Leading European Institutions Significantly Reduce Dose with ASiR-V

Humanitas Research Hospital

Considered one of the most technologically advanced hospitals in Europe, Humanitas Research Hospital (Istituto Clinico Humanitas, or ICH) is the flagship hospital of the Humanitas hospital group that includes five other facilities, including Cliniche Gavazzeni in Bergamo, Italy. A cornerstone of the advanced technology at Humanitas is Revolution™ EVO, designed to support a wide variety of patients and applications with high-resolution, low-dose imaging.

Humanitas acquired five Revolution EVO systems and installed two at ICH and one at Gavazzeni. According to Luca Balzarini, MD, Head of the Department of Diagnostic Imaging at ICH, the system complements the hospitals' mission to promote early detection and prevention of disease. The system has also helped the radiology department ramp up its focus to deliver low-dose imaging and further enhance patient safety.

As part of this effort, Humanitas also implemented DoseWatch™, an enterprise-wide dose management solution designed to automatically collect and analyze patient radiation and iodine exposure across multi-facility, multi-modality and multi-vendor imaging environments.[1]

"The most important benefit was to change our approach regarding CT for our patients," Dr. Balzarini says. From the beginning, based on the Dose Excellence Program methodology, he created a "Dose Team" that included radiologists, technologists and a medical physicist to help evaluate reductions in dose using a stepwise approach. The radiologists' engagement was crucial to obtain the right balance between image quality and low-dose values, he adds.

By adding ASiR-V™ and DoseWatch, Humanitas earned the prestigious European Society of Radiology's EuroSafe five-star certification. ASiR-V is GE Healthcare's latest evolution in low-dose CT imaging, delivering up to 82% less dose, 100% better spatial resolution, up to 135% improved low-contrast detectability, up to 91% less image noise and less streak artifact.[2,3,4]

"There is an increased awareness and sensitivity for dose reduction by healthcare providers," adds Enzo Angeli, MD, head of the Department of Diagnostic Imaging at Humanitas Gavazzeni. "With Revolution EVO, we are achieving the lowest possible dose without reducing the consistency of imaging."

For example, ICH previously used prior generations of iterative reconstruction for low-dose imaging. As a result of the optimization sessions conducted as part of the Dose Excellence Program, up to 40% dose reduction was achieved

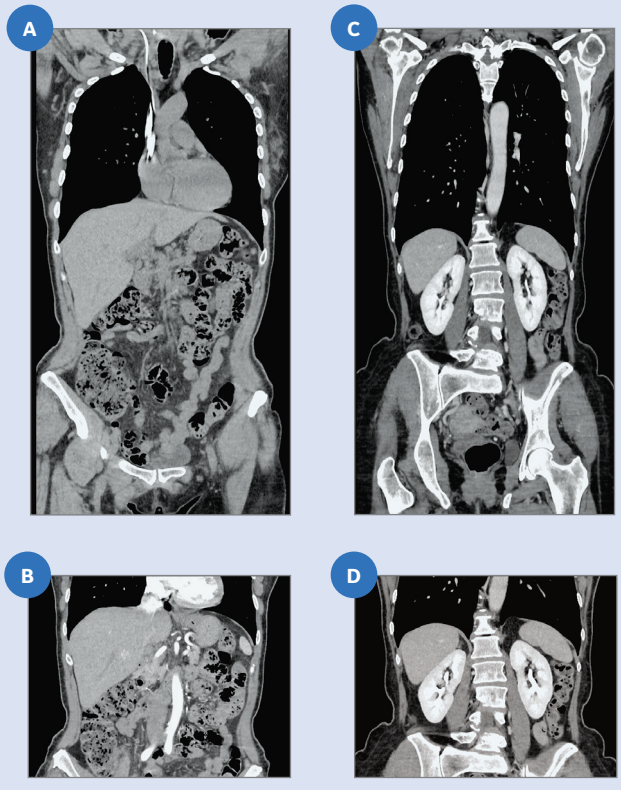

Figure 1. Low-dose four-phase chest-abdomen-pelvis for oncology, hyponatremia and cancer finding. Scan acquired with ASiR-V at 60% using 100 kV and Smart mA modulation.

Images courtesy of ICH.

