

Original Publication

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# Caries Management with the International Caries Detection and Assessment System II: Established Pit and Fissure Lesions

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## Abstract

**Introduction:** Operative dentistry addresses the surgical management of caries, a significant portion of dental practice. Dental students, who typically develop their skill sets in this important discipline by creating idealized preparations in plastic teeth, are often confused by the wide variety of tooth anatomy and caries presentation they see when they subsequently treat patients. To address this significant clinical transition issue, we developed this resource on preparing the moderate carious lesion using a stepwise, structured technique. **Methods:** This resource consists of a flipped-classroom learning module and associated laboratory activity with an algorithm worksheet to practice critical thinking skills. Prior to the exercise, an interactive tutorial introduces the didactic background. The 4-hour class session starts with a short quiz and review, then learners use the worksheet to prepare and restore their tooth specimens. **Results:** Learner response has been very positive. Moreover, faculty note that learners' skills in treating patients in clinic are noticeably higher and require less faculty intervention than was previously the case. **Discussion:** Since new national curriculum standards for caries are currently being introduced, in addition to providing instruction to dental students, this resource presents an excellent opportunity to calibrate faculty members, who are a secondary learner group in this exercise, on a standard clinical protocol.

## Keywords

Operative Dentistry, Caries, Preclinical Laboratory, Cavity Preparation

## Appendices

- A. Tutorial Caries Management 2 - Established Caries.pptx
- B. Caries Management 2 Lab Worksheet.docx
- C. Caries Management 2 Quiz .pptx

*All appendices are peer reviewed as integral parts of the Original Publication.*

## Educational Objectives

At the conclusion of this educational activity, the learner will be able to:

1. Accurately describe clinical features of established caries in natural teeth and formulate restorative treatment plans appropriate to clinical presentation.
2. Explain a stepwise, collaborative treatment of carious lesions, resulting in the appropriate preparation of a tooth with established caries.
3. Explain a clinical rationale for selecting and placing the appropriate base or liner for the clinical presentation.

## Introduction

Developing skills with a dental handpiece is often accomplished in the first 2 years of dental school by having learners create standardized "ideal" cavity preparations on simulated plastic teeth. However, clinical care presents a very different challenge since actual teeth and caries rarely mimic the ideal. Even plastic teeth with simulated carious lesions show an unacceptably low level of variation.<sup>1</sup> The development of critical decision-making skills regarding how to manage a carious lesion based upon presentation and depth is often postponed until learners are actually treating patients. This approach, which requires significant additional faculty oversight in the clinic, can still result in learner confusion. It also increases the risk of inadvertent patient harm.

Traditionally, dentists were taught to diagnose pit and fissure caries by probing with a sharp explorer, with

the presence of a “stick” held to demonstrate the presence of caries.<sup>2-4</sup> This technique has been disproved as a diagnostic technique and shown to be unnecessarily damaging to tooth structure.<sup>5-9</sup> An international collaboration of caries researchers has more recently developed a method of diagnosing pit and fissure caries using visual criteria. After clinical confirmation, this diagnostic approach was published as the International Caries Detection and Assessment System (ICDAS).<sup>10</sup> It was subsequently modified and re-named ICDAS II.<sup>11</sup> While originally created and validated as a classification standard for epidemiology, it has been further developed by an international group of faculty and researchers as a routine diagnostic tool. Diagnosis using ICDAS II has now been accepted in many countries and is gaining acceptance in the US. Subsequently, the American Dental Association convened an expert panel and published the Caries Classification System using the same criteria as ICDAS II but simplifying the classification by combining six categories into three.<sup>12</sup>

At a 2015 national consensus meeting associated with the American Dental Education Association (ADEA), a working group representing 35 of North America’s 69 dental schools voted to adopt evidence-based diagnostic criteria (i.e., visual, tactile, and radiographic methods) as part of a proposed national curriculum framework in teaching caries management. Their consensus plan has been endorsed by the cariology and operative dentistry sections of the ADEA and has been published.<sup>13</sup>

Teaching learners how to identify, diagnose, and treat caries is done in the context of Caries Management By Risk Assessment (CAMBRA), a methodology that evaluates the caries disease process based upon individual factors such as diet, saliva, and hygiene. Each patient receives a risk assessment that is subsequently used to determine nonsurgical and surgical treatment plans.<sup>14-16</sup>

Recent articles have addressed the question of how best to teach students to remove caries. A survey of dental school practices noted that there is a wide variation in the “criteria used for assessment and removal of carious tissue, management of deep carious lesions, and definition of ‘caries remaining at cavity preparations.’”<sup>17</sup> As a method for students to learn this skill, de Peralta, et al. encouraged self-reflection.<sup>18</sup> However, there has not been an article published to date focused on teaching students this skill in detail.

