Bridging the Gap in Caries Management Between Research and Practice Through Education: The Indiana University Experience


Abstract: Although dentistry recognizes that dental caries management encompasses more than restoring the consequences of the disease, caries risk assessment and management that go beyond traditional restorative care have not always had a strong and organized voice during clinical curriculum development and competency assessment in U.S. dental schools. This has resulted in confusion and great variability between the need for risk-based caries management and prevention and how practitioners apply these concepts in private and community settings. Dental education is in the unique position of being able to help bridge the gap to improve dissemination of new information and to enhance communication between research and the practice of dentistry to accelerate adoption of validated approaches for the diagnosis and management of dental caries. This paper presents one example of how a dental school totally revamped its approach to teaching cariology—from a few lectures scattered throughout the curriculum to a Cariology Management Program that is integrated into all four years of the curriculum, that includes both didactic and clinical components, and that emphasizes critical thinking and problem solving. From its inception, the program was centered on a competency requirement for graduation and the principles of evidence-based practice. The process, competency, and initial programmatic outcomes assessment measures are discussed. Barriers encountered are briefly reviewed from the following perspectives: dental school structure, faculty support/calibration, students, reimbursement, and standard of care/public expectations.

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Oral and craniofacial diseases are not merely dental problems; they can affect general health and well-being, lead to extensive pain, and create huge financial burdens on individuals and society. Dental caries, in particular, is considered “the single most common chronic childhood disease, and is most common in lower socioeconomic status groups, minorities, homeless and migrant populations, and children with disabilities and HIV disease.” Historically, dental caries was understood to be a progressive continuous disease that eventually destroyed the tooth unless the dentist surgically or restoratively intervened. Prevention was based mainly on reinforcement of oral hygiene practices and community fluoridation programs. Today, our understanding of dental caries has changed markedly and expanded this simplistic view of the disease, its consequences, and the methods of action of many preventive agents.

This enhanced understanding needs to be reflected in how dentistry is practiced. In 2001, a National Institutes of Health (NIH) Consensus Statement recognized a paradigm shift in the management of dental caries as a disease process. That consensus statement, based on the NIH-sponsored Consensus Development Conference on Diagnosis and Management of Dental Caries Throughout Life, identified the need to apply new strategies 1) to provide enhanced access for those who suffer disproportionately from the disease; 2) to provide improved detection, diagnosis, and risk assessment; and 3) to create and enhance use of improved methods to arrest or reverse the noncavitated lesion while improving surgical management of the cavitated lesion. This paradigm shift from a predominantly surgical model should be correspondingly reflected as changes in the modern management of dental caries. The management and prevention of dental caries beyond the restoration of tooth structure must be incorporated into existing practice using the best evidence-based information available. As research generates new ways to detect, diagnose, manage, and prevent dental caries, this in-
formation must influence and modify private practice and community and public health programs. Simultaneously, the community’s real and perceived dental needs and access to care also influence research needs and practice. Therefore, there is a continuous need to improve dissemination of information and communication between the research and practice domains (Figure 1) to accelerate adoption of needed and validated approaches for the diagnosis and management of dental caries. Dental education and dental schools are in the unique position of being able to help bridge the gap, helping to train our students to be critically thinking and problem-solving professionals, and to improve the dissemination of new information and communication between research and dental practice.

Process of Change in Teaching Cariology

Within the framework of the symposium on “Caries Management: Transitioning from Education and Research to Improve Patient Care” presented at the Joint 2006 Annual Session of the American Association for Dental Research (AADR) and the American Dental Education Association (ADEA), we were asked to 1) discuss how diagnosis, risk assessment, prevention, and remineralization of caries can be implemented in didactic and clinical teaching and in outcomes assessment and 2) discuss barriers to implementing scientifically justified changes in clinical teaching and ultimately in the practice of caries management and prevention. The scope of this article is limited to changes in the teaching of risk-based, nonsurgical management of dental caries, referred to as “cariology” for the sake of these discussions, at Indiana University School of Dentistry (IUSD), with the recognition that this is only one of the multiple pieces of a complex puzzle of training competent health professionals in the areas of disease prevention and management. At IUSD, we were very fortunate that our school’s institutional goal—“to develop highly competent, critically thinking, lifelong learning, ethically and socially responsible practitioners of general dentistry”—provided a solid framework on which to build. In this article, we use our experience as an example of how changes in the teaching of cariology have been implemented within a dental school. With this example, we are not suggesting this is the only way for change to occur; however, we are using this example to highlight certain key elements that, when identified and used correctly, can enhance
this transition and change. We also use this example to draw attention to existing barriers and to present possible solutions.

