



Early complications

Surgical point of view

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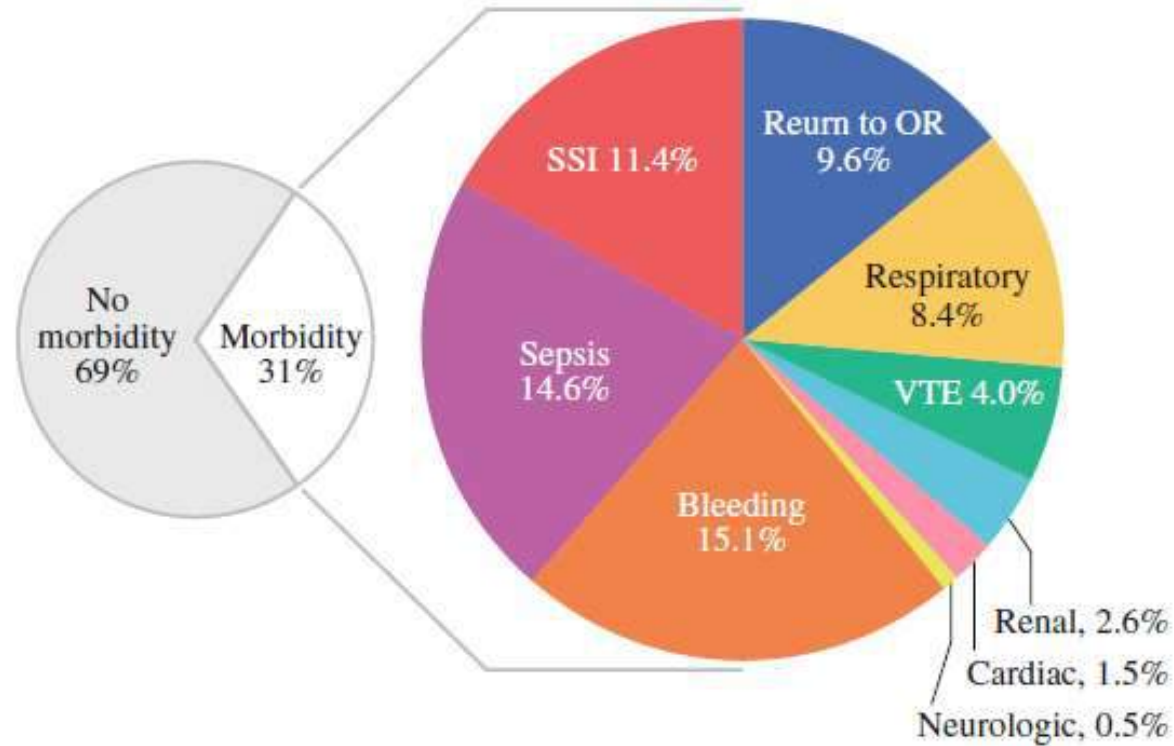
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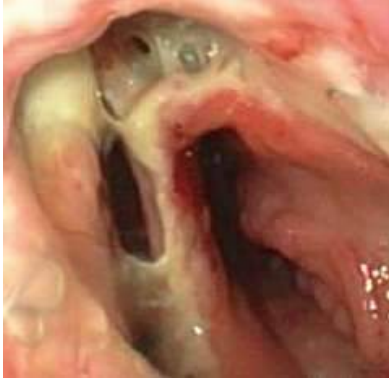
Disclosures

The authors have no conflicts of interest and no financial relationships to disclose

Complications following CRS & HIPEC



Early surgical complications



Anastomotic leakage

Peritonitis

Intraabdominal abscess

Sepsis



Surgical site infection

Superficial / deep SSI

Fascial disruption

Sepsis



How to prevent anastomotic leakage ?

<https://www.thoughtco.com/ways-to-die-climbing-756069>

Anastomotic leakage

- Risk factors and Prevention -

Risk factors for anastomotic leakage

- Distance from the anal verge
- Anastomotic ischemia
- Male gender
- Obesity
- comorbidity (ASA grade, CCI)
- prolonged operation time (>4 hr)
- Malnutrition/hypalbuminemia

