Curriculum guidelines and standards for dental laser education

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ABSTRACT

This paper reports on the revision of the Curriculum Guidelines and Standards for Dental Laser Education. The original Guidelines were developed at a workshop at the University of California, San Francisco School of Dentistry in 1992, presented at the January 1993 SPIE symposium, and published in SPIE Proceedings Vol. 1880. They have since been endorsed and implemented worldwide. The Guidelines define the standard of education for practitioners who use lasers, with a goal to enhance of student and practitioner understanding and knowledge of laser technology applications in dentistry. Four levels of education are outlined. Introductory Courses are designed to provide general information on lasers in dentistry. They are informational, without an assessment of the student's proficiency in laser use. Standard Proficiency, Advanced Proficiency, and Educator Courses have specific educational goals, behavioral objectives, and examinations of proficiency. Standard Proficiency Courses provide a basic level of education with didactic, laboratory, and clinical exercises to be satisfactorily completed before using lasers clinically. Advanced Proficiency Courses increase this level of education to include a clinical case study requirement. Educator Courses define requirements for instructors of laser education in dentistry. Revision of the Guidelines ensures that they keep pace with technological developments and research findings.

Keywords: curriculum, laser education, dentistry

1. STATEMENT OF PURPOSE

This document provides guidelines to assure safe and efficacious use of lasers for the health and welfare of the patient. It establishes the standards of education in the use of lasers in dentistry and defines standards for the demonstration of competency. It is intended to provide guidance to practitioners and educators and to reassure the public on the issues of education, competency, and quality of care in the use of laser in dentistry. These Guidelines do not restrict, limit, or regulate the application of this technology. The curriculum outlined in this document is the standard of education in laser dentistry.

2. INTRODUCTION

The curriculum guidelines for dental laser education were developed through a consensus process with members from dental laser organizations, academia, industry and private practice. The original document was developed at a workshop on the development of standards for dental laser education held at the University of California, San Francisco on July 25 and 26, 1992. It was revised most recently on October 3, 1998 at that same location with concurrent laser instructor certification. The purpose of these workshops was to provide the mechanism for the development and revision of the standard of education for the use of lasers in dentistry.

The document was developed using recommendations from a wide range of information that exists on the use of lasers and are appropriately referenced. The format of this document is in the style of curriculum guidelines as published by the American Association of Dental Schools. As a matter of course these guidelines are circulated among dental laser educators, researchers, practitioners, organized dentistry and members of industry. This document is widely distributed and updated periodically. Questions or suggestions may be addressed to the authors of this document.

Laser applications in dentistry have specific indications and contraindications for use in treatment. A working knowledge of dental laser basic, applied, and clinical science is essential.

The manufacture, marketing, and distribution of dental lasers are controlled throughout the world by various regulatory agencies; e.g., in the United States the U.S. Food and Drug Administration; in Germany, ordinances such as MPG et al.

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as well as regulatories given by the Berufsgenossenschaften (VBG); and in Brazil, by the Associacao Brasileira de Normas Tecnicas (ABNT). These regulatory bodies control dental laser manufacturers but do not regulate the dental practitioner in the use of these devices. Hospitals and institutions have their own credentialing programs for use of specific devices in their facilities. The use of dental lasers does not comprise the basis for a dental specialty, but it does require a level of education for their safe use in dentistry.

3. EDUCATIONAL STRUCTURE

The goal of these curriculum guidelines and standards of education is to enhance understanding and knowledge of the application of laser technology in dentistry.

There are four courses of dental laser education outlined in this document. Introductory Course offers general information but does not assess the enrollee's proficiency. Standard Proficiency Course offers a level of education including instruction, hands-on exercises, and examination. This course must be satisfactorily completed before independently using lasers. Advanced Proficiency Course offers a level of education including instruction, hands-on exercises, clinical case studies and examination. Educator Course offers instruction for teaching lasers in dentistry.

4. EDUCATIONAL PARAMETERS

Practitioners must have training with demonstrated proficiency, knowledge and skill for use of lasers in dentistry. Training must include specific objectives and requirements described below, with demonstration of knowledge and proficiency. Competency evaluation should include both written and clinical examination. Evaluation of competency of practitioners must be assessed by a trained educator.

