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Review Article Open Access

Early Childhood Caries: A Literature Review

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Abstract

Early Childhood Caries (ECC) is defined as the presence of one or more decayed tooth surfaces in any primary tooth in children 71 months of age or younger. ECC is the most common chronic illness among children and adolescents. Studies have found caries prevalence among preschool children varies greatly in different countries, ranging from 17 to 94%. However, in most of the studies; over 90% of decayed teeth were left untreated. Caries progression can lead to pain and reduced ability to chew and eat, which may also lead to iron deficiency due to malnutrition. Reduction of quality of life for children with ECC, resulting from disturbed sleeping and concentration problems, has been reported. Children with severe caries may experience reduced weight and delayed growth. This paper provides an updated literature review of ECC. The aetiology, clinical features, caries prevalence in recent literature, consequences of caries infection and management of ECC are discussed.

Keywords: Early childhood caries; Children; Review

Introduction

Early childhood caries (ECC) is defined as the presence of one or more decayed tooth surfaces in any primary tooth in children 71 months of age or younger [1]. ECC is the most common chronic illness among children and adolescent. Caries progression can lead to pain and reduced ability to chew and eat, which may also lead to iron deficiency due to malnutrition [2]. Reduction of quality of life for children with ECC, resulting from disturbed sleeping and concentration problems, has been reported. This paper performs a literature review for ECC.

Aetiology

The aetiology of ECC involves the interaction between pathogenic organisms, fermentable carbohydrate substrate, host susceptibility, and time [3,4]. With sufficient time, the cariogenic microorganisms in the presence of fermentable carbohydrates, such as sucrose, can induce demineralization of tooth substance, which can progress to loss of tooth structure or cavitation.

The cariogenic microorganisms play an important part in caries development. Streptococcus mutan is an important pathogenic organism in the development of caries lesions [5]. Vertical transmission of cariogenic microbes from caretakers to children is possible. S. mutan constitutes about 60% of the cultivable flora of dental plaque obtained from preschool children with ECC [5]. In children with few or no caries, S. mutans constitutes less than 1% of the flora [5]. A recent study reported an association between the amount of S. mutans and the prevalence of dental caries in children [6]. Apart from S. mutans, a similarly high number of veillonella and lactobacilli have been found in children with ECC [3]. Lactobacilli counts are significantly higher within caries lesions than on adjacent tooth surfaces, suggesting that lactobacilli play a role in caries progression but not in lesion initiation [7].

The major reservoir from which infants acquire cariogenic bacteria, such as mutans streptococci (MS), is the mother's saliva [3,8]. The success of the transmission and resultant colonization of the maternal MS may relate to factors including magnitude of the inoculums [9], frequency of small-dose inoculations [10], and receipt of a minimum infective dose [5]. Infants whose mothers have high levels of MS, as a result of untreated caries, are at greater risk of acquiring the organism earlier than children whose mothers have low levels of MS [9]. Suppressing maternal reservoirs of MS via dental rehabilitation and anti-microbial treatments can prevent or delay infant inoculation [11,12].

Cariogenic bacteria such as MSis often transmitted from an expectant mother's mouth to the infant. Moreover, horizontal transmission of MS between members of a related group can also occur [8]. Recent studies have also shown that MS can colonize the mouth of pre-dentate infants [8,13]. Transmission of MS also occurs between unrelated children older than 4 years of age. Doméjean et al. [14] reported MS could widely transmit from child to child in kindergarten.

In addition to the establishment of oral flora, infants and younger children have other unique risk factors for carries, including development of poor dietary habits and food preferences. High-risk dietary practices appear to be established early, probably by 12 months of age, and are maintained throughout early childhood [15,16]. Frequent consumption of between-meal snacks and beverages containing fermentable carbohydrates increases the risk of caries due to prolonged contact between sugars in the consumed food or liquid and cariogenic bacteria on the susceptible teeth [17]. Sucrose is considered to be a major cariogenic substance in the diet, acting as a substrate both for the production of extracellular polysaccharides and for acid production of the dental plaque. Freshly squeezed or commercially prepared fruit juices and fluid supplements that are claimed to be "natural health foods" frequently contain high sugar content and present caries risk to children. There is some controversy as to whether bovine and breast milk imposes risk for caries. Bovine and human milk both contain lactose, which in vitro can enhance the implantation of cariogenic bacteria and produce caries in laboratory animals [3]. Although it is possible for breast and bovine milk to cause dental caries, the prevalence is low and is associated with frequent and prolonged breast or bottle feeding, during the day and night, until the child is two or more years old [18].

