Automated Surgical Workflow Analysis Utilizing Infrared Depth Sensors in Robotic Bariatric Surgery: A Feasibility Study

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INTRODUCTION

- Studying surgical workflow has become vital for improving efficiency and safety in the operating room (OR). The increased integration of robotic-assisted systems in surgery requires innovative solutions to assess workflow
- While prior research has employed video recordings for OR workflow analysis, patient confidentiality, and staff privacy remain a concern
- We describe an automated system using infrared depth sensors that can automatically assess OR workflow

METHODS

Two Time-of-Flight cameras with infrared and 3D depth sensors installed in robotic ORs

Automated algorithm processed the data → time stamps were extracted

Key elements of surgical workflow were identified including robotic docking, undocking and incision/closure times

RESULTS



Gastric Bypass
21 (60%)



Sleeve Gastrectomy
7 (20%)



Biliopancreatic Diversion w/ DS
7 (20%)

	Mean* ± SD	CV^	Mean* ± SD	CV^	Mean* ± SD	CV^
Patient preparation	**46 ± 10**	0.22	**31.8 ± 7**	0.22	**52.8 ± 13**	0.25
Port placement	**15.5 ± 8**	0.52	**11.4 ± 2**	0.18	**17.8 ± 15**	0.84
Robot docking	**6.2 ± 3**	0.48	**5.1 ± 1**	0.20	**5.1 ± 1**	0.20
Operative time	**168.9 ± 47**	0.28	**78.4 ± 24**	0.31	**175.7 ± 35**	0.20
Robot undocking	**1.8 ± 1**	0.56	**1.6 ± 1**	0.63	**1.4 ± 1**	0.71
Incision closure	**22.7 ± 8**	0.35	**20.7 ± 8**	0.39	**21.9 ± 7**	0.32
Total duration	**258.1 ± 51**	0.20	**152.1 ± 31**	0.20	**269.1 ± 45**	0.17

*Duration in minutes. Abbreviations: w/ DS = with duodenal switch, SD = standard deviation, CV = coefficient of variation
^CV= SD/Mean. Less than 0.30 reflects consistent data, while higher numbers reflect increased variability within the data

CONCLUSION

The use of infrared depth sensors for operating room workflow analysis is feasible

The automatic process of analyzing and extracting data preserves patient and staff privacy

This technology can be utilized to optimize efficiency in the OR and may impact patient outcomes

FUTURE DIRECTIONS

Testing of the validity and reliability of the system in the setting of robotic bariatric surgery using a larger sample size

Studying the association between surgical workflow and patient outcomes

Investigating factors associated with improved efficiency of surgical workflow

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