In the August 2006 Charting Progress newsletter, ADEA Executive Director Richard W. Vachovic discussed the need for change in dental schools’ curricula not only to help incorporate the great influx of new knowledge and rapid advances in technology in our profession and address the needs of underserved populations, but also to change some of the ways we teach. Passive learning environments, filled with memorization and repetition of isolated facts, not only fail to develop students’ ability to become critical thinkers and lifelong learners, but also fail to prepare them to address the future needs of their communities and practices. As Hendricson et al. have written, “The cornerstone of professional practice is the application of thought processes that allow dentists to recognize pertinent information in a patient’s presentation, make accurate decisions based on deliberate and open-minded review of available options, evaluate outcomes of therapeutic decisions, and assess their own performance.”

In answer to the challenges of improving teaching in all areas of dental education, including cariology, ADEA’s Commission on Change and Innovation (CCI) in Dental Education has recently drafted “competencies for the new general dentist.” These competencies include six domains that will help guide the preparation of students as future health professionals: patient care, health promotion, practice management, professionalism, communication, and critical thinking. If students are to move from memorization of facts to an integrated experiential approach that will prepare them in these domains, then our current educational programs must change. The CCI has also determined that “this will demand a different approach to traditional educational formats and a complete reorganization of the educational competencies and content delivery. It has been suggested that a ‘natural critical learning environment’ must be created that fosters reasoning from evidence, improves thinking, and develops inquiry skills.”

When our school recognized the need to change how cariology was being taught in our curriculum, it was agreed that the changes needed to go beyond the philosophical ideology and acceptance of a combined nonsurgical/surgical model of disease management and prevention. They must also include an increased commitment to the use of evidence-based information in teaching, practice, and assessment of students’ ability to manage dental caries; the development of a competency-based educational program to assess newly defined management and learning skills; and the acceptance by faculty, students, and patients of this new program. We specifically designed our caries management educational program to allow for the teaching and assessment of our students’ ability to analyze problems critically and to use evidence-based information to offer a range of possible approaches to solving these problems. Therefore, the caries management clinical forms and competency assessment were designed to allow for flexibility in thinking and use of evidence. These changes have created a challenge in terms of faculty calibration and, over time, also have required the revision of forms to improve standardization across clinics. We also emphasize that, although the general practitioner may decide to use a more structured caries risk form and standard “recipes” for treatment of risk-based scenarios, our goal in dental education should be to teach practitioners how to determine what is the best and most current information available to make future evidence-based decisions in their practices.

The following timeline provides the rationale used to promote the creation and revision of the teaching of cariology at IUSD, as well as some of the changes encountered along the way.

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1999: The Inception—Recognition of the Need for Change

The process of change in the teaching of cariology at IUSD described in this article began in 1999 with the newly created Department of Preventive and Community Dentistry. This department absorbed many of the faculty working at the IUSD’s Oral Health Research Institute. The institute, recognized for its caries research studies, had been supporting a growing number of cariology research faculty and scientists in recent years. This new department played the role of “initiator/motivator” for educational change in the teaching of cariology. As a new department, its stated goals went beyond the institute’s research strategic goals and plans to include goals of education and service. Additionally, with its emphasis in cariology, public health, and prevention, it was well suited to address these new goals.

Although there are multiple ways change can occur within a dental school, a motivator or catalyst for change is generally needed to initiate such a
process. For change to occur, a “need” must also be identified.\(^6\) During 1999 some IUSD faculty were already engaged in a discussion of how cariology was being taught and how it influenced patient care in our Comprehensive Care Clinics. Similar to what many other dental schools are offering throughout the country, these clinics provide most of the clinical experiences for our third- and fourth-year dental students.\(^7\) Some of the cariology researchers had been trained by the school to participate in the teaching needs of a newly implemented problem-based curriculum; concurrently, department faculty were being called upon to replace retiring faculty in the area of cariology. Immediately, a discrepancy was noted between what was being taught in lectures—problem-based learning (PBL) and laboratory exercises—and what was being taught and reinforced in the clinic. To enhance the impetus for change, some faculty within the Restorative Department, including some members of administration, recognized at this same time the need for a structured caries risk assessment and management program to ensure adequate patient care in our clinics.

The newly developed Department of Preventive and Community Dentistry took advantage of this perceived need in the school to reorganize the relevant didactic courses and to develop a clinical component to cariology education into a new Caries Management Program (CMP). This became the predoctoral educational focus of the department. During this initial process, departmental faculty were brought together by the chair to inventory the existing teaching of cariology in the curriculum, to develop short- and long-term goals, and to develop action plans that would ultimately serve as the “drivers”\(^8\) for the process of change. A consensus was reached that the CMP should 1) be based on a school-level competency, 2) involve all four years of the curriculum, 3) include both didactic and clinical components, and 4) involve training and calibration of all full- and part-time faculty involved with predoctoral clinical instruction.