Practitioner use of lasers must be limited to those devices in which the manufacturer has met the regulatory requirements such as Center for Devices and Radiological Health of the U.S. Food and Drug Administration for that product. Manufacturers must meet the requirements and regulations of the Food and Drug Administration. Manufacturers should provide both an operators manual and recommended clinical usage, supported by preclinical and clinical research. Practitioners should use these devices with a sound knowledge of indications and contraindications and within the scope of the practice based on competence as established by education, training and experience. Dental auxiliaries within their scope of education, training and experience must also have specific safety training and demonstrated proficiency in proper laser safety.

Practitioners must have a knowledge of basic laser physics, laser-tissue interaction, and specific laser safety requirements for the dental treatment area. They must also have a knowledge of the device and basic laser and biologic interactions including the safety recommendations outlined in the American National Standard for the Safe Use of Lasers and American National Standard for the Safe Use of Lasers in Health Care Facilities. And they must have a knowledge of laser properties including wavelength, absorption, reflection, transmission, scatter, emission modes, delivery systems, beam characteristics and divergence. Practitioners must furthermore demonstrate knowledge of photothermal, photochemical, photoacoustic, and biostimulation events, tissue absorption characteristics, and the effects of wavelength, spot size, power, exposure duration, energy density, and repetition rate.

Practitioners must know and demonstrate the treatment objective, such as ablation, coagulation, and excision. They must have demonstrated knowledge of appropriate settings to attain specific treatment outcomes supported by research. And they must be able to recognize successful treatment outcomes, manage adverse effects, and must have knowledge of the adverse effect reporting mechanism.

It is the responsibility of the dental practitioner to follow the standard of education as defined by these guidelines.

5. COURSE OUTLINES

5.1 Introductory Course

Introductory courses are intended to be educational, informational and primarily didactic. This level of education is intended for anyone interested in lasers in dentistry.

I. Introduction
   - A. Self-graded pre-test (optional)

II. Fundamentals of lasers
   - A. Production of laser light
     1. Quantum theory
     2. Stimulated emission
   - B. Electromagnetic spectrum
     1. Regions and boundaries
        - a. Ultraviolet (1 – 400 nm)
        - b. Visible (400 – 750 nm)
        - c. Infrared (750+ nm)
     2. Laser wavelengths
   - C. Characteristics of laser light
     1. Spatial and temporal coherency
     2. Monochromaticity
     3. Collimation
   - D. Laser requirements, delivery systems and emission modes
     1. Laser cavity
        - a. Active medium
        - b. Pumping mechanism
        - c. Optical resonator
     2. Delivery systems
        - a. fixed lens and mirror
        - b. articulated arm
        - c. Waveguide
        - d. Optical fiber
     3. Emission mode
        - a. Continuous wave
        - b. Chopped or gated
        - c. Pulsed
   - E. Summary of laser effects on tissue
     1. Reflection, scattering, transmission, absorption
     2. Photothermal effects
        - a. Warming
        - b. Coagulation, tissue shrinkage, hemostasis
        - c. Vaporization, ablation
        - d. Carbonization
     3. Photoacoustic effect
        - a. Disruption
     4. Photochemical effects
        - a. Stimulation of chemical reactions
        - b. Breaking of molecular bonds
     5. Fluorescence
     6. Biostimulation
        - a. Photodynamic therapy

III. Review of types of lasers, delivery systems, special device characteristics, and clinical applications in dentistry
   - A. Laser types
     1. Argon laser
     2. CO_2 laser
     3. Diode lasers
     4. Erbium lasers
     5. Holmium laser
     6. Neodymium lasers
     7. Other lasers
   - B. Device characteristics
     1. Wavelength
     2. Beam diameter (spot size)
     3. Power
     4. Energy density
     5. Repetition rate (if applicable)
     6. Exposure duration
     7. Total energy

C. Clinical applications
   1. Intraoral soft tissue surgery
   2. Treatment of apththous ulcers
   3. Sulcular debridement (soft tissue curettage)
   4. Composite curing
   5. Tooth shade lightening
   6. Caries removal
   7. Cavity preparation
   8. Enamel modification
   9. Illumination for caries detection
   10. Illumination for endodontic orifice location
   11. Removal of coronal pulp
   12. Experimental applications

