

Insights Series

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The future of interventional services

Advancing robotics in healthcare

A thought leadership paper on "Delivering high-value care" co-authored with ECG Management Consultants

Preface

The Insights Series

The Siemens Healthineers **Insights Series** is our preeminent thought leadership platform, drawing on the knowledge and experience of some of the world's most respected healthcare leaders and innovators. The Series explores emerging issues and provides you with practical solutions to today's most pressing healthcare challenges.

We believe that increasing value in healthcare—delivering better outcomes at lower cost—rests on four strategies. These four principles serve as the cornerstones of the **Insights Series**.



Our **Insights** portfolio is an integrated collection of events, speaking engagements, roundtable discussions, and an expanding array of print and digital platforms and products all carefully curated to share ideas, encourage discussion, disseminate original research and reinforce our position as a healthcare thought leader.

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Executive summary

What is the future of interventional services?

Robotic-assisted procedures were first introduced to surgical suites back in 1992. Their potential was immediately clear, but the unease that greeted their arrival was also manifest. People tended to be somewhat skeptical about machines that perform surgery, and that feeling has not yet disappeared. To this day, the leaders of healthcare organizations occasionally wrestle with resistance—their own and that of others—to the notion of investing in certain kinds of robotic technology.

This paper examines the future of interventional services and the role of robotics and is based on conversations with healthcare executives from Europe, Israel and the US. It begins by identifying and exploring some of the challenges facing healthcare organizations today, which include:

- Rising acuity of patients
- Workforce shortage
- Increased complexity of procedures
- Surgeon and staff protection

From there, the paper describes the many ways in which robotic-assisted technology can assist in overcoming these obstacles, ranging from the extraordinary precision and consistency offered by these automated systems to increased physician safety because of reduced exposure to radiation and less orthopedic strain. Other benefits include:

- Data-driven interventions
- Improved patient outcomes
- Reputational gain and patient preference
- Attracting exceptional interventionalists
- Long-term financial advantage

All in all, the paper concludes that when it comes to robotic-assisted surgery, the time for skepticism is at an end. The future of surgery and interventional procedures includes robotics, in one form or another, and organizations that want to successfully meet the many challenges facing them today need to start looking for ways to embrace that future.

Introduction

The increasing role of robotics in interventional services

There is some debate about when the first ever robotic-assisted surgical procedure was performed. One that is often cited occurred in 1985, when a robot was used to orient a needle for a brain biopsy. Another is 1992, when a robot was used to assist with a hip replacement.

Whatever the exact start date, those early breakthroughs ushered in a fundamental transformation in healthcare delivery that is being felt more than ever today. Decades after those first breakthroughs, robotic-assisted procedures are a common option that surgeons and patients expect to have when determining the best course of action for certain diagnoses.

This is not to say that the idea of robots in surgical suites has always been met with enthusiasm. As countless books and movies have made clear, robots and robotics can engender feelings of unease and concern.

Notwithstanding that, it is becoming increasingly clear in healthcare circles that the future of interventions very much includes robotics. Around the world, the population is growing and the number of available health providers is dwindling, which threatens to further diminish access to timely care. Technology presents the obvious solution to these twin problems, and there is growing recognition of that fact. Indeed, one recent US-based study showed that from January 2012 through June 2018, the use of robotic surgery for all general surgery procedures increased from 1.8% to 15.1%.²

This paper examines the future of interventional services, and the increasing role that robotics are certain to play. It takes as a starting assumption that the time for skepticism about robotics is at an end, and that it is no longer a question of if but when. Healthcare organizations face a number of clear and complex challenges, and there can be no question that technology—specifically robotic technology—holds the key to solving many of them.



How it works

The most widely used clinical robotic surgical system includes a camera arm and mechanical arms with attached surgical instruments that the surgeon controls while seated at a computer console near the operating table. The console gives the surgeon a high definition, magnified, 3D view of the surgical sites and lesions, and the patient's unique anatomy.¹

The challenge

How will interventional services be delivered in the future?

The decisions facing healthcare leaders are many, and they are complex. As they plan for how interventional services will be delivered in the future, the ways in which these leaders harness robotic technology will go a long way to determining what kind of success they will have overcoming the obstacles they face.