### 2000: Development, Initial Implementation, and Barriers Encountered

In 2000, the faculty of the Department of Preventive and Community Dentistry developed a document that included our competency statement, an outline of the didactic and clinical four-year cariology curriculum, and the associated outcome measures evaluation process that would support the competency. The competency states that “Graduates must be competent in the detection, diagnosis, risk assessment, management, and prevention of dental caries.” We were fairly confident we could develop and implement the didactic component of the competency, but recognized early in the development process that there would be challenges in implementing the clinical aspects of the program. Initial barriers or challenges included development of universally accepted caries risk assessment and management forms that could function across disciplines in the school (e.g., preventive, operative, prosthodontics, dental hygiene) and would be included as part of the patient’s permanent record; faculty acceptance and training; and compliance by students. To address these issues, it was decided that a multidisciplinary forum was needed that would include all relevant and affected parties, the “stakeholders.”\(^8\) We elicited the help of the associate dean for clinical affairs to form and chair a working group that included faculty from all departments and disciplines throughout the school to ease adoption of the proposed changes. With the help and support of faculty and administration, we developed the clinical forms and implemented the necessary changes in the clinical evaluation process. Students and patients are also important stakeholders in this process of change. But due to the magnitude of the task and the initial barriers, we did not include them in the initial discussion. This has changed after subsequent evaluation of the program, however, and we are now including student focus groups to assess the cariology program and to help modify chart and assessment forms. We are looking for ways to involve our patients in the future.

### 2001: Faculty Training

In 2001, the competency statement, clinical forms, and initial clinical competency evaluation rubric, which had been reviewed and approved by the IUSD curriculum and assessment committee, were finally approved by the IUSD Faculty Council as an official part of the curricular requirements for all predoctoral students. These provided the mechanisms for evaluating the effectiveness of our CMP in the clinics and a means of assessing and rewarding students for appropriate caries management.
Caries Risk Assessment and Management Competency

For informational purposes, we present a summary of our current competency requirements and assessment.

With the inception of the CMP at our school, caries risk assessment and management have become part of the evaluation of all patients seen by our students in the Comprehensive Care Clinics, and the necessary risk management forms can be signed by any trained faculty on the clinical floor (training is explained later in this article). Before students can initiate their competency case, they must have completed the assessment of at least three moderate- or high-risk patient cases in which the individual steps, including caries detection, diagnosis, risk assessment, management, and prevention, are evaluated by faculty from the Department of Preventive and Community Dentistry. An internal code is used to track these patients. The assessment is considered “in process” until patients are reevaluated at the time of their scheduled reassessment/recall (according to risk status) following implementation of a management protocol. After reevaluation, the case is considered to be “completed” for the purposes of the CMP. At reassessment, follow-up treatment for the patient is planned based on the patient’s current risk status. It is, of course, expected that students will continue to reassess their patients’ needs and outcomes of the proposed management plan periodically throughout their care. This is part of the professional outcome assessment measures that students undergo in these clinics.

Students are required to demonstrate their skills in caries detection, diagnosis, risk assessment, management, and prevention using one patient (adult or minor) seen in the Comprehensive Care Clinics. The patient must initially have been assessed as being at moderate or high risk for caries. The competency case, including reevaluation, must be completed by the end of the senior year and is a requirement for graduation. This patient is to be identified from the student’s own patient pool and receives treatment by the student. The competency evaluation is divided into four stages. Normally, stages 1 and 2 are completed in one appointment, and stages 3 and 4 are assessed in a separate appointment. The student must achieve at least a satisfactory level of competence in all of the four component stages to be judged as competent.

The competency stages are as follows.

Stage 1: Initial Diagnostic and Risk-Assessment Procedures. It is expected that the student be knowledgeable about the common procedures performed to determine caries risk, including caries diagnosis and differential diagnosis, and to be able to discuss these procedures with the evaluator. The students are required to fill out the clinics’ caries risk assessment forms and discuss what the different risk indicators mean in the context of their specific patients. At the time of the evaluation, the student must be able to defend the approaches taken to determine the risk status of his or her patient.

Stage 2: Development of Treatment Plan. Based on the data collected as part of the initial diagnostic procedures and at subsequent appointments, the student will develop a written treatment plan designed to control the present level of disease and maximize the chances of preventing future disease. The student must be able to justify his or her preventive and restorative treatment plan, including frequency of reassessment and recall.

