In combined PET/CT and SPECT/CT imaging, the functional data provided by FDG and other radiopharmaceuticals merged with the simultaneously acquired CT images empirically increases overall diagnostic accuracy over conventional PET, SPECT or CT alone.

The clinical applications for hybrid imaging have been predominantly in staging various malignancies. In most departments, the CT component of the PET/CT or SPECT/CT does not utilize contrast enhancement. However, contrast enhancement, both oral and intravenous, has shown clinical usefulness in diagnostic CT for decades. The questions now being raised for hybrid imaging are: (1) how much intravenous contrast is necessary to produce diagnostic-quality images, and; (2) how can contrast CT be incorporated into PET or SPECT without compromising the quality and accuracy of the image data?

In stand-alone CT imaging, contrast agents are applied to differentiate anatomic structures, improve lesion localization and refine lesion characterization. CT contrast agents in PET/CT and SPECT/CT imaging improve accuracy in anatomic localization of pathology and compliment the functional assessment of lesion detection and characterization (malignant versus benign) by the radionuclide used in combined imaging.

The decision matrix for performing a PET/CT or SPECT/CT can be complicated and includes: (1) contrast enhancement...
Focus on the Fellow: Carol Bonanno, CNMT, ASCP, FSNMTS

By Mary Beth Farrell, MS, CNMT, NCT, RT(N)

Despite having worked in nuclear medicine since bell-bottoms and the Beatles were all the rage, Carol Bonanno hasn’t lost her passion. “I just love nuclear medicine,” she professes, “and the people in it.”

Of course, when Carol entered the field back in 1968, the pathway was very different than it is today. In college, she was in the medical laboratory technologist program, and nuclear medicine was part of the department where she trained. “The radiologists didn’t think nuclear medicine was going to go anywhere, so the pathologists were reading the nuclear medicine scans,” she recalls.

Carol was first certified by the American Society of Clinical Pathology (ASCP) and later grandfathered in as a certified nuclear medicine technologist by the NMTCB.

The hospital where she initially worked was actually quite advanced for its time. It had the third Nuclear Chicago camera produced—a camera with only 19 photomultiplier tubes—and a rectilinear scanner.

Technologists rotated between scanning and working in the radioimmunoassay lab. “We did ferritins, CEAs, and digoxin levels,” she laughs. “Tests most technologists today have never even heard of.”

For the past 20 years, she has labored on the industry side of the business. She has sold radiopharmaceuticals and worked as a clinical research associate in oncology, a sales trainer, a regional manager, and marketer. Commenting on the industry, she explains, “I like business because I don’t mind the reports, I like the competition, and I enjoy the people I work with.”

As for the clinical side of nuclear medicine, Carol insists, “I don’t miss it because I still get to spend a lot of time in the departments and with patients. And I get to meet a lot of new people, which is my favorite part.”

Currently she works for Bracco Diagnostics as a technical associate, calling on cardiac and PET centers. Her job with Bracco has allowed her to travel quite a bit—which she enjoys—and she plans to continue traveling when she eventually retires. “Traveling to new places and seeing new things has been fun,” she said. “I’m very curious.”

On the societal level, Carol could be considered the matriarch of the Southeast and Florida chapters, having helped to found both and having served as president of the Florida Chapter.

Asked how she has maintained her enthusiasm all these years, she explains, “I never thought about nuclear medicine as just a job. It’s been a career with many opportunities and places to go.”

Carol Bonanno

Erratum

On page 6 of the July/August issue of Uptake, the photo caption at the bottom left indicated that William Hubble, MA, CNMT, RT(R.N), was being presented with an Outstanding Educator award. In fact he was receiving a plaque in honor of his new status as a fellow of SNMTS. Hubble and Howard Teng, CNMT, were both awarded fellow status at the 2007 SNM Annual Meeting. Kathleen Murphy, CNMT, NCT, RT(N), and Mary Ann (Mimi) Owen, MHE, RT(N), were named Outstanding Educators. See Technologists News, page 21A in the September issue of the Journal of Nuclear Medicine Technology, for more on 2007 SNMTS awards and other news from the SNM Annual Meeting.
Continuing Education Credits are Just a Keystroke Away

By Kathy Thomas, MHA, CNMT, FSNMT, Chair, Continuing Education Committee, and Jannine Henderson, Senior Manager of Continuing Education, SNM

Neeed continuing education credits but lack the time or resources to attend state, regional, or national educational programs? Don't have time to study for an examination demonstrating a new skill set in CT, MRI, NCT, or PET that could provide those much-needed credits for licensure or certification renewal?