IV. Laser safety
   A. Standards, organizations, and regulatory requirements
      1. U.S. FDA Center for Devices and Radiological Health (CDRH)
      2. American National Standards Institute (ANSI)
      3. U.S. Occupational Safety and Health Administration (OSHA)
      4. State and local regulatory agencies
   B. Laser safety officer
   C. Laser safety mechanisms
   D. Adverse effects reporting mechanism
   E. Eye and tissue protection
   F. Environment
      1. Proper warning sign posted
      2. Limited access
      3. Reflective surfaces minimized
   G. High volume evacuation present
   H. Laser external cooling system (if applicable)
   I. Electrical components (cords and footswitch)
   J. Gases
   K. Training
   L. Laser use documentation

V. Infection control
   A. Identification and disposal of biologic hazards
   B. Plume hazards and precautions
   C. Sterilization

VII. Post-test examination (optional)

5.2 Standard Proficiency Course

The curriculum for basic level of education in laser usage includes specific device instruction with demonstrated proficiency in didactic and hands-on knowledge. Hands-on exercises include demonstration and clinical simulation with appropriate oral tissues (e.g. cow or pig jaws), and must meet participation course guidelines. Practitioners must demonstrate competency by written and clinical simulation and examination in the safety aspects of laser use prior to using lasers on patients. This is the level of education that defines the standard of care. Dental auxiliaries are encouraged to demonstrate competency in the safety aspects of laser use. Industry representatives, researchers, and others who demonstrate and operate lasers must demonstrate competency by written and clinical simulation and examination in the safety aspects of laser use.

I. Introduction
   A. Self-graded pre-test (optional)

II. Fundamentals of lasers
   A. Production of laser light
      1. Quantum theory
      2. Stimulated emission
   B. Electromagnetic spectrum
      1. Regions and boundaries
         a. Ultraviolet (1 – 400 nm)
         b. Visible (400 – 750 nm)
         c. Infrared (750+ nm)
      2. Laser wavelengths

C. Characteristics of laser light
   1. Spatial and temporal beam coherency
   2. Monochromaticity
   3. Collimation

D. Laser requirements, delivery systems and emission modes
   1. Laser cavity
      a. Active medium
      b. Pumping mechanism
      c. Optical resonator
   2. Delivery systems
      a. Fixed lens and mirror
      b. Articulated arm
      c. Waveguide
      d. Optical fiber
   3. Emission mode
      a. Continuous wave
      b. Chopped or gated
      c. Pulsed

E. Summary of laser effects on tissue
   1. Reflection, scattering, transmission, absorption
   2. Photothermal effects
      a. Warming
      b. Coagulation, tissue shrinkage, hemostasis
      c. Vaporization, ablation
      d. Carbonization
   3. Photoacoustic effect
      a. Disruption
   4. Photochemical effects
      a. Stimulation of chemical reactions
      b. Breaking of molecular bonds
   5. Fluorescence
   6. Biostimulation
      a. Photodynamic therapy

III. Review of laser types, device characteristics, and clinical applications in dentistry

A. Laser types
   1. Argon laser
   2. CO_2 laser
   3. Diode lasers
   4. Erbium lasers
   5. Holmium laser
   6. Neodymium lasers
   7. Other lasers

B. Device characteristics
   1. Wavelength
   2. Beam diameter (spot size)
   3. Power
   4. Energy density
   5. Repetition rate (if applicable)
   6. Exposure duration
   7. Total energy

C. Clinical applications
   1. Intraoral soft tissue surgery
   2. Treatment of aphthous ulcers
   3. Sulcular debridement (soft tissue curettage)
   4. Composite curing
   5. Tooth shade lightening
   6. Caries removal
   7. Cavity preparation
   8. Enamel modification
   9. Illumination for caries detection
   10. Illumination for endodontic orifice location
   11. Removal of coronal pulp
   12. Experimental applications

IV. Laser safety

A. Standards organizations and regulatory requirements
   1. U.S. FDA Center for Devices and Radiological Health (CDRH)
   2. American National Standards Institute (ANSI)
   3. U.S. Occupational Safety and Health Administration (OSHA)
   4. State and local regulatory agencies

