syngo.CT Coronary Analysis for zero-click segmentation, vessel tracking, and labeling of coronary arteries. Centerlines are automatically calculated. (Courtesy: University Hospital Erlangen, Germany)

Treating Chronic Total Occlusions

Support from new planning and guidance software can help to improve outcomes.

Text: Peter Jaret

Courtesy: Christian Schlundt, MD, University Hospital Erlangen, Germany

"New tools allow us to diagnose and evaluate CTOs faster and with greater accuracy."

Christian Schlundt, MD
Department of Cardiology,
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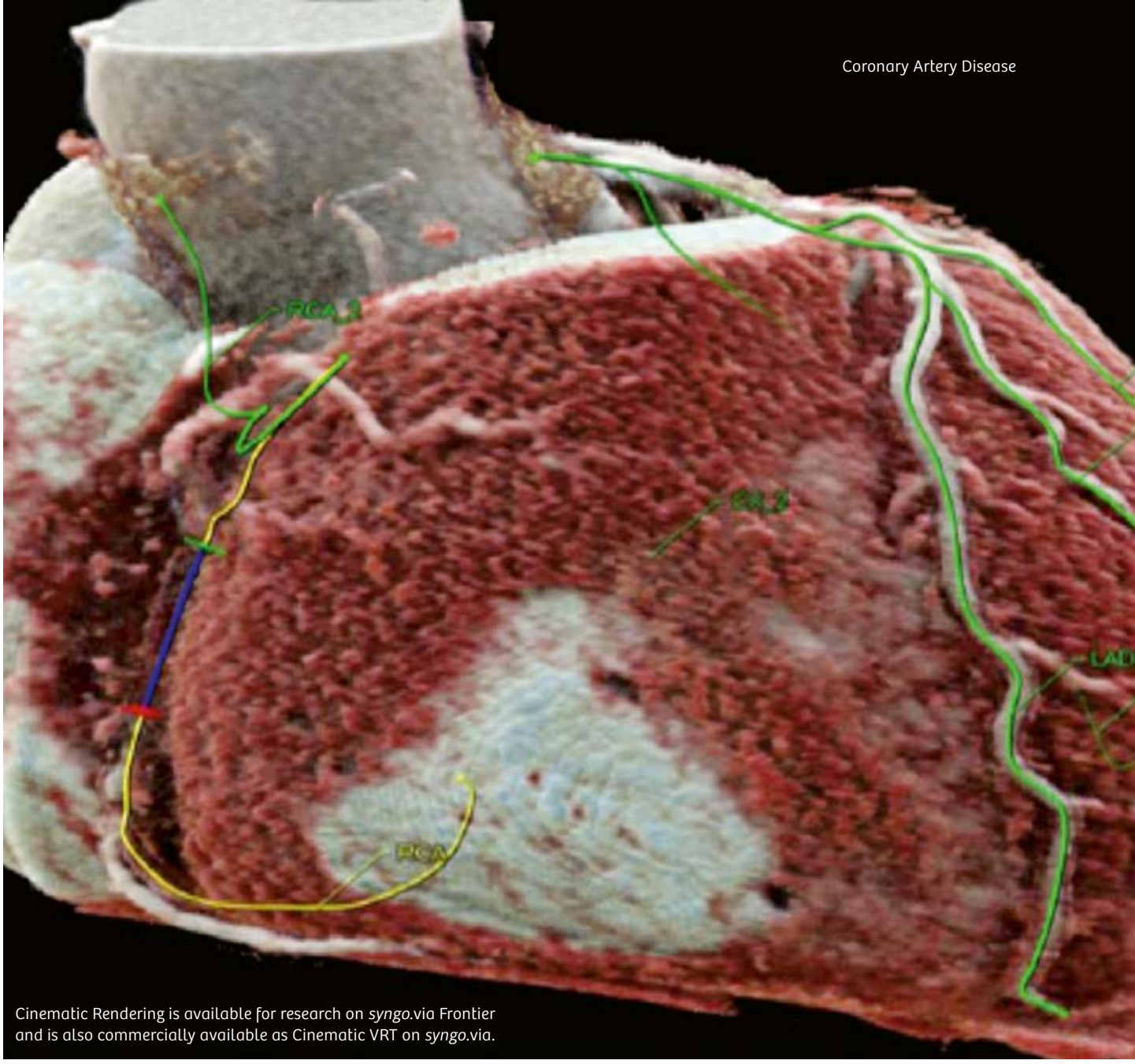
Treating chronic total occlusions (CTO) remains one of the greatest challenges in interventional cardiology. Defined as vessels that have been fully occluded for at least three months, CTOs account for up to one in three percutaneous coronary interventions (PCI).[1] This number is expected to rise as the global population ages.

