

## REVIEW

## Dental disease in children with chronic illness

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This article aims to raise awareness among paediatricians and specialist paediatric services that poor oral health, in particular children with chronic illness, is a major cause of morbidity and can be a risk factor for severe, even life threatening complications. Good oral health and dentition is important for efficient mastication, speaking and of course, cosmetically for smiling. If left untreated, dental caries can lead to pain and infection. Chronic infection around one or more teeth can result in damage to localised structures, such as the developing permanent teeth. Children who are medically compromised (such as being immunocompromised from disease and/or therapy) however are at increased risk of developing systemic complications from dental infections, which may prove fatal.

We focus on the role of the general paediatrician in promoting the importance of good dental health for all children and in particular those children "at risk". We present preventive measures, evidence based where available, that may improve dental care and promote the role of paediatric dental services in the multidisciplinary management of chronic disease.

For this article we have used the term "poor oral health" to encompass caries (tooth decay), and periodontal disease (gingivitis and periodontitis). *Dental caries* is a dynamic disease of the calcified tissues of the teeth and requires the presence of bacterial *plaque* (which is a firmly adherent dense film of bacteria in a mucopolysaccharide matrix formed on the surface of the teeth) and dietary fermentable carbohydrate (sugar) which results in acid production, and subsequent demineralisation of the tooth surface. Dental plaque forms on the tooth surface as soon as the tooth has erupted and reforms over hours following removal. There are many bacteria in dental plaque, but the most important in the aetiology of dental caries are *Streptococcus mutans* and lactobacilli. These bacteria metabolise sugars to generate local concentrations of organic acid in the inner layers of plaque on the tooth surface, which lowers the pH at the tooth surface. When the pH at the tooth surface falls, a process of demineralisation occurs and calcium and phosphates diffuse out of the tooth enamel. When the pH at the tooth surface rises again this process is reversed and remineralisation occurs. However, if demineralisation predominates over remineralisation over a period

of time in a susceptible tooth, sub-surface softening of the enamel occurs. If the lesion progresses this is followed by "cavitation", forming a carious cavity (fig 1). Caries development is more likely at inaccessible areas where plaque is undisturbed and is worse in children with malocclusion and crowding of teeth. The mean time for caries to be confined to the enamel radiographically varies considerably but a mean of 3–4 years has been suggested. Progression is faster however in high caries risk individuals (as discussed below). Dental *erosion* (tooth surface loss), differs from dental caries; erosion results from the enamel of the tooth being attacked by acid which may have been ingested but possibly due to reflux. Erosion in 6–16 year olds is often seen in combination with high consumption of fizzy drinks and fruit juices' (fig 2).

*Periodontal disease* broadly consists of two elements, gingivitis and periodontitis. *Gingivitis* is an inflammatory response of the gums (gingivae) to plaque and is present in most mouths and characterised by redness, swelling and bleeding (on probing) of the gingivae (fig 3). Although gingivitis is readily *reversible* with effective plaque control (toothbrushing, flossing, mouthwashes), it may be a precursor of chronic *periodontitis*, which is the *irreversible* progression of infection and inflammation of the gingivae, periodontal ligament (which anchors tooth in



Figure 1 Caries within primary molars.



Figure 2 Enamel erosions induced by high intake of fizzy drinks.

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**Figure 3** Chronic periodontal disease.

bone), and bone, causing destruction of the periodontium and loss of the tooth.

In summary, caries is a dynamic process which in the early stages of demineralisation can be reversed. Plaque can be removed through good dental hygiene involving toothbrushing, flossing, and mouthwashes. However, if there is a net loss of tooth substance then irreversible cavitation occurs, the surrounding tissues become inflamed (periodontitis), infection may occur, and ultimately there is tooth loss.

### HOW IS ORAL HEALTH MEASURED?

Dental survey programmes involve visual examination by specially trained and calibrated dentists. A mirror and blunt probe are used but no radiographs are taken and thus the surveys are likely to underestimate caries experience. Caries prevalence may be expressed as the proportion of children with active decay and caries severity may be expressed as the number of teeth affected by decay. There are also indices of gingival health (gingival index), plaque (plaque index), and oral cleanliness (oral cleanliness index).<sup>2-4</sup> However, for large epidemiological studies the DMFT (Decayed, Missing, Filled Teeth) index is a validated index of decay experience.<sup>5</sup> This index is a measure of the current decay experience (Decayed element), previous decay experience (Missing and Filled elements)—excluding tooth removal for other reasons and can be applied to both the adult (permanent) dentition and milk “baby” (deciduous) dentition, the latter being called the dmft index.

