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Fluoride prophylaxis - poison or simple way to get rid of early childhood caries (ECC) – review

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ABSTRACT

Introduction: As a prevention, fluoride is used systemically as well as topically in the oral cavity. Thanks to fluoride prophylaxis, one of the most common bacterial disease in the world can be significantly reduced. This disease is dental caries. As such, it constitutes a huge problem in current stomatology, especially the type that affects small children - early childhood caries (ECC). Fluoride has beneficial effects not only in caries prevention but also

in arresting and inhibiting the active decay process. Nevertheless, in recent years the use of fluoride is claimed to be controversial due to its toxic properties.

Aim: The aim of this study is to summarize the current knowledge on the effect that fluoride has on caries diseases affecting children and the safety of its use based on the available research.

Materials and methods: Review of the current literature based on data available in: Pubmed, Ncbi, NIH, AAPD (American Academy of Pediatric Dentistry) and EAPD (European Academy of Pediatric Dentistry) websites using the following phrases: fluoride, fluoride in caries prevention, fluoride in caries, fluoride mechanism, fluoride toxicity, fluoride safety, caries, early childhood caries (ECC).

Conclusions: The use of fluoride is debatable, due to its toxic properties when used in excessive doses. The analysis of the studies proved that fluoride concentrations used in dentistry for the prevention and treatment of early childhood caries (ECC) are safe for the children's organism. The benefits resulting from its use in modern dentistry, which should be based on prophylaxis, are indisputable.

Key words: Fluoride, fluoride prophylaxis, fluoride safety, dental caries, early childhood caries,

Abbreviations: AAPD - American Academy of Pediatric Dentistry, EAPD - European Academy of Pediatric Dentistry, ECC - early childhood caries.

EARLY CHILDHOOD CARIES

Definition:

Early Childhood Caries (ECC) is a disease that affects children of preschool age and mainly affects the primary dentition [19]. It is characterized by the presence of caries in children before the age of 6 (1dmf surface index ≥ 1). The criteria for diagnosing ECC includes: one

primary tooth must have caries, be filled due to caries or have been removed due to caries [1]. Most often, changes start on the incisors of the jaw then spread to the first molars, canines, and finally infect the second molars [19].

¹dmf surface index is an indicator that tells about the state of the oral cavity in relation to primary dentition. d (decay) = at least one surfaces of primary tooth has caries, m (missed) = at least one primary tooth removed due to caries, f (filled) = at least one of the surfaces of the primary tooth filled.

Etiology:

The cause of the disease is multifactorial - it combines environmental, behavioral, socio-economic and biological factors [23]. As with any type of decay it is caused by a combination of bacteria, sugar supply, tooth susceptibility, and time [19]. ECC is mainly caused by bacteria from the Streptococcus - in particular Streptococcus mutans (SM) [4].

Epidemiology:

Research shows that boys are more likely to suffer from ECC. The incidence rate of ECC is higher among people of lower socio-economic status [2]. The influence of transmission of cariogenic bacteria from mother to child remains significant for ECC. The earlier the transmission occurs, the greater the risk of illness [3]. WHO claims that from 60% to 90% of children under 6 years are affected by caries [27].

Prevention:

Prevention should be started already during pregnancy to delay the colonization of the baby's oral cavity with bacteria [29]. However, no influence of fluoride prophylaxis used by the mother during pregnancy on the reduction of caries in the child's primary teeth has been observed [28]. After birth, oral hygiene should be started as soon as the first tooth appears. It should also include fluoride prophylaxis [32].

Treatment:

ECC is a huge problem due to the difficulty in dental treatment of children under 6 years. Stress associated with visiting the dental office results in lack of cooperation from the child.

In this case treatment becomes impossible [5]. Untreated ECC leads to pain and abscesses in mouth. Due to difficulties in feeding the child is at risk of very dangerous, especially in the developmental age, malnutrition and weight loss [19]. Unfortunately, ECC is a bad prognosis in terms of permanent dentition [22]. Children suffering from ECC are 3 times more likely to develop caries in permanent dentition [25]. Often the only therapeutic option for advanced ECC is treatment under general anesthesia [6]. Therefore, it is very important to effectively prevent ECC in the least invasive way in case of disease occurrence [33].

ACTION MECHANISM OF FLUORIDE IN THE ORAL CAVITY

Fluor has a great impact on the caries prevention. It inhibits demineralization of enamel and promotes remineralization of its surface. In addition, it causes inhibition of bacterial enzymes [9]. It acts on enolase, phosphatase, disrupts the transport of sugar to the bacterial cell and interferes with the synthesis of intracellular and extracellular polysaccharides. For this reason, fluoride shows an inhibitory effect on the metabolic bacteria activity responsible for the development of caries - including SM [7]. Fluoride also reduces the amount of SM bacteria in the biofilm. What is more, fluoride compounds used in the oral cavity make enamel less susceptible to acid attack. Fluorides convert the enamel building material - hydroxyapatite into more resistant to dissolution fluorapatite and fluorohydroxyapatite [7].

TOXICITY AND SIDE EFFECTS OF FLUORIDE ACTION

Excess fluoride can act in two ways. This depends on the period of its intake, as well as the size of the dose in which it is taken [10].

