NCRP

Wednesday, November 6, 2002

8:00 a.m. **Symposium Objectives and Background Information**
Fred A. Mettler, Jr., *Program Committee Chair*

8:05 a.m. **Introduction**
Edward V. Staab
National Cancer Institute

Radiation Phenomena

Fred A. Mettler, Jr., *Session Chair*
University of New Mexico, School of Medicine

8:15 a.m. **Limiting Radiation Exposure Dose in Computed Tomography: Rising to the Challenge**
Lee F. Rogers
American Journal of Roentgenology

Recent revelations concerning the potential harmful effects of exposure doses commonly utilized in computed tomography (CT) of children have received notice in the national media and lay press and have caused quite a stir in our profession.

Why were we unaware of the high radiation exposure to patients undergoing CT? Well, maybe we assumed that such an exposure was necessary. Or we may have thought that because CT accounts for only a small percentage of all radiologic examinations, we did not need to be concerned about the exposure dose. And we may have thought that those patients requiring CT were truly sick or desperately ill; and therefore, the risk of such exposure was warranted.

The demand for CT is increasing, not decreasing. And just as certain, not all the patients are desperately ill. So the time has come for us to lower radiation exposure dose in CT for all patients.

Why is radiation exposure in CT so high? Probably because we radiologists and physicists have not insisted that patient exposure dose be lowered. It is time to do so.

CT exposure dose is an area ripe for research. We must devise methods that result in lower exposure dose and yet maintain satisfactory image quality without compromising diagnostic content.

8:40 a.m. **X-Ray Dose in Medicine Overview**

Fred A. Mettler, Jr.
University of New Mexico, School of Medicine

There are over 250 million x-ray examinations done in the United States each year. Medical exposure constitutes the largest source of exposure to the population other than natural background. CT now represents the largest single source of medical exposure and is rapidly increasing. In some university departments CT scanning has grown to account for about 15 percent of the total examinations but now accounts for about 70 percent of the dose delivered.

9:00 a.m. **Mechanisms, Concepts, and Dose Response in Radiation Carcinogenesis**

Eric J. Hall
Columbia University

Cancer is considered to be a stochastic effect. There are four characteristics of a stochastic effect:

1. The severity of the effect does not depend on dose.
2. The probability of the effect occurring is dose dependent.
3. There is no threshold in dose.
4. A stochastic effect is a result of damage to one or a number of cells.

The first two points above are experimental and epidemiological observations and beyond question.

Points three and four are linked and based on an assumption. However, most cancers appear to be clonal in origin and current thoughts about basic mechanisms of carciogenesis are commensurate with the idea of damage to one (or a few) cells. The assumption is therefore reasonable and consistent with current knowledge.

The available data for solid tumors from the atomic-bomb survivors is consistent with linearity down to a dose of 0.2 Gy and perhaps to 0.05 Gy. A threshold in the milligray region cannot be ruled out, but there is no sign of a threshold for doses of the order of a few tens of milligray. In

NCRP

summary, individuals exposed 50 y ago to doses comparable to those associated with helical computed tomography (CT) today, show a small, but statistically significant excess incidence of cancer. No theories, assumptions, extrapolations or models are needed. The atomic-bomb data have now matured to the point where it is clear that young children are at least 10 times more sensitive to the radiation induced malignancies than mature adults. This raises special concern about the use of helical CT in pediatric patients.

9:25 a.m. **Economic and Clinical Drivers to the Growth in Computed Tomography in the United States: Parallels and Lessons' from the Pharmaceutical Industry**

Howard P. Forman
Yale University School of Medicine

In a competitive market place, increasing computed tomography (CT) utilization would be explained by a decrease in the marginal cost of CT services. Still, this does not explain all of the changes in "demand" for such services. Health economists have long argued that supply-induced demand may influence this market, without necessarily being of benefit to society.This talk will (1) explore the areas where competitive assumptions fail, and (2) will offer comparisons with the prescription drug industry in learning lessons and avoiding pitfalls in the continued growth of this important technology.

9:50 a.m. **Radiation Dose in Computed Tomography: Definitions and Typical Values of Current Dose Descriptors**

Cynthia H. McCollough
Mayo Clinic

The rapid evolution of computed tomography (CT) technology and the resultant explosion in new clinical applications, combined with the complexity of dose descriptor definitions and the significance of CT dose, have created a compelling need to teach, understand and use detailed information regarding CT dose. To do this, however, requires precise definitions of the various dose descriptors that are consistently and universally applied. This summary of CT dose descriptors will provide the following:

- a description of fundamental CT dose concepts and quantities,
- an overview of dose measurement techniques and terminology, and
- typical values for various CT dose descriptors.

