterns

SY and RF returned independently to examine the transcribed episodes in more detail with regard to how the EDDNs and parents engage the child in the interaction; how the child responded in turn to any invitation to speak by EDDN or parent, and the triadic communication patterns identified from the turn-by-turn analysis.

3. Analysing the excerpts on the micro-level

The specifics of the conversation including the following: turn-taking, the sequence of turns, interruptions and pauses, tone of voice, pitch of speech, selection of words were also analysed to examine the communication phases and conversational strategies that each speaker used in the health encounter. Non-verbal behaviours such as gaze and positioning were also examined from the supplementary video material. Positioning, for example, was noted if the child was sitting on the parent's lap, or sat adjacent or opposite to the parent.

4. Trustworthiness of the data analysis

The transcriptions were read, examined carefully and analysed independently by SY, RF and GH to ensure the trustworthiness of the data analysis. They examined the transcripts to identity sequence, turn-taking etc. from the thick descriptions of the

TABLE 2 | Conversational analytic transcription symbols (16).

Symbol	Description
[ ]	Overlapping speech
↑	Upward shift in pitch
↓	Downward shift in pitch
Wor:d	(Colon) Prolongation of sound
w<u>or</u>d	(Underline) Emphasis
WORD	(CAPITALISED word) Section of talk that is relatively loud than the surrounding talk
°word°	(Degree mark) Section of talk that is relatively quieter than the surrounding talk
(( ))	Transcriber's comments including non-verbal behaviours
=	No gap between the two turns.
X:X	An underlined colon within a syllable indicates that the intonation within the syllable falls then rises.
XX:	An underlined second letter within a syllable followed by a non-underlined colon indicates that the intonation within the syllable rises then falls.

data. When a difference occurred, this was discussed between SY and RF. In the instance where consensus could not be reached, GH was asked to contribute thus ensuring consensus and achieving confirmability. Using their clinical and social knowledge of paediatric dentistry, permitted SY and RF to have a cogent understanding of utterances during the consultation; SY (20) and GH (32) have in-depth knowledge of video analysis of communication and RF is experienced in qualitative methodologies. In view of this expertise the credibility of the data analysis was ensured.

5. Presentation of the transcriptions

We have taken into consideration, the complex transcription symbols that are used in conversational analysis when presenting verbatim transcripts. To enhance the readability and better understanding of the selected excerpts, we have simplified the detailed transcription symbols (15) in the verbatim transcripts (**Table 2**).

6. Anonymity and confidentiality

All of the children's names provided in the extracts presented have been changed to ensure the anonymity of the participating child and parent.

RESULTS

Forty-four paediatric dental consultations were video recorded. The children were aged between 24 and 70 months, 21 were boys. The participating dental professionals had varied experience with one in their first year since qualification, and the remaining having between 5 and 10 years clinical experience. All accompanying caregivers were mothers, except on five occasions where a grandparent ($n = 1$) and a father ($n = 4$) accompanied the children. Please note that the generic term parent will be used to describe all caregivers.

Recurrent Patterns and Communication Phases

The results are presented in the order of the dental consultation, starting with the dental professional welcoming parent and child, information gathering, answering questions and moving to the objective of the Childsmile visit, that is to provide oral health education and fluoride varnish application. The extracts provide examples from the transcriptions all of which showed features of the communication patterns and communication phases described below.

Two recurring patterns of communication were identified within the duration of the appointment and were dynamic in their nature. We propose that two communication interactions primarily occurred during the Childsmile appointments explored here: the first a dyadic dental professional-parent, and/or dental professional-child and/or parent-child interaction and secondly a triadic dental professional-parent-child interaction which emerged as a continuous shifting cycle of dyadic and triadic interactions. Three phases of communication interaction were observed. These were (i) social talking, (ii) containing worries and (iii) task-focusing. To illustrate in greater detail the three communication phases, key excerpts are presented below and in order.

Communication Phase 1: Social Talking

The following two extracts are illustrative of shifts in social talking to form or maintain triadic communication interactions. In the first extract, Jack a 4-year-old knows the dental professional (EDDN) well: in the second extract Mike a 5-year-old is visiting the practise for the first time. It is evident that the communication interactions used by the same dental professional in the two scenarios provided was different.

In the first extract (**Extract 1**), the dental professional's social talking is more direct to both Jack and mother and the following discussion is between all three participants. In the second, Mike is in a new setting, he is hesitant and relies on mother to speak first and support him in his engagement with the dental professional's social talking. This is reflected in the number of utterances in each extract. Jack has eight compared with five utterances from his mother and the dental professional: Mike and his mother have seven utterances each, while the dental professional has 13. This suggests that a symmetry in the triadic communication interaction existed between Jack, mother and the dental professional. This is demonstrated in the first few moments of the appointment - the questioning (DP: line 1), the support from mother (line 2) and Jack's answers about his sore knee and elbow (for example line 3, "I fell over today") directly to the dental professional (20). The observed symmetry of the triadic communication interaction also reflected the guidance-cooperation (lines 1–3) and the mutual-participation (lines 4–19) phases of the relationship between parent, child and dental professional. The interaction between Jack and the dental professional echoed a lexical alignment with the same words being used between the adjacent pairs, for example in lines 3 and 4. The equality of the interaction, observed in the partnership

working, were apparent and appeared to be characteristic of social talking within triadic communication.

In contrast, the communication interaction between the dental professional, the parent and Mike was different and was typified by the dynamic quality of their communication interaction. During the opening part of the consultation, the interaction was observed as dyadic (lines 1–4) whereas for most of the interaction it was triadic (lines 7–35). As the shifts in dyadic and triadic communication were noted, a change was also observed in the symmetry of the turns, within the interactions, between Mike, parent and the dental professional. Adopting Finset and Ørnes' (25) theoretical model, we propose that the dental professional used her social talking (lines 1–10) to "shape [*Mike and mother's*] responses" (18), suggesting a "guidance-cooperation" phase of their interaction (Mike obeyed when told by the dental professional not to sit on the "tub chair," line 3). Only after mother's comment of her child's shyness did the shift in communication phase become evident and move to a "more affiliated and facilitative communication" as noted in the change to a more symmetrical form (25). The dental professional's social talking appeared to be empathetic as evidenced by Mike's engagement (line 13). Therefore, in this instance, the dental professional's awareness and understanding of the child's shyness and interest in the cartoons on the surgery wall, enabled her to use the cartoon characters as a foundation of her social talking to Mike and mother. However, the closing down of mother's utterance, "Where's the shark?" by the dental professional by asking Mike, "Do you know why you are here today?", suggested something different (lines 31–35). This sudden shift in topic implied that engagement between the three "actors" was interrupted. This interruption signalled a change from a symmetrical to an asymmetrical pattern within the triadic communication interaction, together with a shift from a mutual-participation (lines 7–31) to a guidance-cooperation (line 31–35) phase. The dental professional acted to "optimise" Mike and mother's responses to permit the goal of the dental appointment to be achieved, namely to show mother and Mike how to "Clean teeth↓" (line 35).

Social talking (**Figure 1**) in the form of greeting and welcoming the parent and child, was used by all the dental professionals to speak and engage with parent and the child during the initial phase of the appointment. However, the length of time used for social talking was related to the type of dental professional. EDDNs spent longer and

EXTRACT 1 | Jack returning to the practice.

