ELECTROPHYSIOLOGY LABORATORY

Mission Statement

The mission of the Electrophysiology Service and Electrophysiology Laboratory is to provide state-of-the-art care to patients with cardiac rhythm disturbances while fostering physician education and advancing the state of knowledge about arrhythmias through research.

General Statement of Educational Goals

The Guidelines for Training in Adult Cardiovascular Medicine Core Curriculum Training Symposium (COCATS, JACC 25: 1-34, 1995) describes three levels of training for cardiovascular fellows. At the end of the two-month rotation on the Electrophysiology/Arrhythmia Service fellows will achieve Level I training as described in the COCATS document. Level II training (advanced noninvasive arrhythmology) requires a total of 6 months of EP training and qualifies the trainee for intermediate level expertise but not independent invasive EP procedural skills. Level III training is a full fellowship (1-2 years) in Electrophysiology.

Patient Care		
Learning Objective	Where the Fellows Learn Skill	How We Assess Skill and Ability
Develop ability to make an accurate scientifically based diagnoses and proper selection of patients for EP procedures and/or medical therapy	Daily bedside work rounds	Faculty and Peer evaluations
Safely and accurately perform invasive electrophysiologic testing and treatment procedures	Electrophysiology laboratory	Faculty evaluations
Develop safe and successful implantation, troubleshooting, and follow up skills for implantable devices	Electrophysiology device implant laboratory and outpatient device clinic	Faculty evaluations, Nurse Practitioner evaluations and Peer evaluations
Medical Knowledge		
Learning Objective	Where the Fellows Learn It	How We Assess Skill and Ability
Demonstrate working knowledge of normal cardiac Electrophysiology and presentations and noninvasive evaluation of common and uncommon arrhythmias	Review of consults and admissions with faculty, conference presentations of patients and topics	Faculty and Peer evaluations

Demonstrate an understanding of the anatomy, normal and abnormal physiology pertaining to procedural skills for electrophysiologic techniques, the interpretation of electrocardiogram recordings and the basis and techniques for successful interventions.	Textbooks, current and past medical literature, Electrophysiology laboratory, discussion with faculty during and after procedures, preparation and attendance at conferences discussing patients and topics.	Faculty and Peer evaluations
Demonstrate proper skills for safe and successful implantation of devices (pacemaker, ICD, cardiac resynchronization) with an appreciation of the anatomic and physiologic basis for these techniques. Demonstrate a working knowledge of the skills involved in follow up of implantable devices and their troubleshooting.	Textbook, literature review, discussion with faculty during and after cases, conferences, presentations regarding patients and topics.	Faculty and Peer evaluations, Quality improvement conference and review
Interpersonal and Communication Skills		
Learning Objective	Where the Fellows Learn It	How We Assess Skill and Ability
Communicate effectively with faculty, allied health professions, patients and their families: Develop the ability to explain the importance and appropriateness of procedures to physicians or regulators outside of the specialty	Discussion during and after individual cases with faculty and peers, discussion of patients and topics in conference situations	Continuous faculty interaction and evaluation of fellow and peer evaluations
Professionalism- --		
Learning Objective	Where the Fellows Learn It	How We Assess Skill and Ability
Treat other physicians, all allied health professionals, patients and their families with respect and consideration	Observation of faculty interactions and daily interaction by the fellows with patients and their families and other health professionals	Faculty, Peer and Nursing end of rotation evaluations
Practice-Based Learning and Improvement		
Learning Objective	Where the Fellows Learn It	How We Assess Skill and Ability
Use Information technology, medical literature and guidelines, conference review of complications and other quality improvement material to integrate new information into the care of particular patients arrhythmia problems	Attendance at national and other meetings, literature search and literature review, discussion with faculty and peers about trails and literature, Quality improvement conferences	Faculty review of ability to incorporate new information into practice

Systems-Based Practice		
Learning Objective	Where the Fellows Learn It	How We Assess Skill and Ability
Develop skills and knowledge related to efficient and accurate computer based and other medical records for consultations and procedure reports	Peer and Faculty, ancillary support interactions and consultation as needed	Review of medical record documents by faculty
Develop an understanding and practice of cost efficient arrhythmia care	Discussions with faculty regarding equipment, procedure, hospital and outpatient costs regarding the care of patients	Faculty discussion with fellows regarding costs and cost effectiveness related issues
Develop an understanding of the interaction of the arrhythmia consultant and eletrophysiologist with other hospitals, services, and laboratories to improve efficient and safe care of patients	Interactions with faculty and peers	Faculty and Peer review of fellows

