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ABSTRACT

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MODERN SCIENTIFIC TRENDS IN THE TREATMENT AND PREVENTION OF DENTAL CARIES

Background. Dental caries remains the most common disease of humanity today. The results of scientific research and clinical observations show that dental caries is most often treated surgically. The most effective way to reduce caries incidence is through primary prevention.

Objective. The purpose of the study is to determine the current state of the problem of treatment and prevention of dental caries, to outline promising directions for solving this problem.

Methods. In order to find out the main world trends in the treatment and prevention of dental caries, we studied the English-language papers of authors from Portugal, the USA, Saudi Arabia, Korea, Brazil, China, Argentina, the United Kingdom, Cote d'Ivoire, Italy, Ireland, Germany, France, Norway, Sweden, Denmark, Switzerland, Turkey, Belgium, Poland and Croatia published in 2019–2023, including literature reviews that tracked the fundamental data of previous years. The analysis of literary sources made it possible to determine that world scientists have made significant achievements with methodological and methodical conclusions, conducted a comparative assessment and proposed new ways to solve the problem in modern conditions.

Results. The issue of modern scientific trends in the treatment and prevention of dental caries are presented in this paper. It was established that the main methods of primary prevention in dentistry were the use of sealants for pits and fissures, local professional use of fluoride preparations, use of fluorine-containing toothpaste, chlorhexidine mouthwash at home, use of xylitol, recommendations for regular visits to the dentist, adherence to a non-cariogenic diet and oral hygiene habits. An analysis of various treatment approaches for dental caries is presented. An evaluation of the proposed treatment methods was carried out in the aspect of a critical approach to preventive removal of hard tooth tissues. The main prospective directions for improvement of treatment and preventive measures are outlined.

Conclusions. Dentistry should begin with the identification and elimination of cariesogenic factors, preventive measures should be dominant. With the elimination of carious disease, the need for related specialties will significantly decrease.

Keywords: prevention of dental caries, dental caries, methods of treatment of dental caries.

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РЕЗЮМЕ

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СУЧАСНІ НАУКОВІ НАПРЯМКИ ЛІКУВАННЯ ТА ПРОФІЛАКТИКИ КАРІЄСУ ЗУБІВ

Актуальність. Найбільш поширеним захворюванням людства на теперішній момент часу залишається карієс зубів. Результати наукових досліджень та клінічні спостереження засвідчують, що на сьогодні хірургічне лікування карієсу зубів використовують найчастіше. Найбільш ефективним способом зменшення захворюваності на карієс є його первинна профілактика.

Мета. Визначити сучасний стан проблеми лікування та профілактики карієсу зубів, окреслити основні аспекти вирішення питань, пов'язаних з цією проблемою.

Методи. Для з'ясування основних світових тенденцій у лікуванні та профілактиці карієсу зубів були опрацьовані англомовні літературні праці авторів з Португалії, США, Саудівської Аравії, Кореї, Бразилії, Китаю, Аргентини, Сполученого Королівства, Код Д'івуар, Італії, Ірландії, Німеччини, Франції, Норвегії, Швеції, Данії, Швейцарії, Туреччини, Бельгії, Польщі та Хорватії за 2019-2023 роки, в тому числі, оглядові, що висвітлювали фундаментальні дані попередніх років. Оцінка літературних джерел показала сучасні досягнення щодо лікування та профілактики карієсу зубів як методологічному, так і в методичному планах, була проведена порівняльна оцінка різних шляхів вирішення цієї проблеми.

Результати. У статті представлено сучасні наукові напрямки лікування та профілактики карієсу зубів. Встановлено, що основними методами первинної профілактики в стоматології є застосування герметиків для ямок і фісур, місцеве професійне застосування препаратів фтору, використання фторвмісної зубної пасти, полоскання рота хлоргексидином в домашніх умовах, використання ксиліту, рекомендації щодо регулярних візитів до стоматолога, дотримання некарієсогенної дієти та правил гігієнічного догляду за порожниною рота. Проаналізовано різні лікувальні підходи щодо карієсу зубів. Представлена критична оцінка методів лікування карієсу зубів з профілактичним видаленням твердих тканин зуба. Рекомендовані лікувально-профілактичні заходи щодо карієсу зубів з акцентом на їх можливе удосконалення в перспективі.