1. DP: So [Jack], tell me, what have you been doing to your knee? ((when Mum put the boy onto her lap sitting in the tub chair opposite the dental chair))
2. Mother: °What happened to your knee?° ((when DP pointed to his knee with a plaster))
3. Jack: (He looked at his knee, then looked to the DP) I fell over today.
4. DP: TO:DAY↓ = ((DP looked surprised))
5. Jack: =[Yeah] I did it last week ((showing his elbow to the DP, and then DP touched his wound on the elbow))
6. DP: Okay.
7. Jack: I did this to-day ((Boy's hands put on his knee)).
8. DP: It's a new one↓
9. Jack: Yeah ((Mum nodded and looked at the boy))
10. DP: What did you do? (0.4) You fell over? Where did you fall?
11. Jack: On…on the pavement.
12. DP: Haha haha…at school or…?
13. Mother: Haha…. [Yeah] nursery (0.8He's very literal. And he could be literal (and that could be funny). ((Both Mum and DP giggled))
14. M: Do you know that? ((Mum faced toward the child))
15. Jack: We were=
16. Mother:=[In] the nursery, wasn't it? ((Mum faced the child and waited for him to confirm))
17. Jack: Yeah…
18. Mother: Outside in the garden, wasn't it?
19. Jack: Yeah…

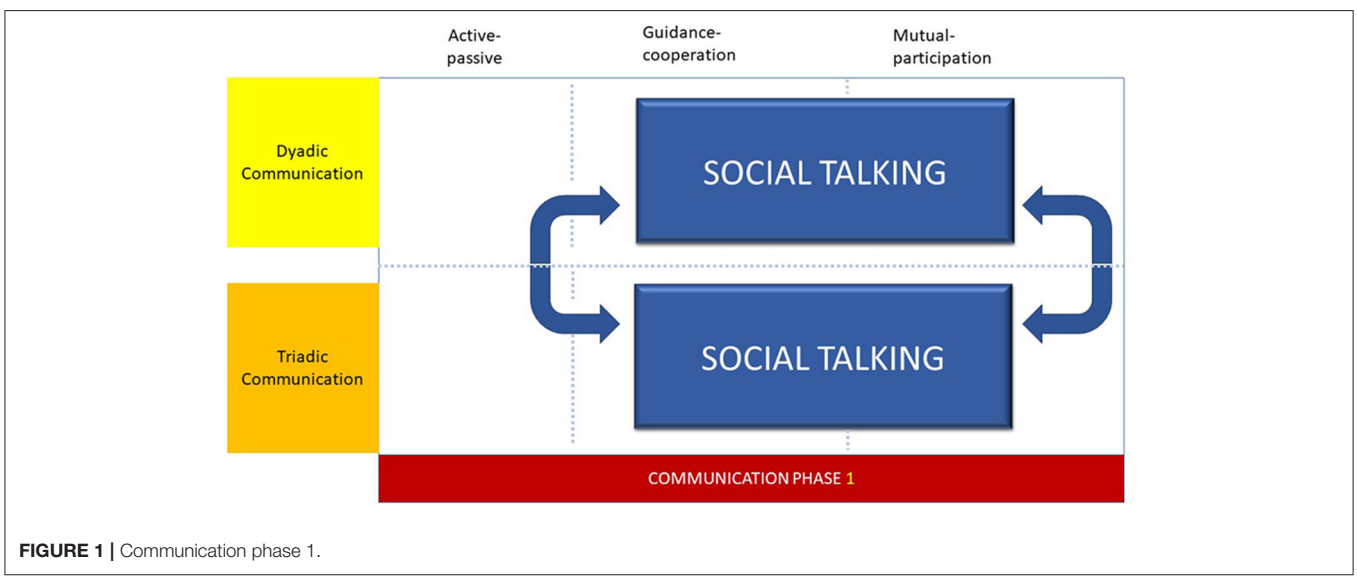

FIGURE 1 | Communication phase 1.

EXTRACT 2 | Cathy containing anxieties and worries and forming the triadic treatment alliance.

1. DP: So what we gonna do today↓ Do you know↑
2. Cathy: emm..em…((child shook her head, smiling at the nurse))
3. DP: Did they tell you↓ ((smiled at the child))
4. Cathy: Emm…em..((child nodded))
5. DP: Okay↓so… we gonna go over toothbrushing, we gonna talk about healthy eating, we gonna talk about sugary treats…We will play a game…
6. M: yea↓
7. Cathy: Huh↑((Child laughed))
8. DP: We will paint your teeth with this special paste like last time, and then we will give you a goody bag↓ ((nurse counted fingers to identify the number of agenda items))
9. Cathy: ==I don't like yucky banana toothpaste ((child put fingers on her nose showing dislike of the FV taste))
10. M: That's what you would say, haha.
11. DP: Yea…((nurse showing a yucky face to the child)) (2.0). But don't worry, we gonna SANDWICH it in beside good stuff ((showing a sandwich with two hands)). So↓ a game is good, paint's yuck, goody bag is GOOD ((nurse used hand gestures and nodding toward the child)).
12. M: Goody bag at the end, hhh… ((Mum used shoulder playfully to nudge the child))
13. DP: Yea↑ ((nurse nodded when looking at the child))
14. Cathy: ((Child laughed and showed a happy face))
15. DP: High fives ((Nurse reached her hand toward the child and then had a high-five with the child)). YEAH↓ So let's get the show on the road↓

tended to use social talking to develop and maintain rapport with children and parents more readily than dentists (20). The success of social talking was also dependent upon the age and rapport building during previous appointments. Therefore, when the child was younger or not known to the practise, social talking was altered and adjusted to form a triadic communication interaction. Therefore, the social talking communication phase was characterised by shifts between dyadic and triadic communication interactions, in which contemporaneous changes are observed within the degree of symmetry of turns, that are suggestive of both guidance-cooperation and mutual-participation phases within the interaction.

Communication Phase 2: Containing Worries

In **Extract 2**, the dynamic nature of the communication interaction is illustrated. This example shows the sequence of communication interactions exhibited by the participating dental professionals during their paediatric encounters with younger child patients. A careful exploration of the data suggests that a continuous shifting cycle of dyadic and triadic interactions assisted the dental professional to form a treatment alliance with the child via the parent, to achieve the goal of the appointment. Therefore, the interaction throughout this example was characterised by the communication phase "containing worries." This phase of interaction contained all the elements of mutual-participation between all three "actors." From the first moments of the meeting the dental professional aligned herself with Cathy, aged 4. This allowed Cathy's mother to observe the empathy expressed in the dental professional's utterance to Cathy as shown in lines 5–6. Allying herself with Cathy (lines 9 and 11) and using Cathy's own word "yuck," the dental professional enabled further engagement with Cathy through mother (line 10). During the triadic interaction, both verbal and non-verbal cues (line 12) were used by mother to support the goal of the Childsmile appointment. Therefore, as the dental professional spoke of fluoride varnish, mother first verbally emphasised Cathy's reward and secondly playfully nudged her daughter's shoulder with her own by way of expressing the importance of Cathy's reward (line 12). It may be suggested that Cathy's laughing, smiling and "high-five" (line 14–15) reflected the containment of Cathy's worries and the formation of the treatment alliance.

The relationship between parental and child dental anxiety, anticipatory worries and fears of separation (9) are known to distort and influence the parent and child fully engaging in the dental appointment. In these situations, the caring dimension of dental treatment is misunderstood and perceived as frightening and to be avoided at all costs by the child. This is irrespective of the degree of invasiveness of the dental procedure (33). Therefore, the child attending for a fluoride varnish application may be as anxious about this non-invasive treatment as a child attending for an extraction. The awareness of the dental professional to identify and to acknowledge the child's treatment worries is of central importance. It is the dental professional's awareness to appreciate the child's emotional reactions, to identify the affect and to respond appropriately, that allows the parent to enter the encounter and achieve the formation of a treatment alliance with the child.