Percutaneous intervention therapy

Today, state-of-the-art planning and guidance software make PCI an option for many patients with CTOs who might not previously have been treated interventionally. "New tools allow us to diagnose and evaluate CTOs faster and with greater accuracy, and to plan treatment strategies in advance," says Christian Schlundt, MD, Department of Cardiology, University Hospital Erlangen,



Cinematic Rendering is available for research on *syngo*.via Frontier and is also commercially available as Cinematic VRT on *syngo*.via.

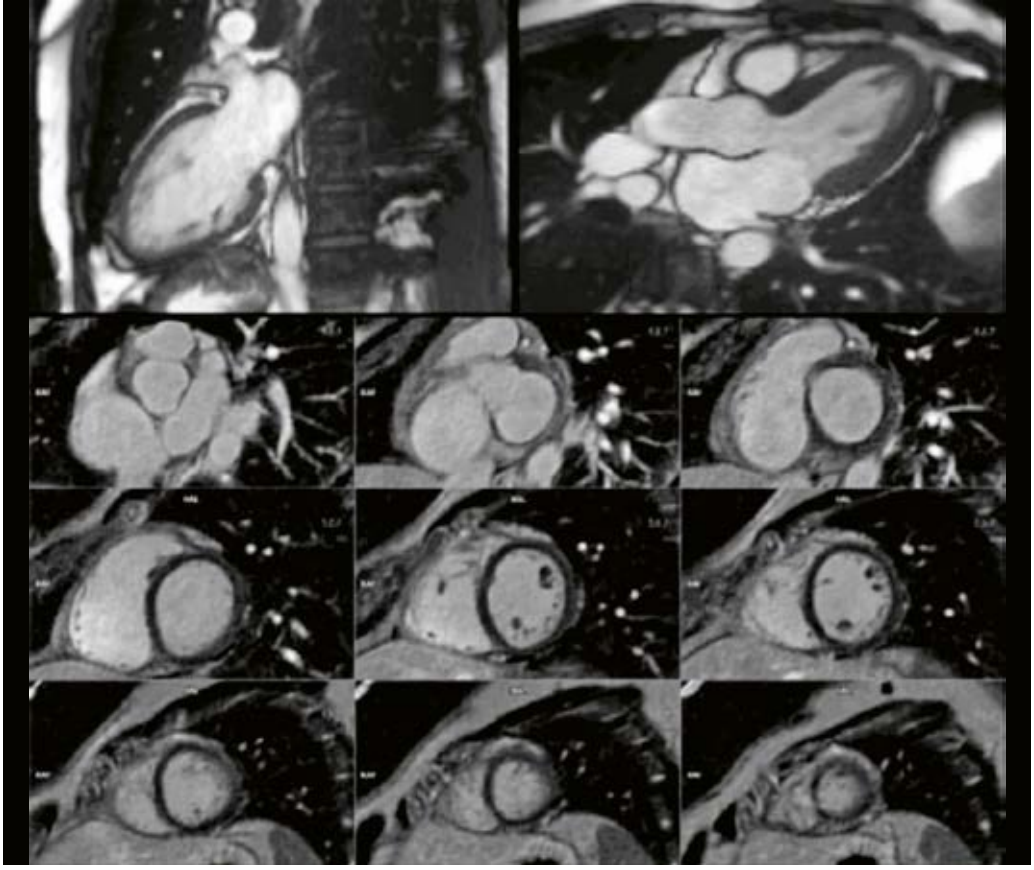
Germany. "At our institution, they have shortened procedure times and improved outcomes."

A case study from University Hospital Erlangen

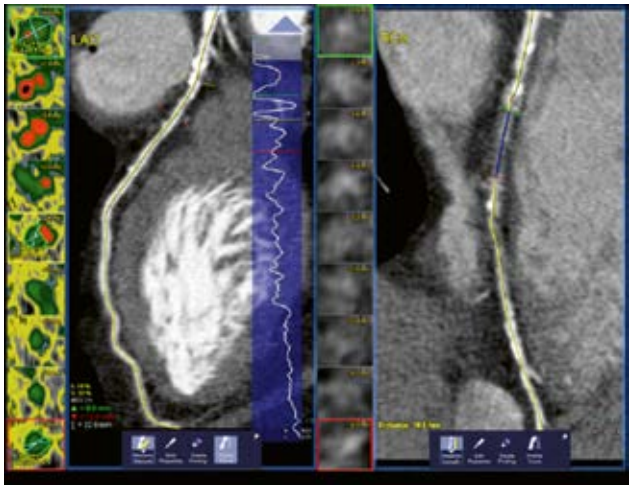
Patient history: A 72-year-old male with typical angina had been referred for elective revascularization of a CTO of the right coronary artery. The patient, who was taking metoprolol, ramipril, and simvastatin, had a left ventricle ejection fraction (EF) of 48%.

