When the First Exam is the Right Exam

Claudette Lew

Whether a patient comes in via the emergency department (ED) or has a scheduled imaging exam, conventional CT scans are often the first choice for imaging. And while CT technology is fast and accurate, CT often produces inconclusive data that can lead to supplemental testing to achieve a confident diagnosis. As pressure mounts on radiology departments to image more patients more effectively and cost-efficiently, Philips is

Figure 1. *Acute pulmonary embolism. A 35-year-old man with a history of hypertension and schizoaffective disorder presented to the emergency department with right-sided chest pain and an elevated D-dimer. CTA revealed right lower-lobe sub-segmental pulmonary embolism. Sagittal reformatted image (A, 3mm, iDose4) reveals sub-segmental pulmonary artery thrombus (arrow). Corresponding spectral reconstruction (B, 3mm, MonoE 42 keV) confirms thrombus. Axial spectral reconstruction (C, fused CT and iodine density map) demonstrates perfusion deficit involving right lower-lobe perfusion deficit without pulmonary infarction. (Images courtesy of HCMC Radiology.)*

focusing its innovation efforts on technologies that get the image right the first time. The IQon Spectral CT scanner was created to address that challenge.

Unique to the CT market, Philips' IQon Spectral CT technology creates multiple layers of data from a single scan. Much like a prism revealing the multiple energies in the visible light spectrum, the IQon's detection-based solution is able to capture and reveal the spectrum of X-ray energy levels. The spectral data allow image reconstructions per energy-specific layers. As this process is "always on" using the detection-based approach, the IQon offers additional information without additional scans, visits, or radiation.

First look

Pablo R. Ros, MD, Chair of Radiology at University Hospitals Cleveland Medical Center and Case Western Reserve University, was one of the first clinicians to see and test the IQon Spectral CT before it was commercially available.

"When Philips first brought the IQon Spectral CT prototype to our department and we started to work with it, we were in awe. To be able to capture all the data in one scan without having to predetermine the low energy setting — because you could go back, after the fact, and see the energy levels you need to see in the post-processing – is truly innovative technology. Our team was really enamored with that aspect of it," Ros explained.