To contain worries the dental professional adopted the "adjacent talk-turn pairs" approach, with the parent and then the child. Providing information to the parent, the dental professional and parent work in unison to reduce child worries to form a treatment alliance. Once more the flow of these exchanges may be observed as shifts from triadic, to dyadic and back to triadic communication interactions. We proposed that it is the dental professional's empathy and understanding of the young child's emotional needs that allowed the formation of the treatment alliance and the acceptance of the preventive Childsmile treatment.

With the parent as an interpreter and decoder of information (34), the parent acted as a go-between, across dental professional and child. It is the parent who enables the child to receive the treatment being offered. In the following short extract, Bobby's superhero was Spiderman. Father used Spiderman to decode the dental professional's words to support Bobby and to understand why he should have the fluoride application:

> "The dental professional described the fluoride varnish process to Bobby and father. Bobby looked tearful, 'I don't want it!' Father smiled and winked at Bobby. Father spoke of Spiderman's need for strong teeth and how the varnish would make Bobby's teeth as strong as Spiderman's. 'Spiderman Bobby' could do anything and with the varnish would have strong teeth like Spiderman."

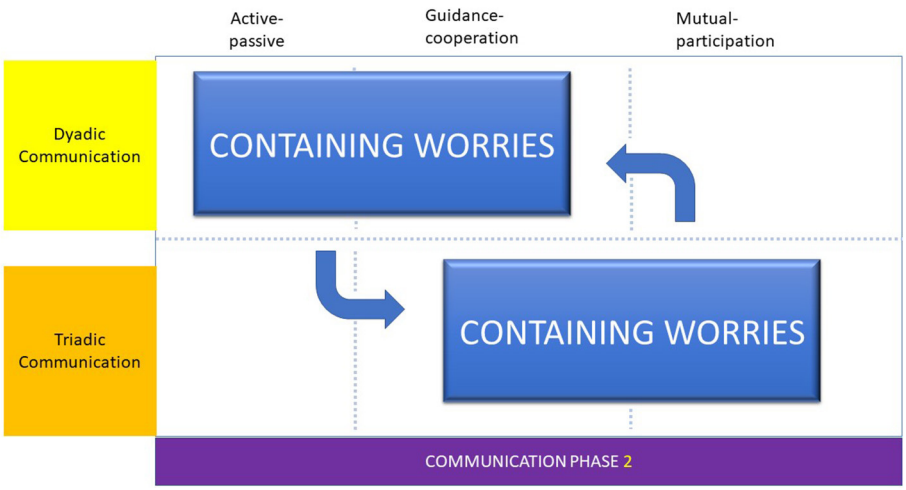

FIGURE 2 | Communication phase 2.

EXTRACT 3 | Dentist asking mother about her child's toothbrushing.

1. D: And brush twice a day↑
2. M: Yes=
3. D: Yea↑ And you still help them↑
4. M: Yes=
5. D: =With both of them?
6. M: Yea

EXTRACT 4 | EDDN asking mother and Jane about toothbrushing.

1. EDDN: Does a grown-up still help you brush your teeth?
2. M: (2.0) Who helps you a lot?
3. Jane: Hmm…
4. EDDN: Who helps you?
5. Jane: Mummy
6. M: Uh:huh:
7. EDDN: Good↓ And how many times a day do you brush your teeth?
8. Jane: Emm…
9. M: Can you think about the best answer?
10. Jane: Hmm….(then gaze at Mum)
11. M: When do you do it? (1.0) Do you do it in the morning…before==…nursery~
12. Jane: Yeah (nodded)
13. M: And then…once before::
14. Jane: Bedtime.
15. M: Good (nodded). So how many times with that↓
16. Jane: Two.
17. M: YES↓

Therefore, the communication phase, containing worries was typified by the cyclical nature of the triadic and dyadic communication interactions, the adoption of an "adjacent talk-turn pairs" approach, providing and gathering information and forming a treatment alliance (**Figure 2**).

Communication Phase 3: Task-Focusing

Extract 3, shows the elements of task-focusing as the dentist speaks to a parent about the child's toothbrushing. Of particular noteworthiness was the predominance of the dyadic communication interaction between dentist and parent.

In comparison, **Extract 4** shows an equivalent situation between EDDN, parent and Jane aged 3. In the encounter a different form of task-focusing was used. In this example, the task was to discover when the child brushed her teeth and although the character of the question-answer turn-taking is similar, Jane was now at the centre of the conversation from the start of the interaction (line 3). The number of utterances shows an asymmetrical communication pattern since the EDDN has only two utterances while mother and Jane both have seven. However, this extract illustrates the dynamic nature of communication with a symmetrical triadic communication interaction (lines 1–7) paving the way for a dyadic communication interaction between mother and child (lines 8–17). In this instance, the EDDN achieved the task of discovering the child's toothbrushing regime with mother's assistance. It may be proposed that two processes are in operation here. First, the mother acted as a translator for the EDDNs' questions and portions the EDDN's questions into understandable "chunks" and in doing so optimised Jane's responses (lines 11–17). The second process belongs with the EDDN. In terms of "adjacent talk-turns," the EDDN provided expressions for mother to use to translate and thereby enabled Jane to speak, provide answers and for the task to be achieved. In subsequent discussions between EDDN, parent and Jane, the triadic communication interaction was restored, and a symmetrical pattern re-established.

In this final example of task-focusing (**Extract 5**), the use of various sequences of utterances, tone and open questioning, provided a setting for an alternating pattern of verbal and non-verbal exchanges during one appointment. These exchanges flowed from triadic, dyadic and back to triadic

communication interactions demonstrating the dynamic and cyclical quality of the encounter. This sequence and pattern of communication was particularly evident during task-focusing, when the dental professional was concentrated upon fulfilling the oral health education protocol. Here a dyadic communication interaction (lines 1–7) shifted to a triadic exchange (lines 8–10) as mother intervened to assist John find words to answer the dental professional's question. From this point on (lines 11–15) the exchange reverted to dyadic between John and the dental professional. The interaction returned to triadic as mother intervened again (from line 16 to end). At the close of the encounter the triadic communication pattern returned and was again established, as the task was completed.

EXTRACT 5 | The dynamic nature of the triadic and dyadic communication interactions.

1. DP: Okay-ducks… (1.0) ((DP put the model back to the counter and sat back on her chair)). So that's how to brush your teeth? How many times a day do you brush your teeth?
2. John: Hmm:::: (1.6) Twi::ce. ((showing 2 with his fingers))
3. DP: ↓TWICE. That's right. Good boy. When do you do it?
4. John: Hmm:::: ((smiling seems thinking hard)) - I don't know ((Jack shrugged his shoulders and then looked at the DP))
5. DP: Do you do it while you (are) lying in your bed sleeping?
6. John: [Uh-huh] ((nodded))
7. DP: NO ((shaking her head))
8. Mother: ((Mum giggled, then child looked at Mummy))
9. DP: (Do) you do it while eating your ↓tea.
10. John: Uh-huh? ((Smiling))
11. DP: NO: ((shaking her head)) (2.0) You don't do that, – you don't sit and eat your ((two arms showing eating behaviour)) – sausages and potatoes when you are brushing your teeth as ↑well:: (at) the same time.
12. DP: When do you clean your teeth?
13. John: I don't know.
14. DP: Yes, you ↓do:::
15. John: No ((smiling and shaking his head))
16. DP: Yes, you do∼↓ (nodding head)
17. Mother: Do you do it in the morning, (or) at lunch time - or at bedtime? When do you do it?
18. John: Hmm:::((looking at Mum))– Morning
19. Mother: ((nodded)) And ↑then? What else?
20. John: Uh::: – I don't know, Mum ((looking at his Mum))
21. Mother: At bedtime.
22 John: At bedtime ((turned to gaze at the DP))
23. DP: ↓Excellent.