Diagnosis and evaluation: The first diagnostic step was to assess the condition of the cardiac muscle supplied by the occluded vessel to determine whether the tissue was still viable and the patient would benefit from revascularization. Cardiac MRI provided crucial information about diameters and ventricular volumes, global left ventricular EF, and regional wall motion abnormalities. Viability assessment demonstrated no contraindications to CTO revascularization and the patient was referred for percutaneous recanalization.

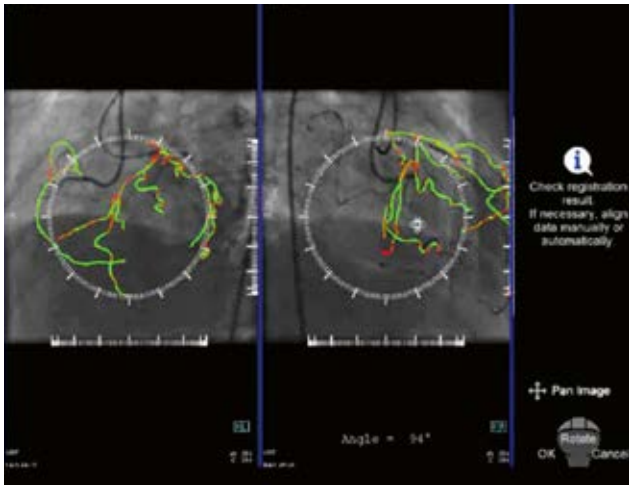
The second step was to perform a diagnostic CT angiogram. Using 3D CT imaging, the team was able to evaluate the course and tortuosity of the occluded vessel. The scan indicated a short CTO in the mid RCA, an occlusion requiring treatment. The CT scan also enabled the medical team to plan the procedure. Using 3D information about the lesion, it was possible to select crossing techniques and to pre-plan angulations even before entering the cath lab for treatment.



Diagnostic CMR with MAGNETOM Aera shows no late enhancement; the patient is considered a suitable candidate for recanalization.



syngo.CT Coronary Analysis enables rapid evaluation and quantification of stenosis and plaque analysis. (Courtesy: University Hospital Erlangen, Germany)