Not to worry! More than 20 free continuing education hours are only a keystroke away at www.snm.org/education, with an additional 90 continuing education hours available for purchase in a wide variety of topics and skill levels.

Free Online Exams

Continuing education credits from articles published in JNM or JNMT require the reader to log on to the SNM Web site to complete a brief quiz related to the article. Obtain a passing score of 80% and earn up to 7 hours for JNMT and 13 hours for JNM. If you do not have access to the Internet, the JNMT quiz can be faxed to the SNM office for a nominal cost of $5.

On-Line Lectures Available for Sale

Each online activity includes a PowerPoint presentation and an online quiz requiring an 80% pass rate for credit. Upon successful completion, CE credits are immediately posted to your VOICE transcript. Available programs include:

- 2005 Annual Meeting Webcast: 21 courses available
- Technology Advanced Oncologic PET and PET/CT series: 8 courses available
- Technology Advanced Cardiac Imaging series
- Basic Science of Nuclear Medicine series: 22 presentations available
- Physician Cardiology series: 7 courses available
- Physician Oncology series: 5 courses available
- Molecular Imaging series: 9 courses available
- Lifelong Learning and Self-Assessment Program (LLSAP): 24 modules available
- PET/CT Cases: Available in 50-case units.
- Diagnostic CT Cases: Available in 50-case units
- 2006 Annual Meeting DVD: 30 VOICE-approved continuing education hours including:
  - Sixteen CE sessions
  - Opening plenary session
  - Cassen Lectureship
  - Two Basic Science summary sessions
  - Dr. Henry Wagner's Highlights Lecture

Acquiring continuing education credits does not have to be expensive or time consuming. Technologists can acquire credits in the comfort of their homes at times that are convenient to them. For additional information, contact Jannine Henderson in the Continuing Education Department at jhenderson@snm.org or Kathy Thomas at kstomas0412@msn.com.

Save the Date!

SNM Mid-Winter Educational Symposium
February 14–17, 2008
Hyatt Regency
Newport Beach, CA

The Technologist Section continuing education program at the 2008 SNM Mid-Winter Educational Symposium will feature The Business of Nuclear Medicine from 2 to 5 pm on Saturday, February 16, and The Science of Nuclear Medicine from 10 am to 1 pm on Sunday, February 17.
versus no contrast enhancement; (2) contrast enhancement before, after, or simultaneously with PET or SPECT imaging; (3) identification of appropriate clinical indications for contrast enhancement; and (4) type and volume of contrast to be used.

Unfortunately, accepted contrast protocols for hybrid imaging are still in the early stages of development. For now, optimization of imaging protocols is at the discretion of the nuclear medicine physician and/or radiologist. In this context the imaging community must determine the role and application of contrast-enhanced CT when combined with either PET or SPECT.

Oral Contrast in Hybrid Imaging

Use of oral contrast can lead to attenuation overcorrection artifacts. Several potential solutions have been proposed to deal with the effects of contrast agents on PET attenuation correction in PET/CT or SPECT/CT. One simple way to avoid contrast-induced artifacts associated with positive oral CT contrast agents is the use of a negative oral contrast agent. These water-based contrast agents assure differentiation of bowel loops from surrounding structures by distending the bowel. But unlike iodine or barium-based traditional positive contrasts, they do not increase CT attenuation and thus do not lead to artifacts or PET tracer quantification inaccuracies. To avoid physiological absorption of the water in the gastrointestinal tract, different substances may be added. A negative oral CT contrast agent is usually a combination of water, 2.5% mannitol, and 0.2% locust bean gum (LBG). Mannitol increases bowel distension based on its osmotic properties and LBG avoids intestinal water absorption using a gelling action.

