

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800

Open access books available

122,000

International authors and editors

135M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Oral Health in Children with Cerebral Palsy

Rahena Akhter, Nur Mohammad Monsur Hassan,
Mangala Nadkarni, Elizabeth F. Martin and
Gulam Khandaker

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/intechopen.79452>

Abstract

Cerebral palsy (CP) is a neurodevelopmental condition comprising a group of permanent disorders of movement and posture that are attributed to nonprogressive disturbances of the developing brain. The neuromuscular problems inherent in CP can affect oral health significantly in several ways. These can include changes in structure of the orofacial region, feeding problems, difficulties with maintaining oral hygiene; additionally, people with CP can encounter barriers in accessing oral health care. Several studies have examined caries rates in individuals who have CP. However, to date, no population-based studies have been published defining the risk factors for dental caries experience among children with CP. There is a high prevalence of orofacial motor dysfunction among people with CP, which can hinder oral hygiene and hence increase dental biofilm formation and retention. Factors such as food consistency, snacking between meals, and associated oromotor dysfunction have also been reported to contribute to the high incidence of caries found in those with CP. Therefore, this chapter will aim to describe the oral health status and factors affecting dental caries experience of children with CP, while also providing preventative and restorative recommendations to combat the prevalence of this disease.

Keywords: dental caries, motor function, oral hygiene, children, cerebral palsy

1. Introduction

Cerebral palsy (CP) is a neurodevelopmental condition comprising a group of permanent disorders of movement and posture that are attributed to nonprogressive disturbances of the developing brain [1, 2]. In children, CP affects approximately 2.1/1000 worldwide, making it

the most common physical disability of childhood. Although some children might outgrow their CP symptoms due to the maturation of neurons, lesions within the central nervous system often compromise motor development severely through time. The classification of CP often differs according to the gestational age at birth, age, and the distribution of lesions. However, classifications are normally registered using two categories, extremity location and neurologic dysfunction. If extremities are involved, diagnosis is subjective to monoplegia, hemiplegia, diplegia, or quadriplegia. If neurologic dysfunctions are involved, it is subjective to spastic, hypotonic, dystonic, athetotic, or a combination [3]. While commonly diagnosed, it is often shown that CP affects many aspects of a child's health. Common health problems associated with CP are excessive drooling, respiratory issues, nutrition, sleep, and poor oral hygiene. With almost one-third of children with CP having difficulties with chewing and swallowing, it is important to note that oral health is a primitive underlying factor for the majority of these complications.

Oral health in children with CP is impacted significantly by their neuromuscular and neurodevelopmental disabilities, leading them to have a higher risk of dental disease due to the greater difficulty for these individuals to perform or receive effective oral hygiene and oral care [4–6]. Specific attributions can be made to the high prevalence of orofacial motor dysfunction, which can lead to poor oral hygiene, and increase dental biofilm formation and retention [7]. Factors such as food consistency and snacking between meals have also been reported to contribute to the high incidence of dental diseases, like dental caries and periodontitis [8]. Nevertheless, dental caries is one of the most common chronic diseases in childhood. Dental caries are defined as one or more decayed, missing, or filled teeth for permanent teeth. Dental caries can also develop at any tooth site in the oral cavity. Hence, with the combined characteristics of poor oral hygiene and orofacial impairments, children with CP make seamless dental caries inhabitants. Several studies have examined caries rates in individuals who have CP [9–11]. However, most of those studies were conducted on highly selected children (e.g., children attending clinics or rehabilitation centers) and in high-income countries. A study from England did not find any significant differences in the levels of decayed, missing, and filled teeth between children who had CP and a control group of children without disabilities. They did find, however, that the children with CP had more untreated decay than children without a disability. Emphasizing the notion that oral health considerations were avoided or even worse, not accessible, which embarks the path of irreversible dental damage and further consequential health issues impacting overall quality of life. For this reason, society must change its outlook on the correlation between healthcare and oral health status for this population.

The concept of oral health-related quality of life (OHRQoL) is defined as the impact of oral health or disease on an individual's daily functioning and well-being. In the United States Surgeon General's report on oral health, they attribute OHRQoL as, "a multidimensional construct that reflects (among other things) people's comfort when eating, sleeping, and engaging in social interaction; their self-esteem; and their satisfaction with respect to their oral health" [12]. Previous studies have in fact demonstrated that dental diseases and disorders have a negative impact on an individual's OHRQoL and the quality of life (QoL) of their parents or

caregivers. Therefore, improving and understanding the factors contributing to the OHRQoL should be the goal for all children with dental disease including children with CP. For these reasons, the motivating factors of dental caries will be explored in order to identify modifications to the oral hygiene behavior and appropriate diet for children with CP. By pinpointing these improvements, a prospective outlook can be set on the impact training and reorganization of preventative dental care can provide for this challenged population.