The ability of the dental professional to maintain symmetry within the triadic communication interaction was affected by the perceived goal or task of the appointment as well as an ability to engage with the parent and provide oral health knowledge in understandable child-centred chunks of information. This type of communication phase was conceptualised as "task-focusing," associated with achieving Childsmile goals and promoting oral health and therefore predominately reflected the guidance-cooperation phase of Szasz and Hollender (28).

Task-focusing followed a pattern and structure for all dental professionals. While all dental professionals used social talking (dyadic interaction) to welcome parent and child, dentists concentrated upon the dental examination (guidance-cooperation phase) and fluoride varnish application (active-passive phase) before providing any oral health advice, whereas EDDNs spent longer on social talking and containing worries before discussing oral health advice and then applying fluoride varnish (20).

The differences in the patterns and structures of the Childsmile appointment resulted in subtle differences in task-focusing phases. For dentists, task-focusing was characterised by a dyadic communication interaction and symmetrical pattern as described as "adjacent talk-pairs" (**Figure 3**). This was observed

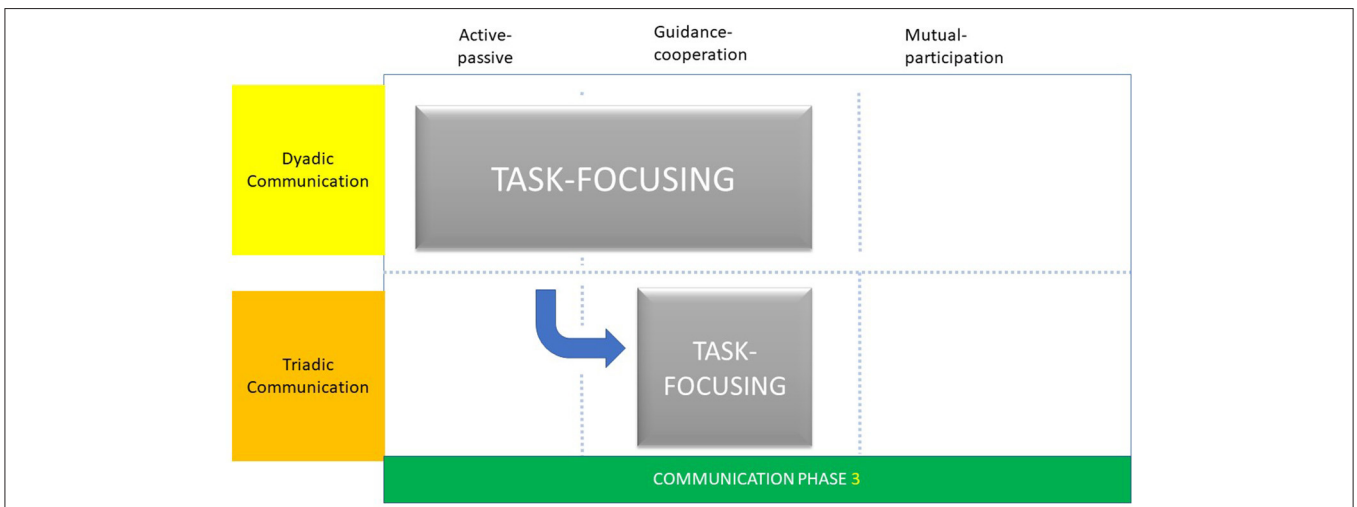

FIGURE 3 | Communication phase 3.

during the Childsmile appointment as the use of a check-list phase of questioning and as short gaps between the questioning by the dentist and answering by the accompanying parent. Irrespective of the age of the child, dentists used this type of interaction which illustrated a form of lexical alignment (35). In this form of lexical alignment, the dentist spoke and listened to the parent simultaneously, and asked questions to shape the parent's responses leading to a pragmatic communication interaction between them. In this respect, the explanatory phase of "guidance-cooperation" was evident as the dentist provided questions (guidance) and the parent complied (cooperation) with appropriate answers.

DISCUSSION

The aim of the present study was to explore the types of communication interactions and phases that may be exhibited in the paediatric dental encounter, and in particular, those between the dental professional, the parent and the young, preschool child. Taking the opportunity to examine communication during the Childsmile preventive visits enabled us to scrutinise not only the types of communication interactions but the phase of communication adopted.

Using a conversational analytic approach, based on the theoretical perspectives of Finset and Ørnes (25) and Szasz and Hollender's (28) models of clinician-patient interaction, it became possible to suggest that the observational interactions could be characterised as dyadic and/or triadic communication and the specific phases of communication as social talking, task focusing and containing worries. Within each of the dyadic and triadic interactions social talking, task-focusing and containing worries were to a greater or lesser extent used during the communication with parents and children. A careful examination of the empirical data exhibited a dynamic and cyclical quality of the communication interaction. It was not only the character of the interaction that changed during the appointment, but the communication phase was altered to enable the aim of the dental appointment to be achieved. This is reminiscent of Tannen's (19) communication scripts and their use in the various frames of the examination and treatment appointment.

We have described the various communication phases as discrete entities, however, we recognise that the communication phases may cross-over between categories - for example, in **Extract 6** – "clean teeth" overlaps between "social talk" and "task focusing." We propose that the crossing over between communication phases has an equivalence to Tannen's paediatrician's shifts from examination to consultation frames and the accompanying changes in communication. Therefore, while the communication phases are presented as discrete entities, the acknowledgement of their crossing-over during the dental appointment illustrates the dynamic quality of the interaction between dental professional, parent and child and the shifting context of the preventive dental treatment visit.

EXTRACT 6 | Mike a new patient to the practice.

1. DP: So↑ What do you think? ((DP looked at the child))
2. DP: Come have a seat (DP looked at the Mum and showed her the tub chair with a welcoming gesture))
3. DP: Not you, Mike ↑ ((DP turned to the child when she noticed the child started to climb onto the chair))
4. Mother: Haha…((Laughed and the child jumped away))
5. DP: (2.0) ((DP observed the child's response by gazing at him))
6. DP: Are you happy? ((DP looked at the child when Mum took the seat))
7. Mike: ((Child jumped happily and nodded to the DP))
8. DP: If you're happy, you know what would you do?
9. Mike: ((The child looked at his Mum and Mum looked back to him))
10. DP: If you are happy and you know it, clap your hands…((the DP sang the song and clapped her hands, smiling at the child))
11. Mother: You are shy, you know↑((laughed when gazing at the child as the child did not know how to respond to the DP)). (2.0)
12. DP: So what do you see? (DP gazed at the child with opened arms)
13. Mike: (2.0) Fis ((Child looked around the room))
14. DP: Fish, that's it.
15. Mike: Tus tis
16. DP: What? ((Then the child pointed to the turtle on the wall and looked back to the nurse and Mum))
17. Mother: Turtle? (1.0) right?
18. Mike: ((child nodded and then walked back to the Mum))
19. Mother: Nemo↓ ((Mum pointed to the Nemo figure on the wall)) look
20. Mike: ((Child walked closer to the wall and looked at the wall))
21. Mother: Where is the Nemo?
22. DP: There's some here, too, look ((DP pointed to another wall with Nemo figures))
23. M: Another Nemo ((pointed to the fish on the wall))
24. Mike: ((Child walked toward another wall))
25. DP: What about this one up there? ((pointed at ceiling))
26. Mike /M: ((Both Mum and the child looked up))
27. DP: Look, who's that↓ ((gazed at the child)) (1 sec) Is that Nemo's friend Dory?
28. Mother: (2.0) Yeah↑
29. Mike: This (the) sea horse.
30. DP: It's the sea horse. (1.6) Someone said there might be sharks
31. Mother:.hhh ((Mum had a surprised face)) where's the shark?
32. DP: hiding (1.6) So↓(0.6) Do you know why you are here today?
33. Mike: Clean teeth↑
34. Mother: ((Mum giggled and turned to the nurse as nurse frown)) CLEAN teeth.
35. DP: Clean teeth↓ ((turned to get the prop and then turned back))

