JACC: CARDIOVASCULAR IMAGING VOL. 1, NO. 6, 2008

ISSN 1936-878X/08/$34.00
PUBLISHED BY ELSEVIER INC. DOI:10.1016/j.jcmg.2008.09.004

iBIZ

BUSINESS AND ADVOCACY

Physician Certification in Cardiovascular Imaging

Rationale, Process, and Benefits

Manuel D. Cerqueira, MD, FACC, FASNC,* James A. Arrighi, MD, FACC, FASNC,† Edward A. Geiser, MD, FACC, FASE‡

Cleveland, Ohio; Providence, Rhode Island; and Gainesville, Florida

Cardiologists, radiologists, and nuclear medicine physicians receive training and may be allowed to perform cardiovascular imaging by using echocardiography, nuclear cardiology, or cardiovascular computed tomography. Given the tremendous variability in training and expertise, physician certification in each of these areas has been developed as a measure of providing quality studies for accurate patient diagnosis and management. In this paper, the history, the process of examination development and administration, eligibility requirements, the results of physician testing, and board recognition will be presented for each of the 3 boards. Payers and government regulators have recognized these boards as a measure of physician quality, and they are often required for physician reimbursement and licensure. Because many physicians provide service in more than 1 specialty, discussions are ongoing to simplify the application, testing and recertification processes.

Accurate diagnosis and management of cardiovascular disease is highly dependent on the use of cardiovascular imaging. Historically, cardiologists have served in the role of clinician imagers or consumers, using their knowledge of cardiovascular diseases to define clinical needs, assist with technological development, interpret imaging studies, and use the results for management. In contrast, radiologists and nuclear medicine physicians usually have served in the role of imagers, using their knowledge of imaging technology to interpret cardiovascular images for referring clinicians who use the results for clinical purposes. Over the years, these roles have started to overlap, resulting in tremendous power struggles at many levels and a turbulent coexistence at best, with battles being waged in areas of clinical versus technical relevance of interpretation, access to equipment and, ultimately, reimbursement.

In addition, there are ongoing trends that impact on all physicians involved in cardiovascular imaging regardless of training. Cardiologists are faced with the growing complexity of imaging equipment and computer processing; the expanding curriculum required for basic cardiovascular training; competition; the need to examine noncardiac structures that are present when imaging the heart; and the requirements by payers to provide and document quality and accurate image interpretation (1). Similarly, radiologists and nuclear medicine physicians are forced to undergo extensive training in multiple imagining modalities being

From the *Departments of Nuclear Medicine and Cardiovascular Medicine, Cleveland Clinic, Cleveland, Ohio; †Division of Cardiology, Rhode Island Hospital and Alpert Medical School of Brown University, Providence, Rhode Island; and the ‡Echocardiography Research Laboratory, University of Florida, Gainesville, Florida. Dr. Cerqueira is the current President of the Certification Board of Cardiovascular Computed Tomography and a past President of the Certification Board of Nuclear Cardiology. Dr. Arrighi is the Vice President of the Certification Board of Nuclear Cardiology. Dr. Geiser is the President of the National Board of Echocardiography.

Manuscript received June 20, 2008; revised manuscript received September 10, 2008, accepted September 11, 2008.

used to image all the major body organ systems. This training does not provide a comprehensive understanding of cardiovascular physiology and pathophysiology or identify the relevant clinical questions that need to be addressed by imaging to select the appropriate therapy from the constantly expanding therapies.

In the midst of this expanding gap and diversity, assessment of the skill and ability of the performing and interpreting physician has assumed greater importance regardless of the background of the physician.

Nontraditional Boards

In this highly politicized environment, testing and certification of competence of cardiovascular imaging physicians, regardless of their field of training, is critical to provide quality diagnostic imaging studies and to allow trained and competent individuals, regardless of their background, to practice cardiovascular imaging. In the last 2 decades, steps have been taken to define the specific training for physicians in cardiovascular imaging and to test competency of both the technical knowledge and the clinical understanding of how to use imaging. Physician certification in cardiovascular imaging has evolved outside the more traditional American Board of Medical Subspecialties (ABMS), and boards have been established and recognized in nuclear cardiology, echocardiography, and cardiovascular computed tomography.

