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A Shared Experience

Patient Safety, Workflow, and Productivity Advance to New Levels

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Introduction

Today's leading radiology practices use smart contrast-injector platforms to deliver superior computed tomography angiography (CTA) exams of the vascular system by standardizing CT imaging protocols for greater efficiency.

One such practice is Northwest Radiology, a large speciality private practice that performs more than 850,000 exams annually for several hospital systems and outpatient facilities throughout central Indiana.

This monograph provides an in-depth look at how Northwest Radiology leveraged Bracco Diagnostics' NEXO® Contrast Management System on their EmpowerCTA®+ Injectors to streamline and standardize their CECT imaging protocols, reduce operational costs, increase workflow efficiencies, and achieve higher-quality images for improved patient care.

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A Shared Experience: Patient Safety, Workflow, and Productivity Advance to New Levels

McKenna Bryant

Iodinated contrast is essential to computed tomography (CT), particularly for highlighting the vascular system in CT angiography (CTA) studies. As a result, today's leading radiology practices are using smart contrast-injector platforms to deliver superior patient care with greater efficiency than traditional injection systems.

One such practice is Northwest Radiology, a large private radiology group responsible for performing more than 850,000 exams annually for several hospital systems and outpatient facilities throughout central Indiana. This subspecialty practice supports a variety of referring physicians and their patients by providing imaging services at five outpatient facilities staffed by 55 radiologists and 47 technologists.

Recently, in an effort to simplify contrast protocol management, Northwest Radiology implemented Bracco Diagnostics, Inc.'s NEXO® Contrast Management System on their EmpowerCTA®+ Injector Systems, also manufactured by Bracco.

NEXO® is a centralized, server-based system that supports standardized contrast delivery management by networking a facility's CT injectors. It then tracks contrast delivery and documents performance to improve safety, streamline clinical workflow, and increase productivity across multiple CT suites. Additionally, Bracco's EmpowerCTA®+ injectors offer many unique features that aid in the administration of contrast media.

One feature is Saline Jump, which allows for the administration of saline immediately after diagnostic levels of contrast enhancement occur, permitting the use of less iodine without compromising the quality of the resulting images.

"We've seen several beneficial returns on investment since using the Saline Jump feature on the injectors," said Richard Hallett, MD, chief of cardiovascular imaging at Northwest Radiology. Dr. Hallett develops contrast-enhanced CT and CTA protocols to acquire consistent, robust organ and vascular enhancement and ensure accurate diagnostic and prognostic information.

"Saline Jump allows us to directly change over to saline once we have diagnostic level (or greater) enhancement; thus, we use less contrast," explained Dr. Hallett. "We bolus trigger at the vascular territory of interest and utilize a

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Richard Hallett, MD
Chief, Cardiovascular Imaging
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high Hounsfield unit threshold for each exam to ensure we have diagnostic enhancement levels." Further, he states, "Once that point is reached, the technologist can immediately start the saline delivery by switching directly from contrast to saline at whatever point is needed, while achieving optimal imaging."

REVIEW | Updating and Streamlining Contrast-enhanced CT Protocols

The NEXO® Contrast Management System has significantly streamlined the process of updating Northwest Radiology's CT protocols.

The ability to store and implement a broad spectrum of CT protocols is extremely useful for cardiovascular imagers who are focused on patient-specific imaging. This includes the ability to inspect and adjust protocols quickly and consistently across a practice. "NEXO® makes protocol adjustments quite simple. If we want to change any of them, we do that once, at a laptop, then push that protocol out to all the different sites and injectors," said Dr. Hallett.

Distributing the protocols across the imaging practice helps to ensure high-quality and consistent output while decreasing operator error or differences that can occur during protocol selection.

"Being able to have the injector data available during the primary exam interpretation increases our confidence that we have acquired quality data and have troubleshot any problematic exams," said Dr. Hallett. He explained that the system generates a report that consists of a DICOM image of the injector parameters, including protocol selection, amount of contrast and saline loaded onto the injector, and the amount of contrast delivered during the exam. The report also includes the contrast and saline injection pounds per square inch (PSI) and flow rates.