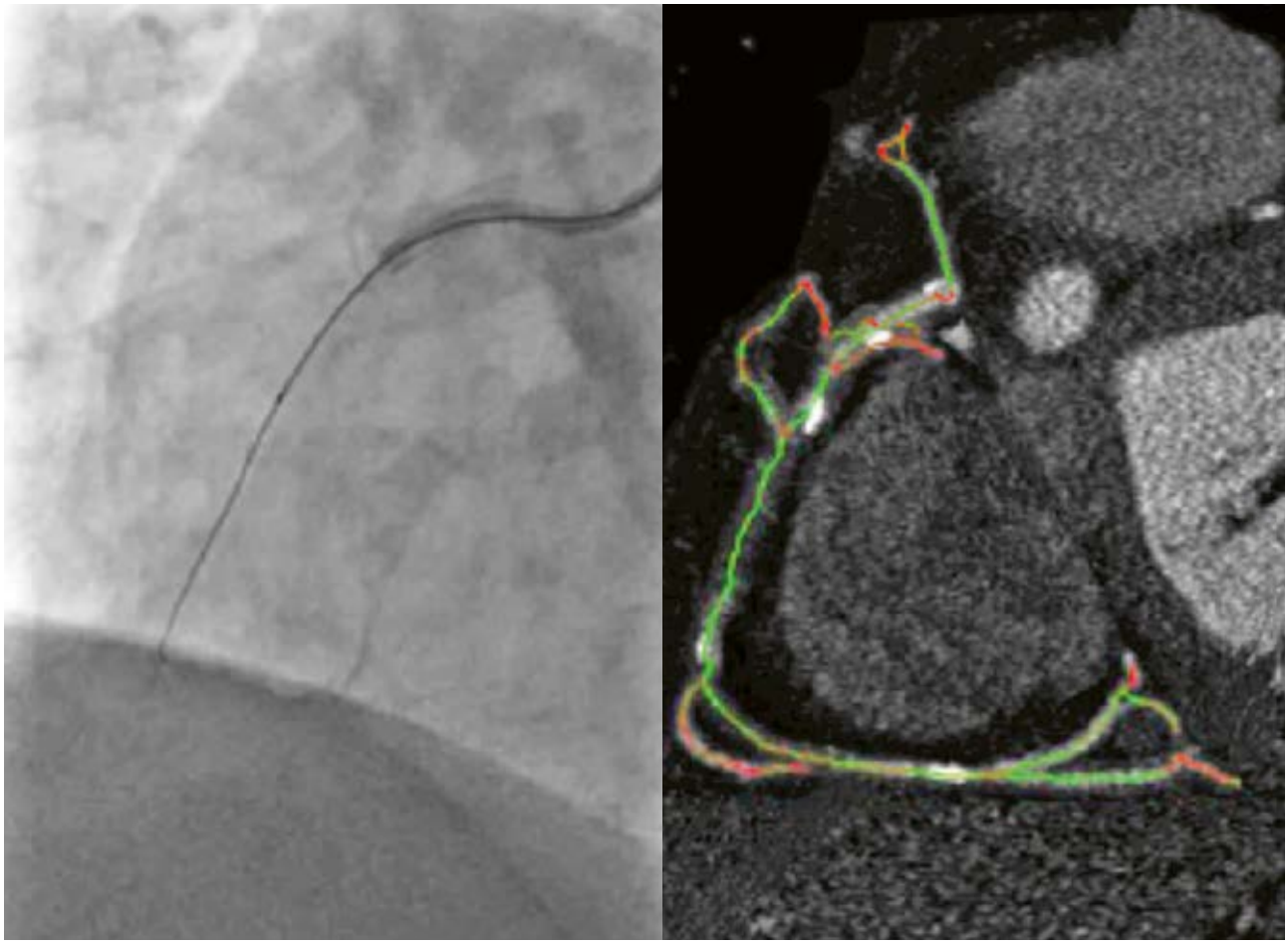


syngo CTO Guidance allows easy registration of color-coded centerlines from CTA with live fluoroscopy. (Courtesy: University Hospital Erlangen, Germany)

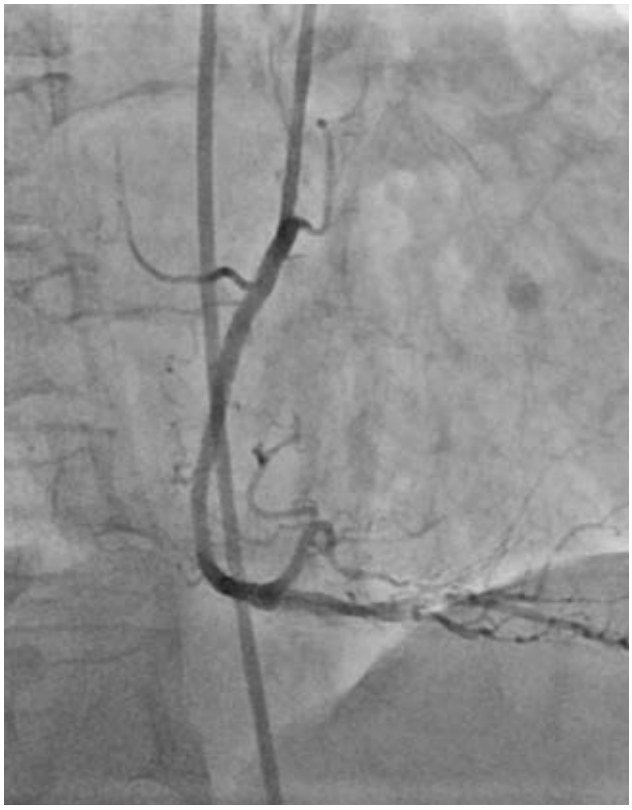
Treatment: During the procedure, analytic and guidance software provided segmented centerlines from the pre-procedural CT scan and co-registered these with the live fluoroscopy to combine 2D and 3D information. By indicating foreshortening, color coding helped guide the cardiologist as he worked across the lesion. Throughout the procedure, 3D CTA information was shown alongside the 2D angio image, with the angle adjusting automatically each time the operator moved the C-arm.

A final angiogram showed that the CTO had been successfully recanalized using minimal contrast.