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As for the host factors, reduced salivary flow can predispose children to the risk of caries. Salivation falls to a minimum during night sleep and reduces significantly during any sleep. This affects mechanical cleansing and buffering following fermentation of cariogenic substrates [19]. The nursing liquid can stagnate and has cariogenic potential. Therefore, a child put to bed with a nursing bottle filled with cariogenic substrate is at risk of caries. Moreover, demographic factors (e.g. age, oral hygiene, and socio-economic and cultural characteristics) also affect the development of ECC [4]. A literature review found that most studies determined an inverse relationship between oral hygiene status and the incidence of ECC [3].

Children's caries status is also found to be related to their socio-economic background [20]. Poor parental education, low family income and single parenting are all associated with a higher caries rate of preschool children [3]. In addition, cultural and ethnic variables are also significant factors that predispose infants and children to ECC because diet, feeding habits, and pacifier use differ between cultures [3]. Neglect, if ECC and untreated tooth decay is associated with avoidance of care [21]; and aversive parental experience and disregard for primary dentition are serious obstacles to improving the oral health of children [22].

Clinical Features

The development of ECC often follows a special pattern. The pathogenesis frequently relates to the eruptive pattern of the primary dentition, the cariogenic feeding pattern, and the oral physiology of the infant or child [3,4,23]. The caries attack usually starts on the labial surface of the upper anterior incisors. The initial lesion appears as a whitish area of decalcification along the gingival margin. These lesions soon become pigmented and spread laterally and coronally. Caries on molars may start simultaneously in the pit and fissure area and the gingival area of the buccal surface. The four upper incisors are usually the more severely affected, since they are among the first teeth to erupt and therefore have the longest exposure to cariogenic substances. Moreover, the nursing liquid always pools around these four teeth. The mandibular incisors are more resistant to decay, which may be due to their close proximity to the secretion area of the submandibular glands as well as the cleansing action of the tongue during sucking [4]. The tongue extends anteriorly during sucking to form an oral seal, which prevents the nursing liquid from pooling around the mandibular incisors [24].