The IQon Spectral CT can provide this type of on-demand result because of its detection-based acquisition. The technology reconstructs data by capturing high and low X-ray energies at the same time and in the same space. The top layer of the spectral detector-based computed tomography (SDCT) detector selectively absorbs low-energy photons and the bottom layer absorbs high-energy photons, thus providing two distinct energy data sets. In addition to the conventional images obtained by utilizing combined data from both detector layers, spectral analysis can be obtained by decomposition of the low- and high-energy data — permitting tissue characterization based on material content.
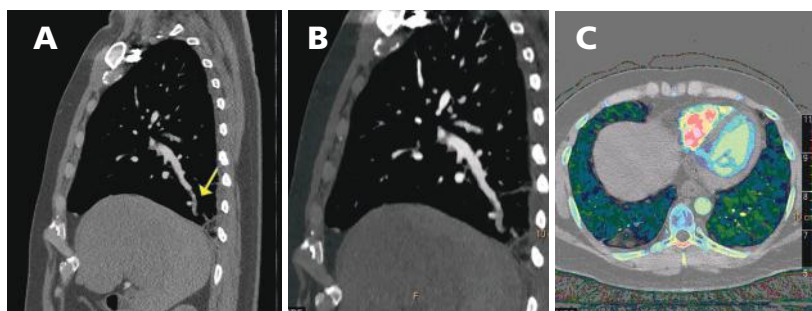
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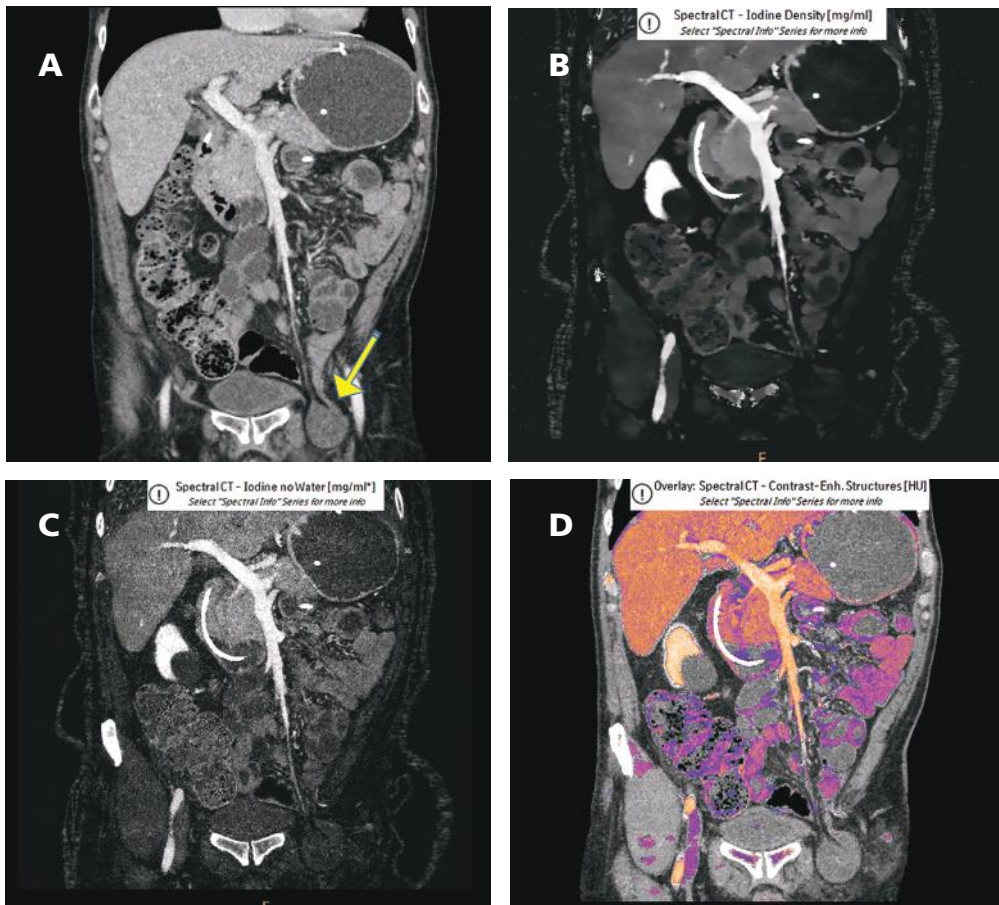
Figure 2. *Acute bowel infarction within strangulated hernia. A 55-year-old man with a medical history including stage IV oropharyngeal cancer presented with an acutely painful bulge in his left groin that had progressed in size and pain over several hours. Coronal reformatted image (A, 3mm, iDose4) reveals mass in left groin (arrow). Iodine density spectral reconstruction (B) shows absence of enhancement. Iodine/no water spectral image (C) confirms absence of iodinated contrast within mass. Colorized fusion map (D) shows normal enhancement of liver, bowel and vasculature, but absence of enhancement within strangulated, ischemic bowel in hernia sac. (Images courtesy of HCMC Radiology.)*

Ros and his team have been using the IQon system to perform very-low-dose, contrast-enhanced exams for renal failure patients. "We get spectacular images injecting only 30 cc of iodinated contrast material, instead of the typical 100 cc. Because contrast material is harmful to the renal function, in patients with borderline renal failure, we're using less than a third of the routine dose, which in addition reduces costs, while decreasing the risk for complications; and we're getting very good images," he said.

Among the clinical areas about which he is most excited, in Ros' department the IQon

Spectral CT system is used to characterize kidney stones, and to determine if a fluid collection in the body is hemorrhagic. Ros' team is also using the spectral post-processing capabilities to remove artifacts caused by metal implants or objects in the body.