2. Oral hygiene

2.1. Oral hygiene and CP

Oral health pertains to the teeth, tongue, gums, and their supporting tissue, but also the upper and lower jaw, chewing muscles, throat, salivary glands, and lips that allow us to explore our five senses [12] through speech, facial expressions, food, smell, or touch. With these valuable assets being compromised under the CP population, it is very common for one to not understand or assume responsibility of a standard oral routine; but it is for this same reason that this specific population must be inspected more heavily. Thus, early oral health preventive care and routines must be explored in order for this population to subside in the category of prevalent dental caries.

Studies have shown that the prevalence of caries experience was higher in individuals who cleaned their teeth less than once a day than those whose teeth were cleaned at least once a day [13]. For this reason, tooth brushing twice a day can provide an effective maintenance of the oral cavity. Alongside with fluoride-containing toothpaste, it is shown to decrease the presence of plaque. Plaque being a microbial biomass is composed of resident bacteria from saliva. If a tooth surface is covered by dental plaque, the metabolic activity alters the chemical dissolution of the tooth surface [14]. Therefore, brushing is essential to disturb and remove plaque in efforts of decreasing the rate cariogenicity.

Tooth brushing and flossing also eliminates the quantity of food debris, which if not removed can lead acid erosion to breakdown enamel and dentin, leaving teeth sensitive and discolored. Being that these are the major factors that promote the increase of dental caries, there are no parts of a tooth that are necessarily, "more or less susceptible." However, the idea of susceptibility is one parent of children with CP must acknowledge that no matter the age, classification of CP, or dietary regime, lesion formation and progression of dental caries can be controlled.

2.2. Fluoride and antimicrobial products and CP

The presence of fluoride within a child's oral practice is essential in the prevalence and severity of dental caries. Fluoride's attraction to calcium inhibits and even reverses the potential of dental caries to form by disrupting demineralization and enhancing remineralization of teeth. Remineralization of teeth increases the acid resistance of the enamel surface structure, thus

preventing the change in pH levels, which are primarily responsible for tooth erosion and the creation of new lesions. Fluoride can be integrated in three main functions, community water fluoridation, pastes, and mouthwashes. Frequent consumption of water containing fluoride can permit a consistent barrier for dental caries to occur among the CP population, with minimal dietary efforts needed. Daily toothpaste use alongside with tooth brushing can provide a direct dosage of fluoride for the enamel to combat acid erosion. Studies relating dental caries risk factors attributed difficulty in the application of fluoride to the oral reflexes, such as biting and vomiting and intraoral sensitivity [7, 15]. As a result, it is advised that parents aide their children in the process of tooth brushing, by altering the child's orofacial position to decrease the probability of these refluxes, thereby promoting the ability to apply the daily dosage of fluoride on all teeth. Antimicrobial products although not noted as often can also be utilized in low concentrations to diminish the role of bacteria within the oral region. With minimal bacterial growth, oral cavities will be less prone to metabolize fermentable carbohydrates. Counteracting the microbial environment will thus set additional inhibitors that these dental caries agents will try and override. Finally, mouthwashes containing low concentrations of fluoride (0.05% neutral sodium fluoride or 0.1% stannous fluoride) and antimicrobial agents can provide an effective mean in increasing salivary production, which will allow a continuous aqueous flow to protect the oral cavity throughout the day.

2.3. Frequent dental visits and CP

Disease preventative measures can be performed within one's home; however, it can also be supported by seeking a professional opinion, at least once a year. Seeking an oral health professional that is an approved medical practitioner in one's estate can provide the family and child with CP, a clear, understandable, and personalized protocol to be followed if the oral health evaluation is not up to par. Oral health practitioners can provide insight on the severity of the dental caries present, and the following steps to be considered if a stronger optical concentrated treatment is needed. Specifically, in low-income and middle-income countries (LMIC), parents and physicians must work together in reassuring the child of an oral evaluation as governmental and service providers are limited in their capacity to quantify current and future resources of this population. This phenomenon has been evaluated by studies in Brazil, Bangladesh, and Japan. Determinations were made on the effects of oral health care access and dental caries progression in LMIC [3, 13, 16]. Results displayed that progression of dental caries was reduced once handicapped children participated in the funded rehabilitative programs of oral health professionals [16]. Practitioners should be specifically trained and equipped to handle CP-related orofacial impairments in order to provide the patient the least amount of discomfort and pain as possible.