10:05 a.m. **Nationwide Evaluation of X–Ray Trends 2000-2001 Survey of Patient Radiation Exposure from Computed Tomographic Examinations in the United States**

Stanley H. Stern
U. S. Food and Drug Administration

To estimate patient radiation dose from computed tomography (CT) examinations, specially trained inspectors from 39 states surveyed 263 CT facilities across the United States in randomly selected samples proportional to state populations. Surveyors measured x-ray exposure (air kerma) centrally and peripherally in a standard head dosimetry phantom as well as free-in-air on the scanner axis of rotation. Facilities provided metrics of patient irradiation technique, estimated frequencies of various head and body examinations, and gave quality-assurance information. Our most important observation is that on average for any given examination of the head or body, effective doses (*E*) are significantly smaller with helical-scanning techniques than with axial-scanning techniques. For the most frequent routine examinations of adult patients, average *E* is 2 mSv (SD = 1 mSv, n = 45) for head exams (axial-scanning), 12 mSv (SD = 7 mSv, n = 21) for abdomen-pelvis exams, 6 mSv (SD = 4 mSv, n = 21) for chest exams, 6 mSv (SD = 4 mSv, n = 19) for abdomen exams, 15 mSv (SD = 10 mSv, n = 18) for chest-abdomen-pelvis exams, and 6 mSv (SD = 4 mSv, n = 15) for pelvis exams, where body exams are done with helical scanning. From facility reports of examination workload, we estimate that there were 58 ± 9 million CT examinations and procedures in the United States during the survey year 2000 to 2001. The preliminary findings suggest that advances in CT scanner technology since the previous survey in 1990 have been rapidly adopted in clinical practice and have thereby significantly affected population dose.

10:20 a.m. **Discussion**

10:30 a.m. **Break**

Computed Tomography Imaging Parameters

Thomas L. Slovis, *Session Chair*
Wayne State University

10:50 a.m. **Trade-Offs in Computed Tomography Image Quality and Radiation Dose**

Michael F. McNitt-Gray
University of California, Los Angeles

There are several mechanisms that can be used to reduce radiation dose in computed tomography (CT) exams. However, each of these mechanisms has implications for the diagnostic image quality of the exam. In this presentation, the various mechanisms to reduce radiation dose will be described along with their impact on image quality. Specifically, the implications of varying milliampere seconds, pitch or tablespeed or for axial imaging, the table increment, slice thickness, kilovolt potential, patient (or phantom) size, and dose reduction options (such as varying tube current during exposure) will be described for both radiation dose and diagnostic image quality. In addition to these direct effects, this presentation will describe possible *indirect* effects that both collimation and reconstruction algorithm *may* have on radiation dose and image quality when compensatory actions are taken to overcome increased noise levels. Finally, this presentation will emphasize that the trade-offs between radiation dose and image quality are task dependent; this will be illustrated with examples from selected diagnostic imaging exams.

11:07 a.m. **Clinical Application of Adult Computed Tomography Scanning**

Joseph T. Ferrucci
Boston Medical Center

Modern medical and surgical practice is heavily dependent on computed tomography (CT) for medical and surgical decision making. The volume of CT scans performed in the

United States has approximately doubled every 5 y and shows every sign of continuing that trend.

The growth of CT scanning as a basis for modern medical practice is one of revolution and evolution. Three successive revolutions each a decade apart, marked the development of CT as follows:

> Decade #1, 1970s: Introduction of image display as a cross-sectional representation combined with extraordinary soft tissue discrimination, using CT attentuation Hounsfield value, permitted differentiation of fat, water, and solid tissues.
>
> Decade #2, 1980s: Continuous refinements in CT detector technology leading to the current multi-detector systems. These have allowed faster scanning speeds and greater patient volume coverage, but do produce large image data sets.
>
> Decade #3, 1990s: Access to powerful independent computer workstations. These permit immediate soft copy viewing and novel image processing techniques. Image manipulation is possible even though the patient has left the scanner.

