Surgical Innovation

Mayo Clinic Rochester MN USA
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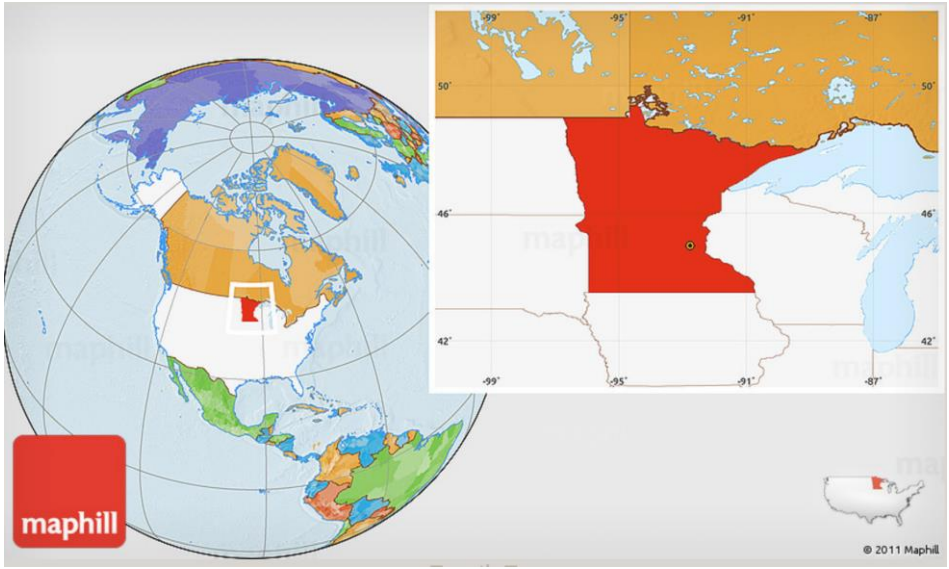
Thank You


24th
Silver Jubilee of ESCRS
ANNUAL CONFERENCE
OF THE EGYPTIAN SOCIETY
OF COLON AND RECTAL SURGEONS

Disclosures

- No Disclosures

You Might Think this is Minnesota



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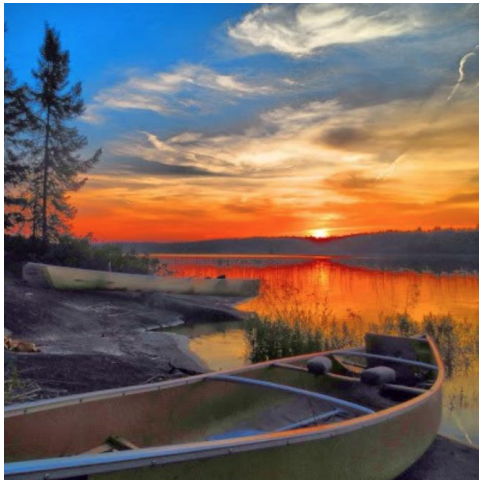


Surgical Innovation

“To achieve something you’ve never had, you might have to do something you never done”

- Academic Research (Patients First Charity)
- Technical Excellence (Intraoperative)
- Collaboration (Perioperative Care)

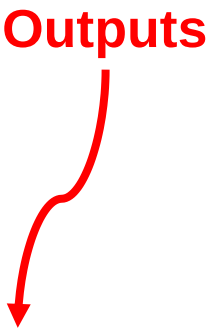
MAYO CLINIC

How Do We Surgically Innovate?

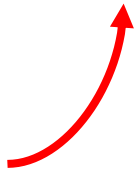
Historical Frame of Mind?

- Traditional Questions:
  - **What Surgical Tools** Will We Develop
    - **How Will We Use** Them

Modern Frame of Mind?



- Historical Question:
  - What Tools Will We Develop?
- **Modern Question:**
  - **What Will Pts/Providers do Differently if We Succeed?**



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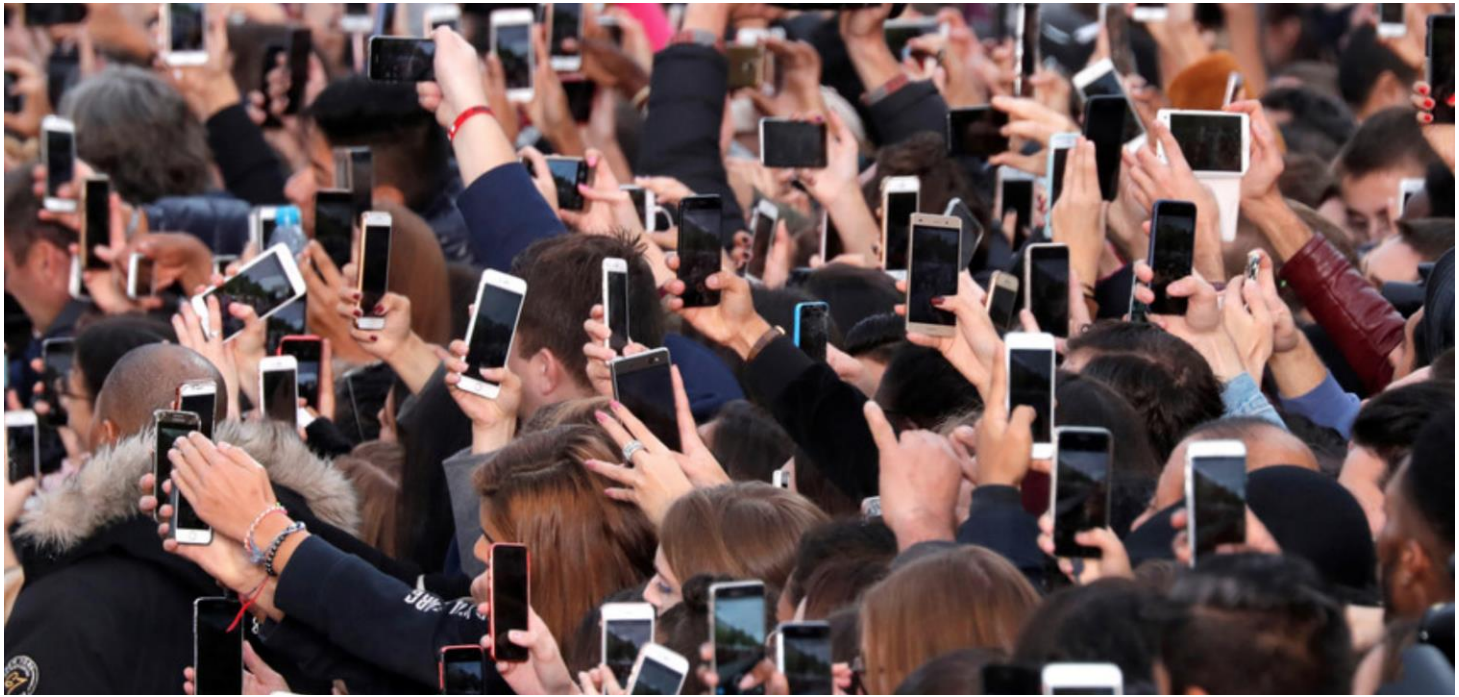
Why not bet on the Tool?