Typical preparation and protocol for a negative contrast agent: two liters of water containing 0.2% LBG and 2.5% mannitol. The first 1.8L of mannitol-LBG should be given orally at a constant rate over 60 minutes. The final 200 ml should be ingested to distend the stomach immediately before the patient is transferred onto the PET/CT table. The choice of concentration for mannitol-LBG is based on results of previous studies to evaluate the two components for small-bowel scanning with magnetic resonance imaging.

Gastroview, a traditional positive contrast agent, can also be used in PET/CT and SPECT/CT. This oral contrast consists of a mixture of 15 ml Gastroview in 24 oz of water given orally at time of FDG injection, followed by another 15 ml of Gastroview in 24 oz of water at 30 minutes after radiotracer administration, followed by 16 oz of water only at the time of scan initiation. The last volume of water is given to dilute stomach contrast to decrease CT-based attenuation correction artifacts. Barium will most likely produce the worst CT-based attenuation correction artifacts compared to water-based contrast or iodinated contrast and should generally be avoided.

Intravenous Contrast

In CT-based attenuation correction, attenuation of the PET photon is increased in the presence of positive contrast agents including iodinated intravenous contrast. The resulting over-estimation of the attenuation properties of intensely contrast-enhanced structures may lead to image artifacts on the attenuation-corrected image sets. These artifacts are usually well correlated with elevated Hounsfield units (HU) on CT images and appear as areas of apparently increased glucose metabolism on co-registered PET images. Because artifacts are found only in areas of high contrast concentrations, in the hands of an experienced reader they may not cause interpretation problems in the clinical setting. Still, there are different protocols that can be used to optimize the results.

Protocol 1: Perform the diagnostic CT with ionic contrast following the PET or SPECT image. This protocol eliminates potential artifacts but will result in increased radiation exposure to the patient. A dose of 120 ml of intravenous contrast containing 200–350 mg of iodine per ml can be administered for vascular and parenchymal assessment.

Protocol 2: Perform the diagnostic CT with nonionic contrast with lower osmolality and viscosity simultaneously with the PET or SPECT image. The contrast phase satisfies the
Every day, thousands of people undergo procedures in which iodinated contrast is injected into their arteries, veins, or other places in the body to delineate them from surrounding structures. Very few experience any lasting adverse effects. Still, it is important to be aware that iodinated contrast media have effects beyond simply providing radiopacity for imaging. The FDA classifies iodinated contrast media as drugs. No contrast medium is completely safe in all situations, at all doses, in all patients.

There are important differences between iodinated contrast media in terms of their toxicities and likelihood of adverse events. Nonionic media such as iodixanol, iohexol, iopamidol, iopromide, ioversol,ioxaglate, and ioxilan are generally safer and better tolerated than high osmolar contrast media (diatrizoate, iothalamate). There have been great advances in contrast media efficacy and safety since their discovery in the 1920s.

Why iodine? The chemical properties of iodine make it uniquely suitable:

- Iodine blocks x-rays more efficiently than lead and has lower toxicity than lead or other metals.
- Iodine can be formulated to be soluble in water/body fluids; otherwise it would cause emboli.
- Iodine can be formulated to be biologically inactive, thereby minimizing interference with cellular functions.

Myth: Nonionic contrast does not contain iodine.
False. Non-ionic refers not to the element iodine but rather to ions. Here is the difference:

An ion is an atom with a positive or negative electric charge, often occurring as salts, making them easily dissolvable in water. Ionic contrast is composed of a negatively charged radiopaque ion (the anion) and a positively charged ion such as sodium or meglumine (the cation). When injected into the body, the ionic contrast dissociates (dissolves) into cation and anion states that interact with ions in the body such as sodium and calcium. This may disturb normal physiological processes, causing cardiac arrhythmias, disturbances in blood pressure, allergic reactions, and injection site discomfort.