These certification boards focus on improving the quality of cardiovascular image interpretation as practiced in both hospital and office-based practice settings. The founders of these boards believe that physician certification in cardiovascular imaging enhances the overall quality of health care. This certification is accomplished by ensuring minimum standards of training and eligibility for candidates as well as documentation of a minimum standard of competency in the area of imaging. Physician certification provides accountability and reassurance to patients and payers when dealing with diplomate providers. The process promotes quality by fostering improvement and continuing education. The examinations provide feedback to physicians that their knowledge and skills meet a recognized standard. The examinations give guidance on best practice for imaging both for diagnosis and management.

Basic Training for Cardiovascular Imagers

In light of the importance of imaging, cardiovascular medicine training guidelines have been developed and periodically updated for echocardiography, nuclear cardiology, cardiovascular computed tomography (CCT), and cardiovascular magnetic resonance (2–4). As a result, all cardiology trainees are exposed to cardiovascular imaging. However, exposure, even at Core Cardiology Training (COCATS) Level II, does not guarantee sufficient competency in the technical and interpretative aspects in 1, much less all 4, cardiovascular imaging modalities. For radiology and nuclear medicine physicians, the training guidelines for cardiovascular imaging are poorly defined.

How does one then determine the ability of diverse trainees to accurately interpret and receive reimbursement for cardiovascular imaging? The Cardiovascular Diseases subspecialty board of the American Board of Internal Medicine does not sufficiently test knowledge in cardiac imaging beyond knowing when to use these modalities and the results for clinical diagnosis and management. In other areas of cardiology training, this problem has been addressed by incorporating a minimum of 1 additional year of training. This year qualifies individuals who have successfully passed the Cardiovascular Diseases board for ABMS to take subspecialty boards in Clinical Cardiac Electrophysiology and Interventional Cardiology. Very few individuals, however, spend a full year in advanced cardiovascular image training, which is a prerequisite to sit for an ABMS subspecialty-approved board (1).

For radiologists and nuclear medicine physicians, the training guidelines are not detailed with respect to normal and abnormal cardiac anatomy, congenital heart disease, or the related pathophysiology. Some programs do not even have exposure to these areas. The ABMS American Board of Radiology or the American Board of Nuclear Medicine certification exam does not test these areas in great depth. As a result of the variability in training, spectrum of exposure to and mastery of cardiovascular diseases, and the failure of ABMS boards to specifically document competency in these areas, non-ABMS boards have been formed to credential physicians in echocardiography (National Board of Echocardiography [NBE]), nuclear cardiology (Certification Board of Nuclear Cardiology [CBNC]), and CCT (Certification Board of Cardiovascular Computed Tomography [CBCCT]). Boards have not been developed for physician certification in cardiovascular magnetic resonance.

These boards developed independently, and invitations to take part in development were sent to all professional medical societies involved in the fields regardless of whether they represented imagers or clinician imagers. We will not address the process by which NBE, CBNC, and CBCCT were formed; how the examinations are developed; and the results to date of testing.

National Board of Echocardiography

Basis and value of physician certification in echocardiography. In the late 1980s and early 1990s, a wide variation in the quality of practice of echocardiography existed. In response to this variation, several task force documents put forth guidelines for training in transthoracic echocardiography, transesophageal echocardiography, and stress echocardiography (4–6). Similar documents have been more recently developed for perioperative transesophageal echocar-

diography (7). These training guidelines are now well accepted and part of accredited fellowship training in cardiovascular disease and in cardiothoracic anesthesiology. On the basis of these published guidelines, the NBE developed 2 processes for certification in echocardiography: the Examination of Special Competence in Adult Echocardiography and the Examination of Special Competence in Perioperative Transesophageal Echocardiography

The NBE was formally incorporated on December 3, 1998, as the union of the adult echocardiography examination formed under the American Society of Echocardiography (ASE) in 1993 and the perioperative transesophageal echocardiography group formed under the Society of Cardiothoracic Anesthesiology (SCA) in 1995. The board now serves as the parent organization overseeing the development, administration, and certification offered through both organizations.