Specific Educational Objectives Regarding Medical Knowledge and Patient Care

- Appreciation of the spectrum of cardiac rhythm disturbances including
  - ectopic depolarizations;
  - ventricular tachycardia, including both monomorphic and polymorphic, including sustained and nonsustained forms;
  - ventricular fibrillation;
  - atrial fibrillation
  - atrial flutter;
  - supraventricular tachycardias, including atrioventricular nodal reentrant tachycardia, atrioventricular reentry (orthodromic and/or antidromic; utilizing a manifest or concealed accessory atrioventricular connection or bypass tract), (ectopic) atrial tachycardia.

- Selection of patients for Electrophysiology studies including for syncope, cardiac arrest, supraventricular tachycardia and ventricular tachycardia evaluations, conduction system disturbances.

- Familiarity of principles of pharmacologic therapy for supraventricular arrhythmias and ventricular arrhythmias, including the predicted efficacy, methods possible for evaluation of efficacy, definition and risks of proarrhythmia, drug interactions, etc.

- Selection of patients for non-pharmacologic therapy including implantable defibrillator devices (ICD) and catheter ablation.

- The goal of this rotation is for cardiology fellows to acquire knowledge and experience in the diagnosis and management of bradyarrhythmias and tachyarrhythmias. Within the 3-year cardiology core curriculum, each fellow is required to rotate on the Pacemaker Service in conjunction with the

Electrophysiology Service for a minimum, of two rotation blocks. This will take place during the second and/or third year. The level 1 cardiology fellowship experience include learning the basic electrophysiology of AV conduction and pacemaker activity, and also the fundamentals of cardiac pacing: knowing indication for temporary and permanent pacing, pacing modes and the general approach to programming and evaluation of the patients implanted with pacemakers. The level 1 fellows will be also formally instructed in and gain experience with 1) the insertion, management and follow-up of temporary pacemakers; 2) measuring pacing and sensing thresholds in patients implanted with temporary or permanent pacemakers.

- Selection and interpretation of non-invasive arrhythmia diagnostic methods, including exercise testing, ambulatory monitoring, transtelephonic arrhythmia and pacemaker evaluation, patient activated event monitors and signal averaged electrocardiography.

- Selection and performance of external cardioversion (> 8 procedures during this rotation and/or during general cardiology) with appreciation of the indications, risks, principles, etc.

- Insertion of temporary pacing catheters for management of bradycardia and as used for Electrophysiology studies, including: 1) measurement of pacing and sensing values; 2) appreciation of radiographic landmarks with respect to cardiac anatomy; 3) essential of intracardiac electrograms interpretation including atrial, ventricular and His bundle region in normal and abnormal rhythms.

- Basic exposure to implantable defibrillator device interrogation and follow-up; implantable defibrillator devices' "trouble shooting"; evaluation and management of patients who have received appropriate and inappropriate therapy from implanted defibrillator devices; emergency department management of devices including appropriate use of external magnets.

- Exposure to arrhythmias related to congenital heart disease, and post surgical adult patients.

Limitations of Level I Electrophysiology Training**:** Level I training in Electrophysiology does not include "hands-on" training in catheter ablations, implantable defibrillator devices or lead implantation; these skills and procedures are advanced techniques requiring one or more years of training in Electrophysiology beyond a general cardiology fellowship (Level III training. Please also see description below for outline of training at Level II.) Level I fellows will have the opportunity to observe and discuss: the selection of patients for these procedures, observe and participate in certain aspects of the tests, review the findings with the attending staff and the Electrophysiology fellows and review literature concerning these procedures.

The level 1 cardiology fellowship experience include learning the basic electrophysiology of AV conduction and pacemaker activity, and also the fundamentals of cardiac pacing: knowing indication for temporary and permanent pacing, pacing

modes and the general approach to programming and evaluation of the patients implanted with pacemakers. The level 1 fellows will be also formally instructed in and gain experience with 1) the insertion, management and follow-up of temporary pacemakers; 2) measuring pacing and sensing thresholds in patients implanted with temporary or permanent pacemakers.

