A Model for an Integrated Predoctoral Implant Curriculum: Implementation and Outcomes

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**Abstract:** The implementation of an implant dental curriculum in U.S. dental schools has been consistently increasing from 33 percent in 1974 to 97 percent in 2004. Among these, only 51 percent have clinical components implemented. A survey of students conducted in 2004 at New York University College of Dentistry (NYUCD) showed an inadequacy in clinical implant restoration experience by graduation. This prompted the development of an extensive dental implant curriculum at NYUCD to meet the needs of the dental students. This report addresses the challenges in implementing such a curriculum and describes a step-by-step approach to develop a program that encompasses didactic, simulation, and patient care components. In 2005, a fully integrated predoctoral implant curriculum was initiated. In 2008, nearly all of the NYUCD students (91.8 percent) completed implant restorations/prosthesis on patients. An assessment revealed a 30 percent increase in students’ positive perceptions of the implant curriculum. Based on our experiences at NYUCD, it is recommended that an implant curriculum become part of the core predoctoral curriculum and be integrated throughout the four years of dental education. This article reports on a model for a predoctoral implant curriculum, which includes planning, curriculum implementation, program management, and post-implementation stages. Using this model, dental schools can develop implant education for their students that is adapted to their institutional missions, priorities, and resources.

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Predoctoral dental education for current students in the United States and Canada includes a competency that states students must “manage partial and complete edentulism.” This competency is part of the predoctoral educational standards of the Commission on Dental Accreditation (CODA). There is strong evidence indicating the success of implant therapy for patients who receive this type of treatment.1-10 This evidence necessitates the inclusion of implants as a treatment choice for patients and justifies an implant curriculum in predoctoral education.

Incorporation of implant education into the predoctoral curriculum has increased from 33 percent of U.S. dental schools in 1974 to 84 percent in 2002.11,12 Combined reports from U.S. and Canadian dental schools indicate that 97 percent of schools had an implant curriculum by 2004 as reported by the deans.12,13 During an American Dental Education Association (ADEA) Implant Workshop held in fall 2004, the details of a survey of dental school deans regarding implant curricula were reported: 86 percent of the schools had implemented both the didactic and the clinical implant curriculum to some extent.13 Although 51 percent of these schools reported that their students received first-hand experience with clinical implant restorations, it was not determined what percentage of students were exposed to this experience. Of this group, 13 percent reported that their schools had a clinical requirement for students to do implant restorations. This report further concluded that there is no predoctoral competency standard for implant prosthodontics in most schools.

While the implant curriculum might seem successful from the perspective of the educators, the annual surveys of dental school seniors in the United States over the past five years have consistently identified implant dentistry as the most deficient area of the curriculum from the perspective of those students.14-18 Several studies that investigated the extent of implant education for predoctoral dental students have recommended a need for further development and expansion of the implant curriculum.11,12,19-22 This call for a fully integrated and expanded implant curriculum was meant to address the needs of newly graduated practitioners as indicated in the senior survey.
One of the stated goals of the 2004 ADEA Implant Workshop was “to share instruction methods.” Effective approaches for the elective programs, limited to a subset of dental students, have been described. It is the intent of our report to share the experiences of a large dental school in developing an extensive, integrated implant curriculum that all students experience during their predoctoral education. This curriculum is spread throughout the four years of dental education and encompasses didactic elements, simulation courses, and clinical patient care components. This article reviews the processes and strategies used to develop this curriculum and describes the short-term outcomes of this approach.

Challenges for Implementation of a Predoctoral Implant Curriculum

Some of the challenges to implementing a predoctoral implant curriculum include an overcrowded curriculum, shortage of trained faculty, insufficient resources including funding, and lack of proven methods for teaching techniques of implant therapy to dental students.

In recent years, there has been significant discussion of curricular content in the dental education literature. Many believe that the dental curriculum is overcrowded and have proposed expanding dental education to beyond four years. Overcrowding is primarily due to advances in sciences and the need to incorporate new scientific breakthroughs into the curriculum. Additions in the curriculum can only be made at the expense of the removal of other content or by increasing the duration of dental education. Dental educators’ reluctance to eliminate current curricular content is a challenge.