The goals of the NBE certification process are to assess the training and level of knowledge of a candidate in a valid manner, provide a stimulus to professional growth in the field, and serve the public by encouraging quality patient care in the practice of echocardiography.

Eligibility. Requirements for certification in adult echocardiography include completing 2 years of advanced training (fellowship) in cardiovascular disease, 6 months of formal training in echocardiography (COCATS Level II), and passing the NBE examination in adult echocardiography. Requirements for certification in perioperative transesophageal echocardiography include a 1-year fellowship in the perioperative care of surgical patients with cardiovascular disease, the study of at least 300 perioperative transesophageal echocardiograms, and passing the Perioperative Transesophageal Echocardiography examination. There are practice experience pathways to certification for clinicians who completed their training before June 2000. Figures 1 and 2 show the number of applicants taking, passing, and being successfully certified for the Adult Echocardiography and Perioperative Transesophageal Echocardiography examinations. The pass rates for both examinations have increased, even though the passing standard is kept constant and adjusted statistically for the difficulty of each yearly examination. This increase suggests that there has been an improvement in the knowledge base and, presumably, the quality of the applicants taking the examination. Therefore, the goals of the certification process are likely being met. Although there is some variation in the number of test takers, in general there is an increase, likely reflecting the increasing demands by payers that providers of imaging service be certified.

Recertification. Because the technology and clinical application of echocardiography continue to evolve, and ongoing physician continuing medical education is variable, recertification is required every 10 years in both fields. The passing rate for each recertification examination is quite high, suggesting that recertification provides a stimulus for maintaining skills and assimilating current knowledge.

Examination development and scoring. Once the first examination committee was appointed and assembled by the ASE in 1993, a content outline was drafted that included 5 major content domains and the percentage of pro-

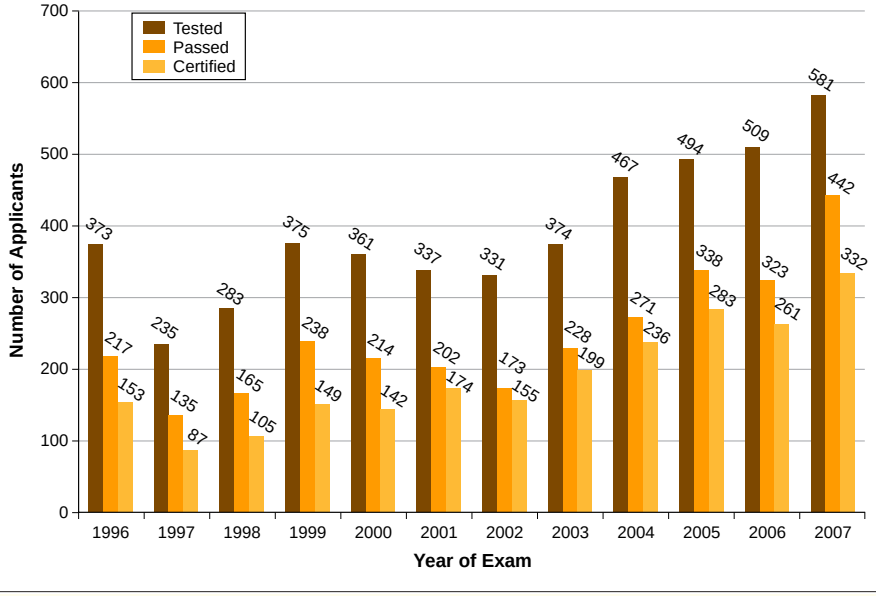

Figure 1. Yearly Number of Physicians Tested, Passed, and Certified by the National Board of Echocardiography Adult Echocardiography Certification Since the Initial Examination in 1996