Caries Prevalence

Some researchers suggested a global reduction of dental caries was

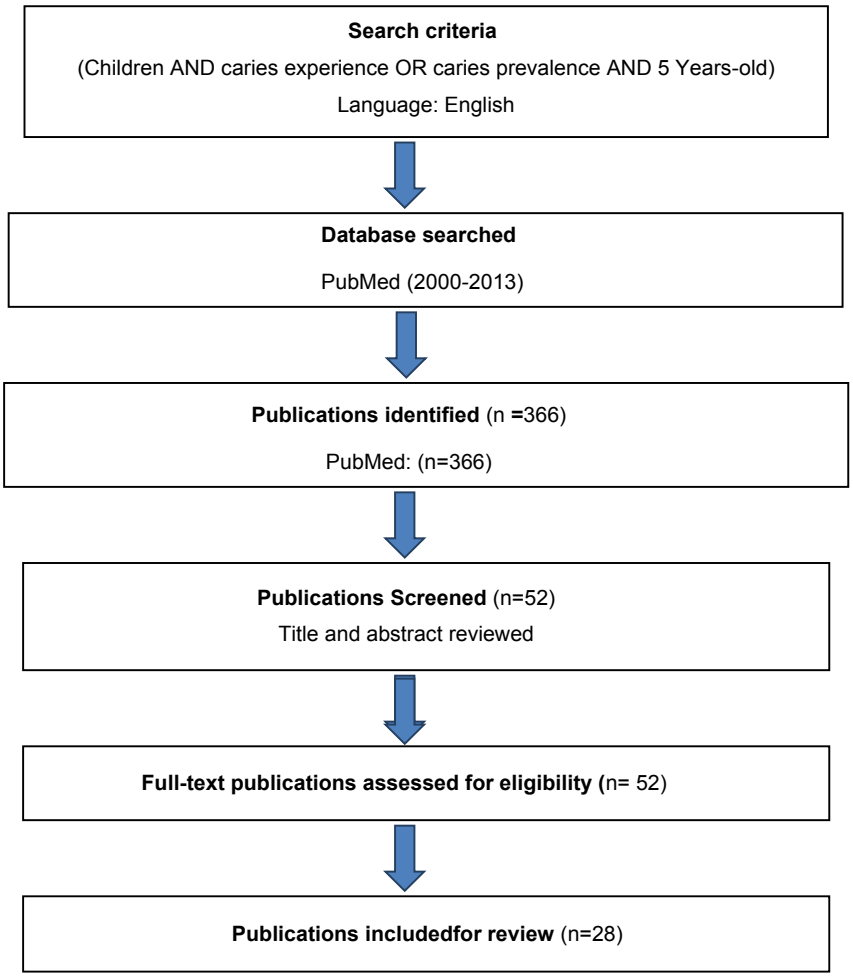

Figure 1: Flowchart of literature search and selection.

observed in recent decades, Bagramian et al. [25] performed a literature search of the available epidemiological data of dental caries from many countries. They reported that the results indicate that there was a marked increase globally in the prevalence of dental caries. In general, the increase in dental caries prevalence affects children as well as adults, primary as well as permanent teeth, and coronal as well as root surfaces. This increase in dental caries signals a pending public health crisis [25]. A PubMed search of the studies published 2000 and after on primary dentition of preschool children was performed (Figure 1). We selected 5-year-old children as recommended by World Health Organisation for survey of primary teeth [26]. Studies have found caries prevalence among preschool children varies greatly in different countries, ranging from 17 to 94% (Table 1). However, more than half of the surveys found the caries prevalence is more than 50%; and in most of the studies, over 90% of decayed teeth were left untreated.

Consequences of Caries Infection

Caries is the most common chronic illness among children and adolescents, and it has a significant impact on oral health and general health. Caries can lead to pain, inability to chew, and reduced ability to chew and eat. This results in limitations in the choice of foods and loss of appetite. For this reason, children with severe caries may experience reduced weight and delayed growth. Dental infection can spread systemically which can be critical. In 2007, a 12-year-old boy living in

Study (Year)	Site (Country)	No. of children	Age / yr	% dmf>0	Mean dmft
Mantonanaki et al. (2013) [74]	Attica (Greece)	605	5	17	Nil
Li et al. (2012) [75]	Shanghai (China)	1850	5	64 (2008)	2.96 (2008)
				64 (2009)	2.99 (2009)
				65 (2010)	3.23 (2010)
				64 (2011)	2.96 (2008)
Chu et al. (2012) [76]	Shan state (Myanmar)	95	5	25	0.90
Wigen et al. (2011) [77]	Oslo (Norway)	1348	5	11	Nil
Sufia et al. (1974) [78]	Lahore (Pakistan)	700	3 – 5	75 (5 yr)	1.85
Simratvir et al. (2009) [79]	Ludhiana (India)	609	3 – 6	59 (5 yr)	4.76 (1995)
Saravanan et al. (2008) [80]	Tamilnadu (India)	508	5 – 10	72	3.00
Cleaton-Jones et al. (2008) [81]	Johannesburg (South Africa)	7185	2 – 5	59 (5 yr)	3.4 (5 yr)
Li et al. (2008) [82]	Shanghai (China)	2132 (1995)	5	72 (1995)	4.76 (1995)
		789 (2005)		78 (2005)	4.17 (2005)
Li et al. (2008) [83]	Sichuan (China)	Nil	5	59	2.77
Cheng et al. (2007) [84]	Liaoning (China)	792	5	74	4.38
Ferreira et al. (2007) [85]	Canoas (Brazil)	1487	0 – 5	40	1.53
Pitts et al. (2007) [86]	England	216873	5	38	1.47
	Wales	10660		53	2.38
	Scotland (UK)	11161		46	2.16
Ferro et al. (2007) [87]	North-Eastern (Italy)	3401	5	31	Nil
Wanjau et al. (2006) [88]	Philadelphia (Mpumalanga)	269	5	53	2.18
Ferro et al. (2006) [89]	Veneto (Italy)	290	5	27	1.34
Pitts et al. (2006) [90]	Dundee (UK)	10381	5	43	1.3 (1983)
					1.4 (1993)
					1.4 (2003)
Haugejorden et al. (2005) [91]	Bergen (Norway)	Nil	5	30 (1997)	1.1 (1997)
				>40 (2001)	1.6 (2001)
				36 (2003)	1.4 (2003)
Pitts et al. (2005) [92]	England	239 389	5 – 6	39	2.16
	Wales				
	Scotland (UK)				
Skeie et al. (2005) [93]	Oslo (Norway)	775	5	48	4.8
Lucas et al. (2005) [94]	Minas Gerais (Brazil)	Nil	5	67	Nil
Autio-Gold et al. (2005) [95]	Alachua County (Florida)	221	5	48	2.5
Mello et al. (2004) [96]	Itapetininga (Brazil)	291	5	Nil	2.63
Peressini et al. (2004) [97]	Manitoulin (Ontario)	51	5	62	4.8
Ueda et al. (2004) [98]	Cambira (Brazil)	73	5	69	3.5
		61			
Cariño et al. (2003) [99]	Northern Philippines (Philippines)	448	5	94	9.8
Pitts et al. (2001) [100]	England	170	5	40	1.52
	Wales (UK)	731			
Mora et al. (2000) [101]	Granada (Spain)	173	2-5	37	Nil