The role of oral hygiene in the prevention and decrement of dental caries within the CP population can be reviewed by three major provisions, daily tooth brushing, use of fluoride-containing products, and scheduled dental visits. The combination of tooth brushing and fluoride toothpaste can provide an effective barrier to the ubiquitous degradation of plaque and cariogenic bacteria. Scheduled dental visits can provide a professional review of the child's current oral health status and can deliver an incentive to change oral health behavior if dental examinations are abnormal. Overall, efforts should be emphasized that the role of oral hygiene plays a significant role in the prevalence of dental caries, and caregivers should focus on providing a primal example of daily oral health routines to combat this notion.

3. Motor and orofacial impairment

Children with CP experience varying degrees of motor impairment as quantified by the gross motor function classification system (GMFCS), which classifies children with CP based on functional abilities and limitations [17]. GMFCS is a classification system intended to enhance communication between families and professionals when describing a child's gross motor function and can be useful when setting goals and making management decisions. The GMFCS levels range from level I of "Walks without limitations" to level V of "Transported in a manual wheelchair." Motor impairment results in difficulty in performing and receiving oral hygiene, which among other factors, such as feeding problems and reduced access to oral health care, increases caries risk. The GMFCS has not traditionally been used to inform dental professionals in their evaluation of dental caries risk and management decisions for children with CP; however, it has recently been identified that children with CP with severe motor impairment are at high risk for dental caries. As a result, this section will focus on motor impairment and its association with worse OHRQoL of children with CP.

3.1. CP type and motor impairment

Motor impairment in children with CP can be communicated in a variety of ways making it difficult to gather information from the literature on the impact of motor impairment. It is commonly described by some combination of location, type, and severity and falls along a continuum with the most severe presentation being of the "quadriplegic spastic type characterized by stiff hypertonic muscles and motor deficits in all four limbs." Location is often described as tetraparesis/tetraplegia/quadruplegia, triplegia, diparesis/diplegia, monoplegia, or hemiparesis/hemiplegia and type is often described as spastic, athetoid, ataxic, hypotonia, or mixed. Recent studies in Brazil found a relationship between increased motor impairment and increased caries experience in children with CP. It has been found that "individuals with mild to moderate mobility disability (GMFCS levels I, II and III) had a 4.2-fold greater chance of having teeth with cavities and those with severe motor impairment (GMFCS levels IV and V) had an eightfold greater chance of having cavities in comparison to individuals without motor impairment" [18]. As a result, attributed difficulty in providing oral hygiene to children with CP can be claimed by the "differences in intraoral sensibility, presence of involuntary physical movements and/or oral pathological reflexes and spasticity in masticatory muscles" [15]. For these reasons, attention must be paid forward in the act of involving primary caregivers in the instrumental role of oral hygiene practices, as they are the main source to provide consistent care and additional oral health care for these children with CP.

3.2. GMFCS and oral health-related quality of life in CP

The OHRQoL instrument has been used in several studies to obtain data from primary caregivers or parents, to reference the effect of their child's current oral health on their daily lives, (i.e., "how often have you had mouth sores because of your teeth/mouth?"). These data points also include the parents' concerns about their child's oral health in regards to being upset, having disrupted sleep, or taken time off work. Studies using this paradigm concluded that compared to children with GMFCS I-III, the group of children with increased motor impairment of GMFCS IV-V had worse outcomes for having difficulty saying words, having trouble

sleeping, having difficulty eating, drinking or chewing firm foods, taking longer to eat a meal, and feeling terrible or frustrated. Furthermore, children were more likely found to feel upset, shy, and avoid smiling or laughing. These main concerns were the elements that resulted with statistically significant differences between the two groups, ranging from 5.2 to 9.1 times more prevalent in the group with increased motor impairment. These components narrate the children's emotional reactions to their oral condition and in particular reflect on their self-esteem, social, and emotional well-being. Having difficulty drinking, eating, or chewing firm foods reflects upon the domain of physical functions while feeling upset and shy reflect upon the individual's social and emotional experience. Concurrent studies in parts of world such as Brazil and Japan also have found that parents of children with CP had greater distress, uneasiness, and lower quality of life, which implicates the attributed complications of motor and orofacial impairments in the performance of quality oral hygiene and life for families worldwide [3, 16].