B. Laser safety officer

C. Laser safety mechanisms

D. Adverse effects reporting mechanism

E. Eye and tissue protection

F. Environment
   1. Proper warning sign posted
   2. Limited access
   3. Reflective surfaces minimized

G. High volume evacuation present

H. Laser external cooling system (if applicable)

I. Electrical components (cords and footswitch)

J. Gases

K. Training

L. Laser use documentation

V. Clinical simulation (specific hands-on demonstration)
   A. Laser instrument set-up and operation
      1. Delivery system
         a. Type
         b. Assembly
         c. Inspection
         d. Maintenance
         e. Sterilization standards and protocol
      2. Set laser operating parameters
      3. Test fire laser
   B. Infection control
      1. Identification and disposal of biologic hazards
      2. Plume hazards and precautions
      3. Sterilization
   C. Treatment objective and surgical technique simulation on bovine tissues or other suitable biologic tissues or inanimate objects
      1. Indications and contraindications of laser use in dentistry
      2. Alternate methods of treatment
   D. Discussion of treatment sequence, patient management, postoperative instructions
   E. Management of complications
   F. Surgical and healing assessment

V. Practice management
   A. Practice organization and management, staff training and patient education
   B. Financial and insurance considerations
   C. Malpractice considerations, jurisprudence, ethics
   D. Record keeping, adverse effects reporting mechanism, informed consent

VI. Laser bibliography
   A. General bibliography for lasers in dentistry
   B. Subject bibliography for specific dental applications

VII. Current research and future developments

IX. Conclusion
   A. Written post-test
   B. Post-test clinical simulation
   C. Course evaluation
   D. Certificate of attendance

Advanced Proficiency Course

Practitioners must have successfully completed a Category II course. Practitioners then gain additional knowledge and experience by one or more of the following:

1. In-office mentor preceptor program
2. University or other accredited dental education program
3. Scientific session educational program
4. Patient care
5. Independent study of the literature

This level of education is elective, and represents an advanced level of clinical competency in safety and clinical use. This level of education is intended for Dentists and Dental Hygienists and includes assessment by written examination, clinical simulation proficiency, and clinical case presentation. This level is also intended for dental auxiliaries, industry representatives, researchers, and others who demonstrate and operate lasers. Assessment of these individuals is by written and clinical simulation proficiency in the safety aspects of laser use.

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         c. Waveguide
         d. Optical fiber
      3. Emission mode
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         c. Pulsed
   E. Summary of laser effects on tissue
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         c. Vaporization, ablation
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         a. Disruption
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      5. Holmium laser
      6. Neodymium lasers
      7. Other lasers
   B. Device characteristics
      1. Wavelength
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      3. Power
      4. Energy density
      5. Repetition rate (if applicable)
      6. Exposure duration
      7. Total energy
   C. Clinical applications
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      4. Composite curing
      5. Tooth shade lightening
      6. Caries removal
      7. Cavity preparation
      8. Enamel modification
      9. Illumination for caries detection
      10. Illumination for endodontic orifice location
      11. Removal of coronal pulp
      12. Experimental applications

IV. Laser safety
- A. Standards, organizations, and regulatory requirements
  1. U.S. FDA Center for Devices and Radiological Health (CDRH
  2. American National Standards Institute (ANSI)
  3. U.S. Occupational Safety and Health Administration (OSHA)
  4. State and local regulatory agencies
- B. Laser safety officer
- C. Laser safety mechanisms
- D. Adverse effects reporting mechanism
- E. Eye and tissue protection
- F. Environment
  1. Proper warning signs posted
  2. Limited access
  3. Reflective surfaces minimized
- G. High volume evacuation present
- H. Laser external cooling system (if applicable)
- I. Electrical components (cords and footswitch)
- J. Gases
- K. Training
- L. Laser use documentation

V. Clinical simulation (specific hands-on demonstration)
- A. Laser instrument set-up and operation
  1. Delivery system
     a. Type
     b. Assembly
     c. Inspection
     d. Maintenance
     e. Sterilization standards and protocol
  2. Set laser operating parameters
  3. Test fire laser
- B. Infection control
  1. Identification and disposal of biologic hazards
  2. Plume hazards and precautions
  3. Sterilization
- C. Treatment objective and surgical technique simulation on bovine tissues or other suitable biologic tissues or inanimate objects
  1. Indications and contraindications of laser use in dentistry
  2. Alternate methods of treatment
- D. Discussion of treatment sequence, patient management, postoperative instructions
- E. Management of complications
- F. Surgical and healing assessment
- G. Post-test clinical simulation