Table 1: Caries prevalence among preschool children.

Maryland, USA died of a toothache [27]. The bacteria from the dental abscess had spread to his brain.

In the case of pulpal involvement, the abscess developed can potentially damage permanent teeth and incur enamel opacities, hypoplasia, or incomplete development. Premature loss of deciduous teeth can lead to reduced dental arch, tooth displacement, tilting, and rotations. Early loss of teeth results in difficulty in phonetics, affecting normal language development. Pain associated with caries leads to reduced quality of life for children, which results from disturbed sleeping and concentration problems [28-30]. Interruption in play and school work from pain and infection due to caries can induce emotional stress, including anger and instability. As a result of aesthetic and/or phonetics problems, children may be teased by other children, which could negatively affect their self-esteem. Children may develop a silent demeanor or avoid smiling and laughing as a result.

ECC is associated with a higher risk of new carious lesions in both the primary and permanent dentitions. Early onset of caries is associated with future caries development [31-36]. Infants with ECC grow at a slower pace than caries-free infants, experiencing with insufficient physical development, especially in height and weight [37,38]. Some young children with ECC may be severely underweight because of associated pain and the disinclination to eat. ECC may also lead to iron deficiency due to malnutrition [2].

Hospitalizations and emergency room visits are required to manage pain and spreading of infections due to caries [39-42]. These visits increase treatment costs and time [43,44], while also causing children to suffer from loss of school days and increased days with restricted activity [45-47], as well as from diminished ability to learn [47,48].

Management of Early Childhood Caries

Regarding the prevention and management of ECC, the focus has been on modifying the dental, infectious, and behavioural determinants of the disease [49]. The treatment objectives for ECC are commonly to improve oral hygiene; to eliminate carious teeth; and to improve the functioning and aesthetics of the child [23]. The management of ECC often requires education of both the parents and the child to improve their dental awareness and attitude toward dental health. The current best practice recommended by the American Academy of Pediatric Dentistry includes twice-daily use of fluoridated toothpaste for dentate children. Parents should provide assisted tooth brushing for preschool-age children. Oral hygiene measures for all children should be implemented no later than the time of eruption of the first primary molar tooth.

Conventional care usually involves preventive and restorative care. Preventive care includes dental health education, dietary analysis and advice, the use of fluoride agents, and the use of anti-bacterial agents like chlorhexidine varnish and fissure sealant to prevent new caries development. Topical anti-microbial therapy using povidone iodine has been reported effective in the prevention of ECC [50]. Restorative care may involve restoration of carious teeth with dental materials like silver amalgam, composite resins, or glass ionomer cements. A stainless steel crown can be used to restore large multi-surface carious lesions. Pulpotomy [51] and pulpectomy are treatments for the pulpally involved carious teeth. Teeth with a poor prognosis should be extracted to prevent pain and the spreading of infection.