Reason 1: The Tool/Product

Doesn’t guarantee the Behavior we seek.

Reason 2: Human Behavior is Unpredictable

Reason 3: Behavior emerges through product use.



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What is the Behavior we seek?

Align **Values** (surgical excellence/research/collaboration)
with **Tools** to achieve **Innovation**

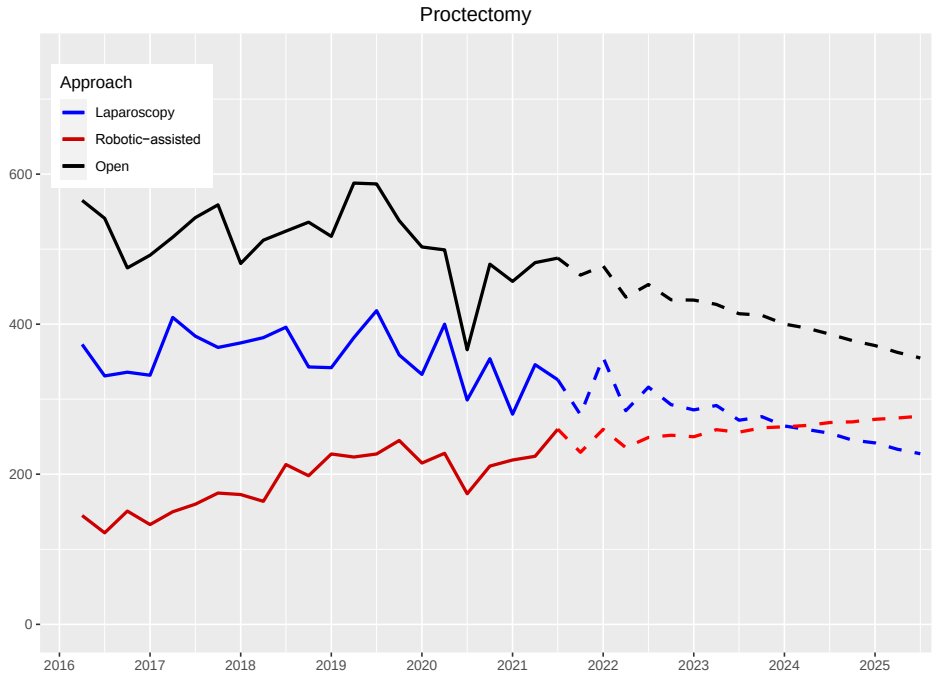
The Future According to Larson?

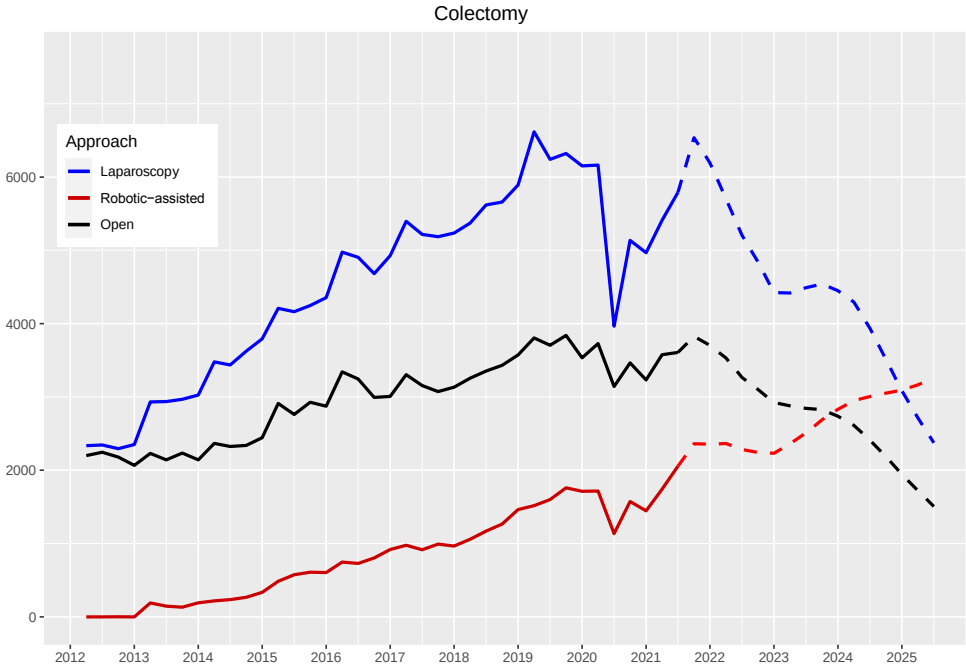
- **Surgeons:**
  - **Deliver Cures** through **Minimal Means**
    - Surgical, Biological, Energy, Pharmacological.
  - Surgery is **Outpatient.**
- **Patients:**
  - **Minimize Clinic or Hospital exposure**
    - **Medical care provided at Home.**
      - Virtual, Automated, Proactive (Descriptive, predictive, prescriptive)

