Augmented Intelligence: The Answer To Surgery's Shortcomings

A Perspective on the Next Frontier in Surgery

SENSUS SURGICAL™

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01 Inside the OR

Today's hospital operating room demands a coordination of knowledge and skill, as well as reliable, innovative tools and equipment for successful patient outcomes.

Technology advancements making their way into the OR are adding new levels of functionality and automation to an inherently dynamic and stressful environment. Groundbreaking developments include a breadth of minimally invasive surgeries that enable surgeons to perform more precise procedures in less time. Hospitals can schedule more surgeries into their OR suites and patients have more choices for their surgical care.

Tempering these innovations is the prevalence of surgical variability. Differences in surgeon training, experience, tools, and methodologies contribute to surgical variability across procedures, hospitals, and continents. Aligning with this inconsistency is a lack of data on how surgical performance impacts patient outcomes. While some OR procedures capture data through audio and video recordings, currently there is no widely available method to organize, annotate, and share this data in a timely manner.

The key to coordination is extracting insights from data.

As innovations in surgery continue to forge the modernization of medicine, there is a remarkable opportunity for hospitals and surgeons to reduce surgical variability and transform clinical outcomes in the near future.

This perspective delves into the gap in today's OR and how hospitals, surgical staff, and patients could benefit from Augmented Intelligence – the missing piece that connects surgeons to insights for informed decision-making and better patient care.

02 A Gap in Surgeon-Patient Care

Around 1890, the first surgical gloves[1] were donned to protect doctors and nurses from caustic disinfectants. While it wasn't immediately apparent, the gloves provided an added benefit of shielding patients from germs on the surgical staff's hands. As a crude medical marvel, it evolved to increase the success of surgical procedures and help to save countless lives. It also created a layer of complexity in how surgeons gauge pressure and depth by feel – and formed a distinctive gap between surgeon and patient.

The introduction of laparoscopy[2] in the U.S. brought a fundamental change in diagnostic medicine. Groundbreaking advances in the 1960s through the 1980s also created a wedge, albeit temporarily, within the surgical community as to the technique's effectiveness. In addition, patients were divided on whether to opt for open surgery to avoid potential complications that can occur during minimally invasive procedures.

Fast-forward to the dawn of robotically assisted surgery[3] with innovative instruments that aid the surgeon in performing operations. Since the first soft tissue robotic surgery over 20 years ago, more than 10 million procedures have been performed. While a successful method of increasing surgeon dexterity and mitigating patient trauma with smaller, more precise instruments, this inherently "hands-off" approach has further distanced the surgeon from the patient, replacing the tactility of human hands with mechanical arms and computer screens.

Digitization[4], or integration of digital tools and technology, is increasing the volume of data generated in the OR. While recording[5] procedures through audio, video, and sensor-based equipment is becoming more common, access to this information is only available after the procedure is performed. Furthermore, it is often limited to surgeons within that hospital or practice and often lacks specific context that could aid other surgeons and procedures.

Healthcare providers that lean into digitization of processes are better positioned to augment their existing resources in a cost-efficient and effective manner. With the right tools and technology, every surgery could provide an opportunity to inform and enhance outcomes for the greater patient population — if the data can be captured, analyzed, and annotated to assist surgeons during procedures. These invaluable insights are the missing piece to improving the surgeon and patient experience and advancing the prevalence of quality patient care.

03 The Missing Piece: Augmented Intelligence

Every day, tens of thousands of surgeries are performed[6] in the U.S. alone; more than 13 million surgeries took place from January 1, 2019 through January 30, 2021. While this number may vary around the world, one thing is consistent: the need for contextualized data from and for the dynamic decision-making[7] that takes place during surgery.

Advancements in traditional laparoscopy continue to be driven by the introduction of robotic functionality and more efficient techniques. With better tools and more data available, however, there is still one key piece missing: surgical insight.

Surgical Insight Through Augmented Intelligence

In recent years, artificial intelligence[8] (AI) was introduced into robotically assisted surgery to give machines the ability to sense and engage. Machine learning[9], motion, natural language processing, voice recognition, and computer vision are all types of AI.

