Electrophysiology/Electrocardiography Committee Members

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Introduction

In order to assure appropriate application, safe performance and judicious interpretation of the complex procedures involved in clinical cardiac electrophysiology, and to guarantee correct application of the wide range of antiarrhythmic therapies now available, a well defined program of training is necessary. The American Board of Internal Medicine (ABIM) has recognized the need for specific training in electrophysiology and will offer an examination for certification in clinical cardiac electrophysiology in 1992. Subspecialty certification in cardiovascular diseases previously required 2 and currently requires 3 years of training. The ABIM has mandated that an additional year of clinical training in cardiac electrophysiology will be required for eligibility to take the certifying examination in electrophysiology.

The purpose of this report is to establish guidelines for training programs in clinical cardiac electrophysiology. The aim of the program is to provide the trainee with a broad base of knowledge and experience in normal and abnormal cardiac electrophysiology and arrhythmias. The trainee should develop knowledge and practical experience in the following areas:

1. Basic cellular and whole organ electrophysiology related to normal physiology and cardiac arrhythmias in humans.

2. Pharmacologic principles underlying use of antiarrhythmic drugs.

3. Management of the care of patients with cardiac arrhythmias.

4. Use of the surface electrocardiogram (ECG) and other noninvasive tools to evaluate complex cardiac arrhythmias.

5. Performance and appropriate interpretation of intracardiac recordings and programmed electrical stimulation techniques for diagnosis and management of cardiac arrhythmias.

6. Appropriate use and understanding of the limitations of nonpharmacologic therapy for arrhythmias.

Electrophysiology" was developed by the Electrophysiology/Electrocardiography Committee of the American College of Cardiology, was adopted by the ACC Board of Trustees on October 14, 1990. This statement was published in the *Journal of the American College of Cardiology* (JACC Vol. 18, No. 2 August 1991: 637Ü40). For information on preferred citation, please see page XXX of this collection.

Qualification of Candidates for Training

Training in clinical cardiac electrophysiology should be offered to physicians with training in internal medicine and cardiovascular diseases. Trainees who will practice in the United States should be eligible to take the board examination in internal medicine of the ABIM. They should also be eligible, or be in a program leading to eligibility, to take the subspecialty board examination in cardiovascular diseases.

Resources and Facilities of the Training Program

ACGME certification.

Training programs in clinical cardiac electrophysiology must be part of a cardiology training program accredited by the Accreditation Council for Graduate Medical Education (ACGME). The Council dìs not currently accredit clinical cardiac electrophysiology training programs. It would be desirable in the future for the Council to accredit such programs residing within accredited cardiology programs. Guidelines in this report might be used as a reference for establishment of accreditation criteria by the Council or its appointed Residency Review Committee.

Training faculty

Faculty responsible for the training of clinical cardiac electrophysiologists should have met all the qualifications and training requirements described in this report, and should be certified in clinical cardiac electrophysiology by the ABIM. During the next few years while certification is not yet available, faculty in the training program may demonstrate qualifications and training equivalent to that which would lead to certification. After certification becomes available, uncertified individuals may serve as faculty in electrophysiology training programs only if they can document equivalent qualifications and training or equivalent credentials acceptable by the Accreditation Council for Graduate Medical Education or the appropriate Residency Review Committee. (See the section on duration of training for additional information regarding previous training requirements of program faculty.)

The program director and other faculty members should spend a substantial proportion of their time, at least 50% in the case of the director, in research, education and patient care related to cardiac electrophysiology and arrhythmias. Faculty members should be committed, effective teachers. They must maintain current knowledge in clinical cardiac electrophysiology and must actively support or be directly involved in related research. Unless the program director is able to provide training on a full-time basis, at least one additional faculty member is needed.

The training program must also have access to faculty with expertise in basic electrophysiology, pharmacology and biìngineering in order to formally provide teaching in basic electrophysiology, pharmacology and the engineering aspects of many of the nonpharmacologic techniques.

Clinical laboratories and equipment

Noninvasive testing capabilities should include routine electrocardiography, ambulatory

ECG recording and analysis, exercise electrocardiography and signal-averaging (high resolution electrocardiography). A pacemaker follow-up program should exist and include capability for follow-up of patients with state- of-the-art implanted pacemakers and cardioverter/defibrillators.