Stage 3: Completion of the Treatment Plan. Once the treatment plan has been developed, the student implements the plan and documents both the procedures performed and the results of the treatment. The student records the patient’s response to dietary modifications, use of prescriptions, etc. If modifications to or deviations from the treatment plan occur, the student must be able to explain and document why these changes occurred and to offer alternative solutions to any problems encountered while implementing the treatment plan.

Stage 4: Reevaluation of Caries Activity and Risk Status. A reevaluation of risk factors and an assessment of the outcomes of caries management are conducted following completion of the initial treatment phase (three to six months based on each patient’s risk level).

Faculty Training

The second challenge we faced when implementing the clinical component of the CMP was to promote faculty acceptance, understanding, and calibration. A training course was developed to help inform all faculty and to allow for a gradual implementation of the CMP in the Comprehensive Care Clinics. Originally, it was planned that all full- and part-time faculty involved in treatment planning in the school’s clinics would participate in calibration for the caries risk competency. A training course with two components was developed that included an online faculty training component and a one-hour question-and-answer session to discuss a calibration
Several of these identical one-hour meetings were offered over a two-week period, and faculty were required to pass the online course. The online course also was made available on CD. Faculty received CE credit for completing this course.

The objectives of the online course were to update IUSD faculty in current evidence-based concepts regarding caries risk assessment and management and to introduce IUSD faculty to the caries risk assessment forms and competency evaluation form. The course was divided into five modules with approximately twenty slides per module. After each module there was a short test. The modules were:

- Module 1: Dental Caries Etiology and Epidemiology
- Module 2: Dental Caries Diagnosis and Detection
- Module 3: Caries Risk Assessment
- Module 4: Dental Caries Management: Plaque, Host, and Diet Control
- Module 5: Caries Management: Fluorides

Data from this initial training exercise demonstrated that the online course was moderately effective in reaching all faculty. The greatest challenge was reaching all part-time faculty. It was decided to include this material in the packet that all future faculty hired in the school would receive in order to inform them of the program and its rationale.

**Didactic Component and Relationship with Clinical Component in the CMP**

As we advanced in our understanding of what skills should be evaluated in our newly developed clinical component and competency, we simultaneously modified our didactic cariology component. This process interrelates closely with surgical management skills, decision making, and other restorative, public health, and behavioral courses in the curriculum. For the CMP, educational objectives and content are carefully planned, sequenced, and emphasized to build upon one another across the four years of the curriculum. The main didactic course for cariology is housed in the first year as part of an oral biology course. The course was restructured to cover all aspects of histopathology and epidemiology of caries, etiologic factors and their management, caries detection, diagnosis, risk assessment, and preventive and management strategies. There are also lectures on the diagnosis and management of dental erosion. In the second, third, and fourth years, additional objectives and content are presented, and main objectives are reemphasized and discussed in the context of students’ overall understanding at each stage of the curriculum. Case discussions, use of evidence-based information, and critical thinking through the use of PBL are used as a means of delivering certain objectives. Recently, we have begun developing ideas for computer-aided learning. We decided to teach using some of the principles used in research by systematically approaching and evaluating the learning that occurred in the classroom, what worked and what did not, and experimenting with different methodologies.

**2002-03: Hands-On Laboratories**

Changes implemented in 2002 reflect an acknowledgment that to expect our students as future practitioners to understand, accept, and use advances in technology, we must include those expectations in our educational goals—along with discussions of the basic science underlying these innovations. Without this strategy, it is unlikely that practitioners will embrace new technology. In turn, without utilization of new technology by the practicing dental community, it is unlikely that manufacturers will support the development of new caries management approaches. To address this need to educate accordingly, the didactic lectures and problem-based learning cases were enhanced, and two hands-on laboratories were added focusing on the use of visual caries detection methods and indexes, along with caries risk assessment. These new hands-on laboratory experiences provide a unique opportunity for our students to detect and diagnose caries lesions, measure salivary flow rate, quantify mutans streptococci and lactobacilli using commercially available tests, and discuss a variety of patient scenarios while applying evidence-based information to risk assessment. The labs were very well received by students and our faculty peers. We began incorporating active learning strategies into the didactic lectures, including in-class analysis of problems and review of cases to increase the application of knowledge and decision making as well as to provide opportunities for students to critique existing decisions. Next year, use of an immediate response system will provide frequent in-class assessments. Many of these strategies have been shown to be useful in developing critical thinking.
In 2003, due to the success of the hands-on experiences, two new laboratories focusing on fluoride use and new caries detection instruments were added to the first-year didactic course. Students now have the opportunity to try products, discuss and review evidence-based information on these products in the market, and use new research technology for caries detection and diagnosis as part of their problem-solving case scenarios.