It is well defined that the health-related quality of life (HQoL) and oral health-related quality of life (OHRQoL) between children with CP are often intertwined. The prevalence of motor deficiencies associated with CP contributes to the inability for this population to perform daily movements and thus making it incapable for children to perform self-care functions such as maintaining adequate oral hygiene, thereby moving the subjective responsibility of oral hygiene, feeding, and overall lively independence to the caregiver. This manner of consistent dependence significantly impacts the physical, social, and emotional well-being of both a child and their caregiver. As a result, an assessment will be made to discuss oral health's multidimensional impact on the livelihood of families. Distinguishing these traits will provide children and families with CP better modus to achieve optimal health.

In summary, motor deficiencies associated with CP contribute to gross limitations in a child's ability to perform activities of daily living, namely self-care functions such as maintaining adequate oral hygiene. Improving OHRQoL should be the goal for all children with dental disease including children with CP. Understanding the impact of factors contributing to OHRQoL will help to inform management in this population. Although often segmented from the physical diagnosis of motor and orofacial impairments, OHRQoL emphasizes the importance of defining appropriate treatment goals and outcomes in order to provide care that focuses on a person's social, emotional, and physical experience. A child simply cannot experience these factors separately. Therefore, they must function in unity for proper medical and dental treatment measures to be obtained. With this in mind, good quality of life can be provided for all CP patients.

4. Saliva, diet, and nutrition

Motor and orofacial impairments significantly impact the capability of children with CP to smell, taste, and chew their food. Children with increased motor impairments of GMFCS IV-V have worse outcomes in difficulty eating, drinking, and chewing firm foods, thereby subjecting parents and guardians to administer alternative food consistencies and frequent snacking between meals for nourishment. However, several studies have reported that these factors

contribute to the high incidence of caries and periodontal disease in those with CP [13]. Thus, elements of dietary control and feeding habits will be investigated to deduce the cause of the high dental caries incidence, in order to determine which oral hygiene practices and nutrition should be suggested for this population to obtain an optimal level of oral health.

4.1. Saliva and sensory function in CP

To subject to a higher standard of oral health, it is important to understand the specific roles of sensory and saliva functions in food consumption. Deficiencies in high-density sensory nerve endings in the craniofacial tissues affect the sensory functions of children with CP. The impact of these craniofacial tissues thereby restricts the movement of the tongue, jaws, and oral-facial muscles [12]. The modulation of these muscles thus affects the salivary glands. The production of saliva in these salivary glands is an essential guard against tooth decay. Saliva flushes out sugars and remaining food particles from the oral cavity and by eliminating these bacterial food sources, the oral cavity will host limited acid diffusion and tooth erosion [19]. In patients with CP, saliva production can sometimes be the only factor contributing to an easier way of chewing and swallowing food. Thus, saliva production within CP patients, especially those with more severe motor dysfunctions, must be monitored in order to create an easier pathway for food to be consumed. To increase saliva production, a child must drink water frequently, chew on sugar-free gum (if capable), and decrease active mouth breathing.

Studies have shown that dental caries incidence within this population can be attributed to food impaction, cariogenic foods and drinks, and sweetened medications [20]. Impaction of food indicates that nominal salivary production is not sufficient enough to keep the oral cavity clean of tooth demineralization. Commonly in CP children, food impaction can be due to “poor masticatory muscular control, which encourages food stagnation in the buccal and labial sulci and poor manual dexterity” [21]. Affirming that oral hygiene efforts including daily tooth brushing and flossing must be used in order to remove any food particles that can harbor within teeth. Removal of these food particles can prevent food from degrading and fostering acidic compounds, which could then lead to acid production. If foods and liquids are composed of acidic compounds, such as foods with high sugars and carbohydrates, cariogenicity is more likely. Therefore, a decreased intake of foods and liquids prevalent in saccharides could provide children with CP a lower plaque count. Additionally, sweeten medications referred for controlling seizures and other medical problems often contain saccharides and artificial flavors. These medications like the anticonvulsant, carbamazepine, are highly viscous and used at night thereby setting the perfect environment for dental caries to form [22]. Digesting these medications at night without the subsequent oral practice of tooth brushing enables the acidic compounds to form around teeth. As a result, parents must take into account that night medication must be considered after brushing and before going to bed, in order to maintain a proper oral hygiene routine.

4.2. Diet and nutrition

Diet and nutrition is essential in the regulation of good oral health and the promotion of overall systemic health. Unfortunately, in children with CP, malnutrition is often encountered due to a child’s frequent pain in the teeth and mouth, difficulty in eating and drinking.