In the United States, there is a constant shortage of faculty in dental schools. In 2004–05, it was estimated that there were over 275 vacant budgeted faculty positions, approximately five positions within each dental school. It was further reported that “it is taking longer to fill the vacant positions.” Within the next decade, these problems will become even more significant as baby boomer faculty reach retirement age. Students have reported that this shortage has impacted their learning experiences. Although the 2004–05 report from the dental school deans indicated that they do not believe these shortages are “affecting the quality of dental education,” it can be argued that a greater number of quality faculty members is needed to share the load and make significant changes and advancements in the curriculum.

Currently, half of dental school faculty members are aged fifty and over. The difference between the baby boomer faculty (born 1946–63) and Generation X faculty (born 1964–81) poses issues beyond just the generation gap and age differences. Many baby boomer faculty are tasked to teach in areas of the curriculum and to supervise clinical procedures in which they have limited experience. This creates a culture that can resist change.

Faculty development and standardization have been recognized as the most significant challenge in establishing an implant curriculum. This is partly related to the culture and partly due to lack of a sufficient number of trained faculty. Funding may also be a challenge. An informal meeting was conducted at New York University College of Dentistry in 2003 for implant industry leaders to communicate the concept that the implant curriculum should be entirely in the control of educators with industry support. This shift from industry teaching the “curriculum” to dental educators’ embracing this change was recognized as a necessity for successful training of future dentists and achieving enhanced patient care. At this meeting, the significance of industry support for these efforts was emphasized. The 2004 ADEA Implant Workshop survey reported that 85 percent of schools were receiving free implant components. The survey also reported that two of the six main identified challenges were related to the cost of implants to patients and schools. It is believed that since this report was produced, implant industry funding to schools has significantly increased. It is beyond the scope of this report to explore the details of development of such funding. Provided that educators are setting the curriculum, such industry support is embraced by the dental educator community at large.

NYUCD Integrated Implant Curriculum

The purposes of developing an implant curriculum at New York University College of Dentistry (NYUCD) were to
1. Create a fully integrated predoctoral program to include didactic, simulation, and patient care components,
2. Optimize student learning in the field of implant dentistry by enhancing direct patient care experience,
3. Improve the feedback on curriculum adequacy among graduating students,
4. Optimize patient care by routinely offering treatment alternatives, including implants, and
5. Share these instructional methods for implementing a predoctoral implant program with other dental schools.

Freshman Year (D1)

The implant curriculum at NYUCD begins in the first year of dental education, when students are taught “indirect” concepts related to implants. These include integration of the anatomy of partial and full edentulism within the anatomy courses. Integration in the histology course includes short- and long-term mechanisms of post-extraction wound healing, histology of osseointegration, and grafting materials. Additionally, students are introduced to biomaterials of dental implants, presented towards the end of the first year.

Changing and enhancing existing lecture contents in anatomy, histology, and dental materials allowed for inclusion of these subjects and curricular hours in the first year without any additional hours. The specific goals and objectives of these didactic elements are presented in Table 1 and are expanded upon in the D2–D4 years.

Table 1. Didactic components of an implant curriculum and related objectives

<table>
<thead>
<tr>
<th>Anatomy of the Edentulous Patient</th>
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<tr>
<td>• Identify the anatomical landmarks of the edentulous maxillary and mandibular jaws.</td>
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<tr>
<td>• Identify hard and soft tissue areas that require pre-prosthetic surgery prior to fabrication of complete dentures.</td>
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<tr>
<td>• Analyze the adequacy of patient’s complete denture for use as an overdenture.</td>
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<tr>
<td>• Analyze the amount of space available for placement of implants for overdentures both radiographically and intraorally.</td>
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<tr>
<td>• Identify medical conditions that require attention prior to implant surgery.</td>
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Biology and Histology of Osseointegration

- Describe osseointegration.
- Define the biological width associated with implants versus natural teeth.
- Define the basic biological processes leading to successful integration.
- Understand the histological processes and appearance at the implant-tissue interface.
- Identify factors that can lead to implant failure.

Biomaterials of Osseointegration

- Describe the history and development of dental implants.
- List different biomaterials used in implant dentistry.
- Understand basic principles of biomechanics.
- Describe the problems associated with edentulism—partial and complete.
- Identify the different categories of dental implants.
- Discuss the current status of and trends in implant dentistry.
- Identify the different types of implant surface.