Steps along the Way:
Technical Evolution

From Maximal to Minimal Surgery

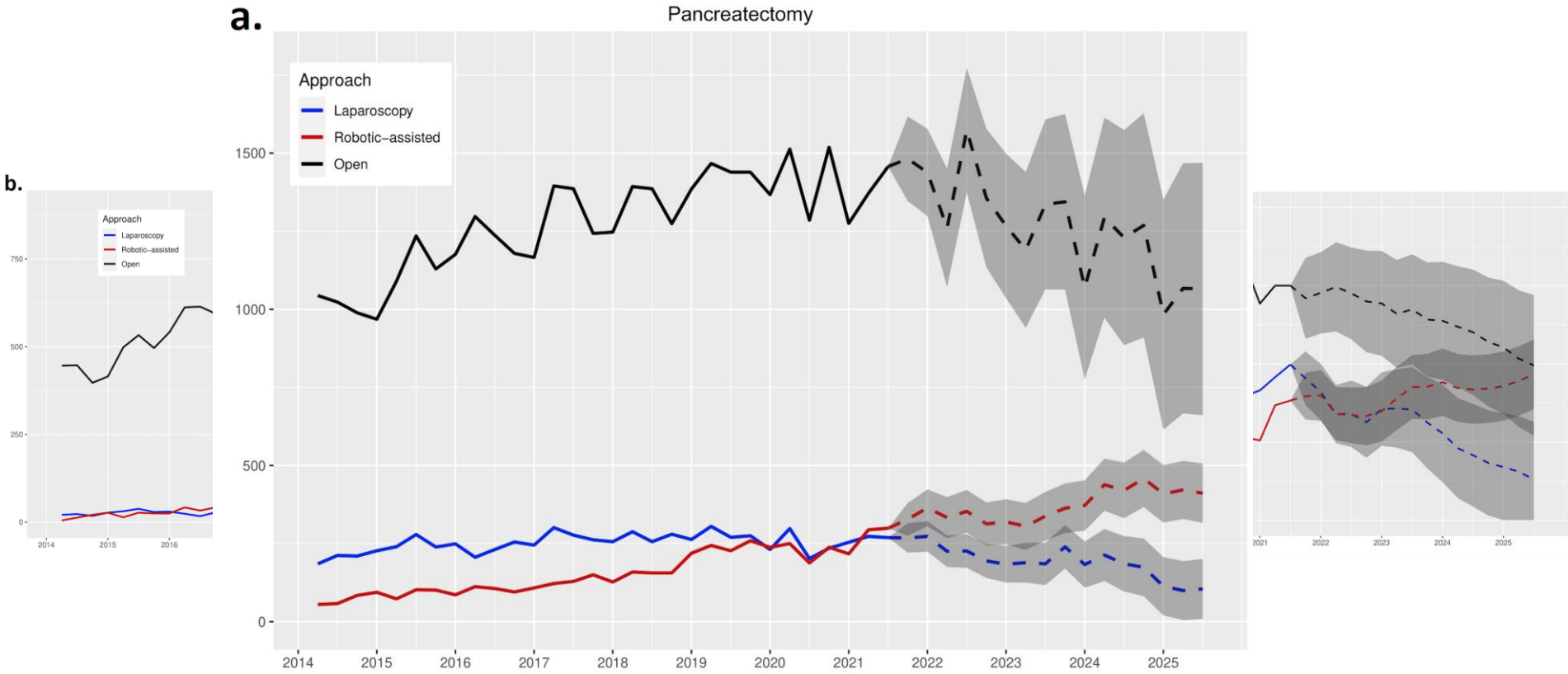
The Death of Laparoscopic Surgery: 360K NSQIP





The Death of Laparoscopy. Davide Ferrari*[1,2], Tommaso Violante*[1,3], Marco Novelli[4], Janani S. Reisenauer, Patrick Starlinger, Rory L. Smooth, David W. Larson[1]

The Death of Laparoscopic Surgery: 360K NSQIP



The Death of Laparoscopy. Davide Ferrari*[1,2], Tommaso Violante*[1,3], Marco Novelli[4], Janani S. Reisenauer, Patrick Starlinger, Rory L. Smooth, David W. Larson[1]

Disruptive Platform to Iterate:

April 2009

OS3
Da Vinci Si

April 2014

OS4
Da Vinci Xi

May 2017

OS4
Da Vinci X

May 2018 US

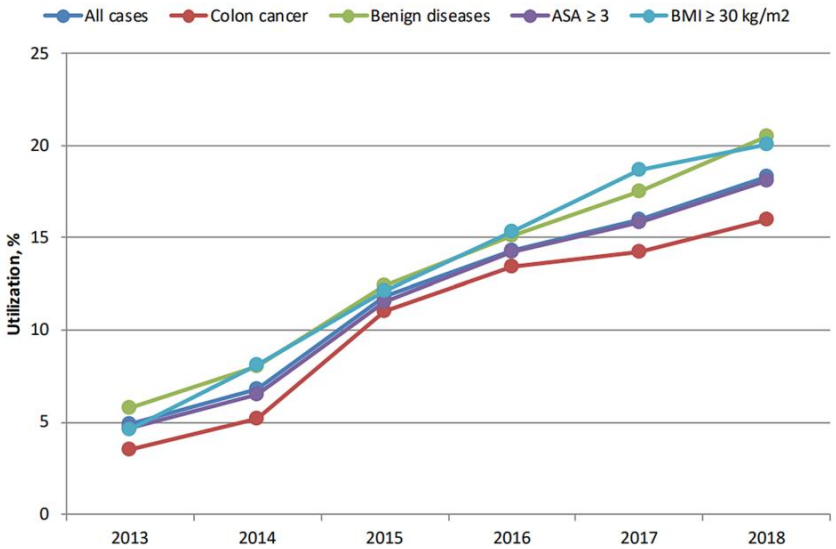
OS4
Da Vinci SP*

Radical Platform
2020 ION

Risks of Conversion

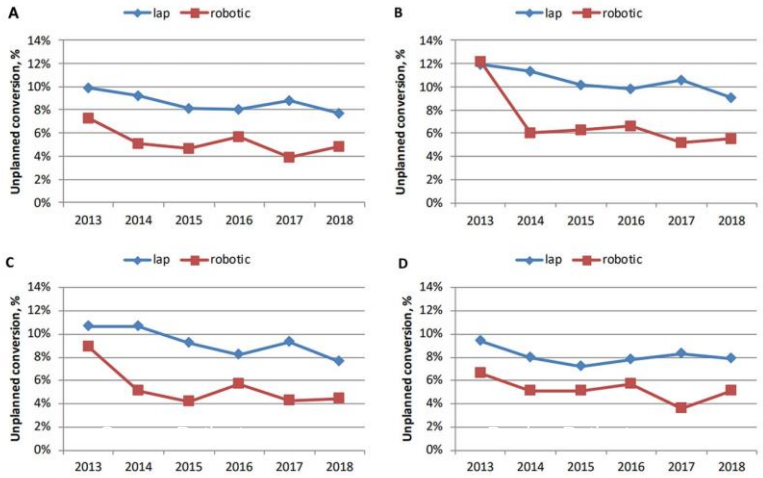
66,652 Patients from NSQIP

Use of Robotics



Conversion Leads to Increase:

- **Mortality,** **OR 2.28**
- **Complications,** **OR 2.36**
- **LOS >6 days,** **OR 2.86**



Trends and consequences of surgical conversion in the United States

Mohamed A. Abd El Aziz[1] · Fabian Grass[1] · Kevin T. Behm[1] · Anne-Lise D'Angelo[1] · Kellie L. Mathis[1] · Eric J. Dozois[1] · David W. Larson[1]

Conversion Risk

13.8% vs 5%

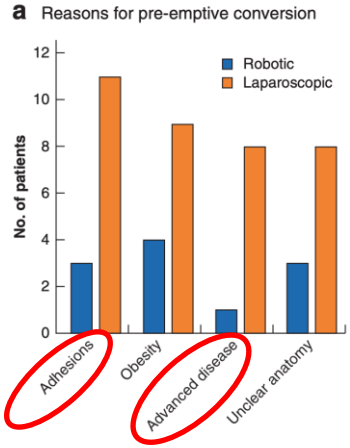
Table 2 Surgical details

	Conversion (n = 55)	No conversion (n = 545)	Total (n = 600)	P†
Procedure (LAR)	36 (65)	398 (73·0)	434 (72·3)	0·241
Surgical approach				< 0·001
Robotic	16 (29)	301 (55·2)	317 (52·8)	
Laparoscopic	39 (71)	244 (44·8)	283 (47·2)	

Table 4 Logistic regression analysis of conversion risk in all patients

	Univariable analysis		Multivariable analysis	
	Odds ratio	P	Odds ratio	P
Sex (M *versus* F)	1·84 (0·95, 3·58)	0·059	2·08 (1·03, 4·23)	0·004
BMI (≥ 30 *versus* < 30 kg/m^2)	2·76 (1·57, 4·84)	< 0·001	2·90 (1·60, 5·27)	< 0·001
Procedure (LAR *versus* APR)	0·7 (0·39, 1·26)	0·241		
Type of surgery (robotic *versus* laparoscopic)	0·33 (0·18, 0·61)	0·001	0·28 (0·15, 0·52)	< 0·001
Treated stage				
I	1·00 (reference)		1·00 (reference)	
II	1·98 (0·81, 4·81)	0·132	2·80 (1·10, 7·10)	0·031
III	1·63 (0·76, 3·50)	0·209	2·24 (1·01, 4·98)	0·048
Previous abdominal surgery	1·43 (0·79, 2·57)	0·233	1·95 (1·03, 3·70)	0·041
ASA grade (III–IV *versus* I–II)	1·42 (0·80, 2·55)	0·231	1·13 (0·61, 2·11)	0·689
Age	0·99 (0·97, 1·12)	0·407		
Duration of surgery	1·00 (0·99, 1·00)	0·362		
Neoadjuvant therapy	0·95 (0·60, 1·84)	0·858		

Fig. 1 Reasons for conversion according to surgical approach

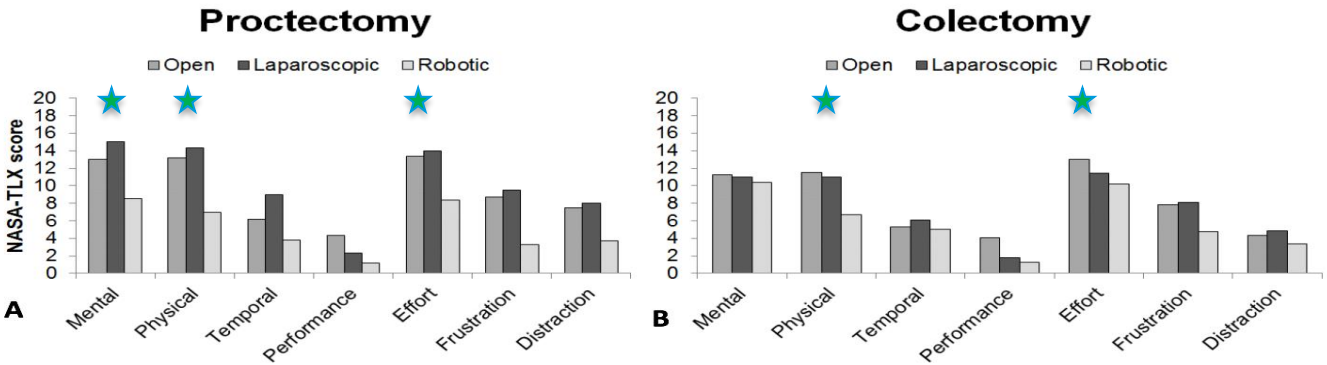


Crippa, Achilli, Larson BJS 2020

Surgeon Workload
217 Case-Modified NASA-TLX

	SURGICAL APPROACH		
	Open	Laparoscopic	Robotic
	M(SD)		
Surgical duration	185.1 min (124.4)	199.3 min (101.5)	357.5 min (117.5)
Overall workload	45.0 (21.4)	47.0 (21.9)	35.3 (19.5) ★
Mental demand	9.4 (5.2)	11.1 (5.3)	9.5 (5.9)
Physical demand	9.0 (5.6)	10.7 (6.1)	6.9 (5.2) ★
Effort	10.2 (5.8)	11.1 (5.8)	9.4 (6.0) ★
Performance	3.0 (3.4)	1.8 (1.8)	1.3 (1.4) ★
Frustration	6.2 (5.3)	7.5 (6.1)	4.1 (3.8) ★

Figure 3. Average workload for proctectomy (A) and colectomy (B) procedures according to surgical approach



Quantifying contributions to variation can identify strategies to reduce surgeon workload Katherine L. Forsyth, Ph.D., [1,2] Bethany R. Lowndes, Ph.D., M.P.H., [3] Scott R. Kelley, M.D., [4] Renaldo C. Blocker, Ph.D., [1,2] David W. Larson, M.D., MBA, [4]M. Susan Hallbeck, Ph.D., [1,2,4] Heidi Nelson, M.D., [4]