In 2013, concerns were raised via feedback about learners’ performance in the treatment of caries on the state board examination. These concerns led to the development of a series of four laboratory experiences for learners called the Caries Continuum, conducted immediately before their first clinical operative experience, which in our school is the second semester of the second year.

The first module of these experiences, titled “Caries Management with the International Caries Detection and Assessment System: Early Pit and Fissure Lesions,” focuses on diagnosing and treating early pit and fissure caries on extracted teeth.<sup>19</sup> This present module concerns the next step of diagnosing and managing moderate or established caries removal. Subsequent modules not yet published on MedEdPORTAL focus on smooth surface caries and vital pulp therapy in severe caries.

Another impetus for the development of the Caries Continuum was a significant increase in class size at this institution that made it imperative to teach clinical skills more efficiently than one-on-one in the clinic. The Caries Continuum modules provide a venue to teach these clinical skills to the whole class in a few lab sessions instead of in multiple one-on-one, faculty- and time-intensive clinical encounters.

The “need for clinician/faculty training and calibration” has been recognized as an important factor affecting the implementation of new paradigms around caries diagnosis and management, such as ICDAS II and CAMBRA.<sup>13</sup> Integration of preclinical teaching with teaching conducted by clinical faculty, both full and part time, requires consistent instruction. This module offers an excellent opportunity to calibrate clinical faculty while they participate in the laboratory activities since, unlike participating in an operative preclinical laboratory, caries is present in the specimen teeth. The algorithm worksheet provides clear guidance to the faculty about how to guide student thinking in a familiar framework.

To develop the learning module, a group of faculty with expertise in operative dentistry and cariology was

formed in 2013 to review the standard teaching references and current literature on pit and fissure caries. Additionally, evidence on treatment recommendations for caries based on age and severity of lesion in the context of risk assessment were evaluated and incorporated.<sup>15, 20-22</sup> Each year, the authors formally met and evaluated both learner feedback and faculty experience in their clinical interactions and revised the exercises. Members of this group are the authors and others acknowledged in the tutorial.

Because of the authors' familiarity with, and confidence in, the flipped-classroom technique of instruction based on current evidence, it was chosen as the educational technique in this course. In the flipped classroom, and the more structured team-based learning technique, the background didactic and conceptual material is presented before class. In this case, the material is a self-paced, interactive tutorial wherein learners master the content prior to class time. In the class session, the key cognitive concepts are tested with a short quiz and reinforced by quiz review. Learners go to the lab and work in pairs, then in groups of 10 to verbalize the situation and their thought processes, guided by a faculty member. The flipped classroom approach and team-based learning have both proven to be effective teaching methodologies in dentistry and the health professions.<sup>23-28</sup>

## Methods

The target audience for this resource is preclinical dental learners with the following prerequisites:

- Operative dentistry course: Basic knowledge of dental instrumentation and procedures relating to bases and liners, bonding procedures for both enamel and dentin, and composite restoration.
- Basic understanding of cariology, including key mechanisms of caries process of decalcification of enamel and dentin, as well as an understanding of CAMBRA.<sup>15</sup>
- Working knowledge of dental operatory procedures and instruments, including personal protection in accordance with Occupational Safety and Health Administration (OSHA) guidelines.<sup>29</sup>

## Logistics

This session is held for the entire class in the preclinical lab in a single afternoon. The overall plan for the exercise outlined in the accompanying [Figure](#).

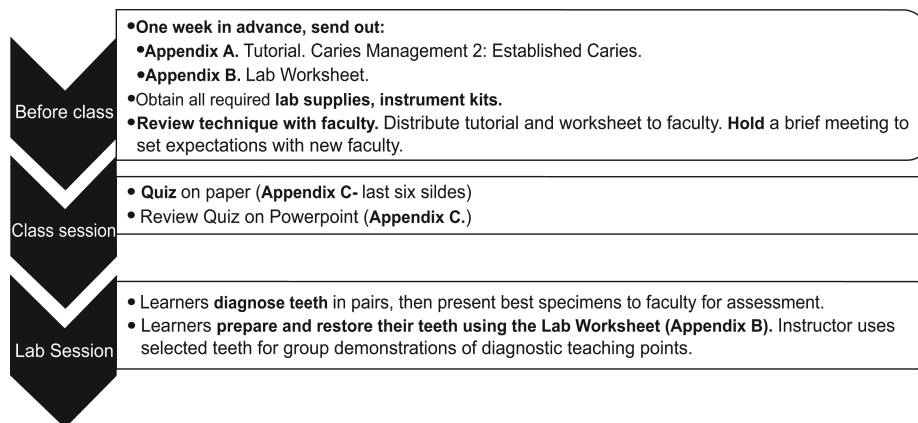


Figure. Exercise Flow Chart.