Diagnostic and Treatment Planning for Fixed/Removable/Implants

Given the information related to the chart, radiographs, diagnostic findings, periodontal findings, clinical assessment, patient’s needs, patient’s attitudes, and cost factors, the student will be able to

- Formulate a treatment plan, discuss alternate treatment plan, discuss a prognosis based upon all the diagnostic findings, organize the chart, and be familiar with clinical paperwork.
- Differentiate between the removable partial denture, a fixed partial denture, and implants; properly select the most appropriate prosthesis for the patient.
- Determine a prognosis of selected treatment plan based upon all the diagnostic findings.

Selection of Patients for Implant Dentistry

Given the various treatment planning techniques available, the student should be able to

- Accurately discuss the basis for proper patient selection for dental implants.
- List available pre-prosthetic treatment for surgical site development for implant dentistry.
- Discuss patient educational components prior to implant placement.

(continued)
Sophomore Year (D2)

During the second academic year, over 270 hours of simulation (laboratory) courses are taught in prosthodontics. Didactic implant education and hands-on simulation training are embedded and integrated within the fixed and removable prosthodontic courses. Each course has lectures as well as a large preclinical laboratory portion in which students learn concepts using manikins and models.

Fixed Prosthodontics: Restoration of Single Implants. The fixed prosthodontic manikin (Columbia Dentoform Corporation, Long Island City, NY), which had traditionally been used to teach crowns and fixed partial dentures, was modified to include two implants (Nobel Biocare, Yorba Linda, CA) of varying sizes (narrow and wide platforms), one in each arch (Figure 1). One implant is utilized to teach implant restorations using a machined standard abutment, and the other implant is utilized for fabrication of a custom abutment and prosthesis. Sequentially, during the didactic portion that accompanies this hands-on training, lectures are presented on treatment planning, indications, case selection, and outcomes related to both fixed partial dentures and implant therapy.

Removable Prosthodontics: Implant Retained Overdenture. The removable prosthodontic manikins (Models Plus, Kingsford Heights, IN) include incorporation of two implants (Nobel Biocare Replace Select, narrow platform) embedded within edentulous resin models in the positions of the mandibular canines (Figure 2). These implants and their healing caps are initially covered with a silicone

Table 1. Didactic components of an implant curriculum and related objectives (continued)

Single-Unit Implant Restorations
- Define and describe osseointegration, and understand the biology and physiology of bone.
- Identify various implant impression copings and components.
- Recognize the indications for single-unit implants in fixed prosthodontics, and determine clinical indications and contraindications accurately.
- Understand the indications for prefabricated implant abutment and custom abutments for single-unit restoration.

Treatment Option for Edentulous Patients: Implant-Retained Overdenture
Given the various treatment options for the completely edentulous ridge to improve retention of denture, to preserve bone, and to improve the quality of life, the student will be able to appropriately select an optimal treatment option for the edentulous patient.

Surgical Procedures, Stages I and II
Given the surgical principles needed for osseointegration, the student will be able to
- Describe the significance of CT, radiographic assessment, and radiographic and surgical templates.
- List specific armamentarium for Stage I and Stage II surgeries.
- Identify the basis of minimally traumatic surgical techniques.

Prosthodontic Procedures in Implant Dentistry
Given the specific techniques of implant prosthodontics, the student will be able to
- List the specific prosthetic components and their indications for usage.
- List the fundamental armamentariums used in the prosthetic phase of implant dentistry.
- Accurately describe various laboratory and clinical procedures (to include provisional restorations).
- Describe the most common dental materials used in implant prostheses.
- List maintenance procedures following completion of implant treatment.

Periodontal Aspects of Implant Dentistry
Given the unique properties needed for implant maintenance, the student will be able to
- List current concepts in diagnosing and treating peri-implantitis.
- List corrective procedures following completion of implant treatment.
- List maintenance procedures following completion of implant treatment.