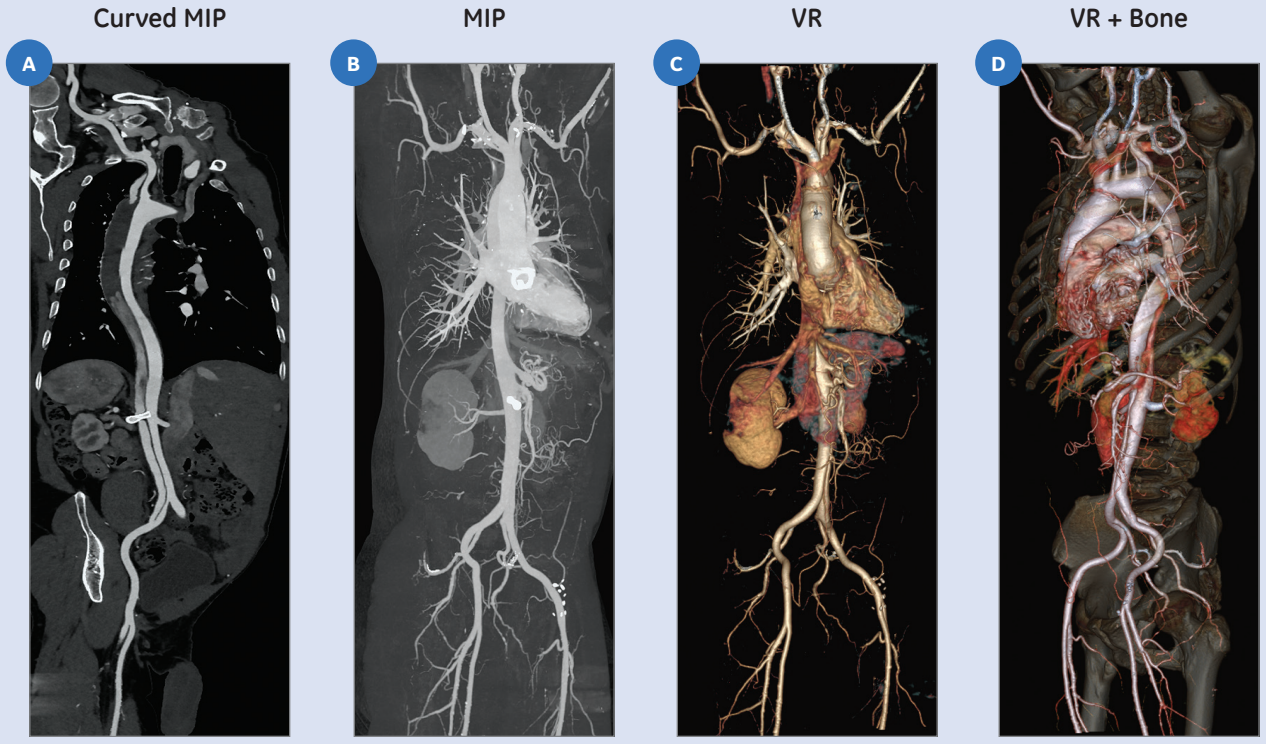

Figure 2. Whole-body aorta for dissection assessment and follow-up: ASiR-V 100% enables a better distinction of the true and false lumen. Scan acquired at 120 kV, 149-353 mA.

Images courtesy of SELARL du Nedon.

across all study types. In particular, with ASiR-V, ICH has further reduced dose in head imaging by 23%, in thorax imaging by 38% and in advanced procedures by 12%. At Cliniche Gavazzeni, Dr. Angeli reports a 25% dose reduction in thorax imaging and an average dose reduction of 13% across all other studies after completing standardization and optimization phases within the Dose Excellence Program.

In addition to ASiR-V and DoseWatch, Humanitas was also a pilot site for GE Healthcare's UW Dose-Optimized CT Protocols. "The decision to pilot the UW protocols was to drive consistency in the image quality and ensure we are delivering the same performance across all the Humanitas hospitals," says Dr. Angeli. "It has also helped us to reduce the dose faster while maintaining contrast resolution. This is particularly noticeable in the liver, where high noise can become a real problem. The 0.5 pitch in the UW protocols enables dose optimization with high image quality."

Dr. Balzarini adds, "We have also achieved another important goal: we've decreased the number of protocols that our technologists need to use by up to 75%." This has helped streamline the technologists' workflow, as well as achieve a high level of standardization.

There are other tangible results of this effort, says Dr. Angeli. By promoting their success in low-dose imaging in a local newspaper, Humanitas has increased demand for its CT imaging services—both from referring physicians and patients.