The level 2 fellows must have successfully completed level 1 training. The goal of this level 2 training is to train the fellows as noninvasive cardiac arrhythmia specialists with advanced competency and proficiency in the diagnosis and treatment of the patients with bradyarrhythmias and tachyarrhythmias and also in the care of patients with permanent pacemakers. In this process, the level 2 fellows become competent with pacemaker programming and interpretations of the electrocardiograms from pacemaker patients and become familiar with implantations of pacemakers of various modes.

The level 3 training is designed for the fellows who wished to specialize in invasive diagnostic and therapeutic cardiac electrophysiology. Requirements of levels 1 invasive diagnostic and therapeutic cardiac electrophysiology must be fully met. The goal of the level 3 training is to train the fellows as invasive cardiac electrophysiologists. The fellows will become experts in the following areas: basic mechanisms and clinical aspects of arrhythmias and AV blocks; implantation and explanation as an independent operator of pacemakers and electrodes of various modes; interpretation of both surface and telemetered intracardiac electrocardiograms recorded from pacemaker patients; pre- and post-operative and longitudinal management of patients with syncope including neurocardiogenic syncope.

Rotation supervision and evaluation is by the Electrophysiology faculty (see below) with the faculty member directly responsible for fellow education being Dr. James P. Daubert.

References

1. Mark Josephson, Clinical Cardiac Electrophysiology: Techniques and Interpretation, (Lippincott Williams & Wilkins, 3rd edition, Philadelphia, 2002).

2. Eric Prystowsky and George Klein, Cardiac Arrhythmias: An Integrated Approach for the Clinician. (McGraw Hill, New York, 1994).

3. Cardiac Electrophysiology: From Cell to Bedside, 3rd ed. Douglas Zipes and Jose Jalife, ed. (W. B. Saunders, Philadelphia, 2000).

4. Electrophysiology Testing. Richard N. Fogoros 2nd edition. (Blackwell Science, 1994, Cambridge, MA, USA)

5. Ellenbogen, Kenneth A. and Mark A. Wood, ed., Cardiac Pacing and ICD's. 3rd edition. (Blackwell Science, Inc. Massachusetts, 2002).

6. Ellenbogen, Kenneth, Kay, G. Neal and Bruce L. Wilkoff, ed.. Clinical Cardiac Pacing and Defibrillation. 2nd Edition. (W.B. Saunders, Philadelphia, 2000.

7. ACC/AHA Practice Guidelines, *Recommended Guidelines for Training in Adults Clinical Cardiac Electrophysiology* (Electrophysiology/Electrocardiography Committee of the American College of Cardiology, 1990)

8. Gregoratos G, Abrams J, Epstein AE, Freedman RA, Hayes DL, Hlatky MA,Kerber RE, Naccarelli GV, Schoenfeld MH, Silka MJ, Winters SL. ACC/AHA/NASPE 2002 *Guideline Update for Implantation of Cardiac Pacemakers and Antiarrhythmia Devices*: A *Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines* (ACC/AHA/NASPE Committee on Pacemaker Implantation, 2002)

9. Tracy CM, Akhtar M, DiMarco JP, Packer DL, Weitz H. American College of Cardiology/American Heart Association *Clinical Competence Statement on Invasive Electrophysiology Studies, Catheter Ablation, and Cardioversion.* (J Am Coll Cardiol 2000;36:1725—36)

Comments: References 2 and 4 are very readable and concise and the fellow should read it in its entirety during or before the rotation. References 1 and 3 are more appropriate as references to explore other topics in greater detail; reference 1 is clinically oriented and especially good on basic techniques and methodology for the invasive electrophysiologic test and also for ventricular tachycardia. Reference 3 is excellent for basic science correlation. The fellow should try to read several chapters from reference 3. Other journal articles will be assigned for journal club or for patient related reading. The fellow will also be expected to perform literature searches when suggested or upon his own initiative on topics which come up during teaching rounds or with regard to patients which are seen.

General Statement of Expectations of Fellows & On-Call Guidelines

First call for the Electrophysiology Service is shared on an approximately equal basis by the cardiology fellow(s) and full-time Electrophysiology fellows. Call will not be more frequent than every other night on average. Responsibilities include 24 hour prompt availability by telephone as well as prompt in-person response to patient care emergencies and urgent problems. Backup from Electrophysiology fellows and faculty is available 24 hours a day, and the fellows are expected to contact the backup fellow and/or the Attending Staff with any urgent consultations or significant change in condition of any patients. The Electrophysiology Fellows are expected to be called and to assist in the evaluation of any complicated arrhythmia problem or any patient with an implanted defibrillator. The fellow is expected to see any new admissions on the night of admission, review the findings and plan with the Attending Staff and write an admission note. The fellow is also asked to evaluate, in person, any significant or potentially significant development, including, but not limited to chest pain, hypotension, heart block or other bradycardia, ventricular tachycardia in any inpatient.