The minimal invasive facility required for an electrophysiology training program is a cardiac catheterization laboratory that contains a programmable stimulator, recording devices and §uoroscopic equipment that allows visualization in multiple planes. We recommend that there be at least one or two technical staff members fully trained in electrophysiology and, preferably, that they work full-time in the electrophysiologic laboratory.

Surgical program

The electrophysiology training program must be affiliated with a cardiac surgery program. One or more surgeons in that program must have experience in and be currently active in implantation of cardioverter/ defibrillator devices, surgical treatment of cardiac arrhythmias and intraoperative recording of electrical activation.

Patient spectrum and volume

The training program should offer sufficient exposure to a broad spectrum of cardiac arrhythmias such as acute and chronic heart block, a variety of supraventricular arrhythmias (including those associated with the Wolff-Parkinson-White syndrome) and ventricular arrhythmias (including ventricular tachyarrhythmias). Firm numerical guidelines are difficult to establish. Some minimal levels are cited later, in the section on clinical exposure.

Composition of the Training Experience

Duration of training

In addition to related training received during a cardiology fellowship fulfilling ABIM requirements, the trainee must receive at least an additional, preferably consecutive, 12 months of clinical training in electrophysiology, which should include the experiences to be described. The Committee strongly recommends that additional research training related to cardiac electrophysiology be obtained, either during cardiology fellowship or at another time.

The discipline of clinical cardiac electrophysiology was smaller in the past. During the past decade and especially in the past few years considerable new knowledge, new diagnostic techniques and new therapies have developed in the discipline. Thus, specialized training in clinical electrophysiology for at least 6 months for those who trained before July 1986 is considered sufficient, so long as they have attained, through subsequent experience, a knowledge base and skills equivalent to those to be described. Individuals who trained before 1980, when few training experiences in clinical cardiac electrophysiology were available, need not have received formalized training in the discipline, but must have equivalent qualifications as judged by the Accreditation Council for Graduate Medical Education or its appropriate Residency Review Committee.

Cognitive training

To provide a broad base of knowledge and experience the program should offer a combination of didactic lectures and direct clinical experience. A series of lectures should be used to provide a thorough understanding of the basic cellular and whole organ

electrophysiology related to the genesis of cardiac arrhythmias. Methods by which the various types of arrhythmia mechanisms can be distinguished should be taught. Lectures should also provide information concerning the effects of pharmacologic agents on cellular and whole organ electrophysiology as well as the basic principles of pharmacokinetics and pharmacodynamics. Finally, continuous training (throughout the fellowship) in surface electrocardiography is mandatory since the trainee needs expert knowledge in this area to determine when use of antiarrhythmic agents and variety of invasive and noninvasive tests are appropriate. Some of this teaching is best accomplished by a series of lectures early in training. The Committee recommends a continuous, regularly scheduled ECG conference throughout the period of training.

Clinical exposure

Patient care management

Trainees should be directly involved in the care of both inpatients and outpatients with cardiac arrhythmias, including patients with an implanted pacemaker or defibrillator. They should also be involved in an inpatient consultative service for patients with arrhythmias. A regularly scheduled meeting in which arrhythmia cases are discussed among trainees and staff electrophysiologists is encouraged.

Noninvasive studies

The trainee must be provided with experience in applying and interpreting in-hospital telemetry monitoring, exercise testing, ambulatory ECG monitoring and signal-averaged electrocardiography. The fellow should be able to place the results of these studies properly in the context of other clinical data in order to make appropriate management decisions. The trainee should be familiar with the technologic aspects of noninvasive tests and should understand both the technical and the diagnostic limitations of the tests.