Over the last three years, there has been a considerable reduction in dose using GE Healthcare CT technologies. "With each step of the dose reduction and image presentation, the image quality has remained consistent for the radiologist to make a diagnosis... that is most important," says Dr. Balzarini. "We are still working to improve the quality of imaging at low dose, but for sure we are using the best technology with ASiR-V and Revolution EVO."

SELARL du Nedon

While ASiR-V is well known for low-dose imaging capabilities, Jean-Marc Treutenaere, MD, radiologist, SELARL du Nedon in Istres, France, has found another important use of ASIR-V.

> *We have also achieved another important goal: we've decreased the number of protocols that our technologists need to use by up to 75%.*
>
> *Dr. Luca Balzarini*

"I believe dose levels will continue to decrease while still improving image quality," Dr. Treutenaere says. "By setting ASiR-V to percentage values higher than recommended to just lower the dose, we realized an enhancement in the signal-to-noise ratio and significant improvements in the image quality."

Installed in June 2015, the clinic first began using the protocols with a fairly conservative value of 15-20% ASiR-V. A year later, Dr. Treutenaere and his colleagues began investigating the capabilities of ASiR-V and Smart MAR (metal artifact reduction) software.

He explains, "If you use ASiR-V values to improve the image quality, you don't modify the initial acquisition parameters. With post-processing, you can use several values of ASiR-V, including ASiR-V at 100%, which corresponds to a reconstructed image with a pure iterative reconstruction. Then you can compare these results with a lower ASiR-V value."

According to Dr. Treutenaere, compared to filter-back-projection, 100% iterative reconstruction (IR) improves SNR and contrast resolution. However, it changes the image structure and appearance, or pattern of noise, which requires the radiologist to learn and adapt when reading. He adds that using IR requires additional modifications, including decreasing slice thickness, making the resolution filter harder and adapting window leveling such as reducing the window width.

"The protocol modification has been done step-by-step to enable the radiologists to adapt to these new images," he says. "We obtained consensus among the radiologists by informing them and demystifying IR by presenting comparisons of reconstructions at higher levels of ASiR-V."

The level for ASiR-V is adjusted in post-processing to obtain the optimum image quality. Initially, ASiR-V at 100% was only used for comparison to ASiR-V 80%; however, once the power of ASiR-V was realized in terms of image quality improvement, ASiR-V 100% was utilized more often. Today, ASiR-V 80% is used to lower dose in most exams, which is below the recommended guidelines, while ASiR-V 100% is used for cardiac, vascular and neuro exams. The resulting dose for cardiac studies is typically between 80-150 DLP, or around 1.5 mSv.[5] In large or obese patients, ASiR-V 100% is also routinely used to help reduce image noise as the protocol mA remains the same.

Dr. Treutenaere also uses ASiR-V with a bone filter. The image can be read with a bone window (wide) and also with a window adapted to the parenchyma (narrow). In patients with implanted metal, such as joint replacements or aneurysm clips, he has discovered that Smart MAR provides more artifact reduction when combined with ASiR-V 100%.

In early 2017, the clinic began performing phantom studies to ensure that no information is lost in the imaging exam when maintaining dose and increasing ASiR-V to 100%. "As a powerful tool, we want to clarify how far we can go based on measurements from our physicists," he says.

As Dr. Treutenaere continues to leverage the power of ASiR-V, he sees the improvement from ASiR to ASiR-V and is convinced that more tools will become available to continue optimizing image quality.

"The quality of the imaging system, progress in IR algorithms and processing and computational power that is now available leads me to believe that the threshold of dose reduction has not yet been reached," Dr. Treutenaere says. ■

References

1. Contrast Data Mgmt. module collects contrast data automatically for class 4 integrated injectors for GE CT scanners only and is available for manual entry for other modalities connected to DoseWatch with the Contrast Data Management Module. Dose tracking for Nuclear Medicine is available for PET, PET/CT for single injection procedures only.
2. Low contrast detectability (LCD), image noise, spatial resolution and artifacts were assessed using reference factory protocols comparing ASiR-V and FBP. The LCD measured in 0.625 mm slices and tested for both head and body modes using the MITA CT IQ Phantom (CCT183, The Phantom Laboratory), using model observer method.
3. In clinical practice, the use of ASiR-V may reduce CT patient dose depending on the clinical task, patient size, anatomical location and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task.
4. ASIR-V is an option on some configurations.
5. Using a k factor of 0.014.