Implant Complications and Maintenance
Given the information on implants, complications and maintenance of implants and soft tissues are discussed.
Figure 1. Arrow pointing to an implant within a fixed prosthodontic model

Figure 2. Arrows pointing within the removable prosthodontics models
material simulating soft tissue, so that the models can be used to teach and fabricate a traditional complete denture. The students then duplicate the fabricated prosthetic in order to create a “surgical template” before revealing the implants. In this manner, they learn the sequence of surgical planning and the rationale for implant site selection. The next steps in the preclinical courses aim to convert a traditional denture into a two-implant-retained mandibular overdenture.

Since a common long-term clinical complication of implant overdentures is fracture of the prosthesis, the students’ last exercise in the laboratory is related to repair of these fractures. Didactically, this course includes description of the process of residual ridge remodeling, demographics of the edentulous population in the United States and globally, and treatment modalities for edentulous patients.

This instructional design has the following advantages:
1. The presence of the implants within the manikin is a constant reminder that an implant restoration is a “mainstream” treatment option.
2. Students and faculty can develop greater familiarity with implant components and instrumentation when these components are examined throughout the course, over many hours.
3. Future referral to these manikins and models will occur in the D3 and D4 years.

The D2 program includes approximately twenty-eight hours of simulation dedicated to the hands-on portion of the implant training, which is equivalent to approximately 10 percent of the total simulation time spent in prosthodontics. These curriculum hours dedicated to implant therapy were essentially taken from the “traditional” prosthodontics courses in D2. To accomplish this reallocation of the curriculum, repetitive fabrications of castings and ceramic application were removed from the fixed course, and the type and number of denture teeth arrangements were reduced in the removable course. Lectures previously related to these traditional topics were also removed from or reduced in the curriculum to allow for the implant curriculum didactics in D2, totaling six hours. The combination of lectures and simulation hours appears to be sufficient and adequately prepares students for the D3 and D4 years and their clinical program.

Junior (D3) and Senior (D4) Years

Clinical care protocols have been established with the goal of students selecting the most appropriate care for their partially edentulous and edentulous patients without decreasing other competencies or departmental requirements. To best accomplish this goal, patient pathways were developed by envisioning how a patient would ideally move through the system from initial registration to completion of treatment. The outcome of this “visioning” of a treatment process is commonly described as a patient pathway. These pathways are communicated to students, patients, clinical staff, laboratory personnel, and faculty.

An extensive Blackboard site (an online course delivery system) is used to facilitate communications internally and for posting of all protocols and faculty standardizations (Figure 3). To operate an efficient and well-controlled clinical program, the following have been established: faculty training and credentialing, patient tracking, student activity tracking, inventory management, and a patient recall mechanism. The details of these are described in the following sections.

Developing a Predoctoral Implant Curriculum

The approach used at NYUCD to develop an integrated implant curriculum consisted of four main stages: planning, implementation, program management, and post-implementation. Steps that should be included within these stages are listed in Table 2.

Planning Stage

Consensus-Building. A critical first step is consensus-building. It is imperative that representatives from all key departments meet to determine if all parties agree to the general concept of curriculum change. A number of important questions were answered at this stage including the following:
- How many lecture hours can be dedicated to predoctoral implant education? What curriculum content can be eliminated to make room for implant education?
- Should there be preclinical simulation learning activities related to implants?
- Should implant simulation be integrated within existing simulation courses, or should there be a separate course/module? If it should be a separate course/module, should there be a simulation in surgical training and prosthodontics?
- Should students place implants?
Should students restore implants?
Who will be the surgical faculty: periodontists, oral and maxillofacial surgeons (OMFS), implant fellowship-trained clinicians, or a combination of these?
Who will be the restorative faculty: prosthodontists, general dentists, or a combination of these?
How will the implant patients be followed?
Should there be a central area for reporting complications?
How many implant cases should the students treat?
What types of implant cases are considered suitable, and what are predoctoral case inclusion and exclusion criteria?

Evaluation of the Existing Curriculum. A curriculum “mapping” prior to start of the implant curriculum is an important step that requires a very thorough evaluation of the relevant existing curriculum throughout the four years of dental education. A task force designated by the curriculum committee performed curriculum mapping in this instance. The members of this task force represented all disciplines related to implant dentistry: basic science, prosthodontics, periodontics, oral and maxillofacial surgery, and dental hygiene. The main role of the task force was to identify all subject matters directly or indirectly related to implant dentistry. The identified subjects were then mapped and included the appropriate year of the curriculum. This mapping offers a better global perspective on the existing components. This mapping was brought back to the core consensus group for prospective comprehensive planning, integration within appropriate courses, expansion, and modification.