Adopting Tannen's idea of "linguistic register" (19) we further propose that differences occurred not only within the duration of the dental visit but also between dentist and the EDDN's interactions between parent and child. For instance, like the paediatrician of Tannen, the dentist in **Extract 3** used "an unmarked conversational register" while the EDDNs in their interactions with the child, appeared to use a "teasing register" with "exaggeration in shifts in pitch... and drawn out vowels" as noted in **Extract 5** and as coded as "joking and humour" in Yuan et al. (18, 20). Therefore, the different

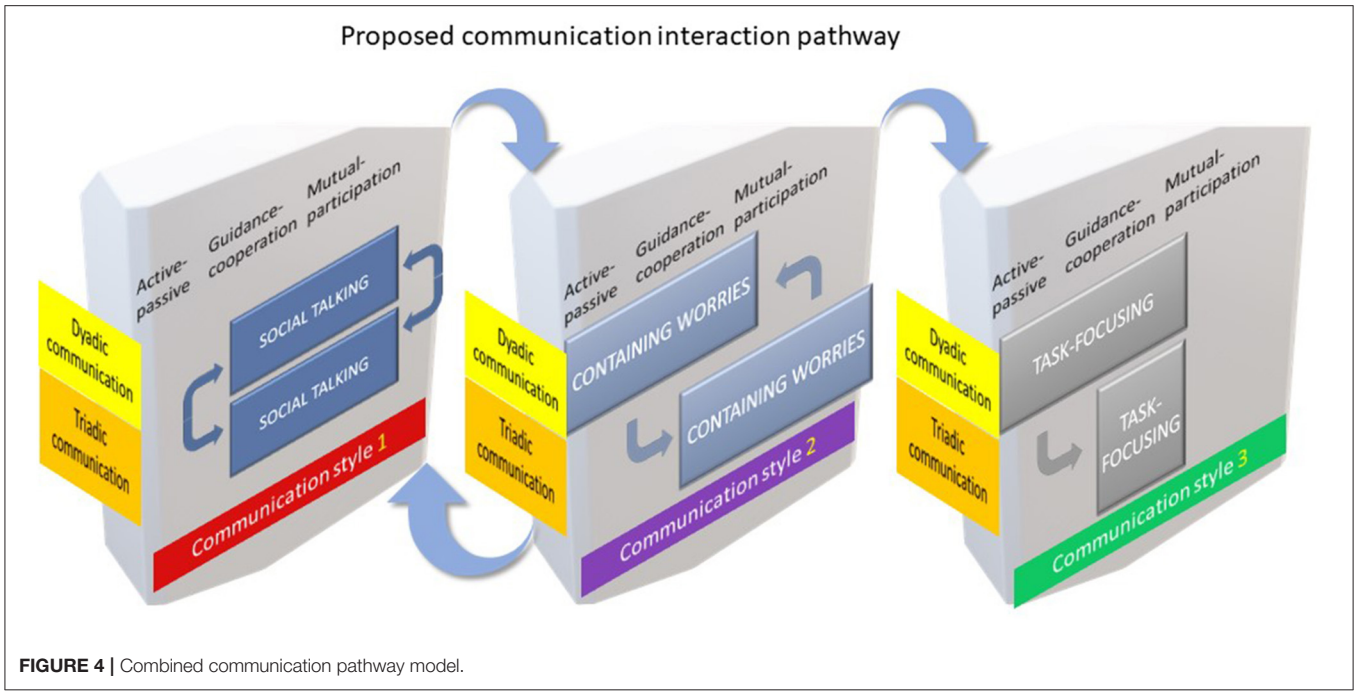

FIGURE 4 | Combined communication pathway model.

forms of social talking and the ability of the dental professional to alter the content and configuration of social talking illustrates the importance of modifying communication phases or in Tannen's conceptualisation, alterations in communication scripts. For example, at the beginning of the dental appointment, the communication phase social talking assisted relationship-building with the parent and therefore started the process of conversing with the child. This parallels to some extent the important notion coined by the Calgary-Cambridge model of clinical communication where the skills of the clinician assist rapport building through the consultation (36). Consequently, when the child and parent were unknown to the practise and attending for the first time, the role of social talking was of a welcoming format, whereas when the child and parent were known to the practice the social talking was used to welcome but quickly moved to information gathering. Both of these forms of social talking were associated with, especially for the EDDNs, a progression to containing worries and eventually task-focusing.

A careful exploration of these phases of communication, suggested that to a greater or lesser extent the "actors" exhibited repetitive interactive behaviours associated with symmetrical communication patterns or "turn-taking" as conceptualised by Finset A, Ørnes (25) as "adjacent talk-turn pairs." Adjacent turn-taking was observed when two of the "actors" were talking, with one responding appropriately to the utterances of other. This was observed, for example during social talking and throughout the questioning and answering of task-focusing. Closely associated with adjacent turns, was "lexical alignment." Thought to ensure effective communication between participants (35), lexical alignment was observed when speakers used similar verbal intonations, pronunciations and even the same words during their conversation. "Lexical repetitions in adjacent turns" (25) were noted, to some degree, in all of the communication phases explored here.

These observations of communication are reminiscent of the phases of health professional-patient interaction as proposed by Szasz and Hollender in their formative paper on the "basic models of the clinician-patient interaction" (28). Proposing a three-fundamental process model of communication, they suggested that interactions could range over three phases "active-passive" to "guidance-cooperation" to "mutual-participation" during one clinical encounter. These phases may not always be in the same order. Likewise, some phases may be absent in some consultations but not in others. This explanatory model may provide a means to understand the subtle changes, observed during the shift in communication interaction during the Childsmile dental appointment. Moreover, it may be suggested that the content of the dyadic communication interaction (for example, task focusing) was suggestive of the active-passive and guidance-cooperation phases whereas the triadic communication interaction (for example, social talking) reflected the guidance-cooperation and mutual participation phases of Szasz and Hollender (28). Dental professionals who adopted these communication phases had the ability to form dyadic and triadic communication interactions with child and parent.

We postulate, therefore, that successful social talking heralded the entrance to containing worries and the formation of the triadic treatment alliance. Together social talking and containing worries triggered an integral pathway to task-focusing and

achieving the preventive goals of the Childsmile appointment. Therefore, on overviewing the results, we constructed a model to summarise the sequence, relative timing and possible repeated cycling of the patterns of communication phase switching between the dyadic and triadic communication interaction, and across the three phases of Szasz and Hollender (28) clinician – patient relationship model (**Figure 4**). The three communication phases, namely: social talking, containing worries and task-focusing are displayed as three separate panels in a proposed sequential order in three easily identifiable stages. Each panel represents the Szasz and Hollender framework (28) against the dyadic and triadic communicative behaviours of the "actors" involved. We observed that the first two phases: social talking and containing worries could cycle that is, go back and forth prior to progressing onto the third and final stage of task-focusing. The formation of the treatment alliance, we therefore propose, is essential to enabling task-focusing to proceed. All features of Szasz and Hollender's framework are present in the communication phase, containing worries whereas, only the active-passive and guidance-cooperation elements are apparent in task-focusing. Consequently, the model is not exhaustive nor reflective of every instance but provides a hypothetical overview of the communication interactions and phases adopted by these practitioners.