Nonionic contrast is a tri-iodinated molecule; the cation is eliminated. This enables the molecule to stay intact and not dissociate in solution. Nonionic contrast contains iodine but does not carry an electric charge. By combining three iodine atoms in a single molecule, the density of iodine atoms is increased, making it possible to achieve adequate radiopacity at smaller doses.

Does Osmolality Matter?
Osmolality describes the concentration of particles in a solution. When a contrast medium whose osmolality is higher than that of blood is administered intravascularly, fluid is drawn from body tissues into the bloodstream. Cells are highly sensitive to the osmolality of surrounding fluids.

- Hyperosmolarity: Cells that are bathed in hyperosmolar/hypertonic extracellular fluid will suffer a loss of water, which may result in cell damage or death. Tissues or spaces containing hyperosmolar fluid will have water drawn into them.
- Hypoosmolarity: Hypoosmolar liquid will cause some cells to swell and burst if it is injected intravascularly.
- Isosmolarity: The osmolality matches that of body fluids.

Nonionic contrast media, because they do not dissociate in solution, produce roughly half the number of particles in solution for a given concentration of iodine.

In clinical use, consider the following:

- Heat and pain: Pain can cause patients to move, requiring repeat exams.
- Fluid shifts: A sudden influx of intravascular fluid may be problematic to high-risk patients with cardiac and renal failure.
- Effects on RBC morphology: Hyperosmolar agents in the plasma will cause a net efflux of water from RBCs.
- Renal safety: Hyperosmolar contrast media decrease renal function through their effect of swelling the renal tubules by drawing water into them.

Viscosity
Viscosity is the resistance of fluids to flow. Viscosity of iodinated contrast media is influenced by iodine concentration, temperature, molecular properties, and cations. When contrast was injected by hand, viscosity was important. Now, with power injectors, precise amounts of contrast can be
delivered at controlled rates.

**Chemotoxicity**

Chemotoxicity involves chemical reactions between the contrast medium and various molecules of the body. Chemotoxicity has been implicated as the cause of “allergy-like” reactions to iodinated contrast media, including:

- Headache (the most common adverse reaction);
- Nausea/vomiting;
- Skin reactions (hives and severe itching);
- Sneezing or coughing;
- Bronchospasm or laryngospasm; and
- Anaphylactic shock (extremely rare with non-ionic contrast media).

Most contrast reactions occur within one to three minutes of injection, but delayed reaction can occur within several days of the procedure.

**Renal Toxicity**

The kidneys are specifically put at risk by the toxic effects of contrast media because they concentrate contrast from the bloodstream to eliminate it from the body. Kidney damage has long been recognized as a potential side effect of iodinated contrast media; it can range from small temporary reductions in kidney function to permanent loss of kidney function, to temporary or permanent kidney failure.

Patients at risk of renal toxicity include those with diminished kidney function, severe heart failure, dehydration, diabetes, proteinuria, exposure to drugs toxic to the kidneys (such as NSAIDs), multiple myeloma, and exposure to large amounts of contrast for one or several exams over a short period of time.

A complete medical history should be gathered prior to each procedure.

It should be emphasized that the majority (95%) of adverse reactions to contrast are not considered serious. However, manufacturers want you to report any adverse events to them so they may track these occurrences.

Your contrast manufacturer can supply you with more specific information regarding the products you use.

Radiologist’s desire for an optimal CT scan; the nonionic contrast reduces the incidence of artifacts, making the PET image acceptable to the nuclear medicine physician; the radiation exposure to the patient is reduced.

Multiple variables are associated with contrast injections—including total volume, time of infusion, and delay of image acquisition following injection—and are dependent on the number of detector rows in a multislice CT scanner, slice thickness, and pitch of the image set.

Most total-body CTs (chest, abdomen, and pelvis) acquired for staging malignancies can be performed with approximately 50 to 70 ml of the nonionic, low osmolality, low viscosity intravenous contrast agents that are available in the market today. Typically, the contrast is contained in a dual-chamber power injector pack, with 50 to 70 ml of contrast.