VI. Clinical summary of laser usage
- A. Pretreatment
  1. Diagnostic tests
     a. Clinical exams
     b. Tooth vitality
     c. Hard tissue tests
     d. Radiographics
     e. Soft tissue exams, including pocket depth measurement (if applicable)
     f. Other
  2. Diagnosis and treatment plan
     a. Diagnosis
     b. Treatment
     c. Possible treatment alternatives
     d. Indication
     e. Contraindications
     f. Informed consent
- B. Treatment
  1. Objective
  2. Laser operating parameters
     a. Wavelength
     b. Power
     c. Repetition rate (if applicable)
     d. Beam diameter (spot size)
     e. Exposure duration
  3. Treatment sequence
  4. Management of complications
  5. Surgical prognosis
  6. Treatment record
  7. Patient management
  8. Post-operative instructions

C. Follow-up care
    1. Side effects and complications (if any)
    2. Assessment of treatment (with time intervals)
    3. Long-term results
    4. Healing assessment
    5. Case documentation

VII. Practice management
    A. Practice organization and management, staff training and patient education
    B. Financial and insurance considerations
    C. Malpractice considerations, jurisprudence, ethics
    D. Record keeping, adverse effects reporting mechanism, informed consent

VIII. Laser bibliography
    A. General bibliography for lasers in dentistry
    B. Subject bibliography for specific dental applications

IX. Current research and future developments

IX. Conclusion
    A. Written post-test
    B. Clinical simulation (post-test)
    C. Clinical case studies
    D. Course evaluation
    E. Certificate of attendance

Educator Course

This course provides specific instruction in planning and presenting the Standard Proficiency Course. Course structure is both lecture and participation. Prerequisites include three years participation in Standard Proficiency level and two years status at Advanced Proficiency.

I. Introduction
    A. Teaching lectures, small groups, laboratories, case studies
    B. How students learn
    C. Videotaping assessments of teacher skills
    D. Critique and feedback on teaching technique

II. How to teach
    A. Critical thinking
        1. Optimal learning experiences
        2. Criteria
    B. Learning modalities
        1. Visual
        2. Auditory
        3. Kinesthetic
        4. Tactile
        5. Olfactory
        6. Gustatory
    C. Multiple intelligence
        1. Logical-mathematical
        2. Linguistic
        3. Musical
        4. Bodily/Kinesthetic
        5. Interpersonal
        6. Intrapersonal
    D. Creativity in Teaching
        1. Problem presentation
        2. Preparation
        3. Generation of ideas
        4. Incubation
        5. Validation
        6. Outcome assessment

III. Teaching excellence in laser dentistry
- A. Focus on selected content
- B. Use of eye movement, continuous eye contact
- C. Use of body movement
- D. Use of gestures for emphasis
- E. Use of language – metaphors, storytelling, personal experience, anecdotes
- F. Use of voice, sound tone, etc.
- G. Use of numbers, calculations, logic, classification, critical thinking
- H. Use of interpersonal skills engaging students in collaborative learning
- I. Use of intrapersonal skills, revealing self to encourage students to connect learning with past experiences, memories, introspection.

IV. Course Administration
- A. Registration
- B. Facilities
- C. Audiovisual Equipment
- D. Laser Equipment and Accessories
- E. Faculty and Sponsorship
- F. Course Schedule and Elements
- G. Recordkeeping

V. Conclusion
- A. Examination of knowledge of subject matter
- B. Examination of teaching
- C. Course evaluation
- D. Certification