### HOW COMMON IS DENTAL CARIES?

Dental caries and periodontal disease remain the commonest chronic diseases in children in the UK. Fluoride is the most important caries protective agent; the levels of decay fell rapidly after the 1970s when fluoridated toothpaste was

introduced.<sup>6</sup> The 2003 Children’s Dental Survey<sup>7</sup> showed that dental decay in 8, 12, and 15 year olds has decreased since 1983.<sup>8</sup> Despite these trends for improvement, the prevalence of caries in children remains unacceptably high. A survey in 1993 indicated that only 54% of UK 5 year old children had no decay experience<sup>9-10</sup> and this had not significantly fallen in subsequent surveys.<sup>11</sup> The prevalence of caries varies geographically in the UK; the proportion of 5 year old children with any known decay experience being highest in Northern Ireland (60%), followed by Scotland (55%), Wales (51%), and England (43%).<sup>11</sup> Millions of children continue to experience caries, periodontal (gum) disease, tooth loss, and malocclusions (crowding), most of which could be prevented with daily oral hygiene practices and professional care on a scheduled basis. Recently there has been increasing concern that children’s dental health in the UK is at risk of further deterioration with the paucity of NHS dentists. In some areas of the UK, two thirds of children (and adults) are not registered with a dentist.<sup>7</sup>

### WHAT CAUSES CARIES?

*Caries* is multifactorial and risk factors are summarised in table 1. Risk factors include socioeconomic, fluoride experience, medication, dietary habits, abnormal salivary flow and quality, the presence of chronic disease, and oral hygiene techniques (especially where there are difficulties in maintaining good oral hygiene, such as tooth overcrowding and malocclusion).

The evidence that sugar causes dental caries is widely accepted.<sup>12</sup> Within a few minutes of ingesting sugar, the pH at the surface of the tooth falls and may take between 20 minutes and several hours to fully recover. The length of time it takes for the tooth surface pH to return above the critical level (at which demineralisation occurs) depends on the quantity and “stickiness” of the sugar intake. If further sugary loads are taken before the pH at the tooth surface recovers, prolonged demineralisation occurs. The greater the number of sugary snacks in a day, the more likely caries is to occur. Children with chronic disease often receive small, frequent, low residue meals and frequent sweet treats given by well meaning relatives. Confectionery is the largest source of sugar consumption in the UK followed by soft drinks and table sugar. Studies in young children, older children, and adults show positive correlations between confectionery intake and decay.<sup>12-13</sup> In the younger age group fruit flavoured drinks have been a major cause of caries in infants. These drinks are commonly given to very young children and infants in bottles and feeder cups. As a result extensive caries in the anterior deciduous teeth (often called *rampant caries*) has affected many children (fig 4). Rampant caries is a

**Table 1** Risk factors for caries in children

	Low risk	High risk
Socioeconomic	Mother’s education: secondary, tertiary Good attendance pattern Family: nuclear, higher social class (I, II, III), employment	Mother’s education: secondary Poor attendance pattern Family: single parent, social deprivation, unemployment
General health	Good general health	Chronic illness
Medication	No sugar containing medication	Sugar containing medication
Oral hygiene	Regular brushing twice per day with assistance Good oral hygiene	Irregular brushing without assistance Poor oral hygiene
Diet	Less than 3 sugary intakes/day	3 or more sugar intakes per day
Fluoride experience	Regular brushing with fluoride toothpaste Optimally fluoridated water supply	Irregular brushing with fluoride toothpaste No fluoridated water supply
Past caries experience	dmft/DMFT less $\leq$ 1 No initial lesions Caries free molars at 6–8 y of age 3 year caries increment $<$ 3	dmft/DMFT $\geq$ 5 $\geq$ 10 initial lesions Caries in first permanent molars at 6 y of age 3 year caries increment greater $\geq$ 3
Orthodontic treatment	No appliance therapy	Fixed appliance therapy