An optimized contrast protocol for CT needs to assure imaging of different body regions in region-specific phases of contrast enhancement (e.g., the thorax should be scanned in the arterial phase; the upper abdomen should be imaged in the portal-venous phase). This goal cannot be achieved by a single whole-body CT acquisition. To improve contrast enhancement of the CT component, new software and hardware solutions that allow CT acquisition to be split for optimized contrast enhancement are required. To avoid additional radiation exposure from a separate nonenhanced CT, this split spiral CT must serve as the attenuation correction map as well.

Some tumor entities require CT imaging in more than one phase of contrast enhancement, e.g., hepatocellular carcinoma requires multiphasic arterial and portal-venous CT imaging. Protocols offering acquisition of more than one phase of CT in combination with PET are most desirable, but for now we are limited to a separate arterial phase CT for protocols involving liver and head-and-neck imaging in PET/CT, while typical body PET/CT and SPECT/CT for infection or oncology (e.g., Prostascint) require only single-phase contrast-enhanced CT.

Multiple institutions across the country are investigating the use of both intravenous and oral contrast agents in hybrid PET/CT and SPECT/CT imaging. A continued dialogue between early users and commercial vendors should result in a refined, multiphasic, contrast-enhanced hybrid imaging protocol in the near future.
This past year has been an exciting and busy time for the area of education. The committee chairs have done a great job, and progress has been made in many different areas. Work is not complete, though.

In the fall of 2006, a symposium was held in Pittsburgh to address the transition of associate and certificate programs to a baccalaureate degree. Members of the entry-level task force, certificate-level program directors, associate-level program directors, four-year program directors, SNM staff, and guests from the American Society of Radiologic Technologists (ASRT), the American Registry of Radiologic Technologists (ARRT), Canadian programs, and the SNMTS leadership were in attendance. This transition is necessary to advance the profession and enable the advanced practice path.

The attendees discussed obstacles, issues and solutions to program transition by breaking into work groups. Each group came back with issues and solutions for their particular program's structure. One common denominator that resulted from the summit was that all agreed that there was a lack of standardization in curricula across programs. Previously, this task force had drafted a core curriculum. Task force members were asked to help with drafting a new core curriculum. This new curriculum was presented at the 2007 Annual Meeting and was approved by both the SNMTS National Council of Representatives and the SNMTS Executive Board.

The Educators Committee also sent an action item to the National Council of Representatives (NCOR) stating that SNM and SNMTS would support program accreditation for nuclear medicine programs. This step was taken in support of the new entry-level and advanced practice issues before us. This action item was approved by both the NCOR and the Executive Board.

Travel grants were awarded by the Professional Development and Education Fund to two faculty members to allow them to present the Nuclear Medicine Technology Certification Board (NMTCB) exam review at the Annual Meeting. The grant is designed to offset the cost of attending the Annual Meeting.

Over the past year, the Advanced Practice Task Force has worked diligently to define competencies and a core curriculum for the program. This work continues with the hope of having the first program ready to go as soon as possible. On the first weekend of August this year, several members from the task force met with the ASRT, ARRT, and NMTCB to collaborate on curricula.

This is an extremely busy time for education in the nuclear medicine and molecular imaging field. Hard work has been done over the past year, and education continues to be at the forefront of our profession. I invite comments or questions that I can bring to the NCOR or Executive Board. Please feel free to contact me at spfdmark1@mchsi.com.

**Call for Nominations: Technologist Section 2008–9 General Election**

The first call for nominations was sent to all SNMTS voting members in September 2007. Applications are due by December 14. The following positions are elected by the general membership:

- President-elect (two-year term: first year as president-elect, second year as president);
- Secretary (one-year term);
- Technologist delegate-at-large to the House of Delegates (three-year term);
- Finance Committee chair (one-year term);
- Finance Committee member (three-year term); and
- Specialty area representatives (three-year term) for the following areas: industry, cardiology, education, emerging technologies, management, students.

The following positions are elected by the National Council of Representatives (NCOR):

- Member-at-large (three-year term);
- Nominating Committee member (one-year term);
- Director-at-large (three-year term); and
- Speaker of the National Council of Representatives (two-year term).