The Commonwealth Dental Association and the World Health Organization held a workshop in 1986 on equity in oral health. One of the many challenges addressed at the workshop was how to provide funding to treat the massive amount of caries in children in developing countries. Atraumatic restorative treatment (ART) is a relatively new approach to the management of dental caries, originally developed to provide restorative dental treatment outside of the traditional clinical settings [52]. Taifour et al. [53] reported that ART using glass ionomer yielded better results in treating carious lesions extending into dentine in primary teeth than the traditional treatment using amalgam after 3 years. Glass ionomer has the ability of bonding chemically to enamel and dentine. Moreover, it releases fluoride and this is believed to prevent secondary caries formation and progression [54]. ART treatment approach is recommended by the World Health Organization for bringing restorative dental treatment to people who would not normally have access to dental care [55]. This treatment can also be provided to patients who may have difficulty tolerating conventional dental treatment with drilling and local anaesthesia injection.

Managing caries through minimally-invasive and low-cost methods is a critical issue. Caries-arresting treatment that aims to halt or slow caries progression provides a practical solution for minimizing children's discomfort and problems stemming from caries. Caries has been demonstrated to be arrested and remineralized with the use of chemical modalities such as topical fluorides [56] and sugar free chewing gum [57]. Topical fluorides have been used to prevent and arrest dental caries. Fluoride application can either be self-applied or professionally applied. Self-applied fluorides reduce the cost of using professional staff but not the cost of the material as it is consumed frequently in low concentrations. Self-application of fluorides also requires close supervision and the procedures may not be suitable for young children.

When the caries progresses substantially into dentine, the mineral component is demineralised and the organic component of collagen fibres breaks down. Carious lesions can also theoretically become arrested at any stage in the progression of caries. Arrested dentine caries is clinically defined by the hardness of the dentine surface and a yellow to dark brown coloration [58]. Advanced carious lesions in dentine consist of two distinct layers with different microscopic and chemical structure [59]. Two types of microbiological carious infected dentine lesions were found: the lactobacilli-rich infected dentine (which has high numbers of lactobacilli) and the non-lactobacilli-rich infected dentine (which as a low number of lactobacilli and a diverse micro-flora) [60]. Although dental caries causes demineralization of mineral tissue and denaturation of collagen fibres, the inner layer is scarcely infected by bacteria but is affected by plaque acid [61]. The inner part of dentine caries still contains a high concentration of mineral salts and can be remineralized [62].

It has been shown that the pulp can remain vital in primary teeth with deep dentine caries. Eidelman et al. [63] reported that 69% of the carious primary incisors in their study had a normal pulp without pulpal exposure. When the dentinal tubules in the area between the soft and the hard dentine were obstructed with large mineral crystals, caries was arrested. Another study found that the lesion in arrested caries had a higher pH than that of active caries lesions [64]. A histopathological study of carious primary teeth in children found that arrested caries had a significantly more favourable pulpal status than active caries [65]. It may even be possible to monitor caries lesions with frank cavitation without placing a restoration on the carious lesion if there is evidence that the caries process has been arrested [66].

Cost-effective caries preventive procedures have been used to tackle the severe caries problem in children in disadvantaged communities.

A study reported that brushing with fluoride toothpaste was effective in re-hardening dentine caries in preschool children [67]. Fluoride varnishes is becoming popular in recent years. It adheres to tooth surfaces for longperiods and prevent the immediate loss of fluoride after application, thus acting as slow-releasing reservoirs of fluoride.Regular application of 5% sodium fluoride varnish over five years was reported to be able to arrest caries [68]. Another study found that active dentine caries should be arrested by daily oral hygiene procedures and fluoride varnish [69]. The two-year longitudinal study on xylitol chewing gum showed that caries could be arrested in children with the chewing gum method [70]. In addition, studies have shown that chlorhexidine varnish can inhibit proteolytic activity, arrest dentine caries, and reduce caries incidence in preschool children [71,72]. However, a systemic review of selected caries prevention and management methods has found that the strength of evidence for the success of fluoride varnishes is fair, and evidence is insufficient for all other methods [73]. In addition, the use of chewing gum may not be indicated for young children.

Conclusion

ECC is a transmissible infectious disease, but these hazardous effects can be prevented by early effective interventions. Progression of ECC can lead to pain and reduced ability to chew and eat, which may also lead to malnutrition and reduction of quality of life of children. The focus on the prevention and management of ECC has been on modifying the dental, infectious, and behavioural determinants of the disease. The management of ECC often requires education of both the parents and the child to improve their dental awareness and attitude toward dental health. Managing caries has shifted from surgical or restorative caries treatment to preventive early intervention to arrest and even reversal of initial non-cavitated caries lesions.

Disclosure

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