Rising acuity of patients

People are living longer. According to the United Nations, the global average life expectancy is 72.9 years,³ and it continues to grow. It should come as no surprise that an increase in life expectancy is associated with an increase in healthcare expenditures, which of course leads to a rise in the total cost of healthcare.³ As a result of pressure from payers aiming to rein in costs, combined with evolving patient preferences and expectations, there is a trend towards moving high-margin, low-acuity surgical and interventional cases out of hospitals and into lower-cost outpatient settings.

As life expectancy across the globe continues to rise, the number of people with multiple chronic conditions and comorbidities will also continue to grow. Combined with the migration, mentioned above, of low-acuity patients into ambulatory settings in the community, this will leave hospitals with the burden of caring for high-acuity patients who require complex, specialized diagnostic and therapeutic procedures. Treating higher-acuity, medically complex patients will require an investment in educating, training, and hiring more specialized physicians, as well as the adoption of advanced technology and equipment necessary to deliver highly specialized care efficiently and effectively.

Workforce shortage

Expert clinicians are in short supply, and current trends suggest that the situation will not be improving anytime soon. Staff shortages promise to be among the greatest challenges for health systems in the years ahead. Part of the problem lies in how long it takes to develop expertise. More time studying and learning is less time practicing, and this further reduces the number of available interventional physicians and surgeons.

By 2032, the United States face a shortage of as many as 23,000 surgeons, with the greatest deficits in surgical specialties that focus primarily on older adults, including ophthalmology, orthopedic surgery, urology, cardiovascular and neurology.⁴ For patients in rural areas, the surgeon shortage is exacerbated by the consolidation of physician expertise into Centers of Excellence in metropolitan areas. Simply put, too few surgeons want to work in rural areas, leaving many places underserved, particularly for specialized interventional and surgical care.

A growing and aging population, increasingly complex health needs, and a projected physician shortage—these add up to a problem health systems need to start anticipating now, because in order to solve it, they will need to rethink how care is delivered.

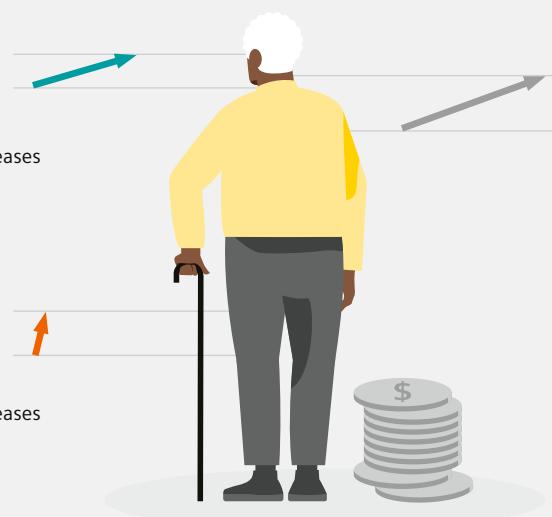
Increased complexity of procedures

In the future, oncological surgical procedures will focus on the removal of much smaller tumors. Precision will be key, and superior control and navigation will be demanded. According to a medical director and senior partner of a healthcare provider in Israel cellular-based diseases like cancer, infection, etc., will slowly have solutions that are less and less invasive thanks to the combination of drugs