Each position has specific qualifications for office. All candidates must be active members of SNMTS, hold or have recently held a national position (for example, chair of an SNMTS committee/task force, elected NCOR member, or member of the Executive Board) and be endorsed by their local chapter. Qualifications, duties, and responsibilities for specific offices are detailed in the application form, which is available online at http://interactive.snm.org/index.cfm?PageID=1678. Nominations must be submitted to Nikki Wenzel (nwenzel@snm.org) by December 14.

For more information on these positions, contact any member of the Nominating Committee: D. Scott Hollbrook, CNMT, FSNMTS (chair); Lynnette A. Fulk, CNMT, FSNMTS; Frances K. Keech, MBA, RT(N), FSNMTS; Anthony W. Knight, MBA CNMT, NCT; and Kathy E. Thompson, MS, CNMT.
Events of Interest to the Nuclear Medicine Community

2007

October 5–6: Impact of PET-CT on Oncologic Imaging, Sheraton Inner Harbor, Baltimore, MD Host: American Roentgen Ray Society (www.arrs.org) CE Credit: 13 hrs Category 1 Contact: Keri Sperry, 703-729-3353, keri@arrs.org, fax: 703-729-4839

October 11–14: 32nd Annual Western Regional Meeting, Embassy Suites South (Disneyland), Anaheim, CA Hosts: Western Regional Chapters CE Credit: VOICE, SCOPE Contact: Sue Hogeboom, wrsnm@cs.com, 425-893-8410, fax: 425-882-7902

October 13: 10th Annual Fall Technologist Educational Meeting (www.swcsnm.org/meetings/07falltechmtg.htm), Reed Conference Center, Midwest City, OK Host: Southwestern Chapter (www.swcsnm.org) CE Credit: 8 VOICE Contact: Charles Metzger, 830-257-0112, cmetzger@swcsnm.org, fax: 830-257-0119

October 13–14: 2007 Central Chapter Fall Meeting, The Columbus-Renaissance Hotel, Columbus, OH Host: Central Chapter (www.ccsnm.org) CE Credit: 11 hrs VOICE (anticipated) Contact: Merle Hedland, mhedland@bacon-hedland.com, 630-323-6880, fax: 630-323-6989

October 27–28: Northeast Regional Meeting, Stamford Marriott Hotel, Stamford, CT Hosts: Greater NY and New England Chapters CE Credit: AMA Category 1, VOICE Contact: Mitchell Stromer, 718-405-8468, mich360@aol.com, fax: 718-824-1369

2008

February 14–17: 2008 SNM Mid-Winter Educational Symposium, Newport Beach, CA Host: SNM Contact: 703-708-9000 x 1229, MeetingInfo@snm.org, fax: 703-708-9274

February 28: 2008 Mid-Winter Meeting, Hilton, Pleasanton, CA Host: Northern California Chapter CE Credit: VOICE, SCOPE, CME Contact: Sue Hogeboom, 425-893-8410, wrsnm@cs.com, fax: 425-882-7902

March 15–16: 2008 Spring Meeting, Embassy Suites Downtown, Portland, OR Host: PNW Chapter CE Credits: VOICE, CME Contact: Sue Hogeboom, 425-893-8410, wrsnm@cs.com, fax: 425-882-7902

March 28–30: SW Chapter’s 53rd Annual Meeting (www.swcsnm.org/meetings/2008mtg.htm), Peabody, Little Rock, AR Host: Southwestern Chapter (www.swcsnm.org) CE Credit: ~17 hrs VOICE Contact: Charles Metzger, 830-257-0112, cmetzger@swcsnm.org, fax: 830-257-0119

April 4–6: Central Chapter Spring Meeting, Intercontinental Hotel Milwaukee, WI Host: Central Chapter (www.ccsnm.org) CE Credit: 17 hrs VOICE (anticipated) Contact: Merle Hedland, mhedland@bacon-hedland.com, 630-323-6880, fax: 630-323-6989

June 14–16: SNM 55th Annual Meeting, New Orleans, LA Host: SNM Contact: 703-708-9000 x 1229, MeetingInfo@snm.org, fax: 703-708-9274