In 2003, due to continued difficulty in the logistics of conducting calibration exercises with faculty from multiple departments, oversight of the clinical competency was limited to faculty within the Department of Preventive and Community Dentistry. Although this has simplified faculty training tremendously, it has also isolated this competency assessment process to one discipline. We are working on ways to address this in the future.

2004-05: Focus on Outcomes Assessment

As part of our outcomes assessment strategy, we developed and implemented the first faculty and program content evaluation survey by fourth-year dental students using a web-based software product: CoursEval (Academic Management Systems, Amherst, NY). This survey was focused on evaluating faculty who had assisted and evaluated students in clinic during their caries risk and management patient assessments. The survey also allowed students to self-evaluate their diagnostic, preventive, and management skills, as well as to express their needs regarding improvement in the process or forms in use. As an example, results of the first survey identified a need for better understanding of caries management of hyposalivatory patients. These data allowed us to restructure some of our problem-based learning case objectives and active learning case exercises during our didactic courses to help address this deficiency. We will continue to follow student understanding of the management of the hyposalivatory patient over the next two to three years to study the impact that changing the didactic structure has on the real and perceived clinical knowledge and experience needed. The survey is repeated annually, and outcomes data are used to assess the didactic component of the CMP as well as for planning faculty calibration exercises.

2005-06: Change to an Electronic Clinic Management System

In 2005 our school changed to an electronic clinic management system, AxiUm (Port Coquitlam, British Columbia, Canada), and the caries risk forms were transformed from paper forms to electronic forms. We spent most of 2005-06 studying the impact the new electronic system would have on our data gathering and forms. In addition, focus groups with faculty and students were conducted, and all outcomes assessment data collected since the start of the program were analyzed. These data are now being used to formulate both short- and long-term plans addressing identified needs and challenges. For example, as a short-term outcome we have recently simplified our caries risk and management forms to make them more user-friendly and to take greater advantage of an electronic format. We also will be analyzing data retrieval needed to monitor care progress. As a long-term goal we are looking into collaborating with other schools to modify the AxiUm system to seamlessly retrieve and collate the needed information for risk assessment and management, perhaps dispensing with the separate form for risk assessment.

Risk Assessment and Management Forms

Dental caries is a disease of multifactorial etiology. Effective risk assessment should evaluate all factors involved with the disease since individual risk factors tend to be poor predictors of caries onset. The assessment of all risk factors not only allows a more accurate assessment of future risk of disease, but most importantly, it identifies the etiologic factors responsible for the disease in a particular patient. This approach encourages management strategies specifically developed for the patient. Although the objective of this article is not to discuss the particulars of our risk forms, the use of the forms is briefly explained here.

Form A is a rapid screening form used to quickly identify those individuals at risk versus those with low risk. To be considered low risk, patients must present clinically without any active caries lesions; must have not had any caries lesion and disease activity for several years; and must have had no recent
changes that would be considered to elevate the risk for future caries disease such as changes in salivary, dietary, or oral hygiene habits or any appliances that might make oral hygiene difficult. Low-risk patients are placed on six- to twelve-month recall assessment intervals; the screening form includes spaces for multiple recall appointments.

Those found to be at risk—that is, classified as moderate or high—require completion of Form B to document the nature of the problem and to facilitate development of a tailored preventive and management treatment plan. Since the forms are used also to assess students’ understanding of cariology, the process has been left open to allow for variations in caries management approaches, as long as the student provides an evidence-based justification. An important component of this process is to evaluate students’ critical thinking and rationale for their caries management decisions.

By 2003, dental schools in California had formed a coalition focused on caries management by risk assessment (CAMBRA) and had developed several of their own forms. With permission from CAMBRA, we incorporated into our CMP a modified version of their patient recommendation form that was then reviewed by a multidisciplinary IUSD faculty committee and accepted by our Faculty Council. This patient recommendation and information form, adopted in 2003, is given to patients to take home.

Domains of the Clinical Component of the CMP

The introduction of caries risk and management forms into the permanent record of all patients in our Comprehensive Care Clinics influenced three distinct domains: clinical, educational, and medico-legal. Although integrally related to one another, each is a distinct entity, and each must have defined outcomes and outcome measures over time.

Clinical Domain. From the inception of the CMP, it was agreed that all forms developed and management recommendations needed to be evidence-based and tailored to patients’ needs. Forms needed to be user-friendly and to have broad acceptance among the students and faculty. Our underlying hypothesis in the clinical domain is that incorporation of a CMP in our clinics will result over time in patients’ improved oral health as it relates to dental caries prevalence, incidence, and the need for restorative replacement due to secondary or continuous caries experience. Stated in this manner, the hypothesis allows us to develop outcome measures that will allow us, over time, to test our hypothesis.