Life expectancy vs. healthcare expenditure from 1995 to 2014

United States
Life expectancy increases from 75.62 to 78.84 years

Total healthcare expenditure increases from \$ 3,788 to \$ 9,403



Central Europe and Baltics

Life expectancy increases from 71.03 to 76.69 years

Total healthcare expenditure increases from \$ 436 to \$ 1,598

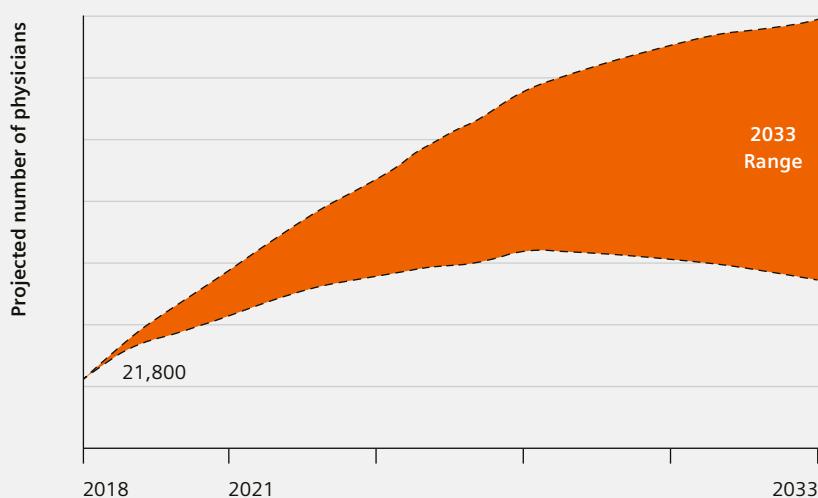
Central African Republic
Life expectancy increases from 46.25 to 50.62 years

Total healthcare expenditure increases from \$ 23 to \$ 25

Total healthcare expenditure per capita is adjusted for price differences between countries and for inflation and measured in international-\$.

Source: Roser M. Ortiz-Ospina E. Ritchie H. Life Expectancy. Our World in Data. October 2019. (ourworldindata.org/life-expectancy)

Total projected physician shortfall range



Source: The Complexities of Physician Supply and Demand: Projections From 2018 to 2033 (aamc.org)

"You will have less and less reason to do aggressive procedures in the large number of cases. Many cancer cases will be detected earlier, especially in the richer part of the world or prevented or treated in a way that there will not be a need to physically remove the bulk of tumor."

Medical Director and Senior Partner

Healthcare provider in Israel

and prevention. Aggressive procedures in the large number of cases will diminish drastically. Many cancer cases will be detected earlier, especially in the richer part of the world, or prevented or treated in a way where a physical removal of tumors is simply not necessary anymore.⁵

In short, surgical procedures will become increasingly specialized and require greater expertise. Likewise, interventional procedures, such as percutaneous coronary interventions (PCIs), will continue to require a high degree of precision and accuracy, navigating complex, tortuous blood vessels, and properly sizing and positioning stents on the first attempt. Today, significant variability exists in interventionalists' skills. Some are simply more experienced and skilled than others. This is important, because there is a real risk to patients undergoing PCI. Many patients requiring PCI have numerous underlying medical conditions that contribute to their need for PCI, and the longer the procedure takes, the greater the chances of complications and poor outcomes. Extended procedure duration as a result of numerous attempts to cross a lesion, imprecise lesion measurement, and inaccurate stent selection could be addressed through the use of robotics, and reduce the need to repeat the procedure in the future.

Surgeon and staff protection

There is one drawback to the increased utilization of minimally invasive surgery techniques, and that is the requirement for increased imaging during the procedure, which results in more exposure to radiation for the surgeon and procedural team. Likewise, the increasing complexity of interventional procedures that require longer fluoroscopy and image capture times is leading to greater radiation exposure to surgeons and other personnel.

The World Health Organization recognizes that excessive exposure to ionizing radiation increases the risk of cancer.⁶ And that risk leads to another. There is the risk of physical strain and injury from wearing protective lead for extended periods of time. Interventionalists working more than 10 hours per day and wearing a single-sided lead apron complain of shoulder pain and back pain, and 47% report body aches due to wearing aprons.⁷

These twin threats will only further exacerbate the projected physician shortage. Health system leaders need to eliminate the harm of lead and radiation on surgeons, interventionalists, and other personnel to keep their staff healthy.

The solution

To overcome these current challenges, future interventional services will need to be accessible, minimally invasive, and data-driven, and the supporting technology will need to be nimble, intuitive, efficient, and safe. Robotic technology has the potential to meet all these needs. Currently, surgical robots are further along in their evolution than interventional robots, but the application of robotic technology is still in its infancy, and there is still significant opportunity for development in the future. The growth of robotic-assisted procedures and interventions will have clinical, organizational, operational, and financial implications for hospitals—whether these are good or bad will depend on how organizations respond to the opportunity presented by robotic technology.