Висновки. Стоматологічна допомога пацієнтам має починатися з виявлення та усунення карієсогенних факторів, профілактичні заходи мають бути домінуючими. У разі ефективності профілактичних програм щодо карієсу зубів буде значно меншою потреба у вузькоспеціалізованій допомозі при втраті зубів.

Ключові слова: профілактика карієсу зубів, карієс зубів, методи лікування карієсу зубів.

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INTRODUCTION / ВСТУП

Preventive measures for diseases of the oral cavity, mainly dental caries, are on the agenda of WHO. In particular, the global tasks assume that by 2030, 50% of countries will adopt directive measures to reduce the use of sugars, and optimal use of fluorides to support oral health at the population level. The main directions of directive measures are methods of providing the necessary amount of fluorides: local independent use (for example, fluoride-containing toothpaste), professional use (fluoride-containing gels, varnishes, etc.); systemic fluoridation (for example, of drinking water): defluoridation of water in fluorosis-endemic areas [1].

Such global WHO measures are dictated by the high prevalence of dental caries, as noted in the WHO report [2]. Therefore, it is relevant to conduct a review of modern literary sources devoted to methods of treatment and prevention of dental caries, assessment of trends, and dissemination of positive practices and methods.

THE AIM OF THE STUDY

To determine the current state of the problem of treatment and prevention of dental caries, to outline promising directions for solving this problem.

MATERIALS AND METHODS

In order to find out the main world trends in the treatment and prevention of dental caries, the English-language literary works of authors from Portugal, the USA, Saudi Arabia, Korea, Brazil, China, Argentina, the United Kingdom, Cote d'Ivoire, Italy, Ireland, Germany, France, Norway, Sweden, Denmark, Switzerland, Turkey, Belgium, Poland and Croatia for the years 2019-2023, including overviews that tracked the fundamental data of previous years. Databases were used PMC free article (https://www.ncbi.nlm.nih.gov/pmc/articles/), PubMed (https://pubmed.ncbi.nlm.nih.gov/), CrossRef (https://onlinelibrary.wiley.com/doi/epdf/10.1111/iej.), Google Scholar (https://scholar.google.com/). At the first stage, a search for literary sources (187) in English was conducted using the following keywords: prevention of dental caries, dental caries, methods of treatment of dental caries. At the second stage, summaries of articles were studied and publications that did not meet the criteria of the five-year period were excluded. At the third stage, the full texts of the selected articles (42) were studied for compliance with the criteria for inclusion in the literature list and research relevance. The criteria for inclusion of publications in the sample, which was subject to content analysis, were the following: 1) coverage of modern information on the treatment and prevention of dental caries; 2) evidence-based medicine; 3) full-text indexing of the article in the PubMed scientometric database.

RESULTS AND DISCUSSION

Dental caries is the most common oral health problem. This disease affects most adults, including those in industrialized countries. According to data from national surveys, the prevalence of caries in permanent teeth in Portugal has decreased significantly, reaching a very satisfactory level, especially among individuals benefiting from the measures developed within the framework of the National Program for the Promotion of Oral Health (Programa Nacional de Promoção da Saúde) . Oral, PNPSO) [3, 4].

Taking into account the experience gained, the development of preventive programs of primary prevention can lead to sustainable maintenance of a high level of oral hygiene, including local and targeted measures that lead to positive changes in the preservation and maintenance of oral health. Such prevention programs reduce the short-term and long-term psychosocial and economic costs associated with oral health problems that lead to complications and help prevent the exacerbation of chronic diseases [5].

