The Fourth Invitational Wintergreen Conference took place on July 12 through 14, 1998, in Wintergreen, Virginia. As with previous conferences, attendance was by invitation only. These conferences are designed to assess the state of the art and future directions of nuclear cardiology. The conference was constructed around seven panels designed to address major issues in nuclear cardiology. These panels were Instrumentation and Quantification, New Tracers and Approaches, Risk Assessment in Chronic Disease, Risk Assessment in Acute Coronary Disease, Molecular Probes in the Future of Nuclear Imaging, Viability and Heart Failure, and Monitoring Aggressive Therapy for Coronary Artery Disease. The format of this conference was different from those conducted previously. Each panel had a chair and a co-chair and an identified membership. A writing group was configured for each panel from the panel membership. The writing groups developed specific panel reports that were distributed before the meeting and then presented briefly by either the chair or co-chair. The reports were to summarize briefly the state of the art and to make specific recommendations for the future. The presentations were designed to be relatively short so that there was ample time for broad discussion involving all participants. All initial presentations occurred on the first day of the meeting. On the second day there were breakout sessions for each panel. Panelists and invited guests from industry participated in the breakout sessions. These sessions were designed to modify the initial reports and conclusions, on the basis of the input from the initial presentation. Beginning on the evening of the second day and continuing on the following morning, there were focused final presentations by the panel chairs, with additional input from the entire participating group. After the meeting the initial reports were modified on the basis of input during the conference. Final reports then were submitted and edited. The ultimate result appears below; it is hoped that this report might be used as a blueprint for considering future developments within the field.

The following individuals participated in this conference:
Kevin C. Allman, MD
Yasuhiko Arakawa
Jacqueline Armstrong
Stephen L. Bacharach, PhD
Timothy M. Bateman, MD
Lewis C. Becker, MD
Jessica J. Bede
George A. Beller, MD
Maureen Bennett, RPh
Daniel S. Berman, PhD
Timothy M. Bateman, MD
Lewis C. Becker, MD
Jessica J. Bede
Kevin C. Allman, MD
Yasuhiko Arakawa
Jacqueline Armstrong
Stephen L. Bacharach, PhD
Timothy M. Bateman, MD
Lewis C. Becker, MD
Jessica J. Bede
George A. Beller, MD
Maureen Bennett, RPh
Daniel S. Berman, PhD
Timothy M. Bateman, MD
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Isaac Fram
Ernest V. Garcia, PhD
Guido Germano, PhD, MBA
Myron C. Gerson, MD
Raymond J. Gibbons, MD
David K. Glover, BS ME
Grant T. Gullberg, PhD
Stephen B. Haber, PhD
Gary V. Heller, MD, PhD
Harvey S. Herschman, PhD
Ami E. Iskandrian, MD
Lynne L. Johnson, MD
Renette Johnson
George Jones
Junichi Katoh
Sanjiv Kaul, MD
Michael King, PhD
Norman D. LaFrance, MD
Avijit Lahiri, MD
Jeffrey A. Leppo, MD
Jamshed Maddahi, MD
John J. Mahmarian, MD
Jim Matons
A. Iain McGhie, MD
Lonnie Mixon
Jagat Narula, MD, PhD
Tsunehiko Nishimura, MD
Adrian Nunn, PhD
Noriake Okamoto

Jerry Olszewski
Paul Ottoson
David Pendleton
Dudley J. Pennell, MD
Pierluigi Pieri, MD
Steven C. Port, MD
Bradley K. Bounds
Martin P. Sandler, MD
Heinrich R. Schelbert, MD, PhD
Markus Schwager, MD
Ronald G. Schwartz, MD
Leslee J. Shaw, PhD
Albert J. Sinusas, MD
Robert Soufer, MD
Nagara Tamaki, MD, PhD
Yasuyuki Tanigawa
James L. Tatum, MD
James E. Udelson, MD
Jean-Louis J. Vanoverschelde, MD, PhD
Marlo S. Verani, MD
Frans J. Th. Wackers, MD, PhD
Denny Watson, PhD
Arthur Weis
Daniel White
Rick White
Kim A. Williams, MD
Richard G. Williamson
Barry L. Zaret, MD
Jack A. Ziffer, MD, PhD
Quantification and computer-aided interpretation of tracer distribution

Nuclear cardiology has seen remarkable growth in the last 10 years. This growth has come almost exclusively because of an increase in the number of myocardial perfusion studies performed in the United States. In 1998 this number is reported to be four million patients imaged with this technique. This growth continues to occur even as managed care continues to penetrate health care. This health care environment dictates that, to sustain this growth and remain competitive, we need to be cost conscious. Cost in this case can be translated to the speed and accuracy of diagnosing coronary artery disease. Cost can also be regarded as the ability of a gatekeeper modality to prevent unwarranted, expensive procedures.