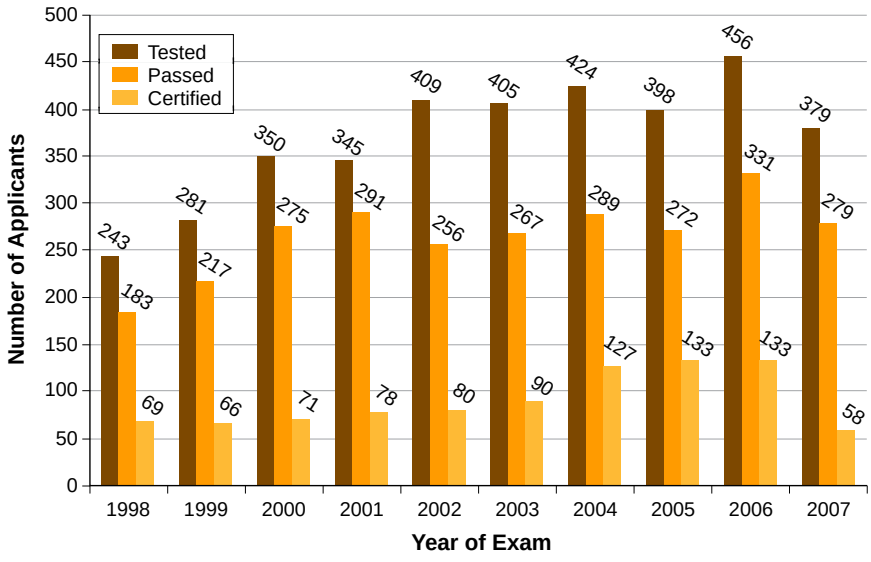

Figure 2. Yearly Number of Physicians Tested, Passed, and Certified by the National Board of Echocardiography Perioperative Transesophageal Echocardiography Certification Since the Initial Examination in 1998

posed test items that would be associated with these domains. This content outline was then mailed to 500 ASE members, of whom 58% responded. Changes in the content outline were then made by the examination committee on the basis of the results of that survey. Similarly, in 1995 the SCA formed the Perioperative Transesophageal Echocardiography Certification Task Force, which developed an examination based on a content outline incorporating feedback from the SCA membership.

Questions are now developed by the Adult and Perioperative writing committees in collaboration with the National Board of Medical Examiners, which has administrative oversight for the process. Each committee consists of 10 members appointed by the NBE based on their expertise in echocardiography. Questions submitted by members of the committee are reviewed by the entire committee for accuracy, relevance, clarity of the question, and consistency of the potential answers (distractors). Only items that have unanimous approval of the respective committee are placed in the database for performance testing on a future examination. The assembly and administration of each examination is the responsibility of the National Board of Medical Examiners. The number of items from each content category is specified, and the questions for the examination are selected from the cataloged database by computer. The respective writing committees then review the selected questions and replace any that is thought to be redundant or unclear, arriving at the final content for the examination. Subsets of the final accepted questions then form the content of the recertification examinations.

Establishing the pass/fail score (standard setting) for the examinations is a complex task. This process has been described in some detail in a previous publication (6). It should be noted, however, that the passing standard is aimed at the perception of a "minimally proficient candidate" by a committee of practitioners. The passing standard is usually re-evaluated every 3 years and was actually increased once for the NBE examination in perioperative transesophageal echocardiography in 2002. Each question in the database is associated with a statistical difficulty, allowing year-to-year comparisons of the relative difficulty of each examination. With the use of this information, the passing scores are adjusted so that the same candidate proficiency (standard) is required to pass each year.

Certification Board of Nuclear Cardiology

The need for physician certification in nuclear cardiology was initially discussed by the American Society of Nuclear Cardiology in November 1994, the Board incorporated as the Certification Council of Nuclear Cardiology with support from the American Society of Nuclear Cardiology and the American College of Cardiology in February 1996, and the first examination was given to 610 candidates in September 1996 (8). Also invited to participate in the process were the American College of Nuclear Physicians, the American College of Radiology, and the Society of Nuclear Medicine, who declined. In February 1999, the name was changed to the Certification Board of Nuclear Cardiology because the Nuclear Regulatory Commission set criteria for recognition of

physician boards that met all the training and experience requirements and allowed diplomates to become authorized medical users without further documentation.

From the beginning, psychometric and testing expertise was provided by Knapp and Associates, International, Inc., which guided the development and maintenance of the examination at all stages. Initial efforts focused on determining candidate eligibility, defining content, developing questions, administering the examination, monitoring the performance, and recertification.