IQon on the front lines

Hennepin County Medical Center Radiology Chief Chip Truwit, MD, and his team have taken a different approach in using their IQon Spectral CT scanner. Serving to stabilize patients with any number of conditions on the front
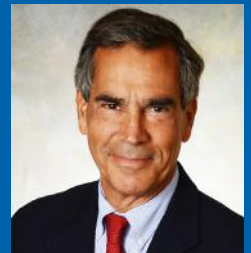
We can upload [a scan] into the spectral system, represent it using the spectral software, and all of a sudden you can rescue a scan.

Chip Truwit, MD
Chief Innovation Officer, HHS Chief, Radiology, Hennepin County Medical Center

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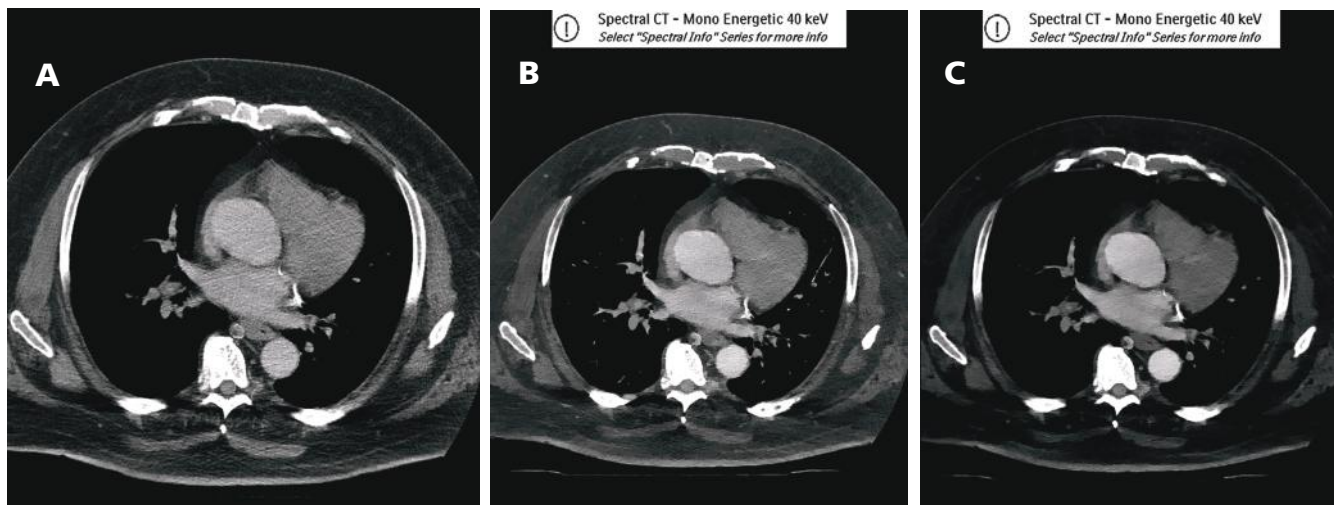
Figure 3. *Aortic root enlargement. A 64-year-old transgender female with chronic renal insufficiency (GRF=38) and dilated aortic root on echocardiogram, underwent aortic CTA performed with 28ml of iodinated contrast to capture accurate aortic root measurements. HCMC standard image (A, 3mm, iDose4) is of marginal quality with such a low dose of iodinated contrast. MonoEV image (B, 40keV, 1mm) enhances contrast resolution. MonoEV image (C, 40keV, 3mm) further improves conspicuity. Volume-rendered image of thoracic aortagrams (D,E) created from iDose4 and spectral datasets show dramatic improvement in contrast resolution by switching to the MonoEV setting. While image measurements could be made from any of three cross-sectional images, monoenergetic spectral scan at 40keV offers contrast resolution of typical contrast CT (80-100ml at most institutions), despite injection of only 28ml of iodinated contrast. (Images courtesy of HCMC Radiology.)*
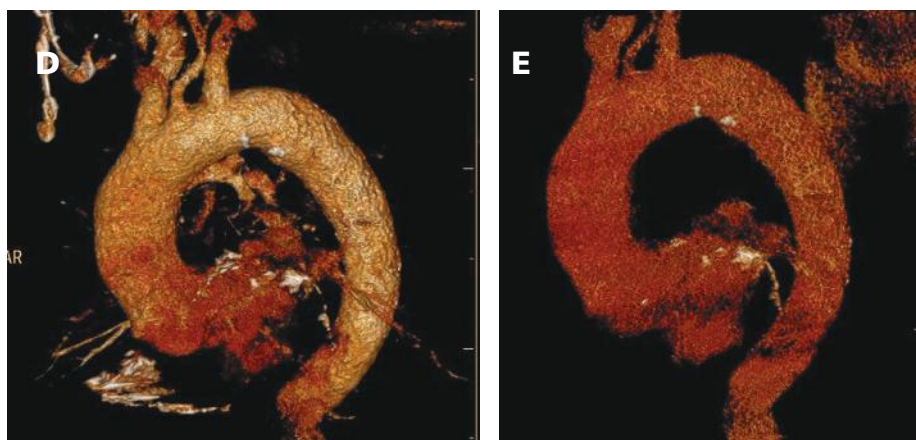
lines in the ED, Hennepin's clinicians turn to the IQon first — not as the supplemental scan that's ordered after an inconclusive CT. It's the first scan Hennepin's ED patients get when they would traditionally be sent for a CT. And according to Dr. Truwit, it should always be that way.