Taken from 1997 UK National Clinical Guidelines in Paediatric Dentistry (Prevention of dental caries in children).<sup>43</sup>



**Figure 4** Caries in primary teeth (rampant caries).



**Figure 5** Gingival overgrowth secondary to ciclosporin use.

disease of deprivation which is frequently more extensive in inner city areas and in children from a lower socioeconomic background or minority ethnic background.<sup>13</sup>

Saliva acts to prevent dental caries in several ways, including a buffering effect which alters the plaque pH, washing away plaque and food debris, an antibacterial action, and contains a reservoir of minerals such as calcium, phosphates, and, under certain circumstances, fluoride. Certain foodstuffs, for example, cheese and sugar-free gum cause the stimulation of salivary flow. Abnormal saliva (quality or quantity), from disease or treatment can increase the caries risk. For example, xerostomia (dry mouth) can be caused by *drugs* such as anticholinergics and tricyclic antidepressants, *disease* such as diabetes mellitus and ectodermal dysplasia, and may occur following *radiotherapy* where such patients are at risk of rampant caries. Xerostomia as a result of Sjögren's syndrome (an autoimmune disease) is rare in children.

Medications have a marked effect on caries risk. Sugar based syrups are often used as alternatives to tablets in younger children to increase palatability and patient acceptance.<sup>14-16</sup> There is clear association between sugar containing oral medicines and dental caries and the effect may be greater if they are taken at night or at bedtime when the protective buffering and cleansing effects of saliva are reduced as the salivary flow rate falls. Sugar-free medicines are defined as oral liquid preparations that do not contain fructose, glucose, or sucrose. Prescription of sugar-free medication is particularly important if treatment is long term (defined as daily or alternate days for more than three months). Many of the children receiving long term medication are medically compromised, deemed high caries risk by way of their underlying disease/learning disabilities, and their dental treatment is associated with increased difficulty. Children with conditions such as congenital heart disease, acute lymphoblastic leukaemia, epilepsy, cystic fibrosis, juvenile idiopathic arthritis (JIA), and chronic renal failure, are often taking long term oral medication with liquid or syrup preparations.<sup>14-20</sup>

It is recommended that sugar-free preparations (or tablets for the older child) be used wherever possible.<sup>21</sup> There are now sugar-free alternatives to most commonly used liquid medicines, including most common antibiotics, anticonvulsants, cough medicines, certain non-steroidal anti-inflammatory drugs (NSAIDs), and paracetamol mixtures. It is noteworthy that many "over the counter medicines" such as cough mixtures are high in sugar content, as is simple linctus which is frequently prescribed. In many cases the sugar-free alternative is the same price as the sugared preparation or only marginally more expensive. In children with musculo-skeletal problems, NSAIDs are often prescribed for long periods of time. In addition to the problem with sugar loaded syrups, they may also cause soft tissue ulceration and

erosions of the tooth surface if they are not chewed and not swallowed.<sup>1</sup>

Poor oral health is a risk factor for candidiasis, bacteraemia, and potential life threatening septicaemia, especially when the patient is immunosuppressed through use of corticosteroids or other agents such as methotrexate, ciclosporin, or azathioprine. Immunosuppressive therapy is commonly used in many chronic inflammatory diseases such as JIA, connective tissue disease, inflammatory bowel disease, and inflammatory myopathies. Methotrexate and ciclosporin can also cause stomatitis and gingival hyperplasia (fig 5) respectively. More recently novel biological therapies have become available (such as etanercept and infliximab) and increasingly used with proven efficacy in severe polyarticular JIA,<sup>22</sup> and also are used in other chronic inflammatory diseases. These drugs are potentially immunosuppressive and infection is one of the major risks in their use. Inhaled corticosteroids are frequently used as maintenance treatment for asthma and can increase the risk of candidiasis in the otherwise healthy child, the risk being greater in the immunocompromised patient, with the ensuing risk of systemic complications.