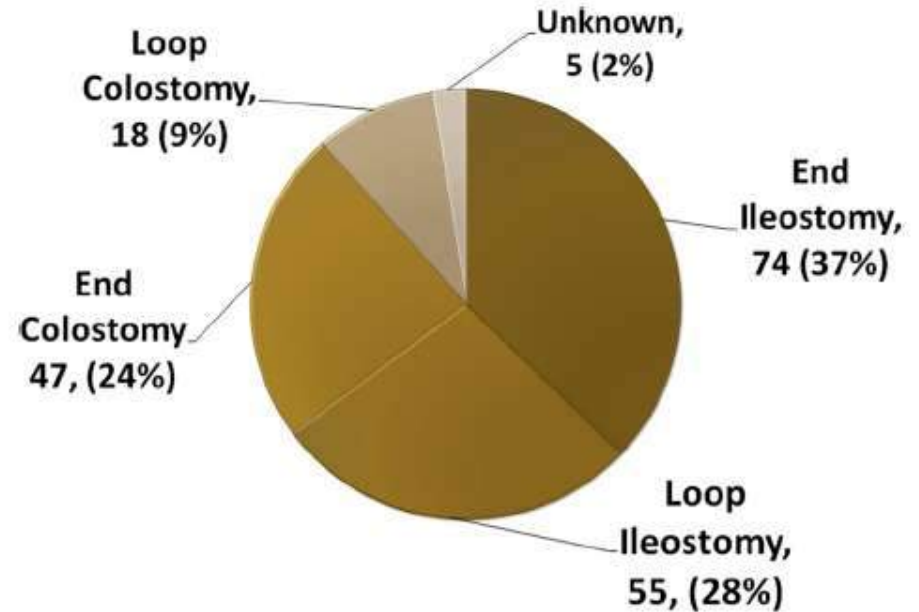
Potential measures for prevention

- Stoma creation
- Anastomotic techniques
- Mechanical bowel preparation
- Oral antibiotics

Stoma creation and Stoma formation

- CRS & HIPEC -

Stoma creation up to 50%



Stoma creation and Stoma formation

- CRS & HIPEC -

	OR	Lower 95% CI	Upper 95% CI	p value
HIPEC age	0.987	0.965	1.01	0.264
Male sex	1.477	0.816	2.672	0.197
Albumin	0.991	0.543	1.809	0.977
ECOG performance status 0/1 2+	Ref. 1.043	0.383	2.842	0.934
Type of primary Appendiceal Colorectal Ovarian	Ref. 1.514 0.607	0.737 0.071	3.11 5.216	0.259 0.649
Resection type R 0/1 R 2	Ref. 0.617	0.28	1.355	0.229
No. of organs resected	1.219	0.994	1.494	0.058
PCI lesions at exploration	1.082	1.033	1.134	0.001
Preoperative chemotherapy	2.001	0.984	4.069	0.055

Stoma reversal

- CRS & HIPEC -

Procedures/stomas/reversal	N	Stomas	Stoma reversed
Complete cytoreductive surgery	693 (72%)	239 (35%)	179 (75%)
Maximal tumor debulking	265 (28%)	113 (43%)	8 (7%)
Total	958	352 (37%)	187 (53%)

Both studies:

Stoma reversal rate 26% - 82.8% (100%)

Anastomotic leak rate after reversal 0.5 - 9%

30 day mortality after reversal 0 - 4.7%

Anastomotic leakage & Stoma creation

- CRS & HIPEC -

Does stoma formation prevent anastomotic leakage?

- CRS & HIPEC data: No !
- Colorectal surgery

	No protective stoma (n = 1848)	Protective stoma (n = 881)	P
Anastomotic leak rate			
Overall	262 (14.2)	128 (14.5)	0.806†
Surgery required	186 (10.1)	32 (3.6)	< 0.001†
Morbidity	635 (34.4)	350 (39.7)	0.007†
Deaths	37 (2.0)	8 (0.9)	0.037†