The evolution of CT as a clinical tool can also be usefully charted by decades. In the 1970s, early CT adopters focused on applications in the head and nervous system which revolutionized the practice of neurology and neurosurgery. In the 1980s abdominal diagnoses became the major focus. CT scans were also used to facilitate interventional treatments by guiding placement of various needles, probes and catheters into the body cavities. In the 1990s disorders of the chest, the acutely traumatized patient, and acute abdominal emergencies became the focus. In the present 2000 decade, new techniques and nitch applications have evolved including virtual endoscopy, CT angiography, fusion imaging, especially PET/CT and CT screening.

The major overall advantage of CT is that it produces the diagnosis non-invasively and avoids traditional surgical exploration and other invasive testing. More leisurely and detailed pre-procedure and or pre-operative planning is possible. The rate of negative exploratory findings is also decreased. Lowered costs of hospitalization and medical care result.

It is of historical note to recall that there were considerable early obstacles placed in the introduction of CT scanning, especially in the 1970s where cost concerns, and regulatory restrictions especially by states, such as Massachusetts and Maryland, led to regulatory moratoria and bureaucratic procedures for determination of need greatly limiting the public's access to CT services.

Examples of new diagnoses and imaging findings with selected case illustrations will be offered.

11:24 a.m. **A Primer of Clinical and Economic Considerations for Computed Tomography Screening**

Bruce J. Hillman
University of Virginia

Computed tomography (CT) screening is emerging contemporaneously—indeed, may be a symptom of—with increasing consumerism in health care. The United States population is better informed than previously about the health technology possibilities available to them, increasingly they will be held more responsible for their cost, and are willing to spend a share of their discretionary income on health care innovations that they believe will increase the length and quality of their lives. Proponents of CT screening tout the possibility of finding serious abnormalities earlier when they say they may be more curable and argue that our society honors the rights of individuals to decide how to spend their money. Others say that there is no proven benefit to CT screening and that population-based screening bears serious societal consequences in downstream costs.

11:41 a.m. **Clinical Applications of Computed Tomography: What Children Have Taught Us**

Donald P. Frush
Duke University Medical Center

Computed tomography (CT) is an integral and increasingly utilized component of current healthcare. The technology has been rapidly evolving, particularly due to multidetector capabilities. This technology is also complex and contemporary CT in children is challenging. There are many ways to perform pediatric CT, some of which result in an excess amount of radiation. One of the most significant issues recently with CT has been radiation exposure. New data indicates that there is a significant increased risk of fatal cancer resulting from “low dose” radiation, such as in CT. Moreover, recent studies have demonstrated that children are receiving radiation doses which are too high, placing them at even greater risk. This is a mandate for appropriate CT techniques. Discussion will briefly review the importance of CT, trends in use, complexity of the technology, and parameters which affect CT radiation dose, and will emphasize strategies for which radiation dose can be reduced in children. While this discussion will focus on pediatric CT, principles discussed are lessons that apply to adults as well.

11:58 p.m. **Multi-Slice Computed Tomography. Why is the Radiation Burden Typically Higher and Does It Matter?**

Peter H. Dawson
University College, London Hospitals

The advent of spiral/helical computed tomography (CT) and, latterly, multi-slice spiral/helical CT have given a new lease on life to an imaging modality hitherto in relative technological stagnation. However, factors intrinsic to the design of these systems, the manner in which they are frequently used to their full potential, and the development of whole new applications has led to anxieties in Europe and the United States that a “high dose” examination has become an even higher dose examination. It appears to be an article of faith, based on a “linear, no-threshold” principle, that patient doses that are frequently associated with modern CT are potentially dangerous. The evidence for this view is by no means strong and there is a respectable and growing body of evidence for a contrary view. This subject will be reviewed.

12:15 p.m. **The Risks and Benefits of Diagnostic Computed Tomography Scan Studies in Children: A Pediatric Perspective**

Robert L. Brent
duPont Hospital for Children

Recent estimates of the exposure to children from computed tomography (CT) scans indicates that the exposures are higher than from conventional radiographic studies. The increased risks associated with the increased expo-sure from CT scans have raised concerns and stimulated discussion. And that is the purpose of this workshop. The cost and benefits also have to be included in any overall evaluation of the use of CT scans in children. Risk estimates using the linear-nonthreshold hypothesis have been utilized to estimate the incidence of cancer in children exposed to CT scans. Utilization of this hypothesis is appropriate for establishing maximum permissible exposures for genotoxic environmental agents, including ionizing radiation, in order to protect the public. The hypothesis may not be appropriate for accurately predicating the incidence of cancer in all CT-exposed children because of the impact of (1) partial versus whole-body irradiation, (2) the extent of immunological suppression, and (3) protraction of the exposure. Other populations of children who have been exposed to radiation and whose incidence of cancer has been studied will be presented. Finally, the dramatic impact of the use of CT scans in clinical pediatric practice saves lives and improves diagnostic accuracy. Therefore, it is crucial that a scholarly evaluation of the risks and benefits be an intricate part of our discussion.