"We started discovering all sorts of things that we never expected to find," Dr. Truwit said. "We'd do a chest CT on a trauma patient and discover a pulmonary embolism or a pulmonary infarction that we weren't even looking for, simply because we were able to shift the iodine curve, so to speak, and look at the spectrum of energies in a whole new way (Figure 1). In addition, we find splenic and hepatic

lacerations much more easily and earlier than before. As well, bowel infarction becomes much more obvious on the iodine maps (Figure 2). In our trauma population, these diagnoses are now being made much earlier and therefore, with improved patient outcomes."

Without the need for prospective scan-time decision-making, the IQon Spectral CT makes perfect sense for the ED and Level 1 Trauma Center and has served Hennepin well.

Serving the Minneapolis/St. Paul area, Hennepin is committed to being a safety net hospital that provides care for low-income, uninsured and vulnerable populations. Dr. Truwit explained that seeing patients with a fragile IV in the ED is quite common and, in the past,

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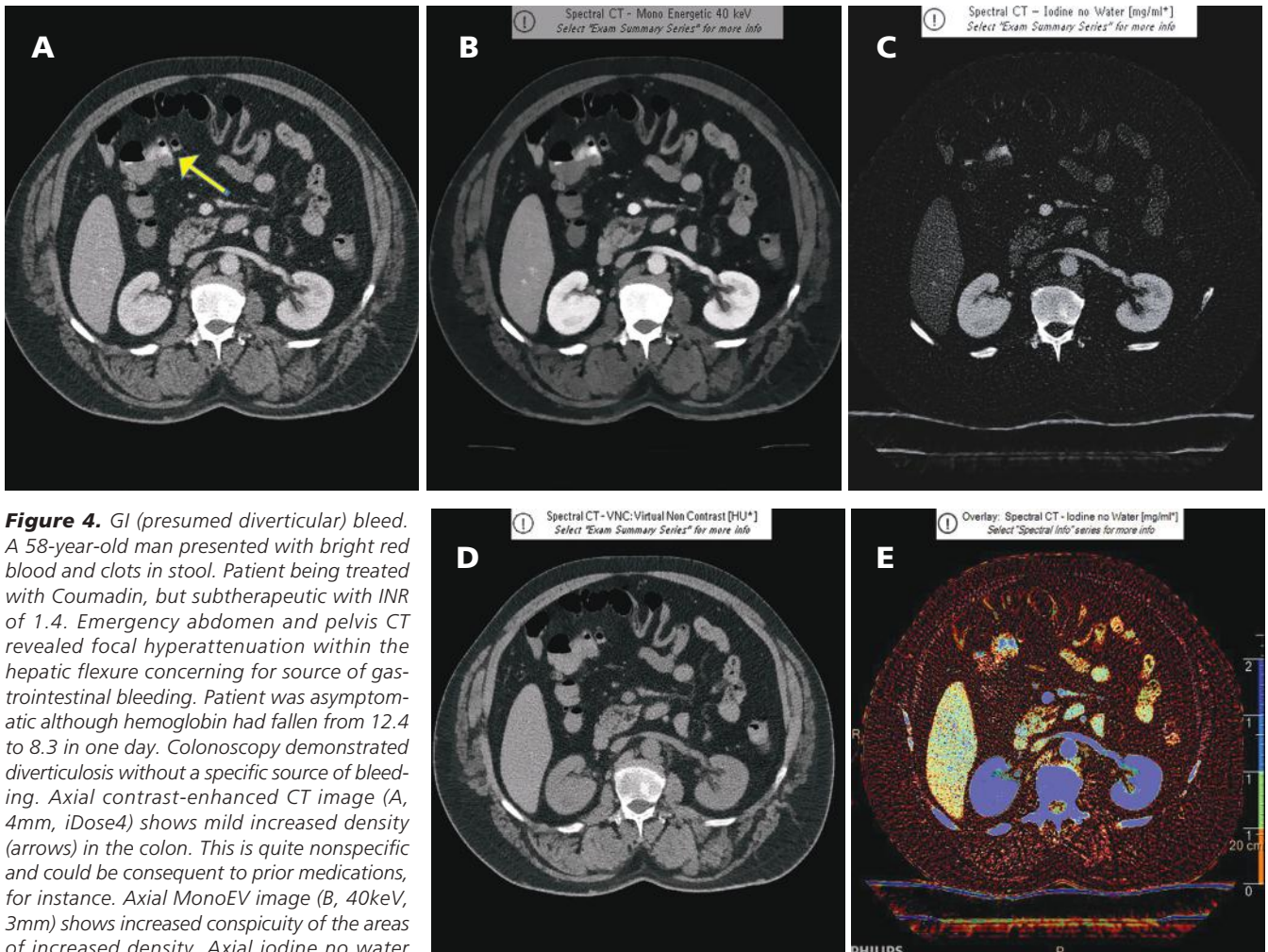
Figure 4. GI (presumed diverticular) bleed. A 58-year-old man presented with bright red blood and clots in stool. Patient being treated with Coumadin, but subtherapeutic with INR of 1.4. Emergency abdomen and pelvis CT revealed focal hyperattenuation within the hepatic flexure concerning for source of gastrointestinal bleeding. Patient was asymptomatic although hemoglobin had fallen from 12.4 to 8.3 in one day. Colonoscopy demonstrated diverticulosis without a specific source of bleeding. Axial contrast-enhanced CT image (A, 4mm, iDose4) shows mild increased density (arrows) in the colon. This is quite nonspecific and could be consequent to prior medications, for instance. Axial MonoEV image (B, 40keV, 3mm) shows increased conspicuity of the areas of increased density. Axial iodine no water image (C) shows persistent hyperattenuation, confirming that this is likely iodine. Axial virtual noncontrast image (D) shows no hyperattenuation. Colorized image (E) shows the large-bowel hemorrhage presumably consequent to a diverticular bleed. Smaller amount of hemorrhage is layering in the bowel, adjacent to the right. (Images courtesy of HCMC Radiology.)

has been an obstacle to quality imaging results. Until the IQon Spectral CT, scans would either have to be repeated, or clinicians would have to accommodate lesser-quality scans. Like the CaseWestern group, HCMC also reports performing studies with significantly reduced iodinated contrast in patients with renal failure (Figure 3).

"When that happens now, we can upload it into the spectral system, reprocess it using the spectral software, and all of a sudden you can rescue a scan," he said. "You can pick up a pulmonary embolism or a subtle bleed that you might not otherwise see because of the quality of the scans (Figure 4). So, we're able to generate better, diagnostic-quality scans out of something that we otherwise might not have."

"This is the first scanner that's come out where you have the opportunity to use this — always," Dr. Truwit concluded. "That's the benefit. Should every scanner be spectral? Absolutely. The spectral CT scanner is as transformative today as the CT scanner itself was disruptive in the 1970s."

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