For the prevention of diseases of the oral cavity, primarily dental caries, it is necessary to carry out individual and collective prevention. To obtain good results in the prevention of dental caries, sanitary and educational work should be carried out, in particular, to expand the knowledge of the adult population about the importance of a healthy lifestyle, oral health; in order to preserve and maintain oral health, new preventive strategies and information campaigns should be developed. The main methods of primary prevention in dentistry in adults are the use of sealants for pits and fissures of teeth, local application of fluorine

preparations carried out in a dental clinic, use of fluoride-containing toothpaste, rinsing the mouth with chlorhexidine at home, replacing sugar with xylitol, regular visits to the dentist, informing patients regarding adherence to a non-cariogenic diet [6].

Another study also shows that a strategy for the primary prevention of dental caries should consider changing behavior patterns and empowering patients by linking oral health to a healthy lifestyle. In this context, personal parameters should be taken into account: financial capacity, human capabilities, motivation, and psychological state. In addition, the modern perspective of health care includes a holistic, global, and integrative approach in a predictive, preventive, personalized, and shared vision. The biggest challenge for oral health is promoting proactive strategies in adult patients. The indisputable guarantee of success will be the joint work of all interested parties. All this requires the effective use of educational strategies [7].

When developing preventive measures for oral health, behavioral factors should be taken into account, including regular dental checkups, regular brushing, flossing, and a balanced diet. It is proven that these factors significantly reduce the risk of oral cavity diseases [8]. Oral hygiene with proper tooth brushing is an effective mechanical method of removing dental plaque, which contributes to the development of caries. Patients should be taught to brush their teeth correctly (correction of hygiene skills) with fluoride toothpaste twice a day, in particular before going to bed [9].

Prevention of caries in adult patients of the Brazilian community included sealing of fissures and natural cavities of teeth, local application of fluorine-containing drugs, recommended use of fluorine-containing toothpastes and mouth rinsing with chlorhexidine, replacement of sucrose with xylitol in the diet was suggested [10].

To reduce the number of bacteria, which will contribute to the prevention of dental caries, the use of local antimicrobial drugs (chlorhexidine) is recommended [11]. Chlorhexidine is the "gold standard" antibacterial agent that reduces mutated streptococci. Over-the-counter and prescription chlorhexidine products are available on the market, including toothpastes, mouthwashes, sprays, gels, varnishes, and gums. The use of the sugar substitute xylitol helps to reduce the level of cariogenic streptococci in plaque and saliva. It should be introduced into gum, lollipops or snacks [11].

Studies by other authors have shown that primary prevention is based on the local use of fluoride-containing preparations (fluoride gel, fluoride varnish) [12, 13], fluoride toothpaste [14], professional teeth cleaning, and the dentist's recommendations regarding oral hygiene and nutrition. Carrying out the above-mentioned measures reduced or eliminated the risk of developing dental caries. Researchers focused on measures aimed at correcting or teaching proper hygienic care of the oral cavity, regular visits to the dentist, i.e. on measures to promote dental prevention [12, 13, 14].

Coating with fluoride varnish in combination with nano-hydroxyapatite treatment effectively stopped the progression of tooth demineralization, in particular, when using fixed orthodontic structures, caries development was significantly reduced by 50% to 70% in pits and fissures. These measures were more effective on the proximal surfaces of the teeth [15].

Despite the lack of literature that confirms the cost-effectiveness of using fluorides and sealants for the prevention of dental caries in adult patients [16], it can be assumed that the patient's interest in caries prevention will be greater than the risk of developing caries.

Studies conducted by Meles et al. [17], showed that in 400 middle-aged patients (35.5 ± 13.1 years), the prevalence of dental caries was 98.7%, the hygienic condition of the oral cavity was unsatisfactory in 36.8% of patients. Patients mainly turned to the dentist for pain (91.5%) and aesthetic complaints (23.5%). Preventive measures consisted of the use of sealants and local application of fluoride preparations. At the same time, the authors claim that it is necessary to increase the level of knowledge of the population regarding preventive measures, regular visits to the dentist, and not only for the appearance of pain, development and implementation of programs for the primary prevention of oral health. In addition, the survey showed that patients did not set themselves the goal of maintaining oral health through preventive visits to the dentist [17].