Presentation of a Proposal to the Curriculum Committee. The results of the core group consensus on suggested changes in the mapping should be presented to the curriculum committee for final approval. It is a typical priority of most dental school curriculum committees to avoid adding hours to the existing predoctoral program. Therefore, it is highly recommended that the proposal include the elimination of some traditional content in order to implement the predoctoral implant curriculum effectively. A method that was used at NYUCD in determining traditional content elimination was to examine redundancies as the first choice for elimination of materials.

The curriculum committee requested a thorough examination and urged the appropriate department chairs to consider elimination of redundancies.
Assessment of Local Patient Needs. This is an important step to assess whether sufficient patients are available within the institution to implement a clinical care component to the program. Some schools have an existing database that can be searched to see how many patients typically receive fixed partial dentures, complete dentures, or removable partial dentures annually. NYUCD used the Dentrix system (Henry Schein, Melville, NY) to access this demographic data. If an institution lacks a data reporting system that will facilitate this appraisal, then this data can be tracked for one to three months prospectively to assess the demographics. In case the assessment indicates there is an insufficient pool of patients who are candidates for implant therapy, then outreach efforts, such as going to a neighboring community, can be explored.

Development of a Budget. The budget is a compilation of the number of students, number of procedures, clinical fees, type of program, and various parts and components used. Although there are many variables to be considered, the two main ones are simulation and clinical costs. The simulation budget is dependent on the number of models and implants used. Our program for simulation in the first two years of its inception was budgeted at approximately $1,000/student. The budget in the subsequent years is lowered by reusing some of the components. Additionally, at the initiation of the program, there should be a budget dedicated to faculty training and later standardization. It is difficult to recommend a specific budgetary plan because each school is unique in its approach to the assignment of funds for particular purposes. We suggest that, at the start of the program, a greater portion of the budget (up to 60 percent) be dedicated to simulation courses; then, as clinical pathways are developed, the majority of the budget should be utilized for clinical care.

In the early years of the program, it is also advisable that the clinical charges be set at a lower fee than customary in the neighboring areas, in order to create an initial demand by patients. Later, the clinical fee structure of the institution can equal or exceed the cost of clinical care and laboratory support, and the program can become financially neutral or profitable.

Development of a Basic Inventory of Implant Components. The core group should determine and consent to a minimum number of implant items and components that will be necessary to meet anticipated surgical and restorative needs. Increasing the selection of dental implant components will have several disadvantages. These include challenges in faculty training, difficulties in student teaching, a more complex inventory management, potential for mismatch of components, and more difficult long-term management. Due to these challenges, the core consensus group at NYUCD, together with the dean, decided that for predoctoral education the clinical program should be limited to one reputable company (Nobel Biocare).

Table 2. Steps in developing a predoctoral implant curriculum

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<tr>
<th>Stages</th>
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<tr>
<td>Planning</td>
<td>1. Consensus-building</td>
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<td>2. Evaluation of the existing curriculum; curriculum mapping</td>
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<td>3. Presentation of a proposal to the curriculum committee</td>
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<td>4. Assessment of local demographic patient needs</td>
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<td>5. Development of a budget</td>
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<td>6. Development of a basic inventory</td>
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<tr>
<td>Implementation</td>
<td>7. Lecture/discussion-based didactics</td>
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<td></td>
<td>8. Preclinical/simulation courses: prosthodontic and/or surgical</td>
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<td></td>
<td>9. Clinical program: surgical pathway for screening and treatment followed by prosthodontics/restorative</td>
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<tr>
<td>Program Management</td>
<td>10. Faculty training and credentialing</td>
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<td>11. Patient tracking</td>
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<td>12. Student activity tracking</td>
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<td>13. Inventory management</td>
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<td>14. Patient recall</td>
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<td>15. Building supplemental resources such as electronic course delivery system</td>
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<tr>
<td>Post-Implementation</td>
<td>16. Outcome assessment</td>
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Implementation Stage

Didactic Elements. Students’ educational experiences with implant dentistry should begin as early as possible, preferably in the first year of dental school. Students should receive foundational knowledge during the basic sciences component of the curriculum including wound healing, anatomy of edentulous patients, histology of osseointegration, and biomaterials related to implant integration. A minimum suggested list of lecture/discussion topics is presented in Table 1 as a guide. In our institution, this list was developed based on the core consensus/expert panel group recommendation, and was later further approved by the Curriculum Committee. The amount of time dedicated to the topics listed is at the discretion and in the control of individual institutions.