After reviewing the data, Dr. Hallett revises CT contrast protocols that utilize saline to further reduce contrast delivery to the patient.

For standard contrast-enhanced CT (CECT) exams, contrast is injected at a standard volume and flow rate, and imaging is completed during solid-organ equilibrium. CTA exam protocols typically employ higher flow rates for optimal vascular enhancement. Imaging is then performed using bolus triggering to the vascular territory of interest during the highest level of vascular enhancement. CTA protocols also utilize weight-based dosing to improve consistency across a wide range of patient sizes.

Saline plays an equally important role in CTA imaging, especially in cases of suspected intraluminal pathology such as pulmonary emboli and vascular stenoses. For these exams, administering saline before and during the injection protocol is critical.

These CTA protocols utilize the Saline Advance feature on the EmpowerCTA®+ injector to evaluate

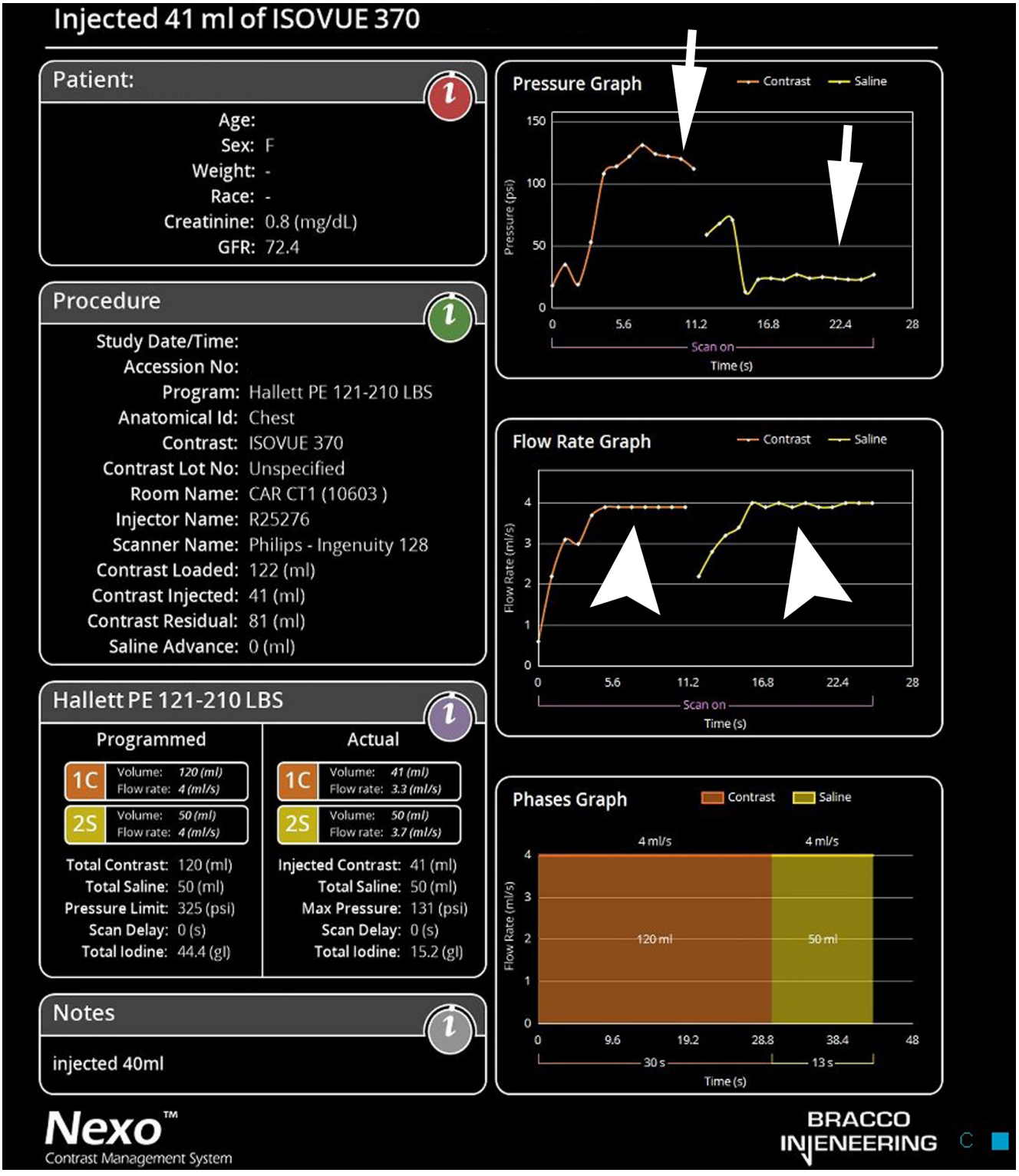

Figure 1. EmpowerCTA® + injector output to PACS from NEXO®. A 72-year-old female with pulmonary artery aneurysms, for surveillance CTA imaging. Injector screen output shows total contrast medium volume injected for CTA with