The main barriers to attending a dentist include fear, the image of dental practices, dental indifference, and apathy.<sup>23</sup> Children, but not adults, in the UK have access to free dental care, but in other parts of the world cost may be a barrier to dental care. It is noteworthy that many children with chronic disease continue to have health problems into adolescent and adult years, and their utilisation of dental services as adults may be a considerable burden with the cost becoming a barrier to care. Furthermore, for the child with chronic disease, dental care is often perceived as a low priority. This is supported by evidence that in a survey of children with congenital heart disease, many such children are not registered with a dental practitioner,<sup>24</sup> and that children with JIA had increased levels of untreated dental disease.<sup>25</sup>

#### WHO IS THE "HIGH CARIES RISK" CHILD?

Many chronic diseases in childhood have been associated with poor oral health and increased caries compared to controls.<sup>14 17-20 24-34</sup> The prevention of dental disease in children who are medically compromised or who have a learning disability must be recognised as having a "dental special need". Box 1 includes a list of conditions known to be associated with poor oral health and increased caries. Although this list is not comprehensive, it highlights the fact that many chronic disease affecting different systems pose a risk, and furthermore dental treatments may be hazardous. Such children often have several risk factors for poor oral health, including social disadvantage, long term exposure to sugar loaded medicines, and the fact that their dietary habits may not be optimal. Some children may have learning disabilities, and/or anxieties about medical/dental

### Box 1: The child at "high caries risk"; some examples

#### Chronic disease

- Structural congenital heart disease
- Bleeding diatheses (e.g. haemophilia)
- Chronic suppurative lung disease (e.g. cystic fibrosis)
- Epilepsy
- Diabetes mellitus
- Juvenile idiopathic arthritis
- Inflammatory bowel disease
- Chronic renal disease
- Immunodeficiency
- Organ transplantation
- Craniofacial abnormalities (e.g. cleft palate)

#### Learning disabilities

- Down's syndrome

#### Children in intensive care

- Head injuries
- Burns injuries

#### Social deprivation

interventions which further compounds the problems. In many cases, preventive dental care for the chronically ill child is not deemed a priority.

It should also be remembered that children with prolonged admission to intensive care units (for example, head injuries, burns, trauma) are at risk of poor oral health, including gingivitis and periodontitis. The oral health changes may well be reversible with resumption of good oral hygiene techniques, but preventive measures are clearly advantageous in preventing systemic complications of bacteraemia and caries in the long term.

*Congenital heart defects* are common (approximately 8 in 1000 live births) and there is an increasing number of children who have undergone successful cardiac surgery. There is strong evidence that untreated dental disease, and the risk of oral bacteraemia is an important aetiological factor in the causation of infective endocarditis, a condition which still carries a high risk of mortality. Studies of decay in children with congenital heart disease have shown a higher prevalence and severity of decay, compared to controls,<sup>24–29</sup> and the provision of restorative care was low.<sup>24</sup> Congenital heart defects may be part of syndromes, such as Down's syndrome, and a disproportionate number of children with heart defects thus have multiple social and learning disabilities, which makes the delivery and acceptance of dental treatment more difficult. Even in children without these additional handicaps, previous medical interventions may make them unduly anxious patients. Children with heart defects should receive maximal preventive dental care, to minimise the need for dental surgical procedures and if procedures are required then appropriate antibiotic cover is required as recommended.<sup>35</sup> However, of concern, there is evidence from the northeast of England that such children are under-registered with a dentist.<sup>24</sup>

Children with *bleeding diatheses* may present with bleeding gums, especially after tooth brushing,<sup>33</sup> and are at risk of chronic periodontal disease. Children may present with acquired bleeding tendencies from malignancy (for example, leukaemia)<sup>27–28</sup> or complications from immunosuppressive

regimes. Chemotherapy, radiotherapy, and neutropenia can result in mucositis—that is, painful inflammation and ulceration of the mucous membrane, which renders the child at risk of chronic periodontal disease, caries, and infection (including candidiasis, invasive fungal, viral, and bacterial infections), which can become systemic and life threatening. Treatment, especially radiotherapy, may result in salivary gland dysfunction and xerostomia with resulting rampant caries. Furthermore, long term use of sugar loaded medication adds to the caries risk, and depending on the age of the child at the time of the cancer treatment, developmental defects of the teeth may occur,<sup>36</sup> which can adversely affect the child's quality of life. Children with haemophilia and malignancy, however, receive dental care as an integral part of their care, often in regional centres; this may explain why the reported incidence of caries in these patients is in fact lower than in controls.<sup>31–33</sup>