Malnutrition alters homeostasis, which can lead to the dental disease progression, reduce the resistance to the microbial biofilm, and reduce the capacity of tissue healing [21]. Deficiencies of vitamin A, vitamin D, vitamin B, iron, and protein can be responsible for enamel hypoplasia, hypomineralization, salivary gland hypofunction, delayed tooth eruption, and dental caries. Consuming foods that are rich in these nutrients are consequently essential in order to defend the oral cavity against infection and its ability to buffer plaque acids. Appropriate nutrition for children with CP should be considered depending on their personalized health deficiencies. Being that a majority of children with CP are dependent on nonsolid food intake, parents must be aware that the physical consistency, sequence, and frequent feedings are associated to the development of dental caries. The high and frequent sugar intake constructs this population to be highly susceptible to food cariogenicity. Thus, parents should be able to associate that a frequency in snacking of more than one time/day increases the dental caries experience [13]. If the child is dependent on nonsolid food intake, these products must have minimal refined sugars. Snacking in between meals should be minimized to decrease the anaerobic metabolism of sugars. Nevertheless, snacking should be used as an additional source of nutritional intake, not as a primary source. If a child possesses signs of nutritional deficiencies and eating disorders, early clinical signs can be noted with inflammation of the lining of the oral cavity, oral lesions, or sore throat [21]. In summary, a substantial diet filled with a variety of vitamins, minerals, and proteins should be consumed regularly in order to prevent a delay in tooth development, which could later be responsible for an increased caries experience.

The incidence of dental caries in this population can be attributed to the direct relationship between motor impairment and poor feeding habits. Children classified with CP are more prone to have trouble drinking, eating, or chewing firm foods, thus leaving food to be caught in between teeth more frequently. To diminish dental caries susceptibility, improvements must be made in the nutrient intake and oral hygiene practices in this population. By changing this behavior, CP children can reduce frequent dental pains and improve their OHRQoL.

5. Psychological and social behaviors

5.1. Effect on CP children's psychological and social behaviors

The World Health Organization has indicated that an individual who is "cured" cannot be categorized as one who is doing "well" [12]. As a child with CP, quality of life is significantly impacted by an inability to eat, be independent, or socialize. These qualities are often exacerbated if the child is at high risk for dental caries, due to the concerns of one's smile and appearance. These elements thus relate the child's emotional reaction to their oral condition and in particular reflect on their social and emotional well-being and self-esteem. Having difficulty in drinking, eating, or chewing firm foods reflects upon the domain of physical functioning, while feeling upset and shy reflect upon the individual's social and emotional experience, thereby leaving a negative impact on the OHRQoL of children with CP. As children with CP who have more severe functional mobility limitations (GMFCS IV and V) have

greater caries experience, these children are more likely to be at high risk for poor OHRQoL [11]. Concurring studies in Brazil address these issues in a population as early as preschool children [11]. As a result, children with CP with more severely impacted OHRQoL are consequently subjected to a poorer well-being. Suggesting that inclusion of OHRQoL measures can provide a more comprehensive assessment of the impact on overall health status.

5.2. Effects on CP parent's psychological and social behaviors

Parents and caregivers are indispensable members of the medical team as they provide daily support for children with CP. On the other hand, this indispensability of caregivers comes at health cost. The need for subsequent care in regard to hygiene, clothing, food, and rehabilitation leads caregivers to be physically and mentally tired [8]. Studies have found that the quality of life within the parental population of children with CP is in fact worse than those of non-CP children [12]. Data suggest that parents of children with CP demonstrate higher levels of distress due to their children's oral health status than parents of children without CP. Additional studies indicate that parents of children with CP had greater uneasiness regarding their child's oral health than those parents of children without CP, and a study in Hong Kong found the same association with parents of preschool children with CP [1, 23, 24]. Parents and caregivers of children with CP may be more likely to experience frustration or difficulties supporting their children's daily oral hygiene activities due to complications related to intraoral sensibility, presence of involuntary physical movements and/or oral pathological reflexes, spasticity in masticatory muscles, and the presence of residual food common to many children with CP [12].

Individuals with CP and their families whom have a poor OHRQoL are subjective to a poorer quality of life. The deficiency of neurological and motor development in children places a dependent responsibility among parental figures. This dependent responsibility can consequently lead to an irritable and counterproductive environment for the promotion of oral health. Efforts should be made to develop an effective oral health promotion program for children with CP. Health programs should abide by the significant relationship between health care professionals, caregivers, and the child with the disability. In turn, the prioritization of this relationship can motivate the caregivers to modify their oral health experience, improve family dynamics, and subsequently improve their overall quality of health.