Preclinical/Simulation. A determination of the need for simulation courses in the surgical and prosthodontics areas of the curriculum is made after the discussions on consensus-building. In developing a simulation curriculum, the key decision is whether to integrate it within existing courses or to conduct implant simulations in a new course. An example of an integrated course is a fixed prosthodontic simulation in which the implants are embedded in the prosthodontic manikin. The advantage of this integration is that, from the outset of such a course, students will view implants as a treatment option that is a reasonable alternative to a traditional fixed partial denture. Learning about implants in an integrated course also has the advantage of instilling students with greater comfort and familiarity with various treatment options during patient care. Another advantage of an integrated course is that the fixed simulation courses, in general, are of longer duration and can provide increased exposure to implant components. An equivalent integrated simulation in removable prosthodontics could include implant overdentures. This course can be designed so that the complete denture fabrication leads to surgical stent fabrication and implant overdentures. A truly integrated surgical simulation would be placement of implants within such manikins. An integrated course typically requires a greater number of standardized faculty members. In contrast, a non-integrated simulation course has the advantage of requiring a lower budget because the models can be easily recycled for several years of use.

Clinical Program. One way to envision a clinical program is to imagine a patient going through the system from registration to completion of treatment, which is the process typically used to create a patient pathway. To develop the details in this step-by-step process requires identification and anticipation of subsequent events. Once the pathway is delineated, the responsibilities of students, faculty, staff, and patients can be identified and should be communicated. This process is an excellent tool for developing a clinical program that will invariably be unique to the institution.

Program Management Stage

Faculty Training and Credentialing. Faculty standardization, credentialing, and training have often been identified by educators as major concerns and potential obstacles to a successful implant program. Prior to training, faculty members should be assured that lack of knowledge is acceptable at the outset. In faculty training, consider the following:

• Be inclusive in faculty selection. If in doubt, having more faculty members is always better than having fewer.
• Develop a core group of faculty members first, and then, every year, have that core group train other faculty members in a branching-out fashion.
• Develop models and manikins used for hands-on training with the same simplicity as those used for students.
• Make faculty training ongoing, and offer the training in various formats. For example, do not offer only online training because, invariably, a number of faculty members (typically of older age) will become excluded.
• As a strong incentive, provide continuing education credits for these training sessions when possible.
• Create optimal faculty training that requires presentation of cases and treatment planning. These cases should be of a suitable type for predoctoral education.

At NYUCD, credentialing restorative aspects of dental implants was offered to all faculty members in undergraduate comprehensive care clinics. Only credentialed faculty members are allowed to treat patients and proceed with treatments in these cases. From 2005 to 2008, 170 faculty members were credentialed. This is 70 percent of the restorative faculty (full-time and part-time). Based on these numbers, it is apparent that faculty members embraced these credentialing processes; as a result, multiple forums were created for feedback and further training.
select group of prosthodontists was designated as a core group (eight faculty members) in charge of troubleshooting complications as well as biannual training sessions for new and previously credentialed faculty. The minimum requirements for credentialing are participation in a two-hour lecture followed by a two-hour hands-on session. An annual online review and self-assessment are used to refresh faculty learning and maintain the knowledge gained.

**Patient Tracking.** Many institutions have a patient tracking mechanism built into their clinical care programs. Our institution tracks the clinical activity using the Dentrix system (Henry Schein). This tracking process is especially important for predoctoral implant programs because there is a lag time between implant placement and restoration. Additionally, for a smooth transition and a continuation of care for patients from graduating students to the next class, up-to-date records of patient treatment and status should be monitored using an available tracking system. If a central system does not exist, manual entry and tracking should be used.