Several studies of children with *learning difficulties* have shown increased markedly increase levels of caries and furthermore, increased levels of untreated decay, which suggests barriers to care. It is noteworthy that many of these children, especially those with Down's syndrome, have congenital heart disease.<sup>37–39</sup>

Children with physical disabilities are also at high risk of caries. *Juvenile idiopathic arthritis* (JIA) is the commonest cause of disability in children. We have recently reported increased rates of caries, at all ages, and furthermore increased levels of untreated disease, which again suggests barriers to care.<sup>25</sup> The explanation is likely to be multifactorial, including salivary abnormalities,<sup>40</sup> sugar loaded syrups, dietary habits, upper limb disability and difficulties with using a toothbrush effectively, malocclusion/tooth overcrowding, and abnormal jaw opening due to temporomandibular disease (TMJ).<sup>20</sup> Children with JIA are also reported to have increased enamel defects.<sup>41</sup> Where dental treatment is required, intubation and airway maintenance may be difficult because of micrognathia or cervical spine disease.

### WHAT CAN BE DONE TO PREVENT CARIES?

The need to improve the dental health of all children is paramount<sup>42–45</sup> and is recognised as a global public health concern.<sup>46</sup> The general paediatrician, and allied health professionals involved in the care of children can play an important role in the prevention of caries in *all* children and especially those with chronic disease with whom they are more likely to have regular contact. Box 2 summarises the preventive measures that can be taken to reduce caries in the high risk child;<sup>42</sup> the general paediatrician and allied health professionals can reinforce this advice and also directly influence the prescription of sugar-free medication. It is imperative that high caries risk children are identified and that paediatric dental services (which will include the dentist, orthodontist, and hygienist) are involved early in the planning of the multidisciplinary management. The paediatrician can certainly facilitate referral to dental services and emphasise the importance of dental care, compliance with appointments, treatment, and advice. For high caries risk groups it is recommended that regular dental care issues are covered within specialist paediatric services. Prevention of poor oral health and caries is the cornerstone of success of dental management with the aim to minimise operative intervention. The success of integrated dental care is exemplified by the services for haemophilia and cancer, where caries rates for children with haemophilia and who receive regular dental care, are lower than controls.<sup>31–33</sup> The emphasis of preventive dental care lies on patient and family education, dietary advice, plaque control, fissure sealants, orthodontic treatment, use of topical fluorides, and use of

**Box 2: Prevention of caries in children**

(including recommendations taken from SIGN Guideline<sup>42</sup> with the level of evidence, based on the SIGN classification, given in parentheses, and of evidence described in Shaw<sup>43</sup>)

**Assessment of the caries risk for each child presenting for dental care [B]**

The following factors should be included in this risk assessment [B]:

- Clinical evidence of previous disease
- Dietary habits (especially frequency of sugary food and drink consumption)
- Social history, especially socioeconomic status
- Use of fluoride
- Plaque control (toothbrushing, flossing, mouthwashes)
- Saliva
- Medical history

**Behaviour modification in high caries risk children**

- Dental health education advice should be provided to individual patients in the chair as this intervention has been shown to be beneficial [A]
- Toothbrushing twice per day using a small pea sized amount of toothpaste that contains at least 1000 ppm fluoride. They should spit the toothpaste out and not rinse out with water [A]
- The need to restrict sugary food and drink consumption to meal times only should be emphasised [B]
- Dietary advice to encourage the use of non-sugar sweeteners (in particular xylitol) in food and drink [B]
- Patients should be encouraged to use sugar-free chewing gum [B]
- Clinicians should prescribe sugar-free medicines whenever possible and recommend use of sugar-free forms of non-prescription medicines [B]