6. Caries prevention and restorative treatment

General rehabilitative efforts among the CP population are often used in order to improve children's health, education, and future employment. Yet, the severity of oral conditions in this population demonstrates the need for interventional dental therapy for a holistic rehabilitation effort to be performed. Involvement of evidence-based techniques such as risk assessments, preventative, and restorative treatment thus can provide a beneficial provision in the incidence of dental caries within this population. Utilizing a combination of these factors can then create a favorable oral environment and substantially reduce caries risk and progression.

6.1. Risk assessment

An assessment of risk factors associated with caries activity is necessary in order to explore and understand the oral capacity of children with CP. Being that the prevalence among dental caries has declined, but not specifically in the CP population, has lead researchers to investigate which risk assessments should more often be considered [15]. Studies have shown that no singular oral examination can be indicative of dental caries status, thus a multifactorial analysis must use combining laboratory examination and observations for a cohesive diagnosis. Characteristics that place a child at high caries risk includes consumption of sugary food or drinks, poor oral hygiene, caries experience of the caregiver, poor resource settings, cavitated or noncavitated carious lesions, missing teeth due to caries, and inadequate salivary flow [25]. Since children with CP often experience frequent consumption of cariogenic nonsolid foods, inadequate practice of oral hygiene in the household, severe motor disabilities (GMFCS level IV-V), and low-quality dental care, it is subsistent for this population to face a high risk for dental caries [12, 13, 26]. Although the susceptibility for this population is high, preventative and restorative measures can still be announced and evaluated in the means of reducing the patient's risk in developing an advanced disease or arresting the disease process.

6.2. Preventative treatment, monitoring and rehabilitation, and CP

6.2.1. *Modifying oral hygiene behavior*

Children with CP and their caregivers must be willing to participate in daily tooth brushing and flossing. Tooth brushing twice a day can provide an effective maintenance of the oral cavity [13]. Through removal of plaque daily should markedly reduce the increment of new carious lesions. Improving oral measures at home can also provide a change in the presence of tooth erosion, plaque, malocclusions, dmft, and DMFT in this population [15]. An intensive oral hygiene instruction followed by periodic reinforcement will need to be provided to the caregivers and CP children. If a child is incapable of performing this action, it is up to the parents/caregivers to supervise this practice into completion.

6.2.2. *Fluorides*

Topical fluoride preventive agents such as mouth rinses, varnishes, gels, foams, and paste have been systematically reviewed by the Australian Dental Association (ADA) as a safe clinical means to reduce or arrest the development of caries. These treatments can be provided at home or professionally in accordance to the ADA clinical recommendation and practitioner's professional judgment [25]. Integration of fluoride in the oral hygiene of children with CP can provide an effective barrier to the demineralization process often caused by food deposits and harboring bacteria.

6.2.3. *Modify the diet*

Feeding conditions for children with CP are impaired due to the lack of neurological and muscular development. Eating efficiency is thus represented to be poor since aspects of oral skills are also impaired. Difficulty to perform normal deglutition in the tongue, lips, and cheeks prevent food to be consumed properly, leaving residual food to inhabit the mouth [27]. To minimize

food cariogenicity, parents are advised to eliminate frequent snacking and nonsolid foods rich in carbohydrates. Future evaluations should be considered in the eating efficiency in this population to provide a better nonsolid supplement for standard nutrition. Several sugar substitutes may be required to provide a broad range for stability, taste onset, and sweetness intensity. Such changes could potentially have a major public health impact in reducing dental caries in CP children.

6.2.4. Improving OHRQoL

The use of dental questionnaires can provide primary caregivers a means of interpreting their children's pain and discomfort, if the child has a limited capacity to self-report. Behaviors can be annotated with questionnaires such as the oral health-related quality of life (OHRQoL), early childhood impact scale (ECIS), family impact scale (FIS), and the child perception questionnaire (CPQ) [11, 13, 28, 29]. Although these questionnaires have been used as an additional means in their prospective studies, their singular results have repeatedly coincided with identifying the nominal risk or presence of dental caries in the CP population. Consequently, making it a functional and easy-to-use instrument to alert parents and physicians alike of the child's dental discomfort or well-being [30].

6.2.5. Restorative treatment

If the progression of dental caries is not controlled, lesions can be formed. In this event, "anatomical grooves, or pits and fissures on occlusal surfaces of permanent molars can trap food particles and promote the presence of bacterial biofilm" [25]. As a result, secondary preventative measures should be taken in order to inhibit the progression of these carious lesions. This management may include topical applications of fluoride varnish, excavation of undermined enamel, dentine conditioning, or temporary fill glass ionomer cement. The aim of lesion management will prepare the oral environment for caries arrest, bacterial infection reduction, and prevent food impaction in open cavities.