Candidate eligibility. In recognition that providers of nuclear cardiology services had varied backgrounds and duration of practice, and that training was evolving, early eligibility criteria required a valid license to practice medicine; board certification in cardiology, radiology, nuclear medicine, or internal medicine; and experience with a defined duration of training and case load. An eligibility pathway for individuals without formal training was allowed in the early years but was phased out with the 2008 examination. Eventually, the COCATS Level II requirements became the minimum training and experience requirements. International applicants were reviewed in a manner that was appropriate to the existing training and Boarding requirements in their countries. Eventually, Internal Medicine boards alone were not acceptable and board certification in one of the other modalities was required.

Practice analysis. The basic philosophy of the CBNC is to test the essential knowledge base required for the actual practice of clinical nuclear cardiology at a level of basic competence rather then testing theoretical or esoteric aspects of the field. To that end, an initial Practice Analysis was undertaken involving 4 distinct steps: a comprehensive literature review, practitioner interviews to develop a survey questioner, a practice survey, and review by a Consensus Panel of Experts. At all steps of the process, every attempt was made to include a representative sample of all specialties involved in clinical practice (cardiologists, radiologists, nuclear medicine physicians), practice settings (hospital, office, academic centers), geographic location, and gender.

The comprehensive literature review was performed by a Consensus Panel that included leading experts and clinical practitioners and used existing guidelines, clinical statements, and clinical literature. A draft survey instrument was created and used for direct practitioner interviews. These interviews defined the major professional responsibilities associated with the practice of nuclear cardiology, the specific tasks requisite to fulfill these responsibilities, and the level of knowledge needed to effectively carry out these practice activities. The findings obtained from the practitioner interviews permitted drafting of a comprehensive survey listing of work activities and knowledge areas associated with professional practice. This instrument was sent to 193 cardiology practitioners and the responses tabulated for review by the Consensus Panel, who determined the precise knowledge areas and relative percentage of each of the 8 content areas and the cognitive level at which each topic was to be assessed. There are 3 cognitive levels: recall, which is memory of previously learned facts or recognition of previously learned concepts; application or ability to apply general principles to a specific situation; and analysis and synthesis of several different types of information to reach a solution to a problem. Each examination includes a mixture of cognitive levels for each of the content areas.

The initial Practice Analysis was completed in 1996 and is repeated every 5 years to track changes, if any, in the knowledge required and the types of clinical studies being performed. Over the years, there have been minor changes in content areas and the relative percentage for each. This process guarantees that the examination remains current with what is being done in clinical nuclear cardiology.

Question development and monitoring of performance. Questions for the original examination were written by a representative group of physicians and scientists from a variety of regions and practice settings. These questions were extensively reviewed and edited by the CBNC psychometric consultants, who then presented the revised questions to a group of content experts charged with reviewing the changes and making further modifications where deemed appropriate. From these, the examination consisting of approximately 175 questions is assembled to match the content areas and cognitive levels defined by the Practice Analysis. This final examination with images is reviewed at a face-to-face meeting by 12 to 15 content experts for accuracy. Once the examination has been administered, every question is evaluated for performance relative to all other questions and the test takers. If specific questions fail to discriminate between high and low scorers, they are subject to review and may be eliminated from the final scoring if found faulty.

Figure 3 shows the total number of examinees who have taken the CBNC examination since the initial examination in 1996. Typical for most new physician examinations, the number of candidates declines after the first few years. For the CBNC, the number was lowest in 2001 with 373 candidates. Subsequently, the number of applicants increased and, in 2007, there were a total of 1,382 test takers, including candidates for recertification. This reversal of the typical trend was due to the growing acceptance by payers of diplomate status as the basis for reimbursement for cardiologists providing nuclear cardiology services and for the greater national emphasis on documenting quality.

