Introduction

In this special issue examining the medical management of dental caries, authors look at methods, programs and means to deal with dental caries as a disease. Although dental caries is the most prevalent infectious disease in humans, affecting 97 percent or more of the population in their lifetime, we primarily treat the effects of dental caries and not the disease itself.

Most restorative dentistry, endodontic and prosthodontic procedures in adults are performed to treat the results of dental caries, not to treat the disease. We are generally limited to surgical restorative interventions because we have historically lacked clinical caries detection tools sensitive enough to see a caries lesion at such an early stage that it can be treated with medicinal therapeutic approaches. Remineralization and other techniques that can assist in reversing the progression of a caries lesion are well established in vitro, but have not found routine clinical use because of the absence of clinically feasible early detection methods. When it comes to reducing the risk of caries within populations or groups of patients within a practice, we typically provide empirical standardized recommendations such as “brush and floss” and “use fluoride toothpaste.” Although many methods of intervention to reduce caries risk are extremely effective within populations at risk, routine measures do not target individual patients who might be at much greater than average risk. New ways of thinking combined with new technologies will dramatically change the way we deal with dental caries as a disease. Managing the disease process by mitigating risk instead of identifying the disease at a later stage when surgical restorative intervention is required will soon become the norm.

The gross domestic consumption of the entire dental profession stands at around $115 billion per year in the U.S. The dental business in the U.S. has grown at a greater rate than the economy as a whole over the last decades, although its growth has recently slowed. Approximately 80 percent of all dental expenditures are for professional services, mainly dentists’ fees. Only 12 percent of expenditures are for consumer products (toothpaste,
mouth rinses, etc.), with approximately 8 percent for professional product sales, including consumable materials and dental equipment. However, when one examines the estimated $115 billion gross domestic consumption in dentistry each year, it becomes apparent that approximately 60 percent of the total expenditure, or about $75 billion a year, is spent on treating the results of dental caries. The vast majority of the caries expenditures (most restorative dentistry) does not treat caries at all, but provides surgical repair for the damage done by dental caries disease. The main reason this situation exists is that dentists do not have the necessary detection tools to identify the caries process on a site-specific basis until very late in the disease progression. At that late stage, surgical intervention is the only available approach.

The caries lesion detection devices the dental profession currently uses are extremely insensitive. Visual examination using an explorer and mirror can identify caries lesions only at a stage when restorative interventions are needed. Radiography is also extremely insensitive in spite of the introduction of digital radiography. The core technology of X-radiation allows detection of proximal caries lesions only when they are at least halfway through the enamel radiographically. At this stage, demineralization can be challenging to undertake, and it is even more challenging to confirm that one has successfully reversed the course of the lesion directionally. Additionally, the ability to superimpose the current status of the caries lesion upon a later-identified status is, at a minimum, challenging. A product that would treat a caries lesion medicinally and later identify the reversal of its progression with adequate precision and specificity is not currently available. This lack significantly reduces the likelihood that a pharmaceutical company would be interested in developing new categories of pharmaceuticals to medicinally treat caries lesions early. The limitation on early detection also causes the profession to miss caries lesions at early stages when remineralization and other medicinally mediated techniques might be effective. Transillumination to identify caries lesions in interior teeth has been used for centuries but is limited to the identification of lesions that are already extensive in their progress within the enamel and are well under way toward cavitation, if that has not already occurred.

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The changes that will transpire in this area of dental practice will alter dentistry perhaps more than anything that has happened to date. When assessing new caries detection tools, one must evaluate them based on important criteria, including sensitivity and specificity. I define sensitivity as the ability of a tool or device to identify the presence of the caries process without false negatives. By this measure, all the tools we have historically used to detect caries lesions are extremely insensitive. Included in this list are visual examination, radiography and transillumination. Specificity by my definition refers to the accuracy of the tool or device in its identification of the condition it detects; in other words, no false positives. Yet, one must further differentiate two distinct components of specificity. The first is whether what has been detected is indeed what it is believed to be. If a radiograph or visual examination detects what appears to be a caries lesion, how certain can one be that what was detected is indeed a caries lesion? The second important part of specificity, which becomes even more crucial as we begin to detect caries lesions at earlier stages, is whether the detected lesion will progress if it is left untreated. This is perhaps the more difficult challenge. Clearly, the earlier one detects caries lesions, the greater the chance that the detected lesions will not progress to a stage requiring surgical intervention. This creates a set of false-positive lesions that, although identified, may not have progressed and resulted in unnecessary (medicinal) treatment. Although this type of unnecessary treatment is not the same as cutting into a healthy tooth unnecessarily, it would undoubtedly generate exceptional unnecessary cost, for which third-party payers would not be likely to reimburse. The natural compensatory mineralization process might allow routine reversal of very small lesions by naturally occurring demineralization. This aspect of specificity — considering whether the lesion would progress if untreated — is important to understand. But most experts are not significantly concerned about employing mineralization techniques for early-detected small lesions, even at the risk of treating some that would not have progressed if untreated.