6.2.6. Patient monitoring

Physicians can educate and motivate patients by monitoring them on a regularly basis. Frequent evaluations can so be utilized to cease, prevent, and reverse dental caries from occurring. Oral hygiene instruction and coaching can also be used to train children with CP how and why it is important to have an oral hygiene routine, in the case that the caregiver is unenthusiastic.

6.2.7. Rehabilitation program

Dental therapy for the physically and mentally impaired should be a part of the normal rehabilitation process. Specifically, in children with CP, their extensive sensitivity for dental caries emulates the level importance of clinical dental evaluations in a rehabilitative program [15]. Programs must consider that oral health in this specific population is a major determinant of their physical, social, and mental well-being. If it is impacted, it can secondarily affect their motivations to integrate into society as a whole. For these reasons, rehabilitation programs should consider the efficacy and economic cost of comprehensive

care, as it must be accessible to all families. Ignorance to this measure would thus extend the gap of hosting an equal opportunity for quality oral and general health for children and families with CP.

7. Conclusion

In summary, efforts should be made to develop oral health initiatives for children with CP. The rudimentary neurological and muscular impairments default this population to be highly susceptible candidates for oral health diseases like dental caries. Children with more severe functional motor impairment might have a higher risk of experiencing dental caries, which could be attributed to difficulties in performing adequate oral hygiene. Therefore, the role of oral hygiene must be emphasized in the household of these families in order to treat the prevalent risk factors. To reduce dental caries susceptibility, improvements such as minimal snacking and carbohydrate intake must be made to mend OHRQoL and frequent dental pain. Prioritization should be given by oral health rehabilitation programs to abide the relationship between the physician, caregiver, and the child with the disability to recuperate family dynamics and subsequently improve their overall quality of health. By pinpointing these improvements, a prospective outlook can be set on the impact training and reorganization of preventative and restorative dental care can provide for this challenged population.

Acknowledgements

We would like to acknowledge Penelope Subervi, Biomedical Engineering from the University of Rochester for drafting the manuscript as a part of her internship program at the School of Dentistry, The University of Sydney.

Conflict of interest

None of the authors reported any conflict of interest.

Author details

Rahena Akhter^{1*}, Nur Mohmmad Monsur Hassan², Mangala Nadkarni¹, Elizabeth F. Martin¹ and Gulam Khandaker³

*Address all correspondence to: rahena.akhter@sydney.edu.au

1 Faculty of Dentistry, The University of Sydney, NSW, Australia

2 School of Dentistry and Health Sciences, Charles Sturt University, NSW, Australia

3 The Children's Hospital at Westmead Clinical School, University of Sydney, NSW, Australia

References

- [1] Bax M, Goldstein M, Rosenbaum P, Leviton A, Paneth N, Dan B, et al. Proposed definition and classification of cerebral palsy. *Developmental Medicine and Child Neurology*. 2005;**47**(8):571-576
- [2] Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M, Damiano D, et al. A report: the definition and classification of cerebral palsy April 2006. *Developmental Medicine and Child Neurology*. 2007;**49**(6):480
- [3] Kuban KCK, Leviton A. Cerebral palsy. *The New England Journal of Medicine*. 1994;**330**:188-195
- [4] Abanto J, Carvalho TS, Bonecker M, Ortega AO, Ciamponi AL, Raggio DP. Parental reports of the oral health-related quality of life of children with cerebral palsy. *BMC Oral Health*. 2012;**12**:15
- [5] El Ashiry EA, Alaki SM, Nouri SM. Oral health quality of life in children with cerebral palsy: Parental perceptions. *The Journal of Clinical Pediatric Dentistry*. 2016;**40**(5):375-387
- [6] Guare Rde O, Ciamponi AL. Dental caries prevalence in the primary dentition of cerebral-palsied children. *The Journal of Clinical Pediatric Dentistry*. 2003;**27**(3):287-292
- [7] De Carvalho RB, Mendes RF, Prado RR Jr, Moita Neto JM. Oral health and oral motor function in children with cerebral palsy. *Special Care in Dentistry*. 2011;**31**(2):58-62
- [8] Rodrigues dos Santos MT, Biancardi M, Celiberti P, de Oliveira Guare R. Dental caries in cerebral palsied individuals and their caregivers' quality of life. *Child: Care, Health and Development*. 2009;**35**(4):475-481
- [9] Boraz RA. Dental care for the chronically ill child. *Pediatrician*. 1989;**16**(3-4):193-199
- [10] Cardoso AMR, Gomes LN, Silva CRD, De SC Soares R, de Abreu MHNG, Padilha WNW, et al. Dental caries and periodontal disease in Brazilian children and adolescents with cerebral palsy. *International Journal of Environmental Research and Public Health*. 2015;**12**(1):335-353
- [11] Clementino MA, Gomes MC, De Almeida Pinto-Sarmiento TC, Martins CC, Granville-Garcia AF, Paiva SM. Perceived impact of dental pain on the quality of life of preschool children and their families. *PLoS One*. 2015;**10**(6):e0130602
- [12] Rockville MD. Oral Health in America: A Report of the Surgeon General. National Institute of Dental and Craniofacial Research, National Institutes of Health. 2000. pp. 35-243
- [13] Akhter R, Hassan NM, Martin EF, Muhit M, Haque MR, Smithers-Sheedy H, et al. Risk factors for dental caries among children with cerebral palsy in a low-resource setting. *Developmental Medicine and Child Neurology*. 2017;**59**(5):538-543
- [14] Kidd E, Fejerskov O. Essentials of Dental Caries. Vol. 4. Oxford University Press; 2016. pp. 1-14. ISBN: 9780198738268