Doud AN et. al. Ann Surg Oncol 2016 23(2): 503–510

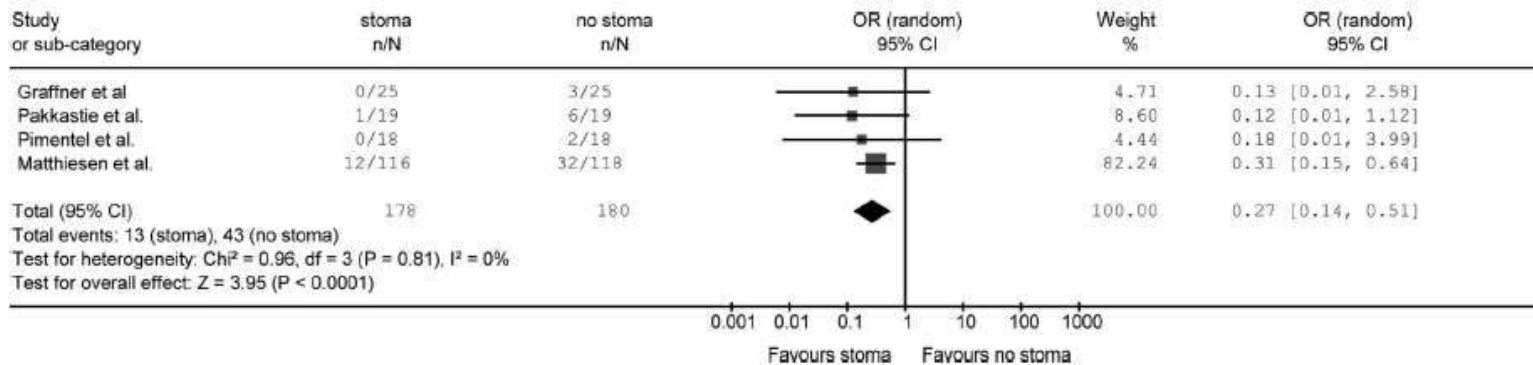
Riss S et al. EJSO 2015; 41: 392-395

Gastinger I et. al. Br J Surg. 2005 Sep;92(9):1137-42

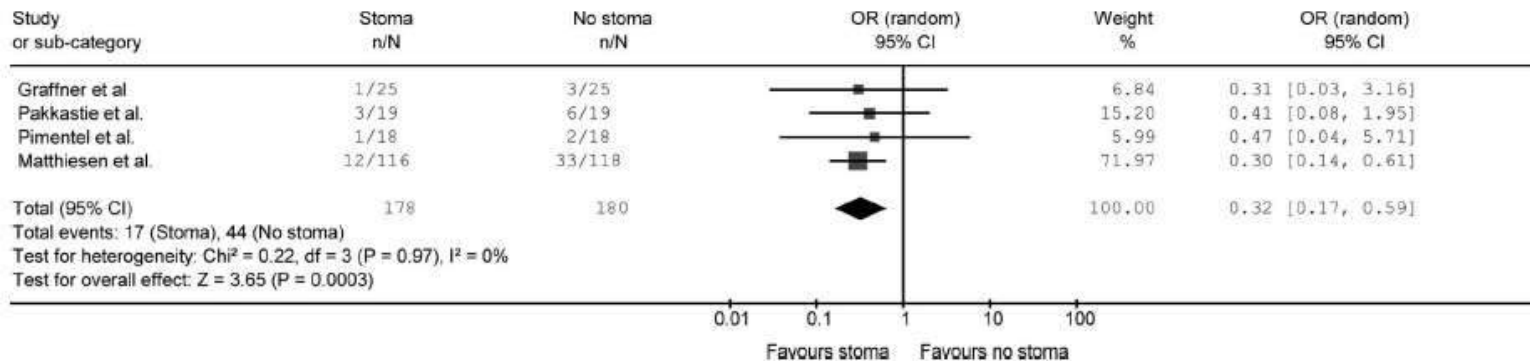
Anastomotic leakage & Stoma creation

- Colorectal Surgery -

Reoperation rate



Anastomotic leakage rate



Anastomotic leakage & Anastomotic Technique

- CRS & HIPEC -

Two layer colorectal anastomosis

N=28

No leakage

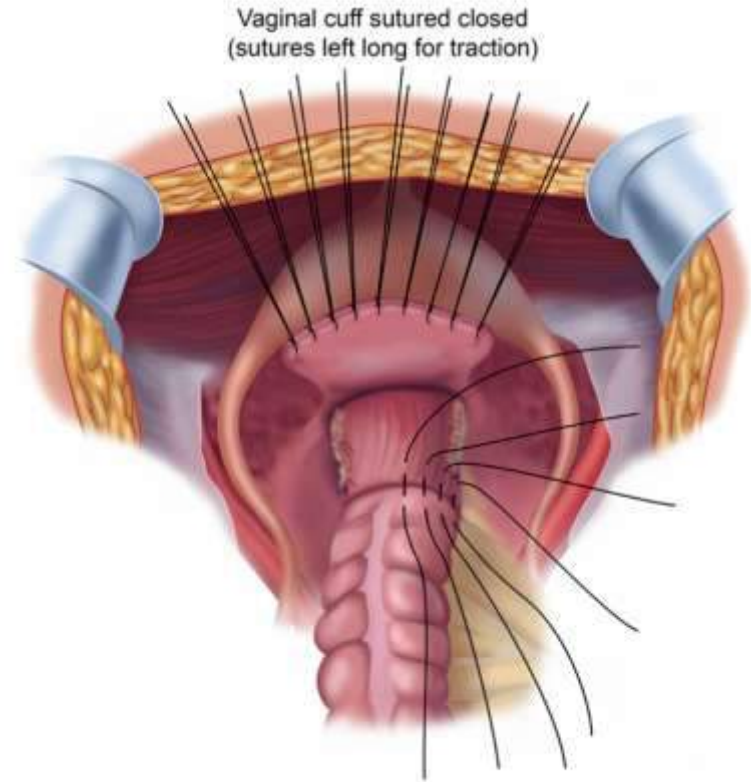


FIG. 5 A layer of sutures is placed circumferentially to reinforce the stapled anastomoses