Clinical implications

Procedural standardization and automation

Simply put, surgical robotics can achieve a level of dexterity and precision when performing complex laparoscopic tasks that humans cannot. They cannot replace humans, but they can augment human capabilities and reduce unwarranted variations between surgeons. In a study comparing traditional laparoscopic surgery and robotic-assisted surgery, the latter provided a reduction in errors at all experience levels.⁸ According to a medical director and senior partner of a healthcare provider in Israel, many minimally invasive procedures “can be done safer and better using robotic technology. Most of it requires skills that are much better robotized than performed solely by surgeons or by humans.” He further positions robots as an intermediary between the surgeons, knowledge, decision-making and an actual, physician activity “that sometimes could be performed better by a system that is motorized. And today we’re hardly using this power at all.”⁵

Robotic-assisted cardiac and neurological interventions, as with surgical procedures, have the potential to utilize Artificial Intelligence (AI) and sophisticated sensors so that proceduralists can effortlessly and efficiently navigate the unique and intricate vasculature of chronically ill and medically complex patients, potentially reducing procedure duration and errors and improving clinical outcomes.

Data-driven interventions

Data-driven interventions can determine patterns within surgical procedures to improve best practices and a surgeon’s accuracy to a submillimeter precision. Surgical robots are equipped with dozens of miniature sensors and cameras that can measure the force being exerted and the position of the robot’s arms inside the patient. The data generated from these sensors allows the

surgeon to make better decisions in real time, with increased accuracy, thereby reducing the chances of complications.

Over the next 10 years, powered by embedded sensing and AI collected data, robotic systems and imaging devices will be increasingly integrated, resulting in greater automation of procedures, reduced operator variability, improved efficiency, and better patient outcomes. The goal is not to enable a robot to perform complex surgeries and interventional procedures without human involvement, but rather to use robotic technology to improve the surgeon's and proceduralist's capabilities and provide higher-quality care to patients.

Increased physician safety

Surgical robots are designed to eliminate the threat of harm posed by lead and radiation on surgeons, interventionalists and other cath lab personnel. The technology has successfully proven to decrease radiation exposure, reduce the use of lead aprons, and cause fewer orthopedic work-related injuries compared to traditional interventions.^{9,10} For cardiologists who've spent years stand-

ing for long hours wearing lead aprons in the cath lab, robotic PCI provides an opportunity to comfortably sit in an ergonomic chair at a workstation that is already radiation shielded. Robotic-assisted surgery can make a real difference by reducing musculoskeletal strain, cut down on radiation exposure, and possibly prolong careers.

Improved patient outcomes

Robotic-assisted surgery makes it possible to perform procedures using a minimally invasive approach, when otherwise an open surgical procedure would be required. The technology enables surgeons to be extremely accurate during complex procedures, while only requiring incisions the size of a dime. Smaller incisions are associated with fewer complications, a decreased infection risk, and a shortened recovery time compared to traditional surgery.¹¹ Currently, patient quality outcomes are equivalent for robotic-assisted and traditional minimally invasive surgeries.¹² As the technology continues to evolve, the next generation of surgical and interventional robots will be smaller, more precise, and more user-friendly, which is expected to translate into improved patient outcomes across all specialty areas.



Surgical robotics in PCI

To learn more about how surgical robotics are currently used in PCIs, see the following article: Siemens Healthineers Insights Series, issue 30: The case for robotic-assisted PCI—What is the value for healthcare executives?

Organizational, operational, and financial implications

Reputational gain and patient preference

A hospital's reputation is built on the range of services it provides, the quality of its clinical outcomes, and the quality of its patients' overall experience of care. A reality that hospitals must face is that patients can no longer be taken for granted. They are increasingly informed consumers who research organizational capabilities and offerings, review publicly reported quality and care experience ratings and rankings, and read physicians' biographies before selecting where to go for care. Informed patients often seek care at hospitals or with physicians that offer the latest and most advanced technologies and services. Hospitals that have invested in surgical robots often differentiate themselves from competitors by marketing their technological capabilities and highlighting the patient benefits. Hospital leaders must consider the intangible benefits of early adoption of new and evolving technology, including robotic-assisted interventional equipment.