12:30 p.m. **Discussion**

12:45 p.m. **Lunch**

Technical Problems, Solutions, Range of Equipment

James A. Brink, *Session Chair*
Yale-New Haven Hospital

1:45 p.m. **Technical Mechanisms for Dose Reduction in Computed Tomography**

Cynthia H. McCollough
Mayo Clinic

The implementation of new technology in clinical computed tomography (CT) systems has in the past, and will in the future, reduce the radiation dose required to create an image of appropriate diagnostic quality. Current technical initiatives by researchers and manufacturers aimed at dose reduction can likely be placed into one of the following general categories:

- x-ray beam filtration
- x-ray beam collimation

- x-ray tube current (mA) modulation
- detection system efficiency
- noise reduction algorithms
- automatic exposure control (AEC)

The last item, AEC, is analogous to photo-timing in radiography or automatic brightness control in fluoroscopy and seeks to deliver the minimum dose required to achieve a specified noise level. Current use of manual technique charts, based on some measure of patient attenuation (width, weight, height) could be replaced by AEC systems that monitor detector signal and modulate milliamperes according to the desired noise level in the final image. The radiation dose from CT will become optimized (for current technology systems) only when CT AEC, using x, y and z mA modulation, becomes a reality.

Manufacturer Panel

2:00 p.m. **Computed Tomography Dose Reductions**
Stanley Fox
General Electric

General Electric is taking steps to reduce the x-ray dose required to acquire diagnostic computed tomography (CT) studies.

- Color coding for kids™ extends the use of a length and weight system designed to reduce errors in the effective dose by the selection of the patient appropriate CT protocol.
- Automatic exposure control that shapes the x-ray exposures to patient size and shape. The physician selects the required image quality and the system applies the appropriate technique.
- Increasing the number of detector rows for thin slices—with the advent of 16 slice CT scanners, the Z axis detector efficiency for 1.25 and 6.25 mm slices has increased to around 90 and 80 percent, respectively.

2:14 p.m. Bernhard Schmidt
Diplomat-Physicians University, Siemens CTC

NCRP

2:28 p.m. **Estimating Patient Dose for Philips Mx8000 Multi-Slice Scanners**

Hugh T. Morgan
Philips Medical Systems

Computed tomography (CT) system manufacturers have for many years been required by the U.S. Food and Drug Administration to provide measured CTDI (Computed Tomography Dose Index) dose information about their scanners and have more recently implemented a display of dose ($CTDI_{VOL}$) on the system's operating consoles in accordance with the IEC 60601-2-44 standard. This useful CT scanner dose information provides an average reference dose to CTDI head and body phantoms for any selected head or body protocol. However, the actual dose delivered to patients is often times not well represented by the CTDI and $CTDI_{VOL}$ values given. The relationship between the provided CTDI indices and estimated patient dose is investigated for the Philips Mx8000 Dose-Right for age and weight specific protocols. It is concluded that a better measure of actual patient dose is needed for modern multi-slice scanners.

2:42 p.m. **Manufacturing Influences on Computed Tomography Dose**

Bryan R. Westerman
Toshiba America Medical Systems

Toshiba is keenly aware of the manufacturer's responsibility in keeping patient dose from computed tomography (CT) as low as possible, consistent with appropriate image quality. Design and alignment of the beam optical path plays an important role in terms of both radiation dose and performance. Filtration and collimation have been carefully designed to reach the best combination. The effect of tube focal spot motion can have considerable dose implications, as reflected by the difference in multi- and single-slice scanners, Computed Tomography Dose Index (CTDI), and this has also been addressed in Toshiba systems.

The relatively recent availability of automatic tube current modulation in CT has been of major significance. This is unquestionably the most important development in patient dose reduction but, as implemented by Toshiba, the operator retains control of image quality.

Finally, software which reminds operators of the dose consequences of technique selection, and which may lead to better protocol choices, can be very helpful. Application training from the manufacturer is also important in reinforcing operator awareness of patient dose.