**Student Activity Tracking.** Information from student activity can be based on performance by individuals or by the group. Student activity is tracked using an internally developed software program that is based on current dental terminology (CDT) codes entered at each clinical visit. Routine analysis of numbers and types of procedures performed can help to further refine the program or to identify the inadequacies of the clinical care. Although student activity can be tracked manually for smaller programs, it is best to use a clinical management system.

**Inventory Management.** The key to management of an inventory is to limit the variety of components used without compromising patient care. Although the institution never developed an exclusive agreement with any one company, a decision was made to limit the products to a single manufacturer for ease of program management. A leading dental implant company (Nobel Biocare) was selected and solicited for product support. It is imperative when choosing manufacturers to consider their longer-term viability within the implant market, so that the treated patients can have optimal follow-up care. A review of the material distribution process within the institution and modeling after an existing system are advisable. For example, most dental schools have a distribution mechanism for denture teeth; a similar type of requisition form can be created for implant components, and distribution can be performed in the same manner. Duplication of this type of distribution mechanism will allow students to easily understand and follow the same system.

**Patient Recall.** Implant maintenance is vital to the success of the implant prosthesis and the oral health of the patient. Maintenance protocols should consist of immediate, short-term, and long-term recalls. The NYUCD protocol is as follows. At the initial maintenance stage, a written home care instruction is given to the patient to maintain proper oral hygiene surrounding the implant restoration. If the patient has a removable overdenture(s), an instruction for implant overdenture care is provided separately. Following this initial maintenance stage, patients are then scheduled for future follow-up visits every three months for the first year. Beginning in the second year, semi-annual or annual implant prosthesis maintenance follow-ups are prescribed. In addition, as part of the long-term maintenance care, yearly radiographic evaluation of the implant and implant prosthesis and assessment of male attachments for the implant overdentures are completed with the routine oral prophylactic care.

It is advisable that all maintenance protocols be developed at the outset and be approved by all involved departments. These departments are typically periodontology, dental hygiene, prosthodontics, and restorative or operative dentistry. The key to the success of the patient recall program is the availability of a central system and adherence to the protocols.

**Building Additional Resources.** As the program evolves, the institution can consider additional resources to augment the curriculum and the patient care activities. Resources for curriculum and faculty include, but are not limited to, electronic course delivery systems, DVDs of clinical procedures, electronic manuals, online faculty standardization, up-to-date reference materials, and an inventory management program. Patient care resources include an information center for frequently asked questions and efforts to involve the greater community.

**Post-Implementation Stage**

**Outcome Assessment.** Effective outcome assessments rely on gathering data from various sources. Although there are many methods of evaluations, they should invariably be linked to the direct goals and objectives of the created program. It is suggested that assessments be related to student feedback/learning, faculty learning, patient satisfaction, and implant success. The results of outcome assessments should be used to continuously improve the program.
Development of a Timeline

The sixteen steps outlined above should be placed on a twelve- to eighteen-month timeline for optimal implementation of the implant curriculum. Figure 4 shows the timeline that was developed for a twelve-month development period at NYUCD. As illustrated, some steps follow one another, while other steps overlap. For example, evaluation of the curriculum (mapping) cannot begin until a consensus about overall curricular goals for the implant education is reached. However, budgetary issues span several stages of development, such as inventory management and faculty training.

The timeline development is a process that demands refinement during the planning stages of the program. Once developed, the timeline should be followed in order to achieve targets and objectives. We recommend that each school develop its own timeline to meet the institutional goals in this program development.

Outcomes

NYUCD exit surveys for senior students, given to graduating classes annually, are comprised of a series of questions that request students’ opinions about curriculum components. One particular question in this survey was specific to implant dentistry. To assess the progress of the stated objectives, data from the last four consecutive years of senior exit surveys (2005, 2006, 2007, and 2008) pertaining to students’ perception of the implant curriculum are presented in Table 3. In all four years, over 80 percent of the students responded to the surveys; this response rate is considered representative of the class. Review of the data in Table 3 shows the highest level of dissatisfaction (61.7 percent of students) in which implant training occurred in the graduating class of 2005, who did not participate in the new curriculum.