Outpatients with implantable defibrillators may contact the Fellows when they have received a shock from their implanted defibrillators. They should be instructed to come to the Emergency Room if they receive more than one shock or have symptoms such as syncope or chest pain preceding or following the shock. If they receive a single shock but then are free of symptoms they may be instructed to return to the clinic on the next weekday for device interrogation. After triaging and speaking with patients after hours please write a brief telephone contact note for the Electrophysiology service chart to allow continuity of the patient's care.

The fellow should notify the Attending about the consult and discuss the degree of its degree of urgency. All consults should be seen on the same day and on an emergent basis if necessary. Because of the importance of diagnostic electrocardiographic data, such as monitor strips of tachycardia or heart block or pauses for future diagnosis and therapy these should be copied for the Electrophysiology service chart and/or securely mounted in the hospital chart. Questions about pre-procedural orders should be reviewed with the advanced Electrophysiology Fellows or Attending staff. If at all possible consents should be obtained by the advanced Electrophysiology Fellows or Cardiology fellow well in advance of the procedure. Attention to anticoagulation status and anti-arrhythmia drug treatment with regard to upcoming procedures should be kept in mind.

Vacation

Vacation is limited to one week per 2 month rotation, timing of which to be approved by the EP service in addition to the Cardiovascular Program Director.

Level II Training

Level II training (advanced noninvasive arrhythmology) requires a total of 6 months of EP training and qualifies the trainee for intermediate level expertise but not independent invasive EP procedural skills. All the goals and requirements of Level I training must be met. Fellows interested in obtaining training at this level should initiate discussions with the Electrophysiology Laboratory Director and have the approval of the Cardiology Program Director. Individuals will be expected to present a proposed training timeline, insuring that all other program requirements will be met by the end of the third year of fellowship. Training at Level II will include a greater depth of exposure to:

- electrogram interpretation from EP studies,
- greater understanding of arrhythmia mechanisms,
- inpatient and outpatient consultation and management
- management of implantable permanent pacemakers) including interrogation, evaluation, trouble-shooting and programming) with exposure to >100 patients.
- expertise in temporary pacing, transesophageal pacing and cardioversion.
- greater proficiency in noninvasive arrhythmia evaluation (Holter, event monitoring, signal averaged ECG, tilt table testing).

Level II training in Electrophysiology does not include "hands-on" training in catheter ablations or implantable defibrillator devices lead implantation; these skills and procedures are advanced techniques requiring one or more years of training in Electrophysiology beyond a general cardiology fellowship (Level III training). A level II trainee will not be qualified to independently perform invasive EP studies or ablations. Surgical implantation will require additional training (see Level III training in EP Fellowship).

General Statement of Educational Objectives for Fellows

The goals will be achieved by the following various methods: all level 1, 2 and 3 fellows are required to attend formal biweekly ECG/arrhythmia/pacemaker conference, (one hour in duration), weekly electrophysiology case review (one hour in duration), and weekly electrophysiology journal club (one hour in duration); seeing and evaluating under close supervision hospitalized and clinic patients with bradyarrhythmias, tachyarrhythmias, and pacemakers. In those conferences, level 1 fellows are required to participate actively in the discussion, level 2 fellows are asked to choose appropriate cases and ECG tracings and are required to participate actively in the discussion; level 3 fellows are asked to choose cases/topics and ECG tracings/EP test tracings and to act as a teacher in the conference, which are attended and supervised by the faculty attendings. Level 3 fellows and some of level 2 fellows wishing to implant pacemakers are closely supervised during the procedure by the faculty.

The faculty members directly responsible for fellow education are: Drs. Toshio Akiyama, Director of Arrhythmia Monitoring and Pacemaker Service; James P. Daubert, Director of Electrophysiology Laboratory; David T. Huang. The following surgeons participating in the implantation of permanent pacemakers are also involved in the teaching of the fellows: Dr. Mark Davies, Yaron Sternbach, Jeffrey Rhodes, Richard Green, Theodore Hirokawa (Vascular Surgery); Drs. Richard Feins, David Johnstone, Thomas Watson, William Risher, and George Hicks (CT Surgery).