The passing score for the examination is determined by careful review of the examination and overall test performance using psychometric analysis. Since the initial examination in 1996, passing rate has varied between 72%

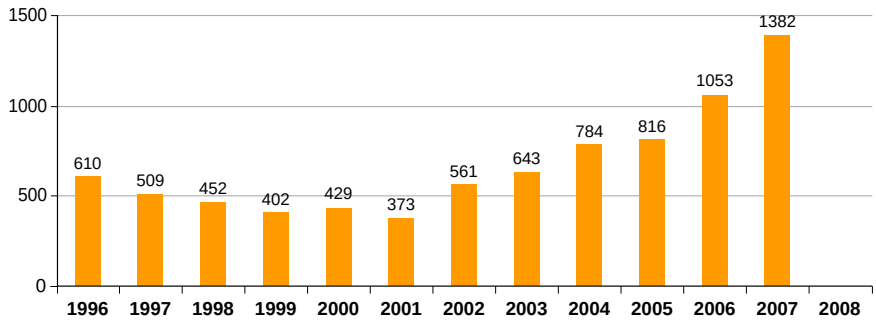

Figure 3. Candidates Taking the Certification Board of Nuclear Cardiology Since the First Examination in 1996

and 81%. This usually requires a correct response to 124 to 130 questions. Figure 4 shows the percentage passing rate for each examination.

A question-writing drive is held annually with the aim of obtaining 125 to 150 new questions each year. At the review meeting, questions from the prior year's examination that performed poorly are reviewed and rewritten, if thought appropriate, or eliminated. After the first year's examination, a certain number of "equators questions" are included that allow tracking of the degree of examination difficulty as well as the performance of each year's candidates. With the accumulation of a large and validated question bank, several versions of the examination can be created that allow administration of the examination over several days, lessening the potential for cheating because each examination is sufficiently different to minimize overlapping questions between them, and reduce the potential for communications between candidates taking the examination at different times.

Examination administration. Although the ideal situation for testing would have entailed direct interpretation of images on a workstation, such logistics are difficult, and the first 10 CBNC examinations used pencil and paper testing at 1 or, at most, 2 sites with hardcopy images. The initial examination was given at a single site and day to avoid potential cheating. For 2 years, an examination also was administered in Vienna, Austria, and the start time selected to coincide with the start of the U.S. administration. In 2006, the first computer-based test was administered at multiple Prometric Center sites throughout the world, using a window of several days when applicants could take the examination. Logistics for computer-based testing were provided by Prometric (Baltimore, Maryland). With each subsequent computer-based test, increasing complexity is being added to the examination, with the hope that it will eventually approximate the environment used for interpretation of clinical nuclear cardiology studies.

Recertification. Diplomate status is granted for a 10-year period, after which recertification is required. The first recertification examination was given in 2006. Figure 5 shows the passing rate over the first 3 years. The number of applicants taking the examination in the first 2 years was very small, and it is difficult to identify trends with such small numbers.

Certification Board of Cardiovascular CT

The field of CCT came into existence only in the last several years but has rapidly matured into a distinct and important field of cardiovascular medicine. The field evolved as a multispecialty development by radiologists, cardiologists,

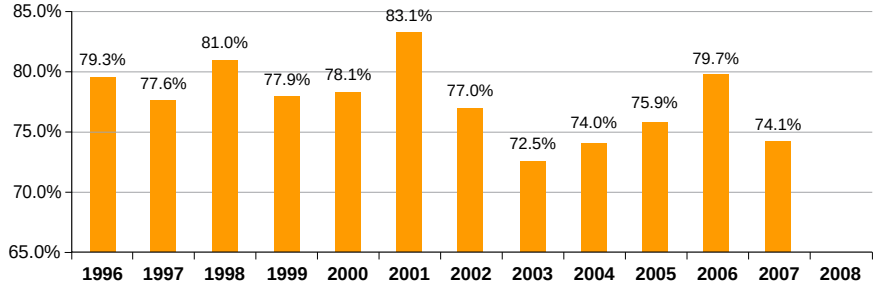

Figure 4. Certification Board of Nuclear Cardiology Examination Percentage Passing Rate for Each Year of Testing