NWR Saline Jump protocol (41 mL). Pressure graph shows normal pressures during injection of both contrast medium and saline (arrows). Flow-rate graphs show achievement of pre-programmed injection flow rates (arrowheads).

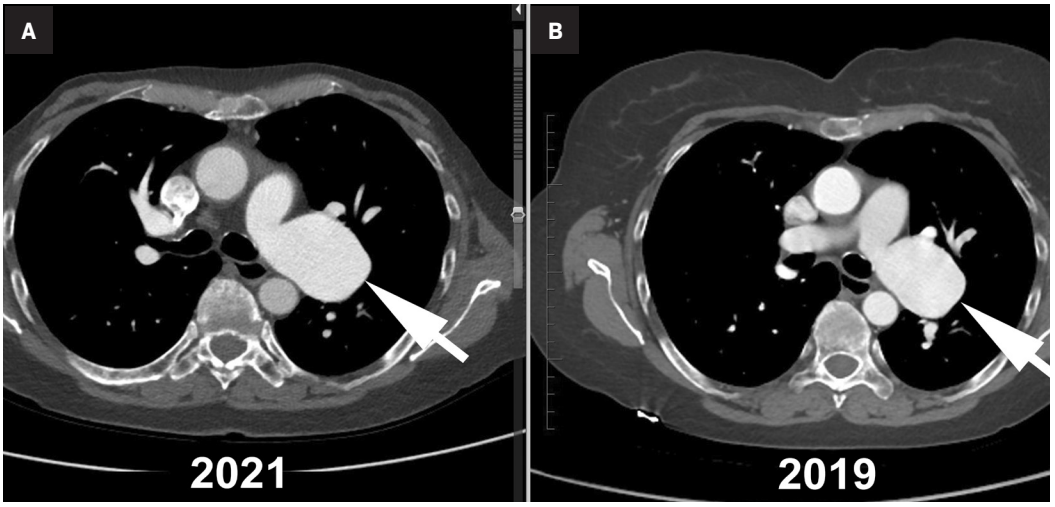

Figure 2. Image output from NWR Saline Jump protocol CTA (A) compared with protocol two years previously, which utilized 100 mL contrast (B). Left pulmonary artery aneurysm again noted (arrow), and unchanged in size. Contrast enhancement in the LPA is similar between the exams (395 HU in A, 380 HU in B).

IV integrity before bolus injection, which helps to reduce the risk of extravasation. Through a simple, weight-based dosing protocol, patients receive appropriate contrast volumes and flow rates based on their size. (The protocol is modified for renal dysfunction when necessary.)

"We use a test injection of saline at the same flow rate as our expected contrast rate, which allows us to prospectively assess the capability and function of the IV cannula before injecting a larger volume of contrast. It helps us identify any problems with the IV before the contrast injection begins. This has reduced our extravasation rate and complication rate significantly," said Dr. Hallett.