2:56 p.m. **Discussion**

3:10 p.m. **Break**

Opportunities for Dose Reduction in Computed Tomography

Cynthia H. McCollough, *Session Chair*
Mayo Clinic

3:30 p.m. **The American College of Radiology Computed Tomography Accreditation Program**

James A. Brink
Yale-New Haven Hospital

The American College of Radiology's Computed Tomography (CT) Accreditation Program will evaluate the following primary determinants of clinical image quality and, ultimately, the quality of patient care:

- qualifications of personnel
- equipment performance
- clinical images and exam protocols
- reference doses for adult head and abdomen, and pediatric abdomen exams

With regard to the evaluation of reference doses, the accreditation process will identify situations where the level of patient dose (for the specified exams) is unusually high. If a dose exceeds the respective reference value, the site will be required to submit documentation detailing its investigation, corrective action if necessary, or justification of the higher dose level. The dose data submitted by facilities will be analyzed in correlation with image quality and used to refine reference values. This activity will be part of the ongoing work within the radiology community to define appropriate dose levels (image noise levels) for various CT applications.

User Education

Jill Lipoti, *Session Chair*
New Jersey Department of Environmental Protection

3:45 p.m. **Radiologists**
Lee F. Rogers
American Journal of Roentgenology

4:00 p.m. **Technicians: Educational Issues for Computed Tomography Technologists**
Anne M. Edwards
St. Luke's Methodist Hospital

The primary responsibility of any radiologic technologist is to obtain the best image quality while delivering the smallest radiation dose possible. This responsibility weighs particularly heavy on computed tomography (CT) technologists, as CT equipment produces radiation doses that are higher than those of other x-ray examinations. CT technologists directly control technical factors such as x-ray tube voltage, the tube current, and rotation time, each of which affects the dose to the patient. Despite these demands, most CT technologists working in the United States today have received little or no formal education in CT. The majority were educated and certified as radiographers and then trained "on the job" to operate CT equipment. CT has evolved and has many new applications, including the use of hybrid PET/CT examinations and for real-time visualization during interventional procedures. The education of CT technologists must evolve as well. The American Society of Radiologic Technologists is considering the development of individualized training modules for initial education in CT. Comprised of both didactic and clinical components the modules would focus on patient assessment, radiation physics, radiation protection, examination protocols, and other issues that promote safe, quality patient care.

4:15 p.m. **Physicists**
Michael F. McNitt-Gray
University of California, Los Angeles

Regulatory Approaches

4:30 p.m. **States: State Regulatory and Non-Regulatory Options to Reduce Patient Dose**

Jill Lipoti
New Jersey Department of Environmental Protection

States can serve as innovators in dose reduction strategies for computed tomography (CT) by testing different mechanisms to encourage or require dose reduction and documenting their relative effectiveness. This paper will present a range of options that state regulators may consider, including regulatory as well as non-regulatory strategies. The regulatory requirements can be complementary to the requirements set by the U.S. Food and Drug Administration/Center for Devices and Radiological Health, that can only regulate new equipment. States can phase in requirements for existing CT equipment. Regulatory requirements can address individuals by setting qualifications, including training and education, experience, and continuing education. State regulations can address record keeping, including documentation of technique factors based on patient size, and documentation of radiation exposure in patient records. Requirements can be set for procedures, such as acceptance testing, calibration, and quality assurance testing at prescribed frequencies. States can require all CT scans to be specifically ordered and authorized by a physician after a medical consultation. Boards of medical examiners can set criteria for CT screening to make it unavailable to asymptomatic individuals.

State regulators can work in conjunction with non-regulatory bodies such as the Joint Commission on Accreditation of Healthcare Organizations, insurance companies, and professional societies. Through these avenues, the state regulators can encourage alternative studies with magnetic resonance imaging or ultrasound, if appropriate, with the goal of minimizing unnecessary CT studies. Non-regulatory options include public information campaigns including statements by advisory boards regarding appropriate criteria for selecting CT patients.

States also serve an important function in collecting data about registered CT machines, CT exposures, and workload so that estimates of the number of procedures and population dose can be made.

The Conference of Radiation Control Program Directors, Inc. (CRCPD) is an organization comprised of representatives from the radiation control programs of the states. CRCPD provides a forum for centralized communication on radiation protection matters between the states and the federal government, and among the individual states. In May 2002, CRCPD passed a resolution on CT scanning which had unanimous support from all of the states. CRCPD expects to publish a patient exposure and dose guide in 2002 that will be a valuable tool in evaluating the effectiveness of minimizing patient dose during routine diagnostic imaging, and includes recommendations for CT.

