Critical View of Safety (CVS) Challenge Summary Report
October 2025

BACKGROUND

Before the CVS Challenge, there was no standardized or validated dataset for identifying the Critical View of Safety (CVS) in laparoscopic cholecystectomy, the surgical step essential for preventing bile duct injury. Various research groups were developing artificial intelligence (AI) models independently, but they lacked a common definition, data source, or benchmark for comparison. Each lab's "ground truth" was inconsistent, often based on limited or non-expert annotation. This made it impossible to evaluate or compare performance across models, impeding progress toward safe and trustworthy AI for surgery.

The goal was to create the first globally validated, expert-annotated dataset defining the Critical View of Safety and to organize an international competition to benchmark AI models against that gold standard. The challenge aimed to:

- Standardize how CVS is defined and recognized in surgical videos;
- Build the world's largest annotated dataset for laparoscopic cholecystectomy;
- Accelerate innovation by enabling global researchers to test and improve their AI models using the annotated dataset;
- Reinforce SAGES' leadership role in surgical safety and digital innovation.

CVS CHALLENGE DESCRIPTION

1. **Planning & Concept (2019–2021):** Formed the SAGES AI Task Force (later Committee). Developed consensus guidelines for surgical video annotation and data governance for surgical videos. Trained dozens of annotators worldwide.

2. **Video Collection and Annotation Phase (2021–2023):** Global video collection and labeling through partnerships with Surgical Safety Technologies and Microsoft Azure. Recruited global hepatobiliary surgeons to create expert labels defining the CVS. Launched the *Annotation School* and developed standardized annotation schemas for temporal and spatial data.

3. **MICCAI:** The Medical Image Computing and Computer Assisted Intervention Society (MICCAI) is the premier international society for medical imaging and computer-assisted intervention research, composed largely of engineers and computer scientists. Its endorsement is the highest quality standard for medical AI datasets and challenges.

   Being selected first as a MICCAI Challenge (2024) and then as a MICCAI Lighthouse Challenge (2025) positioned SAGES as the first surgical society to lead a MICCAI-endorsed competition, bridging surgical and engineering communities and validating the rigor and clinical impact of the project.

   MICCAI 2024 Challenge First public CVS Challenge accepted by *MICCAI* Society. Focused on identifying the CVS in laparoscopic cholecystectomy videos using AI models. Over 40 teams from multiple continents participated. **Outcome:** The winning team achieved ~96% concordance with expert annotations. The top team was Theator, a commercial AI group, demonstrating translational potential.

MICCAI 2025 "Lighthouse Challenge": Elevated to "Lighthouse" status, one of only five selected for "high clinical impact." This phase expanded the challenge to test model *robustness*, *uncertainty*, and *efficiency under limited computing resources.* Participants included teams from Nepal, Colombia, and other emerging centers, demonstrating global engagement and equitable access. **Outcome:** Multiple global teams (Nepal, Colombia, and others) excelled under limited compute and segmentation tasks, showing democratization of innovation.

BUDGET

Entirely funded from in-kind and external contributions.

List of Supporters and Contributions:

- SAGES Foundation Grant ($15,000)
- MICCAI endorsement (non-financial, structural support)
- Industry partners and research institutions (including in-kind data and compute resources)
    - Educational grants from Intuitive, Medtronic, and Olympus ($35,000 each)
    - Surgical Safety Technologies (SST): ~$90,000 in-kind software and technology support, cost $10,000/year maintenance.
    - Additional in-kind support: Azure cloud hosting, MGH compute infrastructure, and partnerships with academic collaborators.

ACCOMPLISHMENTS & DELIVERABLES TO DATE

- **Annotation School:**

  Developed and validated the world's first structured curriculum for surgical video annotation. Now a transferable model for other procedures (e.g., VBA initiative, FLS automation).

- **Videos / Datasets:**

  Will be available first to SAGES members and then made available to public. Expert-labeled global dataset of CVS videos, valuable for training AI and future SAGES initiatives such as Video Based Assessment (VBA).

    - Over three years of global data collection; 1,000+ videos collected.
    - All labeled by expert surgeons using standardized schemas.
    - The largest surgical video dataset labeled for CVS, creating a global "gold standard" for surgical AI research.

- **Partnerships & Communities Formed:**

  Built an international community of surgeons, engineers, and industry experts collaborating on surgical AI. Through this effort, the organization established key partnerships with MICCAI, Surgical Safety Technologies, MGH, NVIDIA, Google, Oracle, AWS, and prospective partners at Microsoft. The challenge also engaged global contributors from institutions across the United States, Brazil, Mexico, Japan, China, and Europe.

Research & Scholarly Activity:

A technical paper from the CVS Challenge has been accepted for publication in the MICCAI proceedings. A clinical manuscript is currently in preparation for submission to *Surgical Endoscopy*. In addition, an accompanying publication titled *"SAGES Annotation School Methodology"* is being developed to describe the framework created for surgical video annotation.

- **SAGES Brand & Impact:**

  The CVS Challenge reinforced SAGES' reputation as a leader in surgical innovation and a global pioneer in the application of artificial intelligence to surgery. It positioned SAGES as the first surgical society to organize an internationally recognized AI challenge, setting a precedent for others in the field. The initiative also attracted new audiences from academia, industry, and global research communities, expanding SAGES' visibility and influence among AI, engineering, and data science audiences.

- **Additional Achievements:**
  - Inclusion as a 2025 *MICCAI Lighthouse Challenge*, one of only five worldwide.
  - Established a repeatable pipeline for ethical, multi-institutional surgical AI collaboration.

NEXT STEPS FOR CURRENT CVS CHALLENGE

Infrastructure:

- Use remaining current budget for STS to continue storing videos/datasets.
- Develop Governance & Infrastructure
  - Build internal system for data request, tracking, and usage agreements.
  - Evaluate long-term data storage and infrastructure partnerships (e.g., AWS, Azure).

Release Plan:

- Datasets and videos to be released to SAGES members: Fall 2025
- Public release (via MICCAI repository) with required SAGES citation: Fall 2025

Upcoming Deliverables:

- Publish the SAGES Annotation School Protocol paper.
- Finalize and publicize the 2024 and 2025 Challenge results and analysis.

FUTURE POTENTIAL & CONSIDERATIONS

The CVS Challenge leaders propose a next phase to our current goals and task force. The Critical Vision of Surgery (CVS) would extend the methodology beyond laparoscopic cholecystectomy to other procedures (colorectal, bariatric, foregut, and hernia surgery) important to the Society. It would leverage the previous work and reinforce SAGES' identity as the innovation society in surgery.

Key strategic considerations:

- Expand annotation to other specialties using the existing school model.
- Work with other SAGES sub-specialty committees to identify areas of greatest clinical need
- Integrate with SAGES VBA for AI-driven scoring and feedback.

- Form strategic partnerships with non-traditional funders beyond medtech (AI tech, imaging, data companies) and global research funders (Wellcome Trust). Explore cost-sharing and co-development for infrastructure and new datasets.
- Maintain leadership in surgical AI innovation, continuing the role of SAGES as the defining authority in what constitutes a “safe” and “expert” operation in the age of machine learning.