**Tooth protection in children at high caries risk**

- Sealants should be applied and maintained in the tooth pits/fissures [A]
- For children living in areas with water supplies with less than 0.3 ppm fluoride ion, supplements may be used with careful guidance according to the age of the child
- Fluoride varnishes may be applied every 4–6 months [B]
- Fluoride tablets (1 mg fluoride/day) for daily sucking should be considered for children at high risk of decay [B]
- Low sugar artificial saliva and/or sugar-free chewing gum should be considered for patients with dry mouth

sugar-free medicines wherever possible. Patients should be particularly advised to decrease both the quantity and frequency of their sugar intake; in particular they should avoid sugary snacks between meals and immediately before bedtime. Paediatricians need to be aware of the markedly increased risk of dental caries in the presence of dry mouth—chewing gum (sugar-free) is advocated to stimulate saliva flow and lubricants and artificial salivas may be helpful. Prevention can also be achieved by effective removal of plaque by diligent brushing and flossing, and tooth strengthening by provision of fluoride and fissure sealants. Tooth brushing with fluoride toothpaste both removes plaque and provides fluoride. It is important to stress that fluoride toothpaste/supplements must be used judiciously to prevent fluorosis (tooth mottling). The wide and effective use of fluoride in toothpaste is the single most effective method of topical caries prevention and is one of the great success stories in preventive medicine.<sup>6, 47–48</sup>

Families of children with congenital heart disease must be aware of the need for antibiotic prophylaxis in the event of dental treatment, and the general paediatrician can reinforce this advice.<sup>35</sup> For the child with physical disability, the occupational therapist and physiotherapist are involved in the assessment of functional limitation. They can help the child to improve manual dexterity, reduce functional limitation, and improve toothbrushing techniques. Furthermore, for children with JIA or other conditions causing upper limb disability, a powered toothbrush may be helpful in improving

oral hygiene, although a reduction in caries risk has yet to be shown. Orthodontic monitoring of growth is advised from an early age, with radiographs where necessary to monitor TMJ changes. Where growth is seen to be disturbed, functional appliances may be indicated to aim for occlusal stability, restoration of function, and uninhibited growth of the mandible.

We recommend to the reader evidence based guidelines of the prevention of caries in children: *Prevention of caries in the high risk child*,<sup>42</sup> *the UK national clinical guidelines in paediatric dentistry*,<sup>43</sup> and systematic reviews published in the Cochrane Oral Health Group which include the role of fluoride,<sup>48</sup> powered versus manual toothbrushes,<sup>49</sup> penicillin prophylaxis for children with congenital heart disease,<sup>35</sup> and fluoridated milk.<sup>50</sup> There is a strong evidence base for the use of fluoridated toothpastes and topical fluoride gels, fissure sealants to prevent caries,<sup>48</sup> and penicillin prophylaxis for children with congenital heart disease undergoing dental treatment to prevent endocarditis.<sup>35</sup> The role of powered toothbrushes is controversial; the Cochrane Oral Health Group concluded that powered toothbrushes do achieve a modest reduction in plaque and gingivitis compared to manual toothbrushing, but further trials in the “at risk” child are required.<sup>49</sup> Subsidised powered toothbrushes are available for children with chronic arthritis through the Children’s Chronic Arthritis Association ([www.ccaa.org.uk](http://www.ccaa.org.uk)). Box 2 summarises the preventive measures recommended by the above mentioned guidelines and the evidence based on

the SIGN classification.<sup>42</sup> Once caries is detected, there is also guidance, evidence based where possible, on the treatment and secondary prevention.<sup>42</sup>

In summary, caries and poor oral health are common in many children. The risk and potential sequelae of poor oral health and caries are greater in medically compromised children. The provision of preventive dental care is a very important aspect of multidisciplinary management of such children. The general paediatrician plays an important role in raising awareness of the importance of good dental health among all children and their families, encouraging attendance, and facilitating referral of at risk children to paediatric dental services. Early involvement of the paediatric dental services as members of the multidisciplinary team will raise awareness, confidence, and cooperation of children and parents. There is a strong evidence base to support preventive measures for the high risk caries child, and the general paediatrician can facilitate these guidelines being used in clinical practice and ultimately improve the quality of life for these children.

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## APPENDIX

### WEBSITES OF INTEREST

<http://www.sign.ac.uk> – SIGN Guidelines

<http://www.cochrane.uk> – Cochrane Database of Systematic Reviews

<http://www.bda-dentistry.org.uk> – British Dental Association

<http://www.iapdworld.org> – International Association of Paediatric Dentistry

<http://www.bsdh.org.uk> – British Society for Disability and Oral Health

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