General Statement of Expectations of Fellows

Level 1, 2 and 3 pacemaker training is provided as an integral part of the electrophysiology and pacemaker training the level 1 and 2 during the 3-year cardiology fellowship and level 3 after completion of the 3-year cardiology fellowship.

Level 1. Within the 3-year core curriculum, each fellow is required to rotate on the pacemaker service in conjunction with the electrophysiology service for a minimum of two rotation blocks. Fellows in pacemaker rotation are required to attend and participate in the formal ECG/Pacemaker Conference (held once every two weeks). Electrophysiology Case Review/EP and pacemaker Journal Club (held weekly), to evaluate a minimum of twenty hospitalized and clinic patients with bradyarrhythmias/pacemakers, to insert a minimum of ten temporary pacemakers, to observe/assist a minimum of ten permanent pacemaker implantations, to program a minimum of ten implanted pacemakers for pacing threshold and sensing function under

direct supervision of a faculty member, to interpret a minimum of twenty transtelephonically transmitted pacemaker ECG tracings. At the end of each rotation block, EP/pacemaker faculty members will have a discussion with each fellow regarding their performance and a written evaluation will be formulated and stored at the office of the Director of the Cardiology Unit.

Level 2. After successful completion of the level 1 training, level 2 training consists of a minimum of 6 months of training as a noninvasive cardiac arrhythmia/pacemaker specialist. level 2 trainees should meet all level 1 requirements. In addition, level 2 trainees should meet all level 1will assume a more active role in the conduct of the biweekly formal ECG/pacemaker conference and weekly EP case reviews/Journal Club in that they are required to choose materials for conferences and to actively participate in the discussion. Each level 2 trainee is required to evaluate under close supervision a minimum of fifty hospitalized and clinic patients with bradyarrhythmias, to assist a minimum of twenty permanent pacemakers, to program a minimum of fifty implanted pacemakers for pacing threshold and sensing function under close supervision, and to interpret a minimum of one hundred transtelephonically transmitted ECG tracings. At the end of this rotation, EP/Pacemaker faculty members will have a discussion with each fellow regarding their performance and written evaluation will be kept at the office of the Director of Cardiology Unit. A level 2 fellow is encouraged to conduct/participate in the clinical studies present their results in the Cardiology Unit conference, and to publish papers.

Level 3. This training is designed for the individual who wishes to specialize in invasive electrophysiology, and lasts for two years. Requirements of levels 1 and 2 must be fully met. Pacemaker training will be provided in conjunction with the electrophysiology training. Each level 3 fellow is required to assume a role of teacher, supervised by EP/Pacemaker faculty, in the biweekly ECG/Pacemaker conference and weekly EP case reviews/Journal Club by choosing conference materials and interpret/discuss the chosen materials under the supervision of EP/pacemaker faculty. Each level 3 fellow, in addition, is required to implant a minimum of 20 temporary pacemakers, to implant/assist a minimum of one hundred permanent pacemakers, to perform noninvasive evaluation of a minimum of one hundred implanted pacemakers using pacemaker programmers, to evaluate a minimum of fifty hospitalized and clinic patients with bradyarrhythmias under supervision, to interpret a minimum of one hundred transtelephonically transmitted pacemaker ECG tracings. In addition, each level 3 fellow will be encouraged to conduct clinical/basic studies present their results in the Cardiology Unit conference, and to publish a minimum of one manuscript.

Research Opportunities

Clinical Research

Electrophysiology service is involved in research studies involving patients at risk for sudden cardiac death (MADIT II, MADIT III, DEFINITE), evaluation of cardiac resynchronization therapy (bi-ventricular pacing) including InSync III Marquis, Companion and other studies.

Basic research including whole animal studies with mapping, ablation, and intra-cardiac ultrasound are available as well.

Medical Staff

	Beeper	**Office**	**Home**
David T. Huang, M.D. (Acting Director of EP Laboratory)	16-4722	275-4775	387-9407
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Sarah G. Taylor, M.D.	16-1117	275-4775	
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Staff

	Beeper	**Office**
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Credentials of Medical Staff

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Residency, University of Pittsburgh Medical Center
NIH Physician Investigator Research Fellowship, University of Pittsburgh
Cardiology Fellowship, Beth Israel Hospital/Harvard Medical School
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