Research by Leggett et al. [18] aimed to qualitatively study the barriers and factors contributing to the prevention of oral cavity diseases. The patients who took part in the study were members of insurance companies, medical and dental teams and committees in the Netherlands, Denmark, Great Britain, Hungary, Germany and Ireland. As the study showed, the main obstacle to strengthening the health of the oral cavity is insufficient financial resources of people. It was found that this was less of a problem in Germany, the Netherlands and Denmark, because in these countries the costs of prevention are reimbursed. In the opinion of dentists, budget compensation is not enough to carry out more effective measures of primary prevention. It was suggested to pay more attention to prevention and changing attitudes towards oral health, to approach dental examinations more carefully. In all six countries, there was a need for change, which involved working

together to more effectively promote oral health in these communities [18].

High-quality restorative caries treatments are currently available [19], but their cost can have a negative impact on the National Health Service (NHS) and patients both from a health and economic perspective [20].

Turning to the characteristics of modern publications, it should be noted that the treatment of dental caries has changed significantly in recent years [21, 22, 23]. The most modern practical approaches are based on early detection [24] and caries prevention with the identification and elimination of risk factors [21, 23]. It is important to use not only clinical methods of caries diagnosis because their use is controversial and debatable since it does not provide further advantages [25]. Visual examination in combination with radiographic examination is usually used to examine and diagnose occlusal and proximal caries. At the same time, the radiograph may underestimate the spread of the carious lesion, since it is likely to be deeper than its radiographic image [25].

It should not be forgotten that the use of dental radiography should be optimized to limit the exposure of the patient to ionizing radiation according to the ALADAIP principle. An alternative such as fiber optic transillumination [26] can always be used.

New approaches to the treatment of dental caries are aimed at preserving healthy tissues, i.e. approaches of minimally invasive dentistry: early detection of carious lesions and remineralization of non-cavitated lesions, if restorative intervention is necessary, the applied procedure should be as minimally invasive as possible, in particular, repair, restoration or polishing, and not replacement of defective ones restorations, even if endodontic interventions are necessary, lean towards pulpotomy instead of pulpectomy in one or two stages [21, 22, 23].

Recently, there has been general agreement that filling non-cavitated carious lesions is a viable option for controlling carious lesions, even if they have reached the outer surface of the dentin. This is one of the most conservative approaches to preserving tooth structure and pulp viability without invasive treatment. The method is called "microinvasive concept" [27].

Sealing of a non-cavitated carious lesion effectively stops the progression of the lesion in vivo and in vitro. Resin infiltration and sealing were more effective than other noninvasive treatments (eg, fluoride varnish) in stopping noncavitated proximal lesions. Several studies have supported WSL resin infiltration and sealing of non-cavitated lesions as an effective treatment option [27].

If we refer to non-cavitated caries, it refers to the first stage of enamel caries (white spots), an area of demineralization that is clinically manifested as a white spot (WSL).

WSL is also common around fixed orthodontic appliances and is considered a serious problem during fixed orthodontic treatment [28].

WSL can be treated non-invasively with, in particular, good oral hygiene, the use of fluoride-containing toothpaste, mouthwashes, gels and varnishes, amorphous calcium casein phosphopeptide phosphate (CPP-ACP) and calcium casein phosphopeptide phosphate fluoride (CPP-AFCP), which is recommended to all [29].

The authors state that cavitation is unlikely when interproximal carious lesions are radiographically limited to enamel. At the same time, one should distinguish carious lesions, which have a higher probability of cavity formation, in particular, if they reach the middle third of the dentin [30]. Filling or infiltrating a carious lesion with a composite are two microinvasive approaches. Both involve removing the surface of the tooth's hard tissue at the micron level, usually performed during an etching step, such as in fissure sealing techniques. The infiltration method involves etching with an acid such as 15% HCl gel for 90-120 seconds, followed by resin infiltration (“Resin Infiltration”; Icon; DMG) [30].

There are methods of conservative composite restoration (CCR), and preventive resin restoration (PRR) - these are minimally invasive methods that are usually indicated for the restoration of small carious lesions of lateral teeth in one step [31].