Following a bolus administration of contrast, a five-second saline flush or "chaser" is delivered to keep the bolus compact. The delivery of this saline chaser at a high flow rate provides higher and longer peak enhancement in the target area.

The saline flush provides three key benefits. First, it supports the ability to image all the contrast administered without wasting any residual contrast (8-10 mLs, or more) that might remain in the IV tubing or the patient's arm veins.

"By utilizing this contrast, we can decrease the total volume of contrast necessary to achieve optimal imaging," said Dr. Hallett.

The saline flush also reduces perivenous streak artifacts when imaging the central vessels, where they can create pseudo-lesions or obscure adjacent vascular structures such as the aorta, pulmonary artery and other great vessels. It also ensures the IV cannula remains clear after the procedure is complete.

Finally, saline administered before and during the procedure adds hydration, which helps reduce the risk of contrast-induced nephropathy (CIN), which can particularly occur in at-risk patients 24-48 hours after the procedure. The adjusted protocols call for the smallest amount of contrast based on each patient's renal function and weight.

"We do everything we can to adapt our imaging protocols so we can minimize contrast and maximize diagnostic information from that scan," Dr. Hallet said. "With the Saline Jump feature, we now have the ability to switch over to saline when the exam image quality is sufficient — without waiting for the entire contrast bolus to be administered." With this,

the technologist and radiologist can focus on imaging the patient.

The CT protocols at Northwest Radiology are reviewed and updated annually based on site experience and/or any new recommendations cited in the radiology literature. The practice has an ongoing quality assurance and peer-review process to identify and learn from exam and protocol deviations. During this process, Dr. Hallett and his team assess the reason for such deviations and determine whether they affected image quality. NEXO® makes the entire process easier, as it acquires a large amount of contrast-related data.

"By reviewing the injection data, which is sent to the NEXO® dashboard remotely and ultimately to PACS, and discussing the case with the technologists, we can usually determine the cause of any deviation and decide how to improve consistency," he said.

Upon analyzing their first 50 CTA cases using the revised contrast protocols, Northwest Radiology saw reductions in contrast utilization for CTA exams ranging from 15% to 60%. Reductions are exam- and patient-dependent, with larger reductions for smaller patients and pulmonary embolism studies. The protocol for these exams includes low kVp imaging with lower flow rates. Exams are obtained with paused respiration and with the patient's mouth open to avoid Valsalva. The practice has observed a 95% diagnostic rate in these patients (versus 85% previously), with contrast savings of 55% for patients weighing less than 132 pounds to 33% for those weighing more than 220 pounds.

By achieving sufficient diagnostic quality with less contrast, fewer repeat studies, and lower radiation dose required to achieve the clinical results, the benefits to the patient are significant. "The impact on patient care is tremendously improved with these new protocol adjustments," emphasized Dr. Hallett.

The NEXO® system also provides advantages for the practice's bottom line. "We continue to be impressed with the analytics, including contrast volumes loaded versus the amounts used, thus impacting what is regularly ordered," Dr. Hallett said. "We found that perhaps 10% less contrast was loaded than under the established protocol, although we certainly use less than that. From a forecasting perspective, we can leverage the dashboard output with the collected data to plan and order contrast and supplies more efficiently, which allows us to fine-tune our ordering patterns given the seasonal variability in our exam volumes."

According to Dr. Hallett, standardizing protocols has significant clinical and operational advantages. He said, "there is a cost savings for both the patient and the practice. Standardizing protocols leads to consistent quality exam output, which leads to more efficient diagnosis and fewer repeat exams. This saves patient time, technologist time, scanner time and supplies."

A review of additional data is expected to result in further adjustments to Northwest Radiology's CT protocols and provide fertile ground for more advanced analytics on the business and patient-care side of the practice. "I am excited to continue to explore this data and how we can improve patient care," he said.

CONFIRM | Empowering the Technologist

With the NEXO® Contrast Management System, Kim Kouns, RT(R)(CT), an experienced technologist at Northwest Radiology, can easily maintain standard CT protocols across the outpatient imaging network. "Now we know that all of our offices are using the same protocols, so they have the same end result for better diagnostic value," Kouns said.