In machine learning, computer models are programmed with specific algorithms to learn and recognize desired behaviors and to draw inferences from data patterns. Augmented Intelligence[10] uses machine learning and deep learning, or the ability to mimic the human brain in processing data and identifying patterns, to support decision-making.

How does this help to improve surgery? A robotic surgical platform trained with clinical insights gleaned through Augmented Intelligence can enable surgeons to elevate their laparoscopic skills and surgical capacity, bringing greater reproducibility and consistency to surgical outcomes.

13 million+ surgeries took place from January 1, 2019 through January 30, 2021

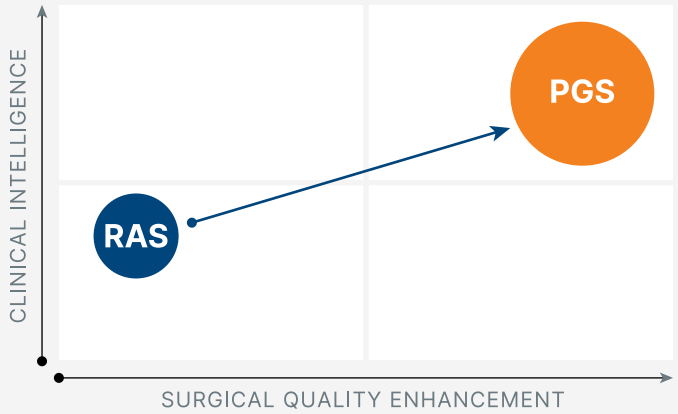
04 Augmented Intelligence and Performance-Guided Surgery™

As minimally invasive surgery evolves, it should leverage advanced technologies in an assistive role to enhance human intelligence rather than replace it. This is the foundation for Performance-Guided Surgery[11], a groundbreaking approach to mitigating surgical variability.

The Evolution of Robotic Surgery

Performance-Guided Surgery (PGS) Expands value by scaling clinical intelligence to increase predictability and deliver consistently-superior outcomes.

Robotic-Assisted Surgery (RAS) Ends with the surgeon using a computer to control the robotic arms and its end-effectors to perform surgical tasks



Performance-Guided Surgery leverages Augmented Intelligence to enable a robotic-assisted platform to perceive (computer vision), learn (machine learning), and assist (clinical intelligence) during surgery.

As the pioneer of Performance-Guided Surgery, Asensus Surgical developed the Senhance® Surgical System and the Intelligent Surgical Unit™ (ISU™) to capture, annotate, and store surgical data for future use. Moving forward, algorithms will take into account historical and predictive performance to glean insights for future procedures. The ISU is designed to perceive and assist surgeons with this clinical intelligence, which can be accessed through innovative/first-of-their-kind digital tools. Active eye tracking allows surgeons to seamlessly control vision during a robotic surgery procedure without stopping to reposition the camera. As well, digital measurement can be done from point to point or over contours, and digital tagging enables surgeons to place a tag wherever they choose to enable data-driven, real-time decisions on precise manipulation and incisions.

Performance-Guided Surgery aims to enhance the entire Surgical Decision Chain, enrich collaboration across surgical staff, and bridge the surgeon-patient gap with consistently superior outcomes.