Recruiting exceptional interventionalists

At their core, physicians are scientists, and as such, they often want to be on the forefront of technology and innovation. Surgeons in particular—and especially the newest generation of surgeons—tend to believe that robotic-assisted technology gives them a competitive edge.

According to a President of a healthcare provider in the UK:

"Our physicians want to be on the cutting edge of where technology is. That they see the future. And they see the future as actually having this capability, which in their mind, actually enhances their ability to do the procedures that they do. It gives them a differential in regard to their own capabilities and comparison to their colleagues or comparison to another institution."¹³

Many of the new generation of surgeons will have completed years of training in robotic-assisted procedures. Now in practice, they expect—and require—access to robotic technology wherever they choose to work. Health systems with robotic capabilities will be better positioned to readily attract and recruit junior specialists, especially important during times of physician shortage.¹⁴

Long-term financial advantage

Hospital leaders are looking for high-value approaches that improve patient outcomes and experience while maximizing hospital and physician value. They face an interesting decision over the adoption of robotic technology. For some health leaders, the return on investment may take longer than they are willing to accept. Other leaders, however, will understand and appreciate the value robotic technology provides in terms of soft dollars. They will have the vision to see how AI and robotic-supported tools can improve overall efficiency, increase patient access, and enhance patient outcomes. They will understand how the technology can attract physician talent and differentiate their services and capabilities in the market. These health leaders will explore these advanced technological opportunities. And in so doing, in preparing for the future of interventional services, they will set their organizations apart from the laggards.

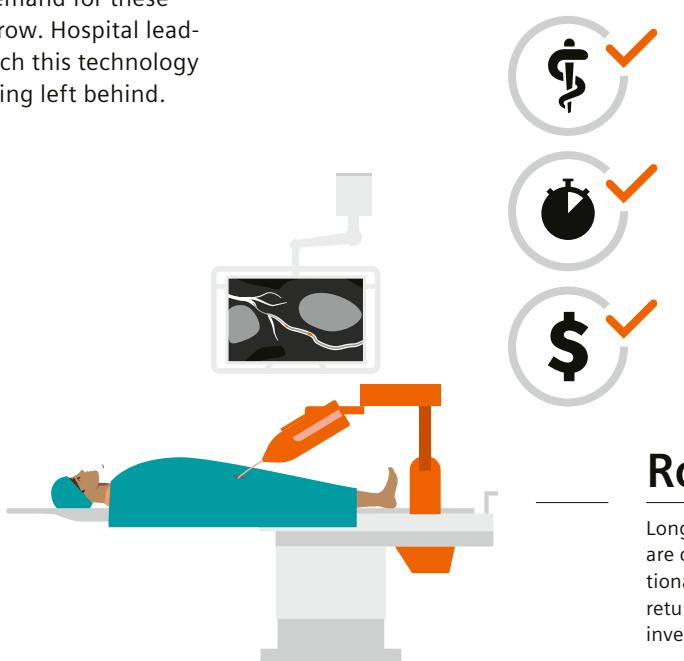
Conclusion

Exploring the use of robotic-assisted technology

There has been a clear increase in robotic-assisted interventions in recent years. The oldest and most widely used surgical robot system is Intuitive's da Vinci robot, with more than 5,300 systems installed worldwide. The system has been used in more than seven million surgeries.¹⁵ Importantly, Intuitive's core patents have begun to expire, triggering increased competition for robot innovation and patents. Many companies are actively developing and implementing new robotic systems, with applications for use in cardiovascular, neurological, and oncological procedures.

What that means is that over the next 10 years, we can expect robotic systems to evolve and become more sophisticated, with the ability to do more things and do them better. These systems will be increasingly integrated to provide improved efficiency, and greater adoption and use cases. Most importantly, they will provide better patient outcomes, which means the demand for these systems, by patients and payers, will grow. Hospital leaders must create an environment in which this technology innovation can flourish, or they risk being left behind.

Robotic-supported interventions and surgical procedures do not remove humans from the care delivery process—instead, these advancements in technology and science will improve clinical quality, patient and clinician safety, and access to lifesaving and life-extending services. Exploring the use of robotic-assisted technology across numerous platforms and specialties, and investing in the research, education, teams, and processes necessary to implement and integrate this technology, is a process that will take time. Healthcare organizations that take these steps now will see clinical, organizational, and financial benefits on their investment in the long term.