- [15] Rodrigues dos Santos MT, Masiero D, Novo NF, Simionato MR. Oral conditions in children with cerebral palsy. *Journal of Dentistry for Children (Chicago, Ill.)*. 2003;**70**(1):40-46
- [16] Ohmori I, Awaya S, Ishikawa F. Dental care for severely handicapped children. *International Dental Journal*. 1981;**31**(3):177-184
- [17] Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Developmental Medicine and Child Neurology*. 1997;**39**(4):214-223
- [18] Dourado MR, Andrade PM, Ramos-Jorge ML, Moreira RN, Oliveira-Ferreira F. Association between executive/attentional functions and caries in children with cerebral palsy. *Research in Developmental Disabilities*. 2013;**34**(9):2493-2499
- [19] Lamkin MS, Oppenheim FG. Structural features of salivary function. *Critical Reviews in Oral Biology and Medicine*. 1993;**4**(3-4):251-259
- [20] Oredugba FA. Comparative oral health of children and adolescents with cerebral palsy and controls. *Journal of Disability and Oral Health*. 2011;**12**(2):81-87
- [21] Sheetal A, Hiremath VK, Patil AG, Sajjansetty S, Kumar SR. Malnutrition and its oral outcome—A review. *Journal of Clinical and Diagnostic Research*. 2013;**7**(1):178-180
- [22] Siqueira WL, Santos MT, Elangovan S, Simoes A, Nicolau J. The influence of valproic acid on salivary pH in children with cerebral palsy. *Special Care in Dentistry*. 2007;**27**(2):64-66
- [23] Arvidson Bufano UB, Holm AK. Dental health in urban and rural areas of central and western Bangladesh. *Odonto-Stomatologie Tropicale*. 1990;**13**(3):81-86
- [24] Dougherty NJ. A review of cerebral palsy for the oral health professional. *Dental Clinics of North America*. 2009;**53**(2):329-338
- [25] Center for Scientific Information, ADA Science Institute. Caries Risk Assessment and Management. ADA; 2017. <https://www.ada.org/en/member-center/oral-health-topics/caries-risk-assessment-and-management>
- [26] Fakir MM, Ul Alam KM, Al-Mamun F, Sarker N. A survey on oral health condition in primary school children. *Medicine Today*. 2010;**22**(2):70-72
- [27] Nowak J. Dental disease in handicapped persons. *Special Care in Dentistry*. 1984;**4**(2):66-69
- [28] Abanto J, Shitsuka C, Murakami C, Ciamponi AL, Raggio DP, Bonecker M. Associated factors to erosive tooth wear and its impact on quality of life in children with cerebral palsy. *Special Care in Dentistry*. 2014;**34**(6):278-285
- [29] Goursand D, Paiva SM, Zarzar PM, Pordeus IA, Allison PJ. Family impact scale (FIS): Psychometric properties of the Brazilian Portuguese language version. *European Journal of Paediatric Dentistry*. 2009;**10**(3):141-146
- [30] Versloot J, Hall-Scullin E, Veerkamp JS, Freeman R. Dental discomfort questionnaire: its use with children with a learning disability. *Special Care in Dentistry*. 2008;**28**(4):140-144