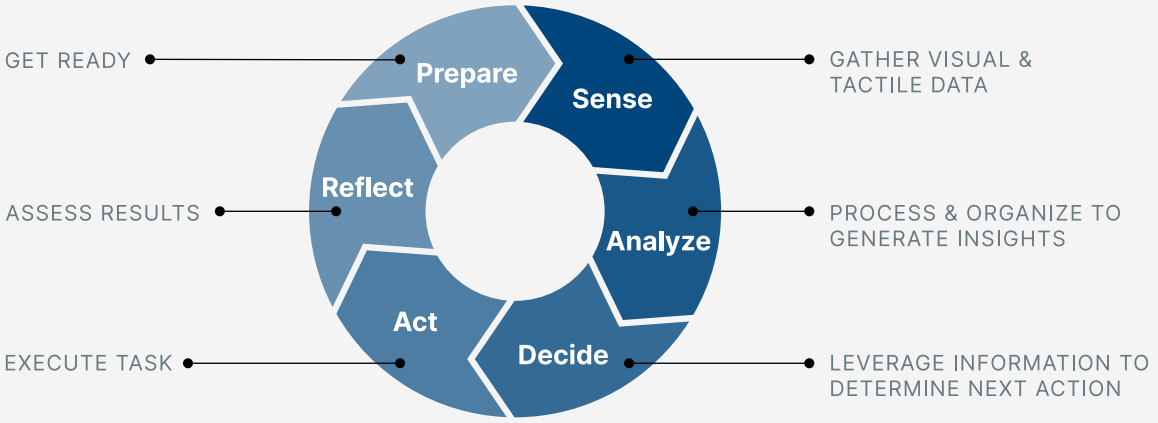
Ergonomic, Purposeful Design

The OR is a crowded environment with a myriad of critical equipment that creates a mix of audio and visual distractions for the surgeon and staff. Performance-Guided Surgery with an ergonomically-designed, open platform surgical system can ease surgeon fatigue, increase peripheral view, and enable clearer communication within the OR. The Senhance Surgical System includes a digital fulcrum that sets a dynamic virtual pivot point to help potentially minimize the incision trauma. Standard, reusable instruments enable hospitals to leverage existing technology investments and help to lower procedure costs.

Performance-Guided Surgery can:

- Ease surgeon fatigue
- Increase peripheral view
- Enable clearer communication within the OR

Surgical Decision Chain



Enhancing Surgical and Patient Outcomes

Performance-Guided Surgery has the potential to significantly mitigate[12] surgical complications and enhance the surgical staff's proficiency in the OR. Studies[13] have shown that technical skill varies widely among surgeons, and that greater skill is often associated with fewer postoperative complications and lower rates of reoperation, readmission, and visits to the emergency department. Performance-Guided Surgery with the Senhance Surgical System could enable more surgeons to adapt[14] to the robotically assisted controls regardless of experience level, rapidly bringing them up to speed in performing digitally-assisted laparoscopic procedures.

05 Who Could Benefit

Surgical variability, operating room inefficiencies, and workforce challenges[15] are impacting healthcare operations across the world. In the future, Performance-Guided Surgery may provide cost-efficient advancements for hospitals, as well as operational advantages for surgeons, and most importantly, patients:

The Hospital

- Attract a higher caliber of surgeons who desire to work with cutting-edge tools
- Reduce staff dependencies and with surgeon-controlled eye-tracking camera to free hands of surgical staff for other in-room activities
- Reduce staff resources needed in the OR during procedures
- Be economically responsible with standard reusable instruments and an open platform architecture that integrates into existing hospital ecosystems
- Accommodate patients seeking quality, dependable care
- Boost hospital reputation with proven procedures backed by data

The Surgeon & OR Staff

- Work with cutting-edge OR technology including 3mm instruments, automatic eye-tracking camera control, and 3D HD visualization of depth and spatial relation of organs
- Mitigate high incidence of physical strain[16] and fatigue[17] from laparoscopic procedures with an ergonomically enhanced surgical console
- Improve patient safety with an open platform layout that increases peripheral view and clear communication in the OR
- Access real-time insights through augmented tools for more precise procedures
- Replicate best practice surgeon skills and knowledge

The Patient

In addition to the benefits gained by hospitals their clinical staff, surgeons enjoy all the benefits associated with traditional MIS:

- Experience less incisional pain, scarring, and bleeding with smaller, more precise incisions
- Resume normal activities more quickly with reduced recuperation time
- Gain peace of mind from repeatable outcomes

06 Closing the Gap

Advancements in digital solutions will continue to evolve surgery with the goal of decreasing surgical variability, increasing efficiency, and enhancing patient care.

Innovations[18] in medical instruments, machines, and procedures have moved enhanced patient care closer to the OR. However, for hospital administrators who struggle to justify the cost of equipment upgrades and training for surgical staff, it is not necessarily within reach.

With the help of Augmented Intelligence, Performance-Guided Surgery is poised to provide a cost-effective solution to attain increasingly smarter insights for safer, more predictable outcomes. With contextualized information from Augmented Intelligence, surgeons will have access to an unprecedented level of historical data and predictive performance to be a step ahead and more confident in their decision-making during procedures. In the future, accumulated knowledge from surgeries around the world will help to drive the collective advancement of patient care.