First, dental learners are asked to collect teeth from community dentists and store them in accordance with CDC guidance.<sup>30</sup> At least 2 weeks prior to the activity, learners are sent instructions to search their specimen teeth to find three to four teeth in ICDAS II codes 3-4, then store them in damp paper towels in a sealed plastic bag. Learners are advised that part of their module grade will be dependent upon finding the correct teeth as well as correctly following the instructions for preparation and storage.

At least 1 week prior to the lab activity, the learners are either emailed or given learning management system access to the tutorial (Appendix A) and worksheet (Appendix B.) Learners are advised that there will be a quiz on the information in the tutorial at the start of the lab session. They are advised to

familiarize themselves with the lab instructions and pertinent material from previous courses.

Each station in the lab is set with an operative cassette and hand pieces. A copy of the worksheet (Appendix B) is set out at each place, printed front and back on a single sheet. Personal protective equipment (i.e., mask, gloves, and eye protection) is provided and required to be worn in accordance with OSHA protocols to simulate clinical care.<sup>29</sup>

Learners retrieve their selected teeth from storage. Each group of 10 learners is assigned an operative faculty member who is familiar with the tutorial and comfortable with small-group interactive teaching.

Each pair of learners then evaluates their selected teeth and chooses the two teeth that best meet the criteria for ICDAS II codes 3-4, presenting them to the faculty for initial confirmation and assessment. Learners adjust the roots with a handpiece until they fit loosely into the corresponding dentoform location. The roots are shallowly notched in three to five locations for additional retention and painted (excluding the corresponding dentoform socket) with polyvinyl siloxane adhesive. This is allowed to dry during the quiz and review.

Next, administer the included quiz (Appendix C) or construct your own six-question quiz on the knowledge base contained in the PowerPoint tutorial. One suggested grading technique is to count off 10 points for each wrong answer, only giving a zero for an unexcused absence. Learners must correctly answer four of the six questions to pass.

Finally, review the quiz. Using the same slideset, go over the quiz and highlight important material to ensure all learners have mastered key knowledge points. Inclusion of slides from the tutorial help link concepts and reinforce learning, as well as reduce arguments.

#### Laboratory Experience

To begin, set the teeth into a typodont. The faculty member dispenses polyvinyl siloxane impression material into the dentoform “socket” to hold each tooth in place. Each learner mounts the typodont into their manikin and a rubber dam is placed to more closely simulate clinical care. Learners are encouraged to use correct ergonomic positioning throughout the exercise.

Working first alone, then comparing results in pairs, learners determine their planned outline form and mark in pencil on the tooth. Following the worksheet, a series of guided choices leads the learner to select the appropriate bur and handpiece. The instructor signs off the treatment plan for each learner, asking questions as necessary about their rationale while doing so.

Continuing to follow the worksheet, learners prepare their teeth and answer a series of questions based on the caries presentation. Finally, they restore the tooth (usually with composite) if time allows. It is emphasized to them that this is the process they will follow in clinic on a patient. The group is then brought together to share particularly interesting caries presentation or treatment decision cases.

As students proceed through their worksheet, the faculty member for each section gives students immediate verbal feedback. Faculty teachers also guide small-group learning by having students share their teeth and preparations. This allows the faculty to identify interesting features in the variety of carious presentations. If faculty note minor errors in student performance, that student may be quietly asked to share the tooth and error at the next group session as a lesson learned.

Next, each learner writes a few comments on the experience, focusing on how well prepared they were, noting any areas where they need more practice or preparation. Self-reflection is an important adjunct to teaching these clinical skills.<sup>18</sup>

This exercise is primarily formative and diagnostic in that it determines if students are ready to treat carious lesions in clinic. To create incentive and soothe concerns over a “lost” clinic period, students are offered two clinical relative value units (RVUs, where each RVU equals a single surface restoration), one for the written exam and one for the laboratory exercise. If the student does not achieve the required passing score on the quiz, they do not receive the first RVU credit.

The laboratory experience is graded as a formative assessment with only pass/fail recorded. Minor errors

are identified within the group and teaching points are clarified. Critical errors, as identified on the worksheet (Appendix B), result in a failure which requires a program of self-study and another opportunity to show understanding and skill with another carious tooth. Learners who commit a critical error, in addition to not achieving the RVU, are not allowed to treat patients in the operative clinic until they have successfully completing this exercise.

The faculty member's overall assessment is based upon whether or not the student follows the correct procedure within the loose parameters bounded by critical errors. However, significant inability to articulate rationales for their choices can also be a factor in borderline performance.

## Results

This exercise has been evaluated over the past 5 years in our internal review board-exempt study. Internal routine quality processes and metrics include anonymous written feedback from learners as well as observations of focus groups of students after they are experienced in clinical care.

Learner reaction to this exercise has been overall positive. Nearly all learners expressed a positive reaction to the exercise as noted in the 2015 feedback (Table).