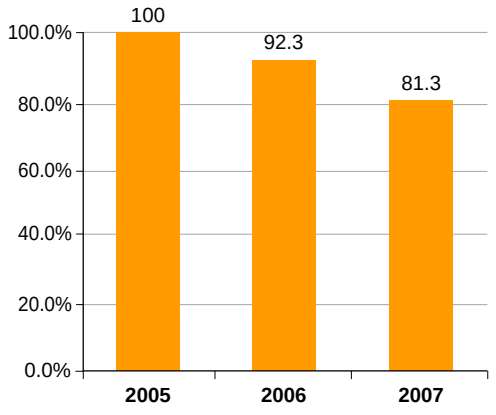

Figure 5. Percentage Passing Rate for the Recertification Examination in Nuclear Cardiology

angiographers, and nuclear medicine specialists. The field is so new that practitioners in many cases have been self-taught or acquired knowledge outside of their institutions at a limited number of formal training programs. Individuals completing general cardiology or radiology training lack specific knowledge and expertise in CCT but, on the basis of ABMS certification, may consider themselves qualified to practice CCT.

Some are attracted to the field for business opportunities. Given the evolving nature of the technology, lack of evidence-based studies, and the absence of traditional training programs; it is a legitimate question to ask whether the field was ready to implement a physician certification examination. However, it was precisely for these reasons that such an examination was judged critical to provide quality patient care by defining the required knowledge base, setting training and experience eligibility criteria for practitioners, and documenting a minimal level of competency for providers of CCT services.

Formation of the CBCCT. Building on the experience of the CBNC and NBE, the American College of Cardiology, the American Society of Nuclear Cardiology, the Society for Cardiovascular Angiography and Interventions, and the Society of Cardiovascular Computed Tomography formed the CBCCT in 2006. The CBCCT was able to learn from the experience and expertise of the 2 existing cardiovascular imaging boards to develop its examination. Knapp and Associates, International, Inc., provided expertise in psychometrics, and the administration of the computer-based examination will be by Prometric. Details on the examination and the application process can be found at http://cbcct.org. Unlike the other established cardiovascular imaging boards, CBCCT gave its first computer-based examination to 879 candidates on September 22, 2008, at multiple sites in the U.S. The examination for 2009 will be given on September 15 and 16 at multiple sites in the U.S. and throughout the rest of the world.

Practice analysis survey and question development. Initial efforts to define the content areas involved an extensive review of the existing literature to define the areas to be surveyed (2,9,10). To ensure reasonable standards, CBCCT used the expertise of physicians and physicists who collectively possess comprehensive expertise in CCT and, thus, are able to precisely define the minimum criteria for knowledge of CCT for initiation and maintenance of high quality CCT practice. A Practice Analysis using methodology similar to that described previously for CBNC was performed, including the meeting of a panel of experts to formalize the content areas and percentages.

An examination of approximately 170 multiple-choice items will adequately sample the breadth of knowledge covered by the examination specifications and required for competent performance. To develop high-quality questions with clear-cut unambiguous answers, a question bank was generated. More than 100 experts in the field of CCT contributed time to question formation, clarification, and finalization. Each of these questions was analyzed, discussed, edited, and/or rejected by consensus of the CBCCT Certification Examination Committee.

Candidate eligibility. Because candidates for the CBCCT examination have a much more diverse background than those encountered for echocardiography and nuclear cardiology, eligibility criteria attempted to include all possible areas of training. These areas include medical licensure, board certification in cardiovascular diseases, nuclear medicine or radiology, training and experience in the provision of cardiovascular computed tomography services, continuing medical education, and ongoing participation in study interpretation. Substantial discussion occurred regarding candidate eligibility. These requirements were based on published guidelines by the involved professional medical societies.

Passing score. The passing score for the examination will be set by a panel of national experts, each representing different disciplines involved in the knowledge and practice of CCT as well as representing both academia and private practice. Each examination question has been specifically examined by CBCCT panel members, and a determination made as to what percentage of minimally competent CCT cardiologist, radiologists, and nuclear medicine specialists would answer that question correctly based on the Practice Analysis. During the process of combining all of the expectations for all questions, a minimum level of knowledge expected of a passing candidate will be defined. This absolute passing score is based upon an expected level of knowledge and is unrelated to the dis-

tribution of scores obtained during a particular examination administration. Thus, for any given examination, a candidate has an equal chance of passing the examination, independent of the test group level of expertise, knowledge, and test performance.