There is a paucity of research exploring the extent of young children's understanding of oral health information, although another investigation had suggested that 8 to 9-year-old school children have the capacity to assimilate oral health knowledge (37). This present exploratory study indicates that if young children are to comprehend oral health messages, the dental professional must be aware of the parents' health literacy and their health learning capacity (14). Therefore, we propose it is important to acknowledge that the young child's capacity to understand any oral health information on toothbrushing with fluoride toothpaste and/or healthier eating is dependent on dental professionals using words and phrases that are understandable and appropriate to the parent to translate to their child. Using appropriate language and providing limited options, we suggest, enables the parent and then the child to respond appropriately to any dentally-related question. Consequently, the importance of such theoretical perspectives as adjacent turn-taking, and lexical alignment are vital considerations if successful communication interactions are to be achieved during the paediatric dental consultation.

To our knowledge, this is the first study incorporating an explicit theoretical structure using conversation analysis to explore communication interactions and communication phases used by dental professionals with young children and their parents. We acknowledge the relatively small sample size, however, within the paediatric dental appointments videoed, we observed over 7,000 verbal turns and non-verbal cues that permitted close examination of communication between the "actors" who participated. Therefore, while questions may be raised regarding the generalisability of the study findings, we propose that our exploration of the communication interactions and communication phases apparent in the primary dental care setting, permits future work to be focused and to generate additional data to support the hypotheses created here.

In conclusion, the findings of this exploration of the transcriptions of the video data, suggests that the dyadic and triadic communication interactions are of a dynamic and cyclical quality that are exhibited during the paediatric dental consultation. Within each of the dyadic and triadic interactions the communication phases of social talking, containing worries and task-focusing were to a greater or lesser extent used during communication with parents and children. Successful social talking, we propose, signals the entry to containing worries and the formation of the triadic treatment alliance. Future work should generate additional data to support the hypotheses created here.

DATA AVAILABILITY STATEMENT

The dataset generated and analysed in this article is not publicly available as this was a requirement of ethical approval.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by East of Scotland Research Ethics Service (Ref: 16/ES/0081). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

SY, GH, and RF: methodology. SY: conversational analysis and coding. SY and RF: qualitative analysis and with assistance as required by GH. SY: writing and initial draft. GH: visualization. RF: funding acquisition. All authors writing, reviewing, and editing and conceptualization.

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Strategic Management of Early Childhood Caries in Thailand: A Critical Overview

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The aim of this report was to advocate early childhood caries (ECC) and share strategic management in Thailand, despite over two decades of free Universal Health Coverage including oral healthcare. The recent Thai national oral health survey in 2017 indicates the very high prevalence of ECC, with an average of three carious teeth affected in 53% of 3-year-old children. This is despite the efforts of the Ministry of Public Health that has launched several interventional programs ranging from an upstream policy that prohibits sugar additions in baby formula milk to downstream remediations such as advocating and encouraging toothbrushing with fluoride toothpastes. Nevertheless, ECC is strongly predicated by other key factors including the family and community commitment and participation, as embodied in the current World Health Organization guidelines. These encompass three different tiers of community-level prevention: primary, secondary, and tertiary. Accordingly, the following strategies for ECC management in Thailand should be based at primary care clusters (PCC) in sub-district health centers, with the assistance of inter-professional health teams. These include community education on the importance of deciduous teeth and effective toothbrushing with fluoride toothpaste (primary prevention), regular examination and detection of ECC lesions and early intervention (secondary prevention), insertion of non-invasive preventive restorations using cost-effective atraumatic restorative treatment (ART) or simplified and modified ART (SMART) (tertiary prevention), and, finally, effective follow-up and monitoring systems. It is anticipated that this triple tier approach to ECC management will improve not only the oral health but also the overall children's health.

Keywords: dental caries, caries management, oral health, public health, Thailand, early childhood caries

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INTRODUCTION

Early Childhood Caries (ECC) is a major public health problem in Thailand. The newest national oral health survey from Thailand in 2017 indicates the very high prevalence and severity of ECC in the country, with an average of three carious teeth affected in 53% of 3-year-old children (1).

Reports indicate that ECC in Thailand usually develops from the initial white spot lesion to cavitated dentine caries within a rapid time frame of 12 months in very young dentate children (2–5). As these early carious lesions aretite poorly controlled, they progress into larger cavities, leading to further complications such as abscess formation and related oral pathology. Further, it is now clear that ECC affects not only the oral health but also the overall health and quality of life of these pre-school children.

In general, ECC is a multifactorial disease due to both intra-oral and extra-oral environment factors. Primary teeth are particularly prone to ECC due to their anatomy, thin enamel, and large pulp chambers. Additionally, poor oral hygiene in young children is also a major contributory factor for ECC, as this leads to dysbiosis of the oral microbiome and the development of a cariogenic plaque biofilm. In terms of extrinsic etiologic factors, it is clear that increased sugar consumption in early life can significantly increase ECC (6). Further, a low socioeconomic status and poor oral health literacy of the parents/care givers, unhealthy breast feeding, and/or long-term bottle feeding habits, and the fact that in rural Thai populations ECC is traditionally considered as the norm and neglected, all contribute to the disease process. Furthermore, these avoidable consequences of neglect has arisen in Thailand despite a wide network of public dental therapists (dental nurses) and dentists throughout the jurisdiction. Hence, managing the current burden of ECC in Thailand appears to be a major health issue that has been largely ignored but needs immediate remediation. Therefore, this study aimed to discuss the ECC strategic management as developed internationally and applied in Thailand.

NATIONAL ORAL HEALTH SURVEYS OF THAILAND

The most recent quintennial survey of Thailand National Oral Health, based on the WHO pathfinder survey (7), indicates the magnitude of the problem. The survey found that of the caries severity (DFT/dft) in all age groups, the ECC in 5-year-old children was the most severe. Besides, treatment of caries in primary teeth, especially restorations, was only 4% (ft) in 5-year-old children compared with the restorations of permanent dentition, which was 50% (FT) in the 15-year-old age group (**Table 1**). Such data are critical for healthcare planners, as early detection of ECC in this younger pre-school children would be an indication for early intervention and strategic management of this burgeoning problem.

However, the findings also report that, in comparison to the previous surveys, ECC or caries in primary teeth was relatively stable with a marginal reduction over the last decade (**Figure 1**). This might due to the overall economic developments in the country including the healthcare system. Nevertheless, the overall caries prevalence of ECC in Thailand is unacceptably high compared to international standards. Hence, more serious, proactive strategies for the overall improvement of oral health, general health, and the quality of life of pre-school children countrywide are needed.

HEALTHCARE DELIVERY SYSTEM IN THAILAND

The accountability for improving the oral health in the Thai population rests with the Bureau of Dental Health. Oral healthcare is mainly provided by dentists and dental therapists working in 899 government hospitals and 9,769 sub-district primary health centers (health promoting hospitals) located countrywide (8). While Thai dentists deliver oral care at primary, secondary, and tertiary levels, dental therapists mainly conduct oral health promotion in community, with simple treatment to children in public dental clinics. However, the survey of dental service utilization in 2015 demonstrated that approximately one-half of the Thai dental patients (46.2%) attended 347 private hospitals and 4,244 private dental clinics, mostly located in Bangkok and urban areas (9, 10). Although the dental service utilization is higher in the urban areas, the dental treatment demand is mainly encountered in the rural areas (1). This implies that an oral health disparity exists between the urban and rural dwellers in the country.