**Table.** Student Evaluation of Caries Continuum

Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I felt the caries continuum tutorials and labs helped my background understanding and knowledge of the clinical procedures better.	24	24	0	0	0
The course and lab exercises were effectively organized.	20	25	1	1	0
The tutorials and labs usefully complemented each other.	22	25	1	0	0
The course developed my abilities and skills in the clinical procedures.	26	23	1	0	0
The course developed my ability to apply theory to practice.	20	25	2	0	0
The course improved my problem-solving skills.	16	24	7	1	0

Evidence of learning often comes from students who note the usefulness of the exercise once they are in clinic. "I couldn't have faced treating patients without that training," is a common theme. Objectively measuring learning is difficult because of the complexity and variability of the task. Faculty observations of student performance have, however, been revealing. The faculty for the operative clinic routinely meet to evaluate learner clinical performance in the second and third years and uniformly observe a significant improvement in student skill level, particularly in the novice learner. They note that the ability of learners to incorporate theoretical knowledge of caries into correct clinical practice is much improved. Introducing ICDAS II to the exercises has improved the learners' ability to anticipate the extent of caries in pits and fissures, increasing their accuracy in planning appropriate treatment. Faculty also note important behavioral improvements in students, such as less confusion and more confidence in clinic. Even the simple mechanics of when to ask for faculty intervention have improved, with faculty reporting that this knowledge has reduced friction and stress in clinic.

## Discussion

This module is the result of a 5-year journey to fill a considerable void in dental education between the hand-skill training of preparing plastic teeth and the individualized, critical thinking skills involved in clinical preparation of carious teeth in patients. Along the way, we have encountered challenges, gained insights, made modifications, identified limitations, and planned future modules.

One limitation of this module is the lack of objective data. Determining exact impacts on student learning and performance has been challenging, particularly since the introduction of significant improvements in the second-year clinical program and major changes in the clinical evaluation of caries removal assessment were both accomplished within the same time frame as the introduction and refinement of the Caries Continuum exercises.

One issue that initially reduced the effectiveness of the exercise was learners selecting the wrong

category of carious teeth. This was solved by having a dedicated assessment component focusing on the quality of their tooth selection. While sorting through jars of extracted teeth is a tedious, unpleasant job, it has significant learning value and mimics clinical diagnosis as learners compare their teeth against the ICDAS II criteria to find the established (ICDAS II codes 3-4) lesions.

A limitation to the lab experience itself is that sterilization processes recommended by the CDC for extracted human teeth, which include storage in dilute bleach and autoclaving, change the appearance of carious teeth somewhat if extended for more than a few months. Another limitation is that learners will only see the teeth that they and their partner have selected unless there is skillful collaborative teaching by the faculty.

When the Caries Continuum was started, there were only two modules, and these were held at the beginning of the third year. However, learners who start their clinical experience in the second half of the second year gave strong feedback that these exercises should be completed before they started actual clinical care. These two lab exercises were accordingly moved to the second half of the second year, and subsequent learner feedback has confirmed that this was an appropriate move. Faculty have validated learner input by observing less learner anxiety and fewer errors since this change was made.

Learners expressed that they would appreciate more time to focus on the stepwise approach to preparing carious lesions in natural teeth. The difficulties of transferring preparation skills learned on a plastic tooth to natural teeth, as well as the variations in preparation design, were quite apparent to them. Learners were additionally troubled by preparation differences based upon which material is selected. Another learner concern cited by a number of third-year learners after they had broader clinic experience in clinic related to how to best manage the deep carious lesion. These learner concerns were addressed by expanding the Caries Continuum from two to four modules by adding this current (second) module and a fourth module on vital pulp therapy.

The lab worksheet has been refined over several years of observing areas of misunderstanding in the lab and in clinic. It now serves as a checklist in the second-year clinic to ensure that appropriate clinical procedures are understood and followed. Anecdotally, faculty have noted fewer instances of adverse outcomes, such as mechanical exposures from following stained dentin, occurring in clinical care. Learners are now better able to estimate the size of planned restorations.

Over the past 5 years, our class size has grown from approximately 75 to 95 learners. This increase in class size has led to a push to do more with less, and this module represents a crucial improvement in clinical teaching efficiency. Instead of each learner being laboriously taught one-on-one chairside in clinic, the entire class can, as a group, expeditiously master basic concepts around how to approach a carious lesion in collaboration with relatively few faculty members. Still, to keep the ratio to one faculty per 10 learners, the number of faculty involved in the Caries Curriculum has been increased annually. These faculty are primarily in the operative department, but faculty from the general dentistry department, who teach the fourth year students, have been included to standardize and calibrate teaching around caries throughout the curriculum.

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### Ethical Approval

This publication contains data obtained from human subjects and received ethical approval.

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