Robotic vs Laparoscopic Rectal Surgery at Mayo

317 Robotic vs 283 Lap

	ROBOTIC (317)	LAPAROSCOPIC (283)	TOTAL (600)	p value
LOS				*<0.001*
Median (IQR)	3 (3-5)	5 (4-7)	4 (3-6)	
LOS≥6 days	68 (21.45%)	122 (43.11%)	190 (31.7%)	*<0.001*
Readmission	43 (13.6%)	30 (10.6%)	73 (12.2%)	*0.266*
Overall Complication	118 (37.2%)	145 (51.2%)	263 (43.8%)	*<0.001*
Anemia	13 (4.1%)	28 (9.9%)	41 (6.8%)	*<0.005*
Transfusion	6 (1.9%)	22 (7.8%)	28 (4.7%)	*<0.001*
Ileus	50 (15.8%)	51 (18.0%)	101 (16.8%)	*0.463*
Leak*	23 (10.9%)	14 (8.9%)	37 (8.5%)	*0.238*
Superficial wound infection	20 (6.3%)	15 (5.3%)	35 (5.83%)	*0.598*
Cardiopulmonary complications	16 (5.05%)	20 (7.07%)	36 (6%)	*0.299*
UTI	5 (1.6%)	14 (4.95%)	19 (3.2%)	*0.020*
Acute Kidney Injury	6 (1.89%)	8 (2.83%)	14 (2.33%)	*0.449*
Adjuvant Therapy	179 (57.2%)	149 (52.65%)	328 (55.0%)	*0.266*
Death <30 days	1 (0.3%)	1 (0.3%)	2 (0.3%)	*0.936*

*Legend: IQR: Interquartile Range; LOS: Length of Stay; UTI: Urinary Tract Infection; *: Assessed for patients undergoing restorative surgery.*

Pathological Markers

Positive CRM	1 (0.3%)	4 (1.3%)	5 (0.83%)	*0.379*

Multivariant Risks for Complication

Type of surgery (Robotic vs Laparoscopic)	0.56 (0.40-0.78)	*<0.001**	0.485 (0.29-0.82)	*0.006**

Robotic surgery for rectal cancer provides advantageous outcomes over laparoscopic approach: results from a large retrospective cohort. Ann Surg 2020. *Jacopo Crippa, MD[a], Fabian Grass, MD[a], Eric J. Dozois, MD[a], Kellie L. Mathis, MD[a], Amit Merchea, MD[b], Dorin T. Colibaseanu, MD[b], Scott R. Kelley, MD[a], and David W. Larson, MD, MBA[a]*

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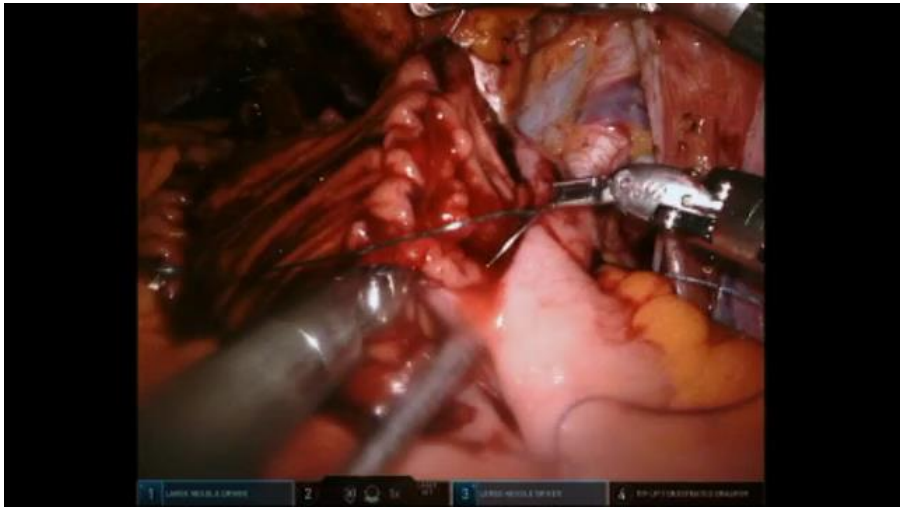
Complexity to Simplicity

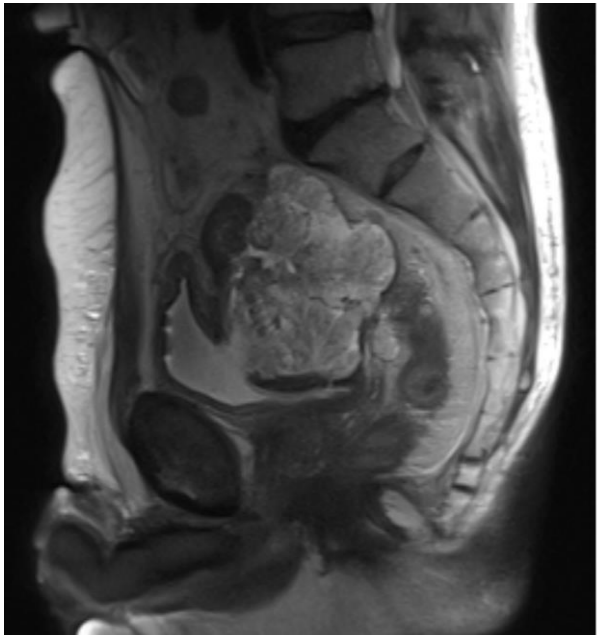
Complex IBD

Pouch Excision

Pouch Revision



Advancing Complex Disease
T4 disease Multi-visceral Resection



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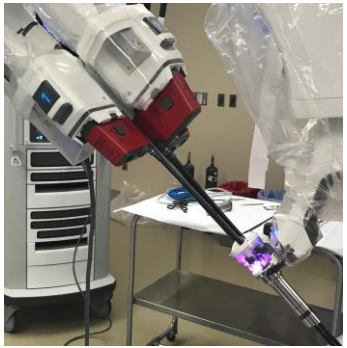
From Minimal to Minimum