Recognition of physician certification in cardiovascular imaging. There has been increasing recognition and acceptance by state and federal regulatory organizations and payers of NBE and CBNC. The CBNC has been recognized by the Nuclear Regulatory Commission and many of the Agreement States as the basis for licensure for the use of radioactive materials for nuclear cardiology tests. Many the payers have mandated certification in these areas as the basis for physicians to provide services and be reimbursed to members enrolled in the health plans. With the increasing emphasis on quality and pay for performance, it is anticipated that physician certification will be mandated by most payers and the number of applicants will continue to increase.

Future Certification in Cardiovascular Imaging

Imaging of the cardiovascular system by echocardiography, nuclear cardiology, and cardiovascular CT will continue to become more sophisticated, complex, and widespread in clinical practice. Both patients and payers continue to demand quality performance and interpretation by the physicians involved in the practice of these modalities and certification and recertification will become more important in the future. No certification process can guarantee the competence of an individual, but examinations of special competence and the certification processes help to identify physicians who have met the requirements in training and experience set forth by professional societies and boards. In this context, we believe that certification processes in imaging will continue to be of value. Further studies are needed to document that diplomat status actually results in improved patient care.

Physicians in private practice involved in noninvasive imaging are feeling overwhelmed by the number of boards and recertification examinations they are required to take. There are ongoing discussions amongst the boards to at least consolidate the application process. Precedent has been set by imaging laboratory accreditation, which has formed a unifying body that will develop a common application process to simplify the process and hopefully decrease cost for applying physicians.

Reprint requests and correspondence: Dr. Manuel D. Cerqueira, Departments of Nuclear Medicine and Cardiovascular Medicine, Cleveland Clinic (Gb3), 9500 Euclid Avenue, Cleveland, Ohio 44195. *E-mail cerquem@ccf.org.*

REFERENCES

1. Beller GA. A proposal for an advanced cardiovascular imaging training track. J Am Coll Cardiol 2006;48:1299–303.
2. Budoff MJ, Achenbach S, Berman DS, et al. Task force 13: training in advanced cardiovascular imaging (computed tomography) endorsed by the American Society of Nuclear Cardiology, Society of Atherosclerosis Imaging and Prevention, Society for Cardiovascular Angiography and Interventions, and Society of Cardiovascular Computed Tomography. J Am Coll Cardiol 2008;51:409–14.
3. Cerqueira MD, Berman DS, Di Carli MF, Schelbert HR, Wackers FJ, Williams KA. Task force 5: training in nuclear cardiology endorsed by the American Society of Nuclear Cardiology. J Am Coll Cardiol 2008;51:368–74.
4. Ryan T, Armstrong WF, Khandheria BK. Task force 4: training in echocardiography endorsed by the American Society of Echocardiography. J Am Coll Cardiol 2008; 51:361–7.
5. Baughman KL, Duffy FD, Eagle KA, Faxon DP, Hillis LD, Lange RA. Task force 1: training in clinical cardiology. J Am Coll Cardiol 2008;51:339–48.
6. Weyman AE, Butler A, Subhiyah R, et al. Concept, development, administration, and analysis of a certifying examination in echocardiography for physicians. J Am Soc Echocardiogr 2001;14:158–68.
7. Cahalan MK, Abel M, Goldman M, et al. American Society of Echocardiography and Society of Cardiovascular Anesthesiologists task force guidelines for training in perioperative echocardiography. Anesth Analg 2002;94: 1384–8.
8. Wackers FJ, Bateman TM. Blueprint of the certification examination in nuclear cardiology. Certification Council of Nuclear Cardiology. J Nucl Cardiol 1997;4:164–8.
9. Jacobs JE, Boxt LM, Desjardins B, Fishman EK, Larson PA, Schoepf J. ACR practice guideline for the performance and interpretation of cardiac computed tomography (CT). J Am Coll Radiol 2006;3:677–85.
10. Kramer CM, Budoff MJ, Fayad ZA, et al. ACCF/AHA 2007 clinical competence statement on vascular imaging with computed tomography and magnetic resonance. A report of the American College of Cardiology Foundation/American Heart Association/American College of Physicians Task Force on Clinical Competence and Training. J Am Coll Cardiol 2007;50:1097–114.

Key Words: certification ■ imaging ■ business.