Other studies have also shown delayed or halted progression of non-cavitated carious lesions treated with the resin infiltration technique [32].

Alternative strategies for the treatment of cavitated or dentinal carious lesions have been described - removing less or no carious tissue, using selective removal of carious tissue (selective excavation), staged removal of carious tissue, sealing carious lesions with sealants, filling with preformed metal crowns, and non-restorative cavity control [33, 34].

The method of selective removal is based on the proximity of the carious lesion to the pulp [35].

There are generally two approaches to caries treatment in pulp-sensitive and asymptomatic teeth: non-selective caries removal and selective caries removal. In selective removal, carious tissues are removed selectively according to the proximity to the pulp, so soft and/or hard dentin remains and is preserved. This approach is also known as the partial caries removal method [35].

There are proposals during the first visit to carry out selective caries removal to the soft dentin, and then restoration of the tooth with glass ionomer cement. During the second appointment, after 6–12 months, an X-ray should be taken to assess the condition of the periapical tissues. Any signs or symptoms of possible pulp pathology should be assessed and a pulp sensitivity/viability test should be performed. Next, selective removal is carried out to hard, dry dentin, or glass ionomer can be used as a base without additional removal of tissue, followed by restoration with a composite material [36].

In case of extremely deep carious lesions, it is recommended to use a technique where the near-pulpal and axial soft carious dentin is left to prevent pulp exposure and "stress" on the pulp. However, the peripheral dentin and dentin-enamel junction are prepared with pink-headed burs or a sharp reamer until hard, dry dentin remains to ensure the strength of the restoration. Compared to the non-selective removal of caries to hard dentin, this approach significantly minimizes the likelihood of pulp exposure [37].

However, constant monitoring is necessary to ensure the integrity and tightness of the restorative material and that the lesion does not progress. This approach is also indicated for use in the selective removal of carious dentin lesions [38].

Indirect pulp capping (IPC) is considered selective caries removal to soft dentin. The IPC approach is commonly used to prepare a deep cavity with or without residual carious dentin that is adjacent to the pulp but does not show visible pulp exposure [39]. It aims to preserve pulp viability by selectively removing carious soft dentin followed by placement of a therapeutic material such as calcium hydroxide. Calcium hydroxide is traditionally used as an inlay, followed by a permanent filling material. However, the use of calcium hydroxide has been questioned due to various disadvantages; as a result, it has been replaced by other biomaterials, such as calcium silicate-based materials [39, 40].

There are recommendations when preparing only pits and fissures of molars affected by caries. Pit and fissure caries are removed, and composite resin is used as a permanent restoration. Glass ionomer can be used as a spacer when the carious lesion reaches the dentin. When the cavity is narrow after preparation, liquid resin is usually used. The remaining fissures are etched and sealed with sealing material [41].

After all, the traditional method of treating dental caries has the right to exist. It is the removal of both soft and hard dentin, regardless of the proximity of the carious lesion to the pulp. It is also known as complete caries removal. Or it can be referred to as removal of caries to hard dentin. This method involves the removal of cariesly changed dentine to a hard one, regardless of the depth or proximity to the pulp [42].

CONCLUSIONS / ВИСНОВКИ

Thus, dentistry should begin with the identification and elimination of cariesogenic factors, and preventive measures should be dominant. With the elimination of carious disease, the need for related specialties will significantly decrease.

In the presence of indications, minimally invasive technologies for the treatment of dental caries should be used as much as possible.

PROSPECTS FOR FUTURE RESEARCH / ПЕРСПЕКТИВИ ПОДАЛЬШИХ ДОСЛІДЖЕНЬ

The conducted review of literary sources will allow the choice of a promising direction of scientific research within the framework of the cathedral's research topic, which is planned for implementation.

CONFLICT OF INTEREST / КОНФЛІКТ ІНТЕРЕСІВ

The authors declare no conflict of interest.

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None.

AUTHOR CONTRIBUTIONS / ВКЛАД АВТОРІВ

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