Like Dr. Hallett, she appreciates the Saline Jump capability. "As a tech, it allows me to

Kim Kouns, RT(R)(CT)
Technologist
Northwest Radiology

"Now we know that all of our offices are using the same protocols, so they have the same end result for better diagnostic value."

have complete control of the contrast administration," Kouns said. "During a scan, when I see that the patient has reached their peak contrast enhancement, I can stop the amount of contrast going in and use the Saline Jump to chase the contrast and maintain the peak opacity of the arteries while hydrating the kidneys."

According to Dr. Hallett, the Saline Jump feature contributes to a great patient experience and optimal clinical outcomes. "We're blessed with technologists who are both interested and involved in the process," he said. "It's a team effort to optimize outcomes for the patient, so it's just not one person responsible, but everybody has a stake in the outcomes."

Prior to availability of the Saline Jump capability, all chest CTA exams utilized approximately 100 mLs of contrast and 50 mLs of saline. Now, these protocols are patient specific and depend on the patient's size; often, less than 100 mLs of contrast can be used. Recently, for example, the new protocols reduced the amount of contrast needed for patients weighing 120 pounds from 120 mLs to an average of 52 mLs. To further explain, a CTA of the abdomen previously required 100 mLs of contrast followed by 50 mLs of saline. Today, patients often receive only 80 mLs of contrast.

"That's a huge savings to the patient's kidneys and huge savings for everybody across the board," said Kouns.

After the scan, a summary report of the contrast injection data is sent to the PACS. This report documents every aspect of the injection, including the selected CECT protocol, the amounts of contrast and saline loaded onto the injector, as well as the actual amounts delivered during the study, the patient's weight, eGFR and creatinine, the contrast flow rate, and pressures (PSI), and a graph of the injection and contrast peak.

Dr. Hallett said the report is extremely valuable, as he uses the recorded data for troubleshooting suboptimal exams. "First, we can see the protocol utilized and observe patient characteristics that may impact the exam, such as a poor IV," he said. Being able to identify flow limitations related to high injection pressures can explain problems seen on the images. "If a repeat exam is necessary, we can modify injection parameters based on this data," he said.

As CT technology advances and scanners become faster with shorter exam times, performance pressures will be placed on radiologists and technologists to improve efficiencies while delivering patient-centric care. SmartInject Solutions will be a logical addition to many CT suites as clinicians performing exams must become more efficient while showing a return on investment.

"These smart imaging solutions are going to help us to be better technologists by empowering

"It's important to find products or solutions that help reduce cost without impacting the integrity of the study."

Lori Bricker, RT(R)(M), RDMS, RVT
Director of Operations
Northwest Radiology

us with the tools to control the amount of contrast that we are giving the patient and getting the best diagnostic image that we can," Kouns said.

IMPLEMENT | A Team Approach

Transitioning to the NEXO® Contrast Management System was smooth, thanks to the team approach taken by Northwest Radiology to implement the software.

The practice became interested in this centralized server-based solution when considering how to reduce contrast costs, which can be one of the largest expenses in the CT suite. However, they didn't want to reduce costs at the expense of imaging quality or workflow efficiencies.

"It's important to find products or solutions that help reduce cost without impacting the integrity of the study. We're also looking for products that allow our staff to gain efficiencies in workflow, so they can engage with the patient to ultimately support the radiologist and the referring provider so they can better manage the patient's care," explained Lori Bricker, RT(R)(M) RDMS, RVT, director of operations at Northwest Radiology.

Bricker manages Northwest Radiology's outpatient facilities and was instrumental in supporting the implementation of NEXO®. Bricker said she had worked with Bracco in the past, making it easy to move forward with the project.

"It's really important to trust your vendor, and it's equally important to get staff buy-in," she said. "Bracco's representatives are trustworthy and dependable, and our staff has an established comfort level with them, making our decision an easy one." The install of the injectors and the deployment of the software was supported by Bracco's Device and IT Application Specialists, who conduct hands-on, on-site training at each outpatient facility.