The greater concern arises when these lesions are treated by surgical restorative interventions, even when they might not have progressed at all or were perhaps treatable with medicinal mineralization approaches. The dental marketplace will not be receptive to these newer highly sensitive tools, even with increased specificity, unless prediction of lesion progression can be maximized. Third-party payers are not
Therefore, we must develop outcomes determining and predicting caries lesions. The prediction of caries lesion progression is the ultimate indicator of success for a caries assessment tool or technology. The dental marketplace, including patients, dental professionals and third-party payers, continues to engage in discussions that would allow the ideal caries assessment tool to be used routinely in practice. Many payers encourage development might aid in predicting caries lesion progression. Over the next years, validated outcomes data will emerge to determine which technologies or collection of technologies and assessment tools will provide the needed predictive value in indicating a precise risk of caries lesion experience.

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The $75 billion spent each year on dental caries in this country is primarily allocated to treating the results of the disease, mostly in the form of restorative dentistry, prosthodontics and endodontics. Given that we understand the science of caries and how it progresses but do not understand the complex nature of caries progression in different individuals, the need for technology risk assessment tools to help predict who will develop caries lesions becomes ever more important. By specifically identifying individuals at risk, we can engage the entire health care team to treat specific caries lesions.

Caries experience in preschoolers remains extremely high, and this is the only category of patients whose caries rates are going up. With many other conditions, the vast majority of disease manifestation exists in a small percentage of the population. Caries disease affects those with poor access to care more than those with easy access. Therefore, the entire community of health care professionals must work together to identify those who may be at risk, regardless of their access point, and focus our caries management efforts on venues and treatments which allow medical management interventions that do not involve only surgery.

Other papers in this issue will examine medical management of caries from a variety of perspectives. The ability to assess a population’s risk and compare that risk to other populations will undoubtedly focus attention on dentistry’s participation in identifying patients at risk for caries. As technologies unfold that are easy to use and highly specific in their ability to predict caries experience in children and adults, they will likely be employed in various venues in the future.

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The future of dentistry’s technology development is not entirely known, but very exciting times are ahead, as we are currently examining all aspects of dental practice. This includes the change from manual fabrication of precision impressions, provisional restorations and laboratory-fabricated customized restorations to scanning the patient’s teeth with direct digital transfer of data to a laboratory and subsequent fabrication of a crown. Nor do we know whether this technique will take place primarily in the dental office or in dental laboratories. It seems to be a race to the finish line as to who can develop digital technologies faster in an effort to better prepare teeth for restorative procedures.

Yet, there is typically much less discussion in the dental profession on the topic of this special issue. Management of caries lesions by medicinal approaches versus restorative techniques is a major question to be dealt with over time, depending on how quickly the necessary technologies and systems can be deployed. The entire subject of computer-aided design and computer-aided manufacturing (CAD/CAM) of digital impressions and laboratory- or dental office-fabricated restorations is based on the assumption that restorative dentistry remains the mainstay of the profession. It certainly will for some time, as caries lesions continue...
to progress, need to be replaced after the initial restorations and eventually require extracoronal restorations. In time, however, additional therapeutic treatments to reduce both the number of initially progressing caries lesions and the resultant number of restorations will delay the replacement of existing restorations. The ability to treat secondary caries activity around the margins of existing restorations will slow the overall progression of caries lesions and the need for restorative intervention across the entire population.

This more comprehensive outcome will take decades, but it must start somewhere. The implementation of data analytics, data mining and access to patient information through a host of sources in the cloud will enable us to use forms of artificial intelligence to create predictive models of the outcomes of all treatments in the dental office. This predictability of outcomes through sharing large datasets will quickly enable us to examine which treatments create the best outcomes. This in turn will accelerate medicinal product development along with identification of highly specific detection tools to shift the curve toward caries lesion management, caries risk management and reduced surgical intervention in favor of medical management of caries and caries lesions.

**RECOMMENDED READING**