Hospitals that adopt technology with a rapid utilization ramp can attract top surgeons, groom the next generation of physicians, and gain a reputation of excellence within their communities, ultimately attracting more patients. The availability of robotically assisted surgeries will help to expand possibilities and offerings for patients.

Hospitals that adopt technology with a rapid utilization ramp can:

- Attract top surgeons
- Groom the next generation of physicians
- Gain a reputation of excellence within their communities
- Attract more patients

Increasingly smarter insights for safer, more predictable outcomes.

06 Closing the Gap

Digital technology will continue to advance the ability for surgical tools to 'learn' in real time from the field of surgeons' knowledge, skills, and best practices, and for those learnings to be applied to the procedures they perform. Features such as haptic feedback[19] can heighten surgeons' sensing and pressure awareness for a more immersive and precise experience. Surgeons will be able to create and contribute to a digital legacy for future generations of surgeons to learn from.

Most importantly, Augmented Intelligence and Performance-Guided Surgery could profoundly improve the surgeon experience and patient outcomes.

Asensus Surgical understands the challenges of surgical variability and the importance of a data-driven, human-centric approach to surgery's shortcomings. Performance-Guided Surgery intends to address these challenges to aid surgeons at every level of experience – and to bridge the gap between hospitals, surgeons, and patients with repeatable results.

A system compatible with reusable instruments and existing technology investments, available today through Asensus, makes the newest surgical advancements more accessible and cost-effective. Ultimately, it could help to dramatically improve the range and quality of an institution's care while simultaneously helping its bottom line.

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Glossary

Augmented Intelligence
The use of technology to enhance human intelligence rather than replace it.

Haptic feedback
Haptic feedback heightens the surgeon's sensing of pressure or tension with sensations in the handles and alerts if a pressure threshold is reached.

Intelligent Surgical Unit™ (ISU™)
The digital engine behind the Asensus Augmented Intelligence system and the world's first Augmented Intelligence system approved by the FDA for use in surgery. During surgery, Augmented Intelligence enables a robotic assisted platform to perceive and assist the surgeon with clinical intelligence. The ISU is designed to integrate with the Senhance Surgical System, and is compatible with a wide selection of laparoscopic camera platforms to deliver a greater degree of surgeon control and clinical insight.

Machine learning
The use and development of computer systems that can learn and adapt without following explicit instructions by using algorithms and statistical models to analyze and draw inferences from data patterns.

Open architecture/system layout
An open console enables the surgeon to have full visibility of the entire operating room and clear communication with the staff at all times.

Performance-Guided Surgery
A form of computer-assisted surgery that digitizes the interface between the surgeon and patient and assists the surgeon when performing demanding procedures. Performance-Guided Surgery aims to combine Senhance robotic manipulation capabilities, clinical guidance during surgery, and surgery data collection and storage in the cloud for future use and future surgeries to enable consistently superior outcomes for a new standard of surgery.

Real-time insights
Augmented Intelligence aims to enable the surgeon to access surgical data while performing the procedure.

Robotically assisted surgery
Usually associated with minimally invasive surgery, robotically assisted surgery allows doctors to perform many types of complex procedures with more precision, flexibility and control than is possible with conventional techniques.

Senhance® Surgical System
As the first digital laparoscopic platform on the market, the Senhance Surgical System provides surgeons with an unprecedented level of control. It offers hospitals a value-driven healthcare model that delivers surgical best practices with a focus on optimal patient outcomes, and cost optimization with standard reusable instruments and an open-platform architecture strategy.

About Asensus Surgical

Asensus Surgical, Inc. and our amazing 200+ team members in 12 countries are committed to developing technology that helps surgeons deliver life-changing patient care with consistently superior outcomes.

For so long, the industry has focused on incremental advancements in robotic equipment; innovations that bring speed, dexterity, and a clear view of what's in front of us to do surgery. Augmented Intelligence goes further by giving surgeons a sense of what's around the corner. And as a surgeon builds on their digital legacy, our technology only gets smarter, ensuring that every surgery that follows will be, too.

Asensus Surgical is digitizing the interface between the surgeon and patient to pioneer a new era of Performance-Guided Surgery by unlocking clinical intelligence for surgeons to enable consistently superior outcomes and a new standard of surgery.

Asensus Surgical - Digital Laparoscopy & Surgical Robotics Manufacturing Company | Asensus

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