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References

1. H. Albrecht, W. Wasche. "Evaluation of potential health hazards caused by laser and rf-surgery." *Laser-Tissue Interaction and Tissue Optics*, H.J. Albecht, G.P. Delacretaz, T.H. Meier, R.W. Steiner, L.O. Svaasand, ed. Proc. SPIE 2624, pp. 200-205, SPIE – The International Society for Optical Engineering, Bellingham, WA, 1995.
2. American Association of Dental Schools, "Curriculum Guidelines," *J. Dent. Educ.* **56**, pp. 409-414, 1992.
3. American Society for Laser Medicine and Surgery, Inc. Wausau, Wisconsin. http://www.aslms.org
   - *ASLMS Guidelines for Office-Based Laser Procedures*. April 3, 1998.
   - *Educational Recommendations for Laser Use by Non-Physicians*. April 3, 1998.
   - Lanzaframe, RJ. Smoking "Guns". (An editorial on the hazards of vaporized tissue plume in the operating room environment). April 3, 1997.
   - *Principles for Non-Physician Laser Use*. April 3, 1998.
   - *Standards of Perioperative Clinical Practice in Laser Medicine and Surgery*. October 7, 1994.
   - *Standards of Training for Physicians for the Use of Lasers in Medicine and Surgery*. April 3, 1998.
   - *Suggested Outline for Specific Laser Courses*. April 3, 1998.
4. A.K. Furr, ed. *CRC Handbook of Laboratory Safety*. (3rd ed.), CRC Press, Inc., Boca Raton, Florida, 1991. ISBN 0-8493-0353-2.
5. International Commission on Non-Ionizing Radiation Protection, "Guidelines on limits of exposure to laser radiation of wavelengths between 180 nm and 1,000 μm," *Health Phys.* **71**, pp. 804-819, 1996.
6. Laser Institute of America. Orlando, FL. http://www.laserinstitute.org
   - *American National Standard for Safe Use of Lasers*. ANSI Z136.1-1993.
   - *American National Standard for the Safe Use of Lasers in Health Care Facilities*. ANSI Z136.3-1996.
   - K. Ball. *Lasers: The Perioperative Challenge*. (2nd ed.) 1995.
   - *LIA Guide to Medical Laser Safety*. 1997.
   - *LIA Laser Safety Information Bulletin*.
   - *Medical Laser Safety Reference Guide*. 1993.
   - *Reporting Requirements for Medical Laser Devices*. 1996.
   - D.H. Sliney, ed. *Guide for the Selection of Laser Eye Protection* (4th ed.) 1996.
   - J.F. Smith , ed. *Laser Safety Guide*. (9th ed.) Orlando, Florida: Laser Institute of America, 1995.
   - U.S. Dept of Labor. Occupational Safety and Health Administration. *Guidelines for Laser Safety and Hazard Assessment*. OSHA Instruction PUB 8-1.7. Washington, D.C., August 5, 1991.
7. W.J. Marshall, "Understanding laser hazard evaluation," *J. Laser Appl.*, **7**, pp. 99-105, 1995.
8. Office of the Federal Register. National Archives and Records Administration. 1993. *Code of Federal Regulations. Food and Drugs. 21. Parts 800 to 1299*. Washington, D.C.: U.S. Government Printing Office.
9. K. Robinson, "Laser safety: Powerful tools need powerful protection," *Photonics Spectra*, **32**, pp. 92-94, 96-97, 99-100, 1998.
10. D.H. Sliney, "Laser safety," *Lasers Surg Med*, **16**, pp. 215-225, 1995.
11. D.H. Sliney, T.N. Clapham, "Safety of medical excimer lasers with an emphasis on compressed gases," *J. Laser Appl.*, **3**, pp.59-62, 1991.
12. D.H. Sliney, S.L. Trokel, *Medical Lasers and Their Safe Use*, Springer-Verlag, New York, 1993. ISBN 0-387-97856-9.
13. G.L. Smokla, R.P. Jones. "Medical lasers can work wonders – But they must be used with care," *Biophotonics Int.*, **2**, pp. 424-444, 446, 448, 1995.
14. A.G. Varanelli, "Electrical hazards associated with lasers," *J. Laser Appl.*, **7**, pp. 62-64, 1995.
15. White JM, et al. Curriculum guidelines and standards for dental lasers education. In: Gal D, O'Brien SJ, Vangsness CT, White JM, Wigdor HA, ed. *Lasers in Orthopedic, Dental, and Veterinary Medicine II*, Los Angeles, Proc. SPIE 1880. SPIE – The International Society for Optical Engineering, Bellingham, WA, 1993:88-98.
16. Winburn DC. Practical Laser Safety. Vol. 11 of *Occupational Safety and Health*. New York: Marcel Dekker, Inc., 1985. ISBN 0-8247-7348-9.
17. Wolbarsht ML. Low-level laser therapy (LLLT) and safety considerations. *J Laser Appl* 1994;6(3):170-172.