Educational Domain. We agreed to develop a process that would allow us to adequately assess our students’ understanding and competency in caries risk assessment and management, as well as to promote critical thinking and use of evidence-based information. This required faculty calibration and a periodic review of educational goals and objectives in the curriculum. Our underlying hypothesis in the educational domain is that this educational experience will help foster a health professional who will be able to adequately address patient care, health promotion, practice management, professionalism, communication, and critical thinking as it relates to cariology in his or her practice and community.

Medico-Legal Domain. Since the forms were now a part of data gathering in the patient’s personal health record at the school, and the information was used in the treatment planning process, we needed to ensure compliance with this process through the school’s quality assurance program. It must be noted that the CMP was gradually implemented into the clinics during a two- to three-year period. The underlying hypothesis on the medico-legal domain is that all students and faculty will comply with this process and all patients will have a risk-based caries preventive and management plan that will be reassessed at risk-based intervals over time. As with the other domains, associated measures to test the outcomes related to this hypothesis were developed, and data are being collected.

Outcomes Assessment

The program is currently being evaluated from six perspectives, described in general terms below.

Use of Caries Risk-Based Management Strategies by IUSD Graduates

Most dentists likely incorporate into their practice some form of caries risk assessment based on their overall impression of each patient. This has been shown, together with previous caries experience, to have good predictive power. However, it is unclear if, and how, this information is systematically incorporated into treatment decisions. As part of the clinical domain’s outcomes assessment data, we will be comparing the use of risk assessment and clinical
management practices by the graduates of our program. We will be looking at whether change occurs and what barriers for change our graduates encounter as they move into practice. We also will look at whether there is a difference in the implementation of new cariology principles of assessment, diagnosis, and management between those practitioners who graduated before and after the implementation and changes in IUSD’s CMP. We will also compare our graduates to our full-time and part-time faculty over time. The hypothesis is that the new CMP will influence and affect the way our graduates and faculty manage dental caries over time. It is expected that, throughout the years, external influences may drive this change (e.g., insurance guideline changes, ADA recommendations, change in standard of care in caries management). Identifying what is and what is not effective in changing practice is important in determining future changes to our program.

As part of the baseline data for our CMP, Bahleda and Fontana randomly surveyed 250 Indianapolis-based dentists who had not gone through the new CMP at IUSD about their use and formal recording of caries risk assessment and management strategies. The survey revealed that most respondents (72 percent) performed some type of caries risk assessment (CRA); however, only 24 percent documented, or charted, the outcome (Figure 2). Ninety percent of respondents stated they assessed caries activity, the most commonly cited risk variable assessed by the respondents in this study. However, only 5 percent of respondents reported assessing salivary flow, which was the least common risk variable assessed by the respondents to the survey. With regard to the management of incipient caries (white spot lesions) in adult patients, the most common treatment used (84 percent) was the prescription strength fluoride dentifrices, mouthwashes, and gels. In children or patients with mixed dentition, the most common response (79 percent) was use of in-office fluoride treatments. After diagnosing incipient caries lesions in adults or children, only 51-53 percent of respondents provided a treatment or management plan based on the patient’s risk status. In addition, 29 percent of those who stated they did treatment plan based on CRA also reported that they did not do a formal CRA; 24 percent of those who reported doing a formal CRA did not treatment plan based on the CRA conducted. These findings suggest that caries risk assessment was not incorporated into almost half of all patient treatment plan decisions; in some cases, the assessment was being done, but the outcomes not recorded, or the information was not used at all for caries management and treatment planning. The process of charting the results of caries detection, diagnosis, and risk assessment—and informing patients about specific findings and their implications for treatment and prognosis—is important for appropriate patient care and effective management of the caries disease process, as is recording the proposed treatment plan and eventual treatment outcomes. One of the areas that may affect our ability to routinely incorporate caries risk assessment and caries management programs into private practice may be the lack of calibration or agreement among different dentists regarding the need for caries risk data in planning for caries management (both surgical and nonsurgical) strategies.

A survey was conducted in France to compare the caries management and treatment threshold decisions among dental school faculty and practitioners. The results illustrate a wide disparity among French teachers concerning restorative treatment thresholds for proximal surfaces, opinions about the rate of caries progression, and the need to monitor lesions near the dentino-enamel junction. The educators’ attitudes also differed from those of private practitioners. The French teachers tended to intervene surgically at a later stage; however, they would intervene earlier in the treatment of the carious process than would Scandinavian dentists surveyed using the same instrument.

