C-SATS
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Harnessing the Power of Machine Learning to Create a Learning Health Care System

There's no disputing the burden or the cost of surgical mortality and morbidity. One study[1] from the *New England Journal of Medicine*, estimates that the rate of mortality after surgery varies widely from hospital to hospital, ranging from 3.5 to 6.9 percent.

Another study[2] from the *Annals of Surgery*, found the risk of anastomotic leak as high as 18% for minimally invasive esophagectomy during the learning phase for surgeons. These negative outcomes may be due, in part, to the learning curve of surgeons.

In terms of financial impact, one recent study[3] in Michigan compared more than 5,000 surgeries, both with and without complications, across many hospitals. The authors concluded that complications were associated with significant increases in costs.

With numbers like these, you may ask yourself, "What can be done to accelerate the learning curve, while potentially reducing variation and costs?"

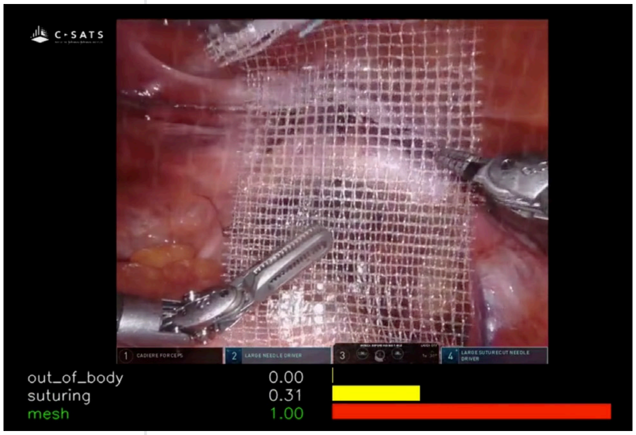
C-SATS marries technological speed with personalized insights to help surgeons strive to reduce outcomes variation through objective surgical analysis and individualized coaching. Created by a team of surgeons, biostatisticians, and computer scientists, C-SATS allows expert surgeons and trained reviewers to provide anonymous feedback to surgeons via shared video recordings of their procedures. Through the C-SATS platform, surgeons are empowered with confidential, near-real-time reviews of cases that are intended to enhance their performance with the goal of improving patient outcomes. Since 2014, C-SATS has amassed the surgical commentary to drive increasingly intelligent software that can help identify procedure steps and critical phases within a case.

The C-SATS platform uses a unique combination of data, computerized analysis and human insights to provide crucial feedback to help surgeons improve surgical skill and technique. These serve as the foundation for an emerging machine learning capability focused on building a learning health care system.

Artificial intelligence (AI) [simulation of intelligent human behavior in computer systems], machine learning (ML) [systems that learn from data sets without being explicitly programmed], and computer vision (CV) [a system's ability to extract meaningful information from images/videos] are core components of the C-SATS platform. ML is a subset of AI. All ML is considered AI, but not all AI is considered ML. One can use ML in CV projects, but not all CV projects are solved through leveraging ML.

What if you could?

- **Record and analyze** important steps in a surgical procedure
- Pool experience and **determine best practices based on objective metrics**
- Provide training that is designed to help surgeons **minimize learning curve morbidity**
- Offer **learning opportunities** inside and outside the OR

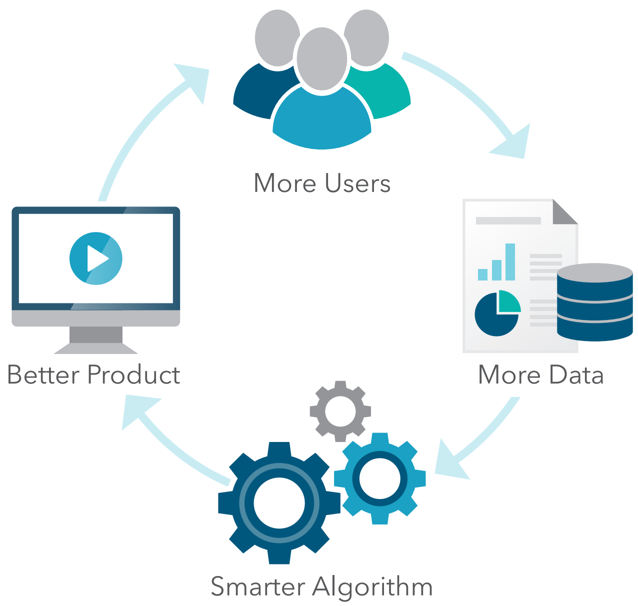


C-SATS actively uses ML techniques to build classifiers that extract meaningful information from video.

Machine learning means scale and analytic efficiency which allows for insights beyond what a single surgeon will see in their lifetime. By absorbing so many bits of raw data, the learning system can identify increasingly subtle variations that could provide new targets for improvement. This can then be applied to answer questions and reduce variability of practice, including:

- Identification of devices and procedure steps to increase efficiency
- Indication of anatomically challenging cases
- Evaluation and analysis of procedure variables to systematically develop standardization and drive more efficient procedures in terms of health care utilization/costs

Machine learning allows for a continually learning health care system that increases efficiency, bends the learning curve, improves clinical outcomes and reduces costs. Research, including a study[4] from the *New England Journal of Medicine*, supports the fundamental idea that improving surgical skill will improve outcomes. Connecting machine learning to this type of research holds the promise of accelerating and developing novel quality improvement (QI) research at scale.



Digital Surgery Vision

Machine Learning has the potential to improve safety in the Operating Room by:

- Analyzing information **with a high level of granularity**
- Minimizing the **learning curve**
- Leveling **perception and judgement**
- Leveraging skills **objectively optimized on pooled knowledge**

In the future, it is possible that a surgeon could receive a suggestion on the dashboard following a surgery that might influence patient care. For instance, if the C-SATS platform could notice that there was twice the amount of cauterization during a surgery, the platform might then show the surgeon a suggestion for improved technique related to tissue handling and hemostasis.

With the continued evolution of ML, C-SATS is a pioneer in helping improve surgical performance and creating a library of surgical procedures that could inform new innovations, thus transforming the health care system on a global scale.

Care to learn more about the C-SATS platform and how we are leveraging the power of ML to improve patient outcomes?

Let's connect. info@csats.com

References/Resources

1 "Variation in Hospital Mortality Associated with Inpatient Surgery," *New England Journal of Medicine*, 2009:361 (14) 1368-1375.
2 "Learning Curve and Associated Morbidity of a Minimally Invasive Esophagectomy," *Annals of Surgery*, 2017.
3 "Hospital and Payer Costs Associated with Surgical Complications," *JAMA Surgery*, 2016;151(9):823-830.
4 "Surgical Skill and Complication Rates after Bariatric Surgery," *New England Journal of Medicine*, 2013: 369: 1434-1442.