Invasive studies

During the course of training, the fellow must become familiar with the indications for and interpretation of electrophysiologic testing in a variety of syndromes. The utility and limitations of electrophysiologic testing for diagnosis of cardiac arrhythmias and its ability to detect and to predict the occurrence of clinical arrhythmias must be learned. Each trainee must actively participate in and analyze 100 procedures, including at least 50 initial procedures. Each procedure can serve as experience for more than one fellow. During the course of this experience, the trainee must learn the anatomy and physiology of the normal cardiac conducting system; various catheterization techniques, including insertion of venous and arterial catheters, catheter placement for recording electrical activity in all cardiac chambers; and which recordings are required for specific conditions. Training should include the recognition and management of complications of these procedures. The trainee must be able to safely operate the equipment used in the course of electrophysiologic studies, including §uoroscopic equipment, programmable stimulators, signal amplifiers, physiologic recorders, electrode catheters and external pacemakers and defibrillators. The trainee must learn the role of unipolar and bipolar recordings and the effect of filtering on electrograms.

The variety of stimulation and recording techniques used to study and treat the entire spectrum of cardiac arrhythmias must be mastered. Each trainee must have adequate experience in studying sinus node dysfunction, atrioventricular conduction disturbances, supraventricular and ventricular tachycardias and pre-excitation syndromes. The trainee must also learn how to utilize electrophysiologic techniques to select the most appropriate form of therapy and to assess the efficacy of therapy.

Each trainee should become familiar with catheter ablation techniques and should understand the various types of energy that can be delivered by catheter for ablation of arrhythmias and the presumed mechanisms by which various techniques work. The extent of histologic damage achieved by different forms of energy and energy delivery, and potential complications of the procedure should be stressed. As these techniques become more widely applied the trainee should develop practical experience with them under supervision.

It is recommended that each laboratory maintain a log of all cases and that the number and type of cases studied by each trainee be recorded.

Implantable devices

The trainee should be fully capable of managing implanted devices for bradyarrhythmias and tachyarrhythmias, including new, complex pacing systems. Knowledge of the indications and contraindications and function of specific devices, methods of implantation, postoperative patient care and long-term follow-up is required. The trainee must become knowledgeable in the physiology of electrical stimulation and defibrillation of the heart and in the analysis of endocardial electrograms. Although implantation of such devices is not required, the ability to evaluate device performance at implantation (such as determination of capture threshold or defibrillation energy threshold) is. The trainee must also learn how to monitor long-term device function, when and how to reprogram devices, how to recognize end-of-life indicators, how to correctly distinguish between normal and abnormal device function and how to utilize programming capabilities to optimize device performance.

Surgical therapy

Surgery is now recognized as an effective and appropriate method to cure or decrease the incidence of ventricular tachycardia and a variety of supraventricular tachyarrhythmias. Thus, the trainee should become familiar with the indications for and effectiveness of surgical procedures for the treatment of specific arrhythmias. The various techniques and their limitations, risks and benefits should be learned. Intraoperative and catheter mapping techniques should be taught both didactically and through practical experience. The trainee should participate in pre- and intraoperative mapping of arrhythmias for which surgery is undertaken as well as in invasive and noninvasive evaluation of the efficacy of the surgical procedures.

Summary

Training in clinical cardiac electrophysiology should take place in an Accreditation Council for Graduate Medical Education accredited cardiology program, and the electrophysiology training program itself should be accredited by the Council. Each trainee must be eligible for board certification in Internal Medicine and either eligible for certification in Cardiovascular Diseases or in a program leading to eligibility. Training faculty should be certified in clinical cardiac electrophysiology or demonstrate equivalent credentials. At least two training faculty members are preferred. The faculty must be dedicated to teaching, active in performing or promoting research and must spend a substantial portion of their time in research, teaching and practice of clinical electrophysiology. A curriculum of training should be established. Faculty experts in the related basic sciences should be available and involved in teaching. The institution should have a fully equipped clinical electrophysiology laboratory and complete noninvasive capabilities. A close working relation with a cardiac surgery faculty member skilled in surgical treatment of arrhythmias is required. Training in application of pharmacologic and all current nonpharmacologic therapies, in the outpatient and inpatient setting, is

necessary. The clinical exposure must include all facets of arrhythmia diagnosis and treatment and must be quantitatively sufficient to allow the trainee to develop proficiency. The period of training should not be less than one year in addition to the period of cardiology fellowship required by the ABIM for board eligibility. A continuous period of training is preferred.