Endorsing the Revised Curriculum Guidelines and Standards for Dental Education

Academy of Laser Dentistry
Academy of Laser Dentistry - Japan
Brazilian Association of Laser Dentistry
British Dental Laser Association (BDLA)
Czech Rep. Institute of Dental Research
Czech Technical University, FNSPI, Prague
German Academy of Laser Dentistry
Institut fur Lasertechnologien
Lasers in Dentistry - SPIE
University of California, San Francisco School of Dentistry
University of Sao Paulo, Brazil

Endorsement Signatures for the 1993 Curriculum Guidelines and Standards for Dental Laser Education

Academy of Laser Dentistry
Academy of Oral Dynamics
Alabama Department of Public Health
ALASE
American Academy of Oral Pathology
American Board of Periodontology
American Dental Laser
American Society of Dentistry for Children
Arlington Implant Institute
Australian Society of Laser Dentistry
Australian Society of Laser Dentistry
Baylor College of Dentistry
Beckman Laser Institute, UCI
British Dental Association
Bureau of Dental Health, Texas Department of Health
Bureau of Health Services, Kentucky
Columbia University School of Dental and Oral Surgery
Corbeel Medical, Belgium
Dental Association of South Africa
Dental Institute, University of Zurich
Dental Society of the State of New York
Department of Health and Social Sciences, Wyoming
Deutsche Gesellschaft für Laserzahnheilkunde
Division of Dental Health, Hawaii Department of Health
Division of Dental Health, Indiana State Board of Health
Division of Pediatric Dentistry, UCSF
Division of Public Health Dentistry,
West Virginia State Health Dept.
General Practice, University of Washington
Greater N.Y. Academy of Laser Dentistry Journal
Hispanic Dental Association, Chicago
Howard University College of Dentistry
Incisive Technologies
Indiana University School of Dentistry
Institute for Laser Dentistry
International Academy of Laser Dentistry
International Association of EAV
International College of Dentists
Jamaica Hospital, NYC
Japan Dental Association
Kansas Dental Board
Laser Dentistry, Booth Memorial Medical Center, New York
Laserdent Technologies
Line Lite Laser Corp.
Litton Laser Systems
Marquette University School of Dentistry
Medical University of South Carolina
MedLas Medical Lasersystems
Metropolitan Academy of Laser Dentistry
Michigan Head and Neck Institute
Mid-Atlantic Dental Laser Study Club
MPS, Dentist and Manger Laser Technologie
National Dental Hygienists Association
Nebraska Department of Health, Division of Dental Health
Nevada Dental Association
Nevada State Board of Dental Examiners
New Jersey Dental School, University of Medicine and Dentistry
North American Academy of Laser Dentistry
Northeast Regional Board of Dental Examiners, Inc.
Norwegian Dental Association
Office of Dental Health, Arizona Department of Health Services
Office of Device Evaluation, Food and Drug Administration
Ohio State University
Oregon Health Sciences University
Omicron Kappa Upsilon
Oral Medicine, UCSF
Philippine Dental Association
Pierre Fauchard Academy
Santa Teresa Dental Center
School of Dental Medicine, University of Montreal
SNDA
South Carolina Department of Health and Environmental Control

South Dakota Dental Association
Southwest Institute of Laser Dentistry
Springtown Dental Office
The Laser Center, The Camilo Castelo Branco University
The London Hospital Medical College
The University of Western Ontario, Faculty of Dentistry
UCSF School of Dentistry
University of Aachen, RWTH
University of Alberta, Faculty of Dentistry
University of Detroit, Mercy, School of Dentistry
University of Florida College of Dentistry
University of Manitoba Faculty of Dentistry
University of Mississippi Dept. of Periodontics
University of Montpellier, LEMP/MAO
University of Pittsburgh
University of Pittsburgh School of Dental Medicine
University of Showa
University of Nebraska College of Dentistry
Warner Medical Center

Inquiries, comments, suggestions and endorsements should be directed to the organizer:

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