Thailand has implemented Universal Health Coverage (UHC) as a component of their National Health System since 2002 (11), ensuring that every Thai citizen is entitled and have the right to access the essential health services for their health promotion, prevention, treatment, rehabilitation, and palliative care throughout the lifetime. Under UHC, all Thai children age lower than 12 years old can receive free-of-charge oral health promotion and prevention (oral examination, extra- and intra-oral radiographs, fluoride application, and sealant) and dental treatment (filling, pulpal therapy, extraction, and obturator for cleft palate baby) at all dental clinics in the public (government) sector.

TABLE 1 | Dental caries prevalence and experience of Thai population from 3-year-old children to 89-year-old elderly (adapted from 8th Thailand National Oral Health Survey in 2017) (1).

Age (years)	Prevalence (%)	Teeth	DT (dt*)	MT (mt*)	FT (ft*)	DMFT (dmft*)	DFT (dft*)
3*	52.9	19.9	2.7	0.0	0.1	2.8	2.8
5*	75.6	19.4	4.2	0.1	0.2	4.5	4.4
12	52.0	25.6	0.6	0.0	0.7	1.4	1.3
15	62.7	27.7	0.9	0.1	1.0	2.0	1.9
35–44	91.8	28.4	1.1	3.6	1.9	6.6	3.0
60–74	98.5	18.6	1.8	13.3	0.8	15.9	2.6
80–89	99.5	9.9	1.8	21.9	0.3	24.0	2.1

*DT/dt, decayed teeth; MT/mt, missing teeth; FT/ft, filled teeth. *primary teeth.*

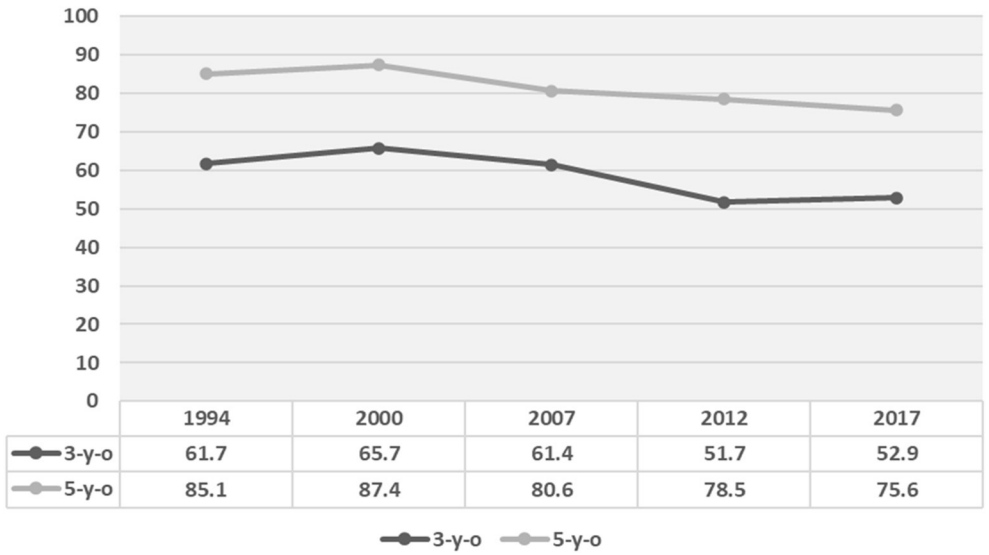

FIGURE 1 | Comparison of dental caries prevalence (%) in primary teeth in the last five National Oral Health Surveys (adapted from 8th Thailand National Oral Health Survey in 2017) (1).

As mentioned, the latest national survey (**Table 1**) demonstrate that more than half of Thai preschool children still suffer from dental caries. Unfortunately, extremely low number of these carious teeth received dental treatment, (0.1 mt and 0.2 ft), figure that has been stable for many decades without any significant increments (1). In addition, another survey in 2015 noted that only 5.8% of preschool children received dental treatment, the smallest proportionate age group that accessed dental service in that year (9). These glaring statistics highlight the issues within the Thai healthcare system as well as other general issues that obviate access to dental treatment for the younger age groups, described above in the introductory narrative. Therefore, oral health promotion, prevention, and management strategies in preschool children in Thailand should be inclusive of both the family and the community, in addition to the governmental measures.

Role of the Family

Several studies conducted in Thai preschool children have shown that various behavioral issues of both children and parents such as irregular tooth brushing habits of children inculcated by their parents, sleeping with bottle feeding, up to 30 months, breastfeeding to sleep, and poor dietary habits had significant impact on the prevalence of ECC (2–4, 12). Other systematic reviews have indicated a significant association between sociodemographic factors, such as low family incomes, low level of parent education, and low maternal age, resulted in a high prevalence and incidence of ECC (13). A recent national survey in 2017 also noted that 86.8 and 89.4% of 3- and 5-year-old children, respectively, brushed their teeth in the morning, but only 42.5 and 14.4% were supervised or assisted by their parents. Notable though, parents of children residing in Bangkok and urban areas brushed the teeth of their children more frequently than parents in rural areas. These clearly show that, parents or caregivers are the key persons who should take care of child oral health, establishing good oral health behavior and escorting them for early dental visits.

The above revelations of the oral health surveys and related findings have led the Thai authorities to promote oral health literacy among families through parental education. These include education on the importance of primary dentition and its impact on the child's quality of life, as well as motivation to introduce early tooth brushing with appropriate fluoridated toothpastes immediately after tooth eruption. It is known that fluoride toothpaste is the most cost-effective homecare method of dental caries prevention in children who are at high risk for caries (14). These information literacy programs reach most Thai families *via* multimedia, such as the television, radio broadcasts, and internet websites. Yet, practical onsite intervention with effective hands-on training remains the mainstay of educating both parents and children.

Role of the Community

A number of interventional focal points are involved in the management of ECC at the community level. These include promoting early dental visits in community health programs (15) and early tooth brushing, organized at the Well Baby Clinics (WBC), especially during child's vaccination visits. Some of the features of the latter community programs include (i) oral examination of each child and caries risk assessment performed by dental staff, (ii) training of mothers to detect dental plaque, (iii) practicing hands-on tooth brushing of their child's teeth, (iv) imparting a knowledge of appropriate dietary habits for child's oral health, and (v) fluoride varnish (5% sodium fluoride) application for children at high caries risk. Concurrently, similar oral health education and guidance

should be conducted in Antenatal Clinics (ANC). Moreover, pregnant woman with oral disease needs to be referred for dental evaluation and treatment at second trimester (16), as oral health status of the mother has an impact on imitating the transmission of cariogenic organisms to the child. Unfortunately, these procedures have been inconsistently performed by most rural ANCs and WBCs. Subsequently, health promotion activities must be included in day care centers/nursery schools, and these must be delivered by dental therapists and trained village health volunteers nationwide.

Another community initiative called "sweet enough network" was established, with the support of the Thai Health Promotion Foundation and a group of pediatricians, dentists, nutritionists, and independent academics in 2002 to minimize ECC and obesity (17). This network aims to educate parents that ECC is mainly due to excessive consumption of sweetened foods and sugary beverages. Also, the Ministry of Public Health announced a national policy in 2004 for sugar-free baby formulas, for those weaning off breastfeeding (18). Under this network, "sweet enough school" has been promoted in many parts of the country to not introduce soda drinks and crunchy snacks at nursery schools/day-care centers. It is believed that the lower rate of ECC in 3-year-old children noted in the last three consecutive national oral health surveys was partly achieved through the latter "sweet enough network" initiative (**Figure 1**).