Multi Port vs Single Port

XI Robot

SP Robot



Case	Final histology	Specimen size (cm)	Specimen area (cm^2)	LOS	Readmission	Return to OR	FU	Recurrence
1	TVA LGD	2.8 x 2.7 x 1.2	7.6	0	0	0	21	0
2	TVA LGD	5.4 x 4.2 x 1.6	22.7	0	1	0	22	0
3	T1 G2 adenocarcinoma	2.5 x 2.1 x 1.1	5.3	0	0	0	30	0
4	TVA LGD	1.9 x 1.3 x 0.9	2.5	0	0	0	15	0
5	TVA LGD	2.5 x 2.5 x 0.4	6.3	0	0	0	11	0
6	T2 G2 adenocarcinoma	2.6 x 2.5 x 1.4	6.5	0	0	0	24	0
7	T1 SM3 G2 adenocarcinoma	1.9 x 1.8 x 0.6	3.4	0	1	LAR	20	0
8	T1 G2 adenocarcinoma	1.2 x 1.2 x 0.6	1.4	0	0	0	23	0
9	TVA HGD	4 x 2.9 x 2.7	11.6	2	0	0	19	0
10	TVA LGD	3.3 x 3 x 0.7	9.9	0	0	0	12	0
11	Tis G1 adenocarcinoma	3.1 x 2.9 x 0.8	9	0	0	0	12	0
12	TVA HGD	1.4 x 0.9 x 0.2	1.3	0	0	0	8	0
13	T1 SM3 G2 adenocarcinoma	2.9 x 2.5 x 0.9	7.3	0	0	0	11	0
14	T2 G1 adenocarcinoma	2.2 x 2.1 x 0.9	4.6	2	0	0	9	0
15	T2 G2 adenocarcinoma	0.6 x 0.4 x 0.4	0.3	0	0	0	7	0
16	No residual tumor	2.7 x 2.2 x 0.8	5.9	0	0	0	7	0
17	T2 G2 adenocarcinoma	3 x 2.6 x 0.4	7.8	0	1	LAR	4	0
18	T3 G2 adenocarcinoma	1.3 x 1.1 x 0.9	1.4	0	0	0	8	0
19	T2 G2 adenocarcinoma	1.7 x 1.7 x 0.3	2.9	0	0	0	5	0
20	TVA LGD	1.1 x 1.0 x 0.3	1.1	0	0	0	5	0
21	T2 G1 adenocarcinoma	1.7 x 0.8 x 0.6	1.4	0	1	LAR	3	0
22	TVA HGD	4.5 x 4.1 x 1.3	18.5	0	0	0	1	0
23	TVA LGD	2.5 x 1.3 x 0.5	3.3	0	0	0	4	0
24	T1 G2 adenocarcinoma	4.5 x 3.8 x 2.5	17.1	0	0	0	2	0
25	TVA HGD	5.8 x 4.3 x 2.4	24.9	0	0	0	2	0
26	TVA HGD	3.4 x 2.8 x 1	9.5	0	1	1	2	0
27	Tis G1 adenocarcinoma	3.7 x 2.3 x 0.3	8.5	0	0	0	1	0
28	T1 G2 adenocarcinoma	3.8 x 2.4 x 1.4	9.1	0	0	0	1	0

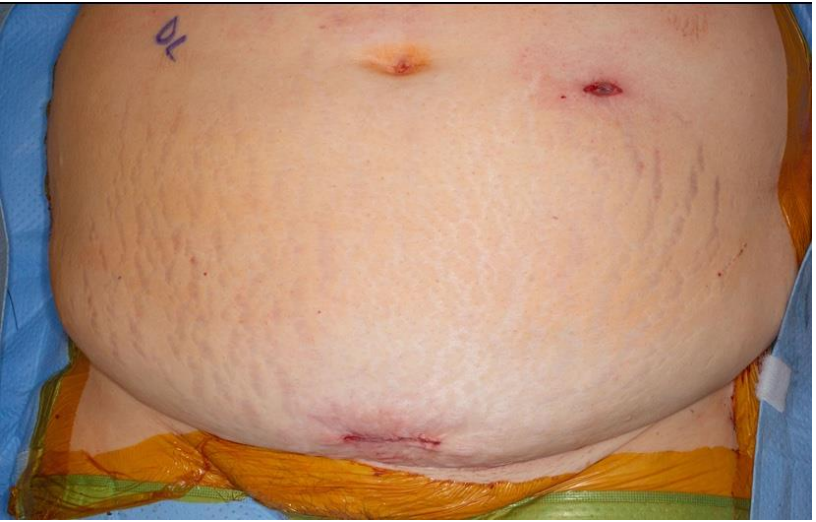
Single-Port Robotic Transanal Minimally Invasive Surgery (SPR-TAMIS): another giant leap forward. Davide Ferrari[1,2], Thomas Peponis[1], Tommaso Violante[1,3], William R. Perry[1], David W. Larson[1], Kevin Behm[1]

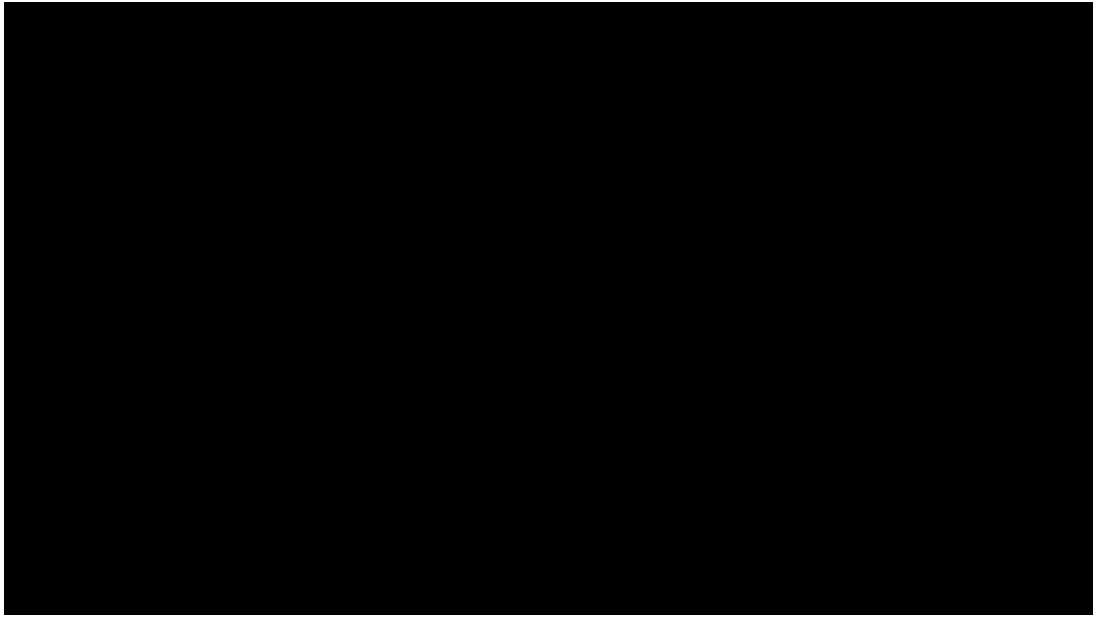
LPLN Dissection

Left and Right iliac artery and vein

SP in Low Anterior Resection or IPAA

Any Colectomy from a Pfannenstiel





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Future is Delivery of Cures

Radical Change

Augmented Reality
Shape Sensing Technology

Collaboration and Relationships

Perioperative care

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Inpatient to Outpatient Care