Acute intoxication:

A single dose of fluoride above 5 mg per kilogram of body weight causes acute intoxication symptoms. Symptoms manifest as nausea, vomiting, hypocalcemia, hypotension, excessive saliva production. In severe cases, metabolic and respiratory acidosis can occur, leading to coma and death. The lethal dose is 16 mg per kilogram of body weight for children and 32 mg per kilogram of body weight for adults [11]. In the case of acute fluoride intoxication, the procedure should involve inducing vomiting as soon as possible and administering a large amount of calcium compounds [10].

Chronic effects:

The visible effect in the oral cavity of using too much fluoride for a long time during odontogenesis is dental fluorosis. Dental fluorosis is characterized by an abnormal version of enamel. Enamel affected by fluorosis is called mottled enamel and it has decalcified structure. It is much weaker than enamel with normal structure. The severity of the changes depends on the cumulative dose of fluoride taken by the patient [13]. Furthermore, the effect of using too much fluoride can be skeletal fluorosis. Skeletal fluorosis can cause pain, stiffness of joints, ligament calcification, muscle weakness, and ultimately permanent damage to the musculoskeletal system [8]. However, for the disease to appear in an average person, fluoride must be consumed in large doses for a very long period (6-10 mg per day for 10 years) [11]. Excess fluoride also has a negative effect on kidney and digestive system function. Due to its ability to cross the blood-brain barrier, the central nervous system is exposed to the negative effects of fluoride during the developmental period. Its negative effect on intellectual development has also been proven [11]. Genotoxicity has not been proven [10]. In children up to 5 years, the best proven side effect of fluoride prophylaxis is the aforementioned dental fluorosis [18].

CLINICAL ASPECTS OF FLOURIDE PREVENTION IN CHILDREN WITH ECC**Prevention:**

Fluoride in caries-free dentition has a strengthening effect on enamel and an inhibitory effect on bacteria, therefore effectively protecting preschool children's dentition from the ECC. The AAPD recommends the use of toothpastes with age-appropriate fluoride concentrations from the appearance of the first tooth in the oral cavity. In addition, the AAPD recommends professional fluoride prophylaxis in the dental office for children at risk of ECC [21].

Arresting caries:

The use of fluoride in children already affected by ECC causes the existing carious changes to stop. It has a cariostatic effect on carious lesions at any stage. It is a great, cheap method that can be a supplement to ECC treatment or its basis for people who cannot afford more expensive treatment [20][21].

RECOMMENDATIONS AND SAFETY IN FLOURIDE PREVENTION

Fluoride can be administered both systemically and topically. According to research, the best results are obtained from consuming fluoridated water, milk, salt. Topically: toothpastes, varnishes, gels and rinses are used. WHO recommends drinking fluoridated water [12]. Fluoridation of drinking water reduces the occurrence of caries in primary teeth by 36% [14]. The action of fluoride is mainly local, so it is recommended to additionally use it topically, e.g. in the form of paste [12]. For children under 6 years, toothpaste with fluoride is the best option, used twice a day. Fluoride toothpastes are also the most cost-effective method of topical prevention [15]. It is important to use the safe amount of toothpaste, which for a single brushing should be the size of a pea [30]. In the case of children under 6 years of age with a high risk of caries, after consultation with a doctor or dentist, high-fluoride agents, preferably in the form of varnishes, are recommended [15]. For children with a high risk of caries, the combination of fluoride varnishes with the supply of fluoride from various sources, are an effective method of preventing ECC [16]. The use of varnishes with a high fluoride content results in a reduction in the occurrence of caries around 5-63% [22]. The use of fluoride is safe if the recommended dose of 0.05-0.07 mg/kg body weight per day is applied [11]. The start of fluoride prophylaxis in children should take place immediately after the eruption of the first tooth [26]. Fluoride in doses used in fluoride prophylaxis is safe for the children [31]. AAPD confirms the safety and effectiveness of fluoride preparations in preventing and arresting the progression of caries in children [14]. It is very important to encourage parents to use fluoride in children. At small costs the desired effect can be achieved [14].

Recommended concentrations of products used in fluoride prophylaxis:

- The concentration of fluoride toothpaste below the age of 6 according to EAPD - 1000 ppm fluoride twice a day (for children under 2 years, the amount of paste should be equal to the size of a rice grain, above 2 years of age - a pea sized grain).
- The concentration of fluoride varnish according to EAPD - 22600 ppm fluoride 2-4 times a year.
- The concentration in water according to EAPD - 0.5-1.1 mg/L [17].

SUMMARY

Fluoride is undoubtedly an important element of modern dentistry focused on prevention. Thanks to its strengthening effect on enamel and inhibition of bacterial metabolic activity, it affects the prevention of caries and the arrest of existing changes. Thanks to the use of fluoride prophylaxis, it is possible to significantly reduce the occurrence of caries in children.

This is important due to the problems that arise from the advanced form of the disease. Dental treatment in children often involves stress and pain, which can lead to later dentophobia and then an unsatisfactory state of the oral cavity not only in the primary teeth, but also in the permanent teeth. Both AAPD and EAPD confirm that the doses of fluoride used in dentistry do not cause negative effects on the body. It is important to take into account the cumulative doses of fluoride from all sources - if they are within the recommended limits, the use of fluoride in children can be considered safe.

Author Contributions

Conceptualization, J.M.S; check, A.G., W.P. and H.D.; writing—original draft preparation, J.M.S., J.K., R.G., M.P. and J.R.; writing—review and editing, Z.C., W.P, A.G. and M.G.; project administration, J.M.S, J.K and M.G. All authors have read and agreed to the published version of the manuscript.

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The author declares no conflict of interest.

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