STRATEGIES FOR PREVENTION OF ECC

According to WHO Expert Consultation on Public Health Intervention against ECC, recommendations for health promotion and management should be based on three levels of community prevention, viz: primary, secondary, and tertiary prevention (19).

Primary Prevention

Promoting healthy behavior is the cornerstone of primary prevention, which begins with the mother during her antenatal period. At this stage, all pregnant women should be provided instructions on good oral hygiene practice, for instance, twice daily tooth brushing and avoiding cariogenic diets (20). During the postnatal period, mothers should initiate breastfeeding until the child reaches the age of 6 months, which could be prolonged for up to 2 years (21). Moreover, throughout early years of life, sugar should not be added to a child's food or drink (22). Children should also wean from bottle feeding, at 12–24 months, and avoid consuming fermented carbohydrate containing liquids while bottle feeding or no-spill training cups (23).

Also, home visits should be paid by dental professionals where they train the parents and caregivers on how best to examine for dental plaque of the primary dentition, as well as white spot lesions of incipient caries. In Thailand, the recommend technique is "lift the lip" campaign followed by provision of hands-on toothbrushing and plaque removal training (24).

Children should be brought for their first dental examination as soon as the first tooth erupt, either during their general medical checkup or during the routine vaccination visits. Appropriate and effective, twice daily toothbrushing with fluoride (1,000 ppm) toothpaste should be universally available for all children. When adopted, these measures appear to have led to salutary benefits in reducing ECC. For instance, a recent randomized control study of Thai children aged 0.5–1.5 years, where health education and hands-on training in toothbrushing were provided (with the assistance of the mothers), and triennial monitoring, reported a significant 2.5 times reduced incidence of ECC after 1 year (25). In contrast, another similar randomized control trial reported that although dental health education to parents or caregivers significantly improved oral hygiene practices, such as toothbrushing activities and feeding behavior, this was still inadequate in preventing ECC increments (26).

Secondary Prevention

Early detection of primary signs of dental caries, such as white spot lesions, should be performed by dental professionals or other well-trained healthcare professionals during the first visit of children to a dental clinic or to a community primary health center. This should be combined with the application of fluoride varnish, used in Thailand for over a decade, both in primary health centers and in dental clinics. A cohort study in Thailand in 2009 reported a 30% reduction of ECC in children younger than 3 years due to fluoride varnish application (27). Moreover, it appears that silver diamine fluoride (SDF; 38%) is more efficacious than fluoride varnish in arresting ECC, as reported in a systematic review where the former effectively arrested the progression of cavitated carious lesions in enamel and dentine of the primary dentition (28). Recently, another randomized control study in Thailand showed that SDF is twice as better in arresting dentine caries in young children compared with fluoride varnish when applied biannually (29).

Tertiary Prevention

Tertiary prevention aims at controlling disease progression and restoration of the functionality of teeth through simple interventions such as atraumatic restorative treatment (ART) and simplified and modified ART (SMART) using glass ionomer cements. It is now known that glass ionomers used in ART have comparable retention to that of the fluoride releasing composite resins. In a 1-year randomized control study in Thailand, using the above technology and partial caries removal demonstrated that, in primary teeth with class I or II cavities restored with either materials, it showed 100% pulpal survival in radiographic examinations (30).

ART is a simple, straightforward, procedure where dentinal caries is selectively removed with a hand instrument and the deficit restored with a fluoride releasing high viscous glass ionomer cement (31). It is known that their mechanical properties are ideal for this purpose due to the firm chemical bonding with both the enamel and dentine, thermal expansion comparable to that of the tooth structure, biocompatibility, good fluoride releasing ability, and low moisture sensitivity (32). In addition, SMART has been developed as an improved extension of ART, entails partial caries removal (selective removal up

to soft dentine) (33), and restores the carious cavity with a capsulated high viscous glass ionomer (34, 35). Both ART and SMART are ideal for field setting as tertiary management tools for ECC.

DISCUSSION

The healthcare system in Thailand is grounded on the principle of free universal health coverage, with emphasis on the primary care clusters (PCC) that are focused on the family unit and its well-being (11). The PCC so constituted will engage family physicians at the peripheral and sub-district health units assisted by a team of nurses, dental therapists, and other health professionals working together with the "village health volunteers" who overarch this defined community. Although dentists are currently not included in this team, it is likely that in the near future, the PCC will include a family dentist as a member of the latter inter-professional health complex.

The critical importance of the inter-professional healthcare in such PCC cannot be over-emphasized. Dental therapists have a significant role to play here as they could assist and support the dentists in the public sector and other professional team members of the cluster. In addition, they could work as an intra-professional unit and not only collaborate in the management of ECC and oral health but also oversee the general health of the population subgroups.

Early dental experiences of children in formative years are highly likely to modulate their subsequent adult dental behavior (36). Systematic review of current restorative treatment of ECC demonstrated that some ECC cases were treated under general anesthesia; however, this is expensive and traumatic (37). Hence, interventions and management of ECC need to be conducted with gentle care using non-invasive approaches mentioned above to gain the children's trust and for the latter to cultivate good dental attitudes and amicable visits to the dentists throughout his/her lifetime.

In terms of active intervention in ECC management, the Thai approach is for routine early oral examination during home visits or at primary health centers during the childhood vaccination period. These visits are exploited to initiate and deliver oral healthcare for young children at the earliest period of their life. At this stage, as an introductory intervention measure, painless preventive dental procedures such as oral examination, fluoride varnish application, or even sealants application are encouraged as introduction to "dentistry". Dentine caries lesions are managed by non-invasive, painless, dentistry such as ART and SMART, delivered by either the dental therapist or the dentist. Such approaches have been popularized in Thailand by slogans such as "no injection, no drill and no pain" procedures. These techniques are implemented with the partial caries removal techniques based on the conservative preservation of tooth tissues, aimed toward the protection of healthy pulp tissues (33, 38).

Therefore, at a patient level, ECC management should be limited to control of the disease through preventive and non-invasive measures that are pain-free (39). Keeping such objectives in mind the Ministry of Public Health of Thailand launched in 2018 "The first miracle 1,000 days of life" campaign with the aim of nurturing a caries-free child population, who are healthy during the critical developmental years (40). Such a program, which has been successfully implemented in Brazil, has also an oral health component similar to the Thai program (41).

As mentioned, the importance of inter-professional collaboration in ECC management and subsequent healthcare delivery must not be overlooked. This could be initiated at the primary health centers and subsequently proceed through various stages, mainly in the community hospitals. For example, caries risk assessment for non-dental healthcare providers created by AAPD (American Academy of Pediatric Dentistry) (42) could be modified for this purpose, as these could be implemented by physicians, nurses, or other health workers simply through observation and interviews. Thereafter, children with high caries risk could be referred for appropriate oral health services in contiguous or area dental clinics. An additional advantage of this is that dentists or dental therapists can work with physicians or pediatricians and nutritionists to control both ECC and non-communicable diseases (NCD) such as diabetes and obesity.

Last but not least, improving oral health literacy in the country should be a major strategic goal underpinning the whole exercise. The importance of this is clearly seen in the statistic that only 5.8% of Thai children receive oral health services annually (9). It is anticipated that pro-active oral health services at the domestic day-care centers by PCC dental team may increase dental utilization, especially with ART/SMART.

The foregoing optimal ECC management strategy, operationalized within the free universal healthcare system of Thailand, not only will control ECC but also can lead to the overall improvements of child health, in general, for years to come.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

TS, PT, and PP conceived the manuscript, did the searches, and wrote the draft of the manuscript. PP contributed to the discussion. TS and PP critically revised the manuscript. PT rearranged the references. All authors contributed to the article and approved the submitted version.

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