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Caries and restoration prevention

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Is it possible to maintain lifelong oral health with no or few restorations in populations that traditionally have had high incidences of caries? The answer is yes. Research has led to great advances in the prevention of primary dental caries. According to current knowledge in cariology, the development of caries to the extent that it requires surgical intervention largely can be prevented.

Implementation of effective preventive programs in general dental practice requires the active participation of dentists and dental hygienists, who have the primary responsibility for educating and training patients in preventive behaviors. Attention to other factors under the control of clinicians, notably criteria regarding when to place restorations, is important in understanding the improvements recorded. In addition, patients’ motivation and compliance are essential to ensure the success of most preventive approaches to dental caries.

Different age groups of patients have been studied to demonstrate the effect of various preventive and restorative programs. The World Health Organization (WHO) has focused on 13- and 14-year-olds, while others have studied 18- to 20-year-olds. Studies of the decrease in caries initially focused on children and adolescents, and the question of whether the effect

ABSTRACT

Background. The authors analyzed studies of decayed, missing and filled (DMF) rates for surfaces and teeth in Norway published during the last 30 years. The result of active fluoride therapy combined with a change in criteria for when to place restorations led to a marked reduction in the need for restorations.

Methods. The authors reviewed independent, cross-sectional DMF studies of representative samples of young adults performed every 10 years during the period 1973 through 2006. The clinicians involved in the studies used standardized and calibrated methods. The authors of this article also reviewed an additional series of studies collecting DMF data from representative samples of 15-year-old adolescents that also had been carried out independently from 1979 through 1996. In these studies, the investigators examined clinical records and bitewing radiographs with attention to progression of carious lesions and restorative treatments.

Results. The authors noted a marked reduction in the mean decayed, missing and filled surface (DMFS) scores from 1973 through 2006 in the two adult groups. They also found a significant decrease in treatment of caries. The reduction was most marked after the mid-1990s. They noted that the most dramatic change in the data from the 15-year-olds resulted from a change in the treatment criteria during the 1980s. Approximal lesions in enamel were monitored by the investigators of those studies in combination with the use of fluoride toothpaste.

Conclusion and Clinical Implications. A caries treatment approach based on active caries-preventive treatment and restrictive criteria for restoration placement are good bases for reducing the need for restorations as shown in cross-sectional studies reviewed.

Key Words. Restorative dentistry; operative; general practice; research; review literature.

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noted was merely a postponement of the onset of the caries remained at issue until it was shown that the caries decline was maintained into adulthood.\(^4\) This article interprets published data and trends in oral health development and change in treatment criteria across more than 30 years. It focuses on the caries and restoration situation in Norway, but the situation is much the same in all the Scandinavian countries and in some non-Scandinavian countries. Aside from this geographical focus, the clinical and science aspects of our assessment should be comparative between countries.

METHODS AND MATERIALS

This article focuses on published cross-sectional data regarding decayed, missing and filled surfaces (DMFS)/decayed, missing and filled teeth (DMFT) from 1973 through 2006. We based our selection of the age groups on the assumption that the adult groups comprising people aged 35 to 44 years were considered to represent the dental care provided well into adulthood and that people aged 15 years represent the outcome of dental care in childhood.

We present data on the adults first because they represent the endpoint of the outcome of the dental restorative care in this review. One group was from an urban area\(^5\) and the other from a rural area.\(^6\) We present results from the 15-year-old age group\(^7\) to assess if the improvements noted in the decayed, missing and filled (DMF) data regarding the adults’ teeth and tooth surfaces are consistent with the results from the 15-year-olds and if they conform to the relatively rapid improvements noted in the adult groups.

RESULTS

The adult groups. Data on representative samples of 35-year-olds in Oslo, the capital city of Norway, have been recorded by investigators\(^5\) every 10 years for several decades as part of a health survey of people in this age group. DMFS/DMFT data have been recorded by these investigators since 1973, and the last examination was completed in 2003. Thus, cross-sectional data across a 30-year period are available.\(^5\) The criteria for recording caries were standardized (WHO criteria), and the clinical examiners’ methods were calibrated at each of the examinations across the 30-year period.

The DMFS data from this urban population in 1973 showed that, on average, 70 tooth surfaces had been restored or were missing or carious (Figure 1).\(^5\) The restored surfaces constituted by far the largest component of the DMF index; almost 50 surfaces involving 16 teeth had been restored. Decay, including primary and secondary (recurrent) caries, averaged 6.5 surfaces on 3.2 teeth, and 2.8 teeth were missing. Third molars were not included in the DMF index.