4:45 p.m. **Federal: The Role of Federal Agencies in Optimizing Radiation Dose from Computed Tomography**

Thomas B. Shope, Jr.
U.S. Food and Drug Administration

This presentation will address the roles that various federal agencies currently have or might undertake to foster the optimum use of radiation exposure associated with the use of x-ray computed tomography (CT). The meaning of optimizing radiation dose in this context is the use of the minimum amount of radiation exposure to the patient that is consistent with obtaining the necessary diagnostic or clinical information to render effective medical care. One of the most effective means of reducing dose from CT would be actions to assure that only medically warranted examinations are performed. This is an example of the justification principle in radiation protection. Other activities to reduce dose involve education of physicians and others regarding the doses typically required for various CT procedures and providing benchmarks against which individual facilities may compare their practices. These activities and the efforts of the CT system manufacturers to provide systems which result in reduced patient radiation doses are examples of the optimization principle in radiation protection. The roles and current activities of federal agencies related to this subject will be briefly reviewed. These include primarily the regulatory and public health promotion activities of the U.S. Food and Drug Administration and the research and health promotion activities of the National Institutes of Health. Possible activities for several other federal agencies will be explored. The need for nationally-representative data on the extent of CT usage and the patient radiation exposures from the various types of CT procedures will be described and a suggestion for an approach to develop such data will be proposed for consideration.

5:00 p.m. **Risk Communication**
Otha W. Linton
International Society on Radiology

Despite efforts to make a scientific discipline of risk assessment, the larger part of any risk analysis and action program is the art of communicating risk concepts to those at risk so that they can make decisions for themselves. Scientific concepts, including degrees of certainty, size of error bars, and other appropriate qualifications, often translate poorly into headlines or newscaster voice bites.The challenge for the person or agency asking acceptance of risk is to find terms and concepts which are accurate and yet understandable and acceptable to the audiences involved.

5:15 p.m. **Discussion**

NCRP

Thursday, November 7, 2002

8:00 a.m. Working Sessions – Moderators

The working sessions are intended to allow conference participants an opportunity to contribute to a series of recommendations to be made to the conference sponsors and to other public and scientific organizations involved with medical imaging and radiation protection. Because of the brevity of comment periods earlier in the program, these sessions will allow more extensive input from participants and the organizations they represent.

Four sessions are planned, each, as noted, to prepare recommendations in the area indicated by its title. Recommendations from the four sessions will be brought to the closing plenary session for further discussion and possible improvement. These recommendations will be included in the report from the meeting.

Education

James A. Brink
Yale-New Haven Hospital

Anne M. Edwards
St. Luke's Methodist Hospital

Equipment – ALARA

Cynthia H. McCollough
Mayo Clinic

Michael F. McNitt-Gray
University of California, Los Angeles

Policy Regulation

Jill Lipoti
New Jersey Department of Environmental Protection

Howard P. Forman
Yale University School of Medicine

Clinical
Lee F. Rogers
American Journal of Roentgenology

Donald P. Frush
Duke University Medical Center

10:00 a.m. **Break**

10:30 a.m. **Plenary – Moderator**
Fred A. Mettler, Jr.
University of New Mexico–School of Medicine

Education

Equipment–ALARA

Policy Regulation

Clinical

11:30 a.m. **Summary**
Fred A. Mettler, Jr., *Program Committee Chair*
University of New Mexico, School of Medicine

11:40 a.m. **Closing Remarks**
Thomas S. Tenforde, *President*
National Council on Radiation Protection and Measurements

11:50 a.m. **Adjournment**

NCRP

The Program Committee

Fred A. Mettler, Jr., *Chair*
University of New Mexico, School of Medicine

James A. Brink
Yale-New Haven Hospital

Stanley Fox
General Electric

Donald P. Frush
Duke University Medical Center

Walter Huda
New York State University

Otha W. Linton
International Society on Radiology

Jill Lipoti
New Jersey Department of Environmental Protection

Thomas B. Shope, Jr.
U.S. Food and Drug Administration

Thomas L. Slovis
Wayne State University

Edward V. Staab
National Cancer Institute

Registration

Wednesday, November 6, 2002
7:00 a.m. - 5:00 p.m.

There is no registration fee.

2003 Annual Meeting

"Radiation Protection at the Beginning of the 21st Century – A Look Forward"
April 9-10, 2003 in Arlington, Virginia

Financial support for this symposium from the Diagnostic Imaging Branch of the National Cancer Institute is gratefully acknowledged.