Reduce Pain, and Reduce Complication Risk

RCT Exparel Tap Block vs Intrathecal

209 patient (98 IT vs 102 Tap)

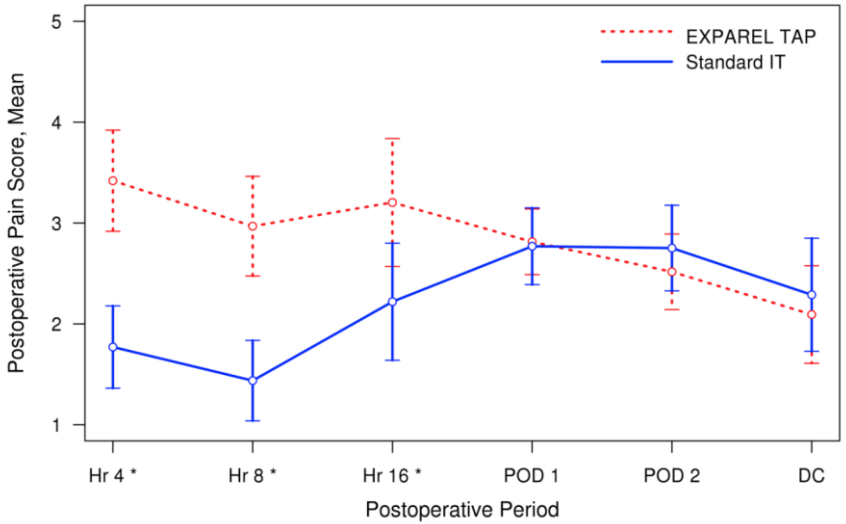
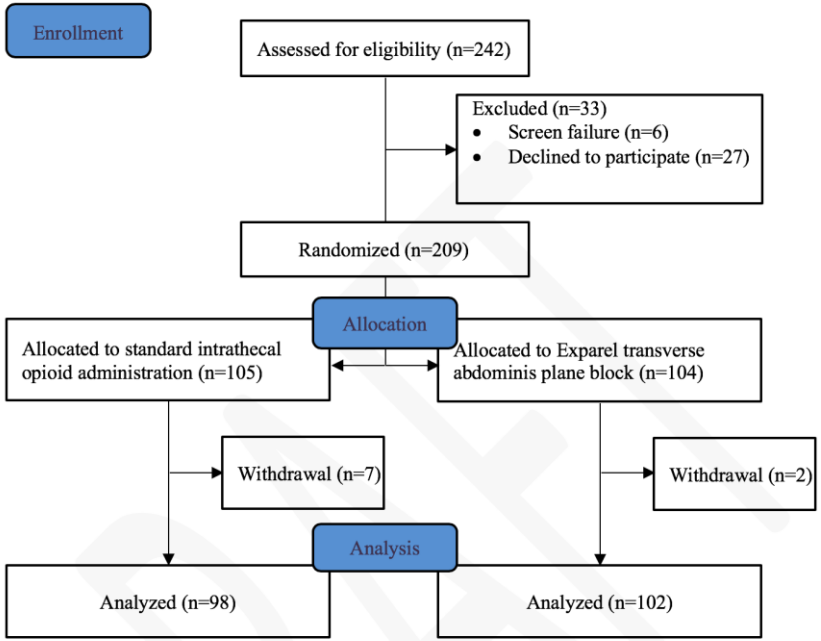


Figure 2. Participant flow diagram



Improving Outcomes

Robotics/MIS, ERAS Treatment, DIET, Fluids

7,103 Colectomy patients Treated with ERAS

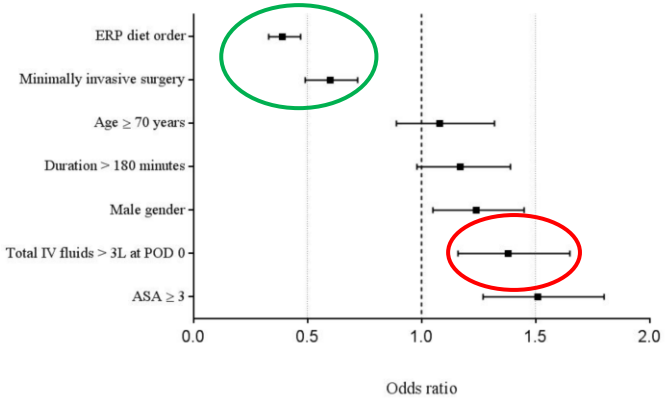


Figure 2. Multivariable analysis. Multivariable analysis of univariate demographic and surgical items ($p < 0.05$) associated with POI. An Odds ratio of >1 indicates increased risk of POI. ASA—American Society of Anaesthesiologists, ERP—enhanced recovery pathway, IV—intravenous, POI—postoperative ileus. Odds ratio, 95% Confidence Interval.

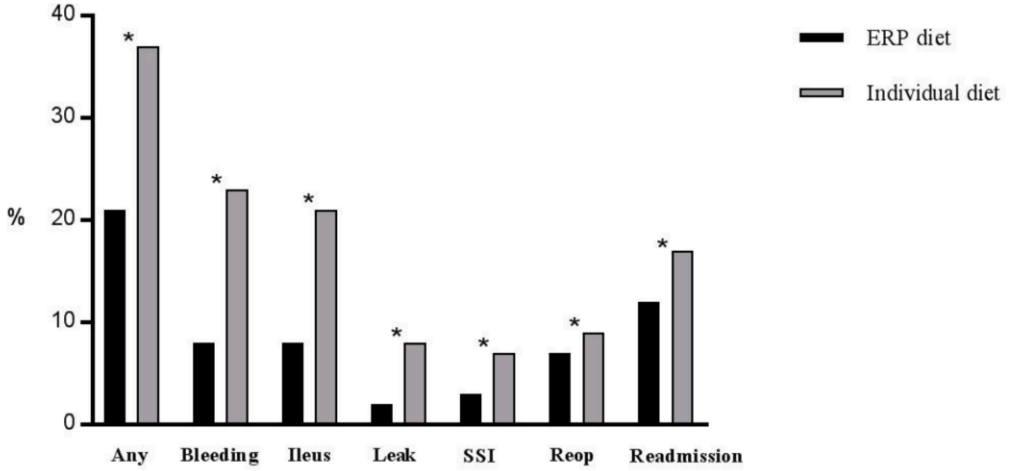


Figure 1. Outcome. Postoperative complications in patients assigned to the ERP re-alimentation pattern (n = 5862) and patients assigned to an individualized re-alimentation pattern (n = 1241). Any complication: Clavien grade I-V, ERP—enhanced recovery pathway, SSI—surgical site infection, reop—reoperation. * indicates statistical significance ($p < 0.05$).