Robotics

Long-term benefits are clinical, operational, and financial returns on your investment.

Guidance for C-suite executives in conversations about the future of interventions

Below are guiding questions that hospital administrators might consider asking to help inform their decision to invest in robotic technology.

- 1** What current procedures could be performed using robotic-assisted technology?
- 2** How long do these procedures typically take?
- 3** What variability exists among providers who perform the same procedures?
- 4** How long does it take patients to recover, and how does that align with their expectations?
- 5** How do we evaluate the technical skill and proficiency of our proceduralists and surgeons?
- 6** What variability exists in the technical skill and proficiency of our proceduralists and surgeons?
- 7** Which surgeons and proceduralists are proponents of robotic technology? How are they perceived by their peers?
- 8** What is our reputation in the community? How might we differentiate ourselves?
- 9** What is the Board of Trustees' understanding and support of robotic technology?



Access the guiding questions online to assess for yourself where you stand. Follow the QR code for a 10-min self-assessment.



Suggested follow-up on

siemens-healthineers.com/insights

- Siemens Healthineers Insights Series, issue 30: The case for robotic-assisted PCI—What is the value for healthcare executives?
Available at: siemens-healthineers.com/insights/news/robotic-assisted-pci-healthcare-executives
- ECG Consultants Thought Leadership Article: Cardiac Catheterization in the ASC: Strategic Considerations for Hospitals and Health Systems.
Available at: ecgmc.com/thought-leadership/articles/cardiac-catheterization-in-the-asc-strategic-considerations-for-hospitals-and-health-systems



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A visionary, results-oriented healthcare executive and registered nurse with more than 25 years of broad clinical and operational experience, Sandy is known for delivering innovative and strategic approaches to improving clinical operations, fiscal performance, and the care experience for patients and providers alike. A former ED and flight nurse, chief nursing officer, and chief patient experience officer, Sandy has a master of business administration degree in healthcare administration and a master of science in healthcare financial management from Temple University. She earned her bachelor of science in nursing degree from Pennsylvania State University. Sandy is a member of Sigma Theta Tau International Honor Society of Nursing, the American College of Healthcare Executives, and the American Organization for Nursing Leadership.



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Annegret has over 20 years of medical imaging know-how, with 15 years of marketing and leadership experience at Siemens Healthineers. Her background is broad and encompassing having worked in four different business units such as magnetic resonance, molecular imaging, angiography and in central marketing & sales operations in Germany and in the United States. Prior to her roles at Siemens Healthineers she successfully developed and implemented an MR didactic curriculum for the radiology program at the University of Dusseldorf. As part of the European Team at Marconi Medical Systems she contributed to the overall European market development in MR utilizing her clinical background from her professional experience of several years as a certified radiographer. She has professional authored articles and a radiology compendium with case studies for residents and radiographer.



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Morgan's experience working with organizations across the healthcare industry gives her firsthand knowledge of the financial and operational challenges faced by hospitals and health systems. Before joining ECG, Morgan was a senior consultant at IBM Global Business Services, where she worked on a variety of projects focusing on strategic planning, process improvement, and project management. Morgan has a master of health services administration from the University of Michigan and a bachelor of science degree in healthcare management and policy, with a minor in health promotion, from Georgetown University.



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With more than 10 years' leadership experience in healthcare marketing, Reto Merges has a strong track record in building effective teams for clinical and innovation marketing. In addition, he has four years of work experience in China, ramping up efforts for research collaborations in China and South Korea. He holds a degree in electrical engineering and information technology from the Karlsruhe Institute of Technology, Germany, and has studied at the Nanjing Normal University, China. His scientific background is in the field of medical imaging, where he has authored many publications and holds multiple patents.

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At Siemens Healthineers, we pioneer breakthroughs in healthcare. For everyone. Everywhere. By constantly bringing breakthrough innovations to market, we enable healthcare professionals to deliver high-quality care, leading to the best possible outcomes for patients. Our portfolio, spanning from in-vitro and in-vivo diagnostics to image-guided therapy and innovative cancer care, is crucial for clinical decision-making and treatment pathways.

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