Comments: Although success rates for PCI treatment of CTOs have improved, they still remain lower than for non-CTO PCI. Part of the problem has been that conventional 2D fluoroscopy does not allow cardiologists to fully visualize the occlusion or to guide the wires with optimal precision. In challenging cases, physicians have often had to stop procedures because they were unable to see the course of the lesion adequately enough to proceed. When CTO PCI revascularization fails, these patients often suffer from higher complication rates, which make follow-up procedures all the more difficult. Given these



syngo CTO Guidance visualizes 3D CTA information side-by-side with live 2D angio image always at the same angulation. Siemens COROwave indicates foreshortening. (Courtesy: University Hospital Erlangen, Germany)



The effective and accurate diagnosis, preplanning, and guidance supports successful CTO recanalization that requires less time and dose. (Courtesy: University Hospital Erlangen, Germany)

challenges, many cath labs have been reluctant to treat patients with complex CTOs, even though CTO patients make up roughly one-third of patients with stenoses.

This is changing. Technological innovations, including 3D imaging coupled with advanced guidance software, are making it possible to safely and effectively treat even the most complex CTOs interventionally. Here, quality 3D image acquisition without motion artifacts is key. In this instance, the scan was performed on a Dual Source CT scanner that can freeze cardiac motion to provide optimal diagnostic image quality even in challenging cases.

New tools support diagnosis, planning, and treatment

Today, new planning and guidance software tools are available to diagnose and evaluate CTOs faster and with greater accuracy. Using smart algorithms, Siemens Healthineers *syngo*.CT Coronary Analysis offers stenosis evaluation of the scan for fast and accurate diagnosis. With a single click, the software segments and tracks vessels, and labels the three main coronaries including branches and bypass grafts. What is more, the software automatically calculates and marks the centerlines of the coronary arteries. *syngo*.CT Coronary Analysis displays curved planar reformations of the vessels and calculates the minimum diameter. A plaque lens can even distinguish calcified from non-calcified plaques.

During procedures, *syngo* CTO Guidance brings crucial 3D information to the cath lab. The software allows for easy registration of color-coded centerlines from the CTA with two fluoro images. Siemens COROwave color codes the centerlines, indicating in-plane in green and foreshortened in red, and providing operators with far greater control.

PCI teams benefit from the new imaging tools in a number of ways. First, the ability to see the anatomy of a lesion in far greater detail makes diagnosis and preplanning for CTOs faster and more accurate. In a 2013 report in the *International Journal of Cardiovascular Imaging*, Rolf et al. found that the success rate of PCI was significantly higher among 30 CTO patients who underwent preprocedural planning with CT angiography – 88% vs. 24%.[2]

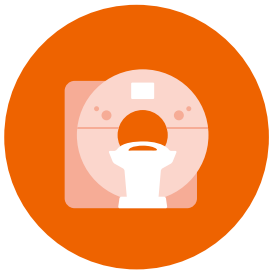
The availability of 3D CT information during the procedure in addition to the 2D invasive coronary angiography also helps improve success rates of PCI procedures for CTOs and reduces the time required for these complex procedures. It can even lower the patient's radiation exposure and contrast burden.

syngo.CT Coronary Analysis

- segments and tracks vessels
- labels the three main coronaries, including branches and bypass grafts
- automatically calculates and marks the centerlines of the coronary arteries
- displays curved planar reformations of vessels and calculates minimum diameter
- a plaque lens distinguishes calcified from non-calcified plaques

syngo CTO Guidance

- accurate planning through automated reconstruction of coronaries, centerline extraction, and color-coding of the centerlines (COROwave) to indicate foreshortening of vessel segment
- saves time and dose through easy registration of color-coded centerlines with two angio images



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SOMATOM Force Dual Source CT scanner

Freezes cardiac motion for accurate diagnostic scans without the need for breath-hold or beta-blockers

Increasing team expertise

For interventional cardiology departments that want to expand their technical expertise in treating CTO patients, advanced guidance software can help shorten the learning curve and enable them to do more of these complex procedures.

"The standard of care is changing as the outcomes for these procedures improve. The better our ability to visualize the lesion and plan a treatment strategy in advance, the better our outcomes are likely to be," says Schlundt. ●

Peter Jaret is a frequent contributor to the *New York Times* and other publications. He is the author of several books, including *Nurse: A World of Care* (Emory Press) and *Impact: From the Frontlines of Global Health* (National Geographic).

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[1] Fefer P, Knudtson ML, Cheema AN, Galbraith PD, Osherov AB, Yalonetsky S, et al. Current perspectives on coronary chronic total occlusions: the Canadian multicenter chronic total occlusions registry. J Am Coll Cardiol. 2012; 59(11): 991–7.

[2] Rolf A et al. Preprocedural coronary CT angiography significantly improves success rates of PCI for chronic total occlusion. Int J Cardiovasc Imaging. 2013; 29: 1819-27.

The outcomes by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption) there can be no guarantee that other customers will achieve the same results.

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