**Evaluation of the Clinical Implementation Efforts and Improvement in Patient Health**

The overall objective of the change in risk-based management in our clinics is to improve the health of our patients in a cost-effective manner. Our desired primary outcome indicator for long-term success of our risk and management protocols is the extent of the reduction in new caries and restorative procedures required over time for the different risk categories. The pitfall is that this requires time, so we will not get an immediate response on the effectiveness of our CMP. However, periodic evaluation of the implementation of caries risk assessment and management in our clinics is of utmost importance to the success of the clinical and medico-legal domains.

We have involved students in the evaluation of the CMP and hope this will have a positive impact on their awareness of the importance of the program. As part of the baseline evaluation of our CMP, Ley et al. completed a random review of 350 clinical
charts in IUSD clinics from 2002 to 2004. Part of this time frame included the period in which the new CMP had been gradually introduced in the clinics to third- and fourth-year students. They found that caries risk forms were filled out and signed in 46 percent of examined charts, 11 percent were filled out but not signed, and 43 percent of the charts had forms that were not filled out. Fewer than half of the charts (44 percent) included a reevaluation of caries risk, despite the majority of patients (70 percent) being classified as moderate to high risk. For the patients who were reevaluated, there was no change in risk status for 61 percent of patients; 37 percent of patients improved; and one patient’s risk increased. Although significant associations were observed between the presence or absence of a caries risk factor and the presence or absence of a management plan for that factor, the presence of a risk factor was not always associated with a management recommendation to help control it. These data served to identify areas that needed to be addressed in the future to obtain 100 percent integration of this program into our clinics.

Student, Faculty, and Program Content Evaluation Survey

As stated previously, in 2004 we developed a survey focused on evaluating faculty who had assisted and evaluated students in clinic during their caries risk and management patient assessments. The survey also allows students to self-evaluate their diagnostic, preventive, and management skills and to express their needs related to CMP improvement. Outcomes of this survey are used to help evaluate our educational domain, and the survey is repeated annually.

Competency Proficiency

Successful, on-time completion of competency requirements by our graduates is an important outcome used to evaluate our educational domain. Throughout the years, we have made changes in the manner and frequency in which we coordinate and communicate with students during their clinical years to emphasize and answer questions regarding their
Competency requirements in preparation for graduation. These changes in communication appear to have had a positive impact on students’ timely approach to their CMP responsibilities. For example, in January 2003, no seniors had started their competency case. In January 2004, with increased clarity and frequency of communication regarding the CMP, 50 percent of the senior class had successfully started their caries risk competency, and 4 percent had completed this requirement. By January 2005, 41 percent of the senior class had successfully started their caries risk competency, and 19 percent had completed it.

Student Exit Interviews

Student exit interviews are looked at annually, as they may impact programmatic objectives or faculty involved in the CMP. The outcomes of these interviews are considered additional important information to help assess the success of our educational domain.

Chart Audits

Assessment of health records and compliance with the school’s policies are supervised by the school’s Quality Assurance Program. As part of this program, charts are evaluated for completion of all forms and the assessment of adequate patient care. The outcomes that relate to completion of caries risk-based management on all patients within the comprehensive care clinics are important to evaluate the educational and medico-legal domains of our program.

Barriers

Multiple barriers are unavoidable when implementing curricular change. We address some of those encountered during the development of our cariology curriculum, as we believe they may also be encountered in other institutions.

Dental School Structuring: Who Is in Charge of Cariology?

As mentioned previously, caries management includes both surgical and nonsurgical intervention. A risk-based analysis of the patient’s etiologic factors, disease progression and severity, and prognosis for treatment alternatives helps the clinician decide on the best caries management approach for a particular patient. In our school, the responsibilities for the educational processes (determination and delivery of specific content) for surgical and nonsurgical domains are housed in two separate departments: restorative dentistry and preventive dentistry, respectively. This seems to have resulted in faculty and students’ assumption that risk assessment and prevention treatment planning are completely separate entities from restorative treatment planning; such an assumption is contradictory to our goals for an integrated CMP. One solution to this problem might be to combine the locus of control of restoration and disease management into the same department (e.g., Department of Cariology or Department of Preventive and Restorative Dental Sciences), which would have as its goal integration of all components of disease management. Certainly, this will not solve all problems and goes beyond what can be controlled by a few committees at a school level. Institutions wishing to implement a CMP will have to function within the constraints and realities of their structure or work to change the structure.