In the last 10 years we have also enjoyed unprecedented growth in the computer and information technology fields. Although medicine usually lags behind business, applications manufacturers of nuclear cardiology equipment are poised to take advantage of the latest computer hardware and software advances. These advances are taking place at an ever-increasing reduction in cost. These advances coupled with the managed care environment are also creating a demand for storage in databases and use of all of the clinical information available about each patient.

The scenario is that the nuclear cardiology laboratories that will continue to succeed are those that can keep costs down and at the same time provide the quickest and most accurate image interpretation. One approach to keeping costs down is to charge less per procedure but perform a high volume of procedures. The implication is that to succeed a physician has to maintain a high level of image interpretation, with an ever-increasing amount of available information per patient (and per modality) in significantly less time per interpretation compared with the past. It is clear that to attain this goal the power of computer and information technology must be exploited to assist the human expert.

Quantification of the myocardial tracer distribution. Fortunately, almost since its inception, nuclear cardiology procedures have been digital by their nature of how the myocardial images are acquired and analyzed. Pioneers in the assessment of myocardial perfusion distributions first used quantification methods as an objective method for comparing the results of one approach with another (such as comparing planar to tomographic techniques). Soon it was realized that there were some parameters that were difficult to be visually evaluated such as myocardial washout that could be quantified with computers.

Quantification in this field has had several meanings. Relative quantification such as that extracted from a count profile has been used to compare the counts in one myocardial segment with another or in the same segment from one time to another. Databased quantification techniques compare a patient’s relative tracer distribution after normalization to expected normal patterns developed from populations with low likelihood of coronary artery disease (CAD). A weakness of databased quantification approaches is the dependence of the normal pattern on the protocol used and how the patient’s anatomy compares with those of the control subjects used to develop the normal databases.

Absolute quantification, although less widespread, has also been used and consists of at least two different varieties: 1) the measurement of the absolute tracer distribution and 2) the measurement of some other cardiac parameter extracted from the tracer distribution. The measurement of the absolute tracer distribution requires that the pixel (voxel) count values are directly proportional to the true tracer distribution. This usually necessitates corrections for photon absorption, scatter, and variations in the response of the imaging system. Taken one step further, absolute quantification allows for the measurement of absolute blood flow, as is the case with the use of $13^N$-ammonia images obtained with positron emission tomography (PET). Although single photon emission computed tomography (SPECT) corrections methods have been developed and commercialized to generate the necessary correction for absolute quantification, to date no specific method is widely accepted as reliable as the PET methods. Moreover, differences between different commercial system’s implementations imply that different qualitative and quantitative results are obtained dependent on the SPECT commercial system used. Although some clinical applications have been suggested for the use of absolute quantification of flow, because of its complexity and questionable clinical benefit, it has not received widespread acceptance.

The measurement of cardiac parameters extracted from the tracer distribution is a much more clinically accepted development. Recently, electrocardiography-gated myocardial perfusion studies have been used to extract functional information. By extracting the endocardial and epicardial myocardial left ventricular (LV) boundaries functional parameters are being quantified such as ejection fraction, end-diastolic and systolic volumes, and myocardial wall thickening and motion. Total automation of the entire procedure has greatly facilitated these measurements. These same automation and analysis techniques can and are being used to measure myocardial mass, mass at risk, viable mass, transischemic dilation, and others. Although the clinical use of these measurements are quickly gaining clinical utilization, no comprehensive, large prospective trials exist documenting the robustness of the automation algorithms or the accuracy of the parameters being quantified. Moreover, the limited clinical trials available have been mostly conducted by those who developed the techniques.