A marked decrease in the DMF index did not become apparent until the 1993 survey, and the decrease continued in the 2003 investigations. From 1973 to 2003, the data showed a 62 percent reduction in DMFS, an 83 percent decrease in the mean number of carious lesions and a decrease of 73 percent of missing teeth. The number of restored surfaces decreased by 56 percent. Primary and secondary caries together, on average, were diagnosed in less than one tooth surface per

ABBREVIATION KEY. DMF: Decayed, missing and filled. DMFS: Decayed, missing and filled surfaces. DMFT: Decayed, missing and filled teeth. WHO: World Health Organization.
patient and constituted 0.7 teeth in the sample of 35-year-olds in 2003.

The investigators independently collected DMF data from the rural adult group by using the WHO criteria every 10 years from 1973 through 2006 (Figure 2). The 35- to 44-year-old subjects in this group showed similar results to those reported in the urban population. The investigators noted a decrease in the mean number of DMFS/DMFT in 1994, and the decrease continued as shown in the 2006 recordings. The mean number of restored teeth remained similar from 1973 through 1983. After a slight increase in 1994 in the number of restored teeth, the investigators noted a decrease in the 2006 recordings. A comparison of the DMF recordings from the urban (Figure 1) and rural (Figure 2) adult populations indicates the decreasing trends are similar in the two populations, although the DMF values are higher for the rural population than for the urban population.

The 15-year-old age group. The cross-sectional DMF data for the 15-year-old subjects were available from the same urban population to which the adult group belonged (Figure 3). Researchers reviewed DMF data regarding representative samples of 15-year-olds during the period from 1979 through 1996, paying special attention to the presence of caries that received restorative treatment. They randomly selected treatment records, including the radiographs obtained immediately before the clinical examination, from those of the sample group of 15-year-olds. The radiographic examination was limited to approximal surfaces from the distal surface of the first premolar to the mesial surfaces of the second permanent molars. Researchers performed radiography under standardized conditions, and carious lesions were recorded as being in the outer or inner one-half of the enamel or in the outer or inner one-half of the dentin. The researchers noted surfaces missing owing to caries and restored surfaces in the same locations and compared them with those observed at the previous treatment session. The researchers assessed changes in treatment criteria by comparing the depth of the carious lesions that had been restored during the next treatment session.

The number of restored surfaces was reduced dramatically in the 1980s because of a change in the criteria for placement of restorations in the treatment of enamel lesions (Figure 3). The number of restored surfaces decreased by 92 percent because clinicians were treating caries in the enamel preventively instead of by placing restorations.

DISCUSSION

Fluoride plays an important role in the prevention of caries and consequently in restoration placement, but attention to other factors, notably criteria for when to place restorations, is essential to understand the improvements recorded in the adult populations reviewed here. A number of interacting conditions must be in place to ensure the success of caries-preventive programs that involve easy access to fluorides, including daily use of fluoridated toothpaste; the engagement and supervision of caries progression by dental practitioners and dental hygienists; a public interested in good oral health and aiming to prioritize oral hygiene; and restrictive criteria for placement of restorations.

A combination of the aforementioned factors is key, but other factors—such as an increased level of education, access to dental care and enhanced

![Figure 2. Cross-sectional data on decayed, missing and filled surfaces; decayed, missing and filled teeth; and filled teeth data in 35- to 44-year-olds from a rural county in Norway from 1973 until 2006. Source: Holst and colleagues.]
living conditions, including increased personal income—also play a role in the success of caries prevention programs. Such effects are expected to have greater potential significance in the United States, where a part of the population cannot afford dental treatment, while in some other industrialized countries, virtually everybody seeks and receives regular dental care. Our own experience during the last 40 to 50 years indicates the positive effect of caries and restoration prevention in practice in Norway. The caries- and restoration-preventive achievements that affect the entire population in Scandinavian general dental practices have not reached all parts of the world, including the United States.

The demineralization of the dental tissues is the main basis for the detection and characterization of caries lesions. Primary caries lesions on the proximal surfaces of teeth most often are detected clinically, especially when supplemented by examination of bitewing radiographs. In this way, cavitated and noncavitated lesions can be diagnosed. Other smooth-surface lesions are identified solely by means of clinical examination. The diagnosis of occlusal primary lesions is more difficult than that of lesions on other surfaces because of the convoluted distribution of enamel making up the pit-and-fissure pattern of the occlusal surface.