Faculty Support/Calibration

Many dental schools with primarily comprehensive care clinics seem to have a high proportion of part-time faculty, and this trend appears to be increasing. Although this is a vital and important workforce component of our education system that provides our students with in-depth connections to practice, scheduling problems make it difficult to gather part-time faculty together for periodic calibration exercises. Lack of calibration can have devastating effects on any educational program, especially when the program is trying to teach students to manage a disease whose diagnosis and management paradigms have undergone the large shifts that have occurred with caries. Dentists who had traditional training may view current efforts to educate students with skepticism. Phrases such as “this is not real-life dentistry” or “you will never have to do this in practice” are sometimes encountered as responses to our risk-based management efforts in clinic.

Possible responses to this issue include the following: 1) increase the opportunities for faculty calibration and CE courses either online or during times when part-time faculty may be able to access the information; 2) simplify the risk-based, decision-making process to help make the calibration process easier, which may include simplifying the forms or the information retrieval process; and 3) modify the competency requirement and quality assurance process to ensure that appropriate care is being pro-
vided to all patients and that our students are indeed competent beyond the few cases assessed.

**Student Acceptance and Understanding of the Program and Assessment of Critical Thinking Skills**

It is very interesting how quickly students learned to use evidence-based information as our program evolved, and, as a consequence, they rapidly recognized the need for risk-based nonsurgical management and prevention of the disease. This change occurred even prior to the clinical years of the curriculum. For example, during PBL cases, students were challenging the educational model when caries management was provided using solely old surgical models. However, dental students soon learn to prioritize their time in favor of courses, procedures, or competencies that are given more value in the clinic and in the curriculum. Therefore, although students can be an invaluable moving force behind a CMP, they need to be adequately motivated and rewarded for their actions. The solution is to devise a curricular plan that adequately rewards the clinical time spent doing diagnosis and nonsurgical management of the disease. If such a caries management philosophy is truly part of the school’s goals for student education and for patient care, reward for time spent in these areas must be comparable to rewards for surgical time. At IUSD we are trying to move away from a “point-based clinical system” to a strictly competency-based system. Possibly, in the future, an enhanced reward system in combination with assessment of individual cases and/or use of a portfolio of cases to verify competency may motivate students enough to drive their actions.

**Reimbursement**

Reimbursement of services, or lack of reimbursement, is often cited as a barrier to the rapid acceptance of certain advances in dentistry into practice. This topic is beyond the scope of this article, but is addressed in a separate article by Maxwell Anderson.

**Standard of Care/Public Expectations**

Standards of care can sometimes change due to public need and expectations and sometimes due to external or outside forces such as professional groups’ influence and licensing requirements. Undoubtedly, that management of dental caries using only a surgical model is outdated. Anusavice and Benn surveyed forty-six of the fifty state or regional licensing board examinations in 2001. At that time they found that 72 percent of the states allowed teeth with either E1 (outer half of enamel) or E2 (inner half of enamel) lesions to be restored. This contrasted, they reported, with only 30 percent of dental schools permitting enamel lesions to be restored. This demonstrates the discrepancy between what research is suggesting regarding management of noncavitated lesions, what dental schools are teaching, and what some dental boards are testing. An important engine for change in practice and education will be the licensing agencies promoting and encouraging an evidence-based, decision-making process that promotes preservation rather than unnecessary destruction of noncavitated lesions.

Another important engine for change will be what patients expect and require. There is an increasing awareness of the desirability of healthier lifestyles and a growing skepticism among some groups about excessive invasive surgical aspects of Western medicine and dentistry. Changes in medical practice to a more preventive and risk-based model forecast changes that need to occur in dental care and education. Some argue that the scientific basis for dental caries risk assessment is not absolute, but neither is the scientific basis for many of the surgical procedures done in dentistry. Patients are questioning the need for invasive procedures and ask about nonsurgical strategies such as xylitol, chlorhexidine, and different kinds of fluoride. The Internet era in which we live exposes the general public to the abundance of research findings. Additionally, management of infections is not solely the purview of dentistry. If dentistry does not respond to the challenges and needs of the future, other health professionals will take advantage of the opportunities that new technology provides, such as using saliva as a diagnostic fluid and using the innovations offered for disease management. As stated by Elderton in 1997, “Dental education needs to rise proactively to the challenges presented by modern dental care, or it will be forced to change from a defensive position.”

**Conclusion**

Dental education is uniquely positioned to improve dissemination of new information and com-
communication, thus bridging the gap between research and practicing dentistry in order to accelerate the adoption of validated approaches for the diagnosis and management of dental caries. We have the responsibility as dental researchers and educators to prepare the dentist of today with the knowledge and tools needed for tomorrow.

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