The implant curriculum implementation began in the academic year 2005–06 and was expected to be evaluated by the graduating class of 2008. In the
interim, the graduating class of 2006 received only simulation training by the time of graduation; only 5.6 percent of students in this class received first-hand clinical care experience with implants, as shown in Table 4. The 2006 graduating class data shows that 56.8 percent of students expressed dissatisfaction with implant education. This indicates that students did not consider implant education that primarily consisted of simulation training in laboratory courses to be adequate. Review of the students’ clinical activity revealed a substantial increase in first-hand clinical experience with implant restorations from 2.7 percent of the 2005 class to 91.8 percent of the 2008 graduating class (Table 4).

All of the graduating class of 2008 received simulation training, and 100 percent of the class had treatment-planned patients requiring implants. The majority (91.8 percent) of the students had clinical experience described as having restored single-unit implants and/or implant overdentures. The effect of these educational experiences on the graduating class of 2008’s perception of the adequacy of implant curriculum shows the “satisfaction” response improving from 13 percent in 2005 to 31.6 percent in 2008; the “fair” response improving from 25.3 percent to 37.8 percent between 2005 and 2008; and the “inadequate” response decreasing from 61.7 percent to 30.0 percent from 2005 to 2008. This resulted in a 30 percent decrease in students’ inadequate rating of the implant curriculum.

Despite the fact that direct correlation cannot be made between dissatisfied students and those lacking direct patient care experience, it is believed that increased activity of the students in the patient care area will further improve the ratings.

Additional ongoing outcome assessments include faculty and patient perceptions, student clinical progress and number of experiences, students’ perception of current knowledge, and the need for continuing education courses. These data will be presented in the future.

**Conclusions**

Based on our experiences with development and initial implementation of a longitudinal implant curriculum at NYUCD, we recommend that an implant curriculum become part of the core predoctoral curriculum and be integrated throughout the entire span of dental education. This recommendation is for those schools with a goal of improving their senior survey responses on the adequacy of the implant education students receive. The curriculum should begin with foundation biomedical concepts in the freshman year, followed by simulation experiences and then direct patient care experiences in the junior and senior years.

The model used to plan the predoctoral implant curriculum at NYUCD included planning, developing strategies and opportunities for curriculum

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**Table 3. Student exit survey responses on the curriculum coverage of implant dentistry, by percentage of total respondents**

<table>
<thead>
<tr>
<th>Graduation Year</th>
<th>Percentage of Graduating Students Responding (%)</th>
<th>Excessive (%)</th>
<th>Satisfactory (%)</th>
<th>Fair (%)</th>
<th>Inadequate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>96</td>
<td>0</td>
<td>13.0</td>
<td>25.3</td>
<td>61.7</td>
</tr>
<tr>
<td>2006</td>
<td>83</td>
<td>0</td>
<td>14.8</td>
<td>28.4</td>
<td>56.8</td>
</tr>
<tr>
<td>2007</td>
<td>81</td>
<td>1.1</td>
<td>28.9</td>
<td>37.2</td>
<td>32.7</td>
</tr>
<tr>
<td>2008</td>
<td>94</td>
<td>0.7</td>
<td>31.6</td>
<td>37.8</td>
<td>30.0</td>
</tr>
</tbody>
</table>

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**Table 4. Students’ clinical activity**

<table>
<thead>
<tr>
<th>Graduation Year</th>
<th>Number of Students Per Class</th>
<th>Number of Implants Placed</th>
<th>Number of Implants Restored</th>
<th>Percentage of Students with Restoration Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>338</td>
<td>42</td>
<td>30</td>
<td>2.7%</td>
</tr>
<tr>
<td>2006</td>
<td>323</td>
<td>309</td>
<td>22</td>
<td>5.6%</td>
</tr>
<tr>
<td>2007</td>
<td>329</td>
<td>480</td>
<td>492</td>
<td>69.9%</td>
</tr>
<tr>
<td>2008</td>
<td>343</td>
<td>760</td>
<td>596</td>
<td>91.8%</td>
</tr>
</tbody>
</table>
implementation, program management, outcomes assessment, and post-implementation planning including evaluation by students. This model is intended to serve as a protocol for curriculum development that perhaps can be employed by other dental schools to enhance education in implant dentistry or other areas of the curriculum to prepare our students for the rapidly evolving set of competencies needed for contemporary dental practice.

REFERENCES