Ordering a Normal Diet at the End of Surgery—Justified or Overhasty?

Fabian Grass [1,2], Martin Hübner [2,*], Jenna K. Lovely [3], Jacopo Crippa [1], Kellie L. Mathis [1] and David W. Larson [1]

Patients with Lowest Risk of Complications

TABLE 4. Occurrence of postdischarge complications by day of discharge group

Complication, n (%)	*POD 0/1 (N = 906)*	*POD 2 (N = 6825)*	*POD 3–5 (N = 28,795)*	*p*
Anastomotic leak	5 (0.6%)	68 (1.0%)	356 (1.2%)	0.05
Missing, n	3	16	60	
Ileus	17 (1.9%)	104 (1.5%)	594 (2.1%)	0.01
Missing, n	4	4	37	
Readmission	43 (4.8%)	349 (5.1%)	1,670 (5.8%)	0.04
Reoperation	11 (1.2%)	72 (1.1%)	359 (1.2%)	0.43
Superficial surgical site infection	16 (1.8%)	108 (1.6%)	663 (2.3%)	<0.01
Deep surgical site infection	1 (0.1%)	9 (0.1%)	82 (0.3%)	0.05
Wound disruption	1 (0.1%)	7 (0.1%)	47 (0.2%)	0.48
Pneumonia	0 (0.0%)	12 (0.2%)	41 (0.1%)	0.41
Unplanned intubation	0 (0.0%)	6 (0.1%)	27 (0.1%)	0.65
Venous thromboembolism	0 (0.0%)	24 (0.4%)	147 (0.5%)	0.03
Progressive renal insufficiency	2 (0.2%)	6 (0.1%)	25 (0.1%)	0.42
Sepsis or septic shock	1 (0.1%)	50 (0.7%)	233 (0.8%)	0.06
Urinary tract infection	8 (0.9%)	32 (0.5%)	210 (0.7%)	0.05
Myocardial infarction	0 (0.0%)	3 (0.0%)	9 (0.0%)	–
Cardiac arrest requiring CPR	0 (0.0%)	3 (0.0%)	10 (0.0%)	–
Stroke	0 (0.0%)	0 (0.0%)	0 (0.0%)	–

CPR = cardiopulmonary resuscitation; POD = postoperative day.

Is Same-Day and Next-Day Discharge After Laparoscopic Colectomy Reasonable in Select Patients?

Nicholas P. McKenna, M.D.[1,2] • Katherine A. Bews, B.A.[2] • Omair A. Shariq, M.D.[1]
Elizabeth B. Habermann, Ph.D., M.P.H.[1,2] • Kevin T. Behm, M.D.[3] • Scott R. Kelley, M.D.[3]
David W. Larson, M.D., M.B.A.[3]

- Inclusion
  - ASA class <3
  - Age <65

Results of SAME DAY Discharge

Table 2. Patient demographics.

	OP-ERP Patients (n=115)	Standard ERP Patients (n=230)	P value
Average age (SD), years	49.7 (12.8)	49.7 (12.9)	0.993
Male, n (%)	66 (57.4)	130 (56.5)	0.878
Average BMI (SD), kg/m²	27.2 (6.3)	27.0 (5.5)	0.695
Obesity (>30 kg/m²), n (%)	32 (27.8)	61 (26.5)	0.797
ASA class, n (%)			0.382
1	0 (0.0)	3 (1.3)	
2	72 (62.6)	134 (58.3)	
3	43 (37.4)	93 (40.4)	
Current smoker, n (%)	6 (5.2)	12 (5.2)	1.000
Average major comorbidities, mean (SD)	0.7 (0.9)	0.6 (1.0)	0.741
Hypertension, n (%)	29 (25.2)	54 (23.5)	
Heart failure, n (%)	2 (1.7)	3 (1.3)	
Diabetes mellitus, n (%)	8 (7.0)	19 (8.3)	
Chronic kidney disease, n (%)	7 (6.1)	19 (8.3)	
Obstructive sleep apnea, n (%)	14 (12.2)	14 (6.1)	
Coronary artery disease, n (%)	3 (2.6)	11 (4.8)	
History of venous thromboembolism, n (%)	12 (10.4)	27 (11.7)	

	OP-ERP Patients (n=115)	Standard ERP Patients (n=230)	P value
Intraoperative fluids, mean (SD), ml	1040.9 (380.2)	1221.2 (422.4)	**0.000**
Estimated blood loss, mean (SD), mL	20.2 (18.1)	26.8 (39.2)	0.085
Mechanic double stapled anastomosis, n (%)	59 (51.3)	121 (52.6)	0.819
Postoperative analgesia, n (%)			**0.000**
Intrathecal analgesia	0 (0.0)	133 (57.8)	
Local anesthetics	115 (100.0)	97 (42.2)	
Mean length of stay, days (SD)	0 (0.0)	3.3 (3.7)	**0.000**
Postoperative complication (30d), Any, n (%)	17 (14.8)	59 (25.7)	**0.022**
ED visit (30d), n (%)	7 (6.1)	10 (4.3)	0.482
Readmission (30d), n (%)	12 (10.4)	22 (9.6)	0.798
Average length of readmission, days (SD)	7.6 (5.6)	5.2 (6.3)	0.264
Reoperation (30d), n (%)	4 (3.5)	5 (2.2)	0.474

Table 3. Intraoperative variables and post-operative outcomes.

Same-Day Discharge is Feasible and Safe in Select Patients as Part of an Innovative Enhanced Recovery Pathway Kristen K. Rumer, MD, PhD[a]; Jenna K. Lovely, PharmD[b]; Amit Merchea, MD[c]; David W. Larson, MD, MBA, FACS[a]; Mohamed A. Abd El Aziz, MBBCh[a]; Jennifer Ellefson, APRN, CNP[a]; Adam Amundson, MD[d]; Ryan Chadha, MD[e]; Robert R. Cima, MD, FACS[a]; Sherief Shawki, MD, MBBCh[a]; Kevin T. Behm, MD, FACS[a]

Conclusion

- Vision: How do You want to Practice 10 years from Now?

- Robotics and Perioperative care is a Change Agent
  - Will Allow Surgeons
    - Deliver Complex Operations
      - Minimal Means
      - With Outpatient Delivery

Thank You!