Primary caries lesions are classified as either enamel or dentin lesions. Enamel lesions may be subdivided into outer- and inner-enamel lesions. Caries that have reached dentin are classified as being in either the outer or the inner dentin; alternatively, the dentin lesions may be divided into three depth categories: outer, middle or inner dentin. An important question in the discussion of restoration prevention is the decision of when restorative therapy should be started in the treatment of caries. The restrictive attitude toward restoration decisions among dentists shown in this review (that is, not treating enamel lesions surgically) has been confirmed in other studies. This restrictive trend gradually has entered general dental practice. A comparison of results from similar studies in 1983 and 1995 shows an increase from 66 to 82 percent of practitioners in Norway not treating enamel lesions surgically. Also, the reduction in the number of restored surfaces occurred at a time when caries lesions in general were decreasing; that is, the reduction in restorations cannot be entirely credited to the restrictive criteria for placing restorations. Furthermore, fewer restorations placed to treat primary caries will result in fewer replacements of failed restorations.

The decision to place the first restoration in a previously unrestored surface of a tooth is a crucial event in the life of a tooth, because a permanent restoration, in the true sense of the term “permanent,” does not exist. Every dentist recognizes that restorations, once placed, will require replacement or repair after some time. Repair of localized lesions are indicated to save tooth structure lost owing to repeated replacements, but many teaching programs and clinicians consider repair of localized lesions an inferior, “patchwork” type of restorative treatment, despite good clinical experience and positive outcome of repair in clinical studies. Clinicians may need to be reminded that removal of carious tissues and placing of restorations per se cannot be a permanent solution to the caries problem. Restoration treats the effect of the disease but does not focus on the cause of caries. If only the carious tissue is removed, not the reason for the development of the lesions, caries will prevail and occur both on previously unrestored surfaces or adjacent to restorations as secondary caries.

One country’s fight against caries. Soon
after World War I, legislation was passed in Norway providing free dental services to children aged 7 to 14 years. At that time, Norway was a poor European country. This service, which became known as the School Dental Service, was not effective before World War II because of the insufficient numbers of dentists due to the lack of training and education. The School Dental Service improved gradually in quality and quantity of coverage, and it became part of Norway’s National Public Dental Service. Today, it covers children and adolescents from birth to age 18 years. Adults are treated on a fee-for-service basis similar to that in private practice anywhere in the world. However, the sparse population of some parts of the country does not provide a patient pool large enough to support private practice. The dental service, therefore, was developed into a combined public dental health care system based on free dental treatment for children and special groups (such as people with disabilities and older adults) and a fee-for-service system for adults with a fee schedule similar to that in private practice.

Virtually all children voluntarily participate in the National Public Dental Service, so preventive services reach the entire population from birth to 18 years of age. Because dental offices in Norway usually are located in school buildings, the conditions for introducing preventive programs are close to ideal. A private practice setting, in which most children in the United States receive dental care, requires initiative by the patient or parent, and, thus, compliance is less certain. While not detailed here, the threshold for when to intervene surgically also varies between U.S. and Scandinavian dentists.

Numerous studies and public health service statistics in Norway during the last three decades have demonstrated the effectiveness of the restorative services provided. Yet, the body of evidence indicates that caries was not and cannot be cured by placing restorations. One example of the effectiveness of the restorative system was a study of 18- to 20-year-old Norwegians in the late 1950s. These young adults had, on average, a DMFS score approaching 50 and the filled component was by far the largest proportion for those who had received regular dental care.

Oral hygiene has long been emphasized in Norway, and 94 to 97 percent of students reported toothbrushing more than once a day. In the prefluoridation era, it seemed like the dentists and the patients were fighting a losing battle. As a consequence of the improved oral health, the frequency of dental examinations have increased gradually.

As fluoride entered caries-preventive programs, significant positive changes arose. Initial programs involved supervising students’ rinsing with a fluoride solution as an alternative to the professional topical application of sodium fluoride solution. Soon these regimens were followed by prescription of fluoride tablets. Fluoride clearly had a positive effect, but it was not until after 1971, when fluoride toothpaste could be purchased without a prescription, that the beneficial effects of fluoride could be demonstrated on a population basis. This event was a major breakthrough in caries prevention for the entire population. Attention also was focused on a number of other areas later, including the diagnostic criteria and at what stage in the caries development restorations were indicated for the treatment of the caries. The findings demonstrated that the change in the criteria for when to place restorations, combined with access to fluoride primarily via toothpaste, resulted in a positive reduction in the number of restorations needed. Additional effects likely also have played a role, including a higher level of education, improved living conditions and higher personal income. Naturally occurring and artificially fluoridated water fluoridation programs and supplies are rare in Norway.

CONCLUSIONS

Restoration prevention is linked closely to caries prevention. A number of factors play a role in preventive approaches. Our literature review focused on access to fluoride and restrictive criteria for when to place restorations once the disease has occurred. Provided initial carious lesions diagnosed in enamel are subjected to active preventive treatment, a marked, long-term reduction in the number of restorations can be achieved.

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