How do variations in energy delivery impact clinical outcomes? A novel method to measure and compare techniques of energy device usage.

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INTRODUCTION

- Video Based Analysis (VBA) and artificial intelligence (AI) can uncover previously inaccessible data on variable intraoperative events, driving research that identifies optimal techniques
- Surgeons vary widely in their techniques for the same energy-driven dissection tasks, whether in energy delivery method (monopolar vs bipolar vs ultrasonic), device settings (mode, power level, etc.), or device usage (duration of activation, tension on tissue, etc.). These techniques all theoretically vary in their respective microscopic impact on target and surrounding tissues.
- It is unclear if and how these variations impact patient outcomes past anecdotal theory[1]. Here we demonstrate objective methods to measure energy usage techniques for bipolar and ultrasonic devices.

METHODS

- Computer vision (CV) models can facilitate the scalable collection of energy device data from surgical video recordings.
- These data are initially generated by trained annotators, which are then used to train a CV model to automatically detect the same data in new videos with limited human intervention.

METHODS (cont.)

- These include data such as:
  1. Duration of on-screen device presence
  2. Frequency of activations
  3. Duration of activations
  4. Surgical momentum (number of activations per minute of case time)
  5. Activation momentum (number of activations per minute of total activation duration)
- Comparing these data at scale allows for an objective approach to measure differences in surgeon skills, techniques, and devices[2]
- Figure 1 below demonstrates a very close alignment between inference (automatic CV model detection) and ground truth, while figure 2 shows that majority of the activations (~80%) are longer than 1.9 sec which was used to identify the length of each clip during the training.

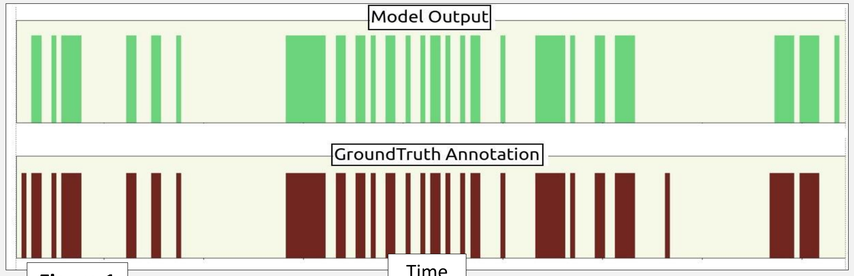


Figure 1

RESULTS

Data: 57 Roux-en-Y gastric bypass recordings across at least 6 surgeons were annotated by trained annotators and the AI model. Analyses of these videos showed the following variations per case:

Device Presence Duration	**49 to 871 sec (STD = 185.9)**
How long is the instrument on screen?	
Activation Count	**4 to 92 activation instances (STD=19.6)**
How many times is the instrument activated?	
Surgical Momentum	**2.4 to 15.4 activations/min (STD=2.9)**
How often is the instrument being activated?	
Activation Momentum	**13.3 to 41.9 activations/min of activation time (STD=7.0)**
How long is the instrument being activated for?	

A separate analysis of 118 sleeve gastrectomy cases for this metric showed a range of 5.1 to 34.1 activations/min of activation time (STD=6.7)

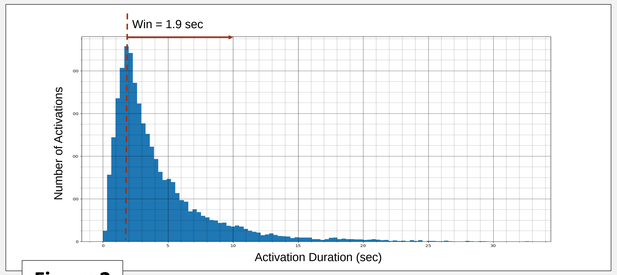


Figure 2

CONCLUSIONS AND FUTURE DIRECTIONS

- Wide variations in exist in how energy devices are used even within the same procedure, step, and/or task
- This framework and subsequent CV technologies can help determine if and how these variations impact clinically significant outcomes[3]
- CV models are currently being built to automatically detect the presence and activation of an instrument. Momentum will be analyzed across surgeons in relation to bleeding events and other case metrics to attempt understanding of surgeon skill, techniques, and patient complexity

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DISCLOSURES

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