Since installing the NEXO® software on the EmpowerCTA®+ injectors, Northwest Radiology is well on its way to achieving its clinical and business goals. "With the use of the advanced features on the injectors, along with the results of the recorded analytics, we've been able to refine our images while simultaneously reducing the amount of contrast. That's a win-win for the patient, the provider, and our practice," said Bricker.

NEXO® also allows for continuous adjustment of protocols. "Once a new protocol is confirmed, we can quickly push it out to our other injectors located in CT suites in different locations in our practice. It's almost seamless, and it has dramatically improved that process for Northwest Radiology," she said.

Bricker calls Bracco's style "high-touch," with excellent communication that includes a planning document outlining and guiding the project from start to finish. "Working with Bracco's team was excellent," she explained. "We did not have any delay in the delivery of our patient care during the install and software deployment. It was truly a seamless process."

Marty Buening
Director of IT
Northwest Radiology

"Implementation of NEXO® was seamless. The Bracco team took the time to understand the Northwest Radiology IT environment and then explained how the software would fit into that."

Kouns agreed, adding, "it's extremely important that communication and training is top-notch during something like this, and that we know what we're doing because, in theory, these patients' lives are in our hands." Installing easy-to-use imaging equipment and software can reduce stress for the technologists and for the patient. "The very first patient that I scanned, I realized how the design of this system made it easy for us to achieve this task. There were no extra steps. It was simply the touch of a button, and it was all in my control."

After getting buy-in from the radiologists and technologists and to ensure the success of this project, Bricker noted, "it is crucial that members of the IT department be included from the beginning."

Marty Buening, the director of IT at Northwest Radiology, manages six IT professionals who are responsible for applications and infrastructure throughout Northwest Radiology.

"From an IT perspective, the implementation of the NEXO® was seamless. The Bracco team took the time to understand the Northwest Radiology IT environment and then explained how the software would fit into that," he said.

During that process, Buening and his team learned they needed to create a virtual machine to install a server for the software, set up networking for their injectors, and perform checks in their PACS. Regular meetings kept the team on track. Bracco was able to deploy the NEXO® software remotely and install the CT injectors on site with minimal in-person contact. The Windows-based setup includes one virtual machine running the software and the four injectors connected via ethernet.

"The implementation was exceptionally smooth. They made it as simple as it could be, and they did all they could do to make it easy on us. It wasn't a burden on our resources to make it happen," said Buening.

Overall, the project took approximately two months to complete, with no impact on CT suite uptime, staff productivity, or patient care.

Buening said he believes Bracco was just as invested in their success as his team was, which leveled up the customer service to Northwest Radiology. "Customer service has become a problem in the IT industry, but the way they managed things was exemplary," he said.

Dr. Hallett agreed. "We found the installation process to be very smooth, and the platform allows us to be more efficient when doing our CT studies."

GROW | Expanding Imaging Services

Dr. Hallett recommends that large-volume CT practices seeking to improve efficiencies and standardize imaging protocols take a close look at Bracco's platform.

"If you have a practice that is heavily involved in CT, particularly CT angiography, and you wish to improve workflow and imaging outcomes by using less contrast, the installation of a centralized, server-based program that automatically collects the contrast injection data is an excellent solution," he said.

From a technologist perspective, Kouns encourages her peers to embrace the new technology. "Embrace the fact that we as technologists have this control to deliver optimal scans with less contrast and ultimately protect the patient," she said.

The advantages of the SmartInject technology will continue to support consistency and quality as the practice adds a fifth outpatient imaging center to its network.

Northwest Radiology continues to grow its practice by offering imaging services that will reach more patients.

"As we open our next outpatient center, being interconnected by a smart CT solution allows us to improve patient care, streamline ordering, and standardize our CT protocols where perhaps we wouldn't have previously," Dr. Hallett concluded. "Our patients are getting diagnostic exams with less contrast dose and often less radiation dose because of fewer repeat studies and higher-quality exams."

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