Anastomotic leakage & Anastomotic Technique

- Colorectal Surgery -

Source	Level	No. of Cases	Outcome	Results
Everett, ⁵¹ 1975	1b (RCT)	92 Patients, colorectal	Clinical AL	AL: 1-layer, 5.0% (n = 40); 2-layer, 4.8% (n = 52); nonsignificant
Ceraldi et al, ⁵² 1993	2b (nonrandomized)	84 Patients, colon	Clinical AL	AL: 1-layer, 6.8% (n = 44); 2-layer, 9.5% (n = 21); nonsignificant
Fielding et al, ⁵³ 1980	2b (nonrandomized)	1466 Patients, colon	Clinical AL	AL: 1-layer, 12.0% (n = 458); 2-layer, 13.5% (n = 968); nonsignificant
Reichel et al, ⁴⁷ 1975	2b (nonrandomized)	408 Patients, colorectal	Clinical and radiological leak	AL: 1-layer, 10.3% (n = 320); 2-layer, 10.3% (n = 88); nonsignificant
Source	Level ^a	No. of Cases	Outcome	Results
Clinical				
Choy et al, ⁸⁹ 2007	1a (meta-analysis)	955 Patients, ileocolic	Clinical AL	AL: stapled, 1.1% (n = 357); hand-sewn, 3.8% (n = 598); not significant
Lustosa et al, ⁸⁷ 2001	1a (meta-analysis)	1233 Patients, colorectal	Clinical AL	AL: stapled, 6.3% (n = 622); hand-sewn, 7.1% (n = 611); not significant
MacRae and McLeod, ⁸⁸ 1998	1a (meta-analysis)	2256 Patients, colorectal	Clinical AL	AL: stapled vs hand-sewn: odds ratio, 0.89 (95% CI, 0.58-1.29); not significant
Fingerhut et al, ⁸¹ 1995 ^{b,c}	1b (RCT)	159 Patients, colorectal suprapерitoneal	Clinical AL	AL: stapled, 0 (n = 85); hand-sewn, 0 (n = 74); not significant
Docherty et al, ⁷⁷ 1995 ^{c,d}	1b (RCT)	625 Patients, colorectal	Clinical AL	AL: stapled, 4.5% (n = 330); hand-sewn, 4.4% (n = 321); not significant
Fingerhut et al, ⁸⁰ 1994 ^{b,c}	1b (RCT)	113 Patients, left infraperitoneal	Clinical AL	AL: stapled, 3.7% (n = 54); hand-sewn, 8.5% (n = 59); not significant
Sarker et al, ⁸⁶ 1994 ^{b,c}	1b (RCT)	60 Patients, rectum	Clinical AL	AL: stapled, 0 (n = 30); hand-sewn, 6.7% (n = 30); not significant
Kracht et al, ⁸³ 1993 ^{b,c,d}	1b (RCT)	268 Patients, colorectal	Clinical AL	AL: stapled, 8.8% (n = 137); hand-sewn, 12.2% (n = 131); not significant
Friend et al, ⁸² 1990 ^c	1b (RCT)	239 Patients, left colon	Clinical AL	AL: stapled, 3.5% (n = 114); hand-sewn, 8.8% (n = 125); not significant
Cajozzo et al, ⁷⁶ 1990 ^c	1b (RCT)	48 Patients, colorectal	Clinical AL	AL: stapled, 8.3% (n = 24); hand-sewn, 4.2% (n = 24); not significant
Elhadad, ⁷⁸ 1990 ^b	1b (RCT)	272 Patients colorectal	Clinical fistula	AL: stapled, 8.3% (n = 139); hand-sewn, 11.5% (n = 133); not significant

Anastomotic Technique has no Influence on Anastomotic leakage

Mechanical bowel preparation & HIPEC

- Anastomotic leakage -

TABLE 2 Preoperative preparation

Practice of interest	n (%)
Formalized preoperative pathway	
Yes	66 (68)
Printed educational material	48 (86)
Support groups with previous patients	24 (43)
Website	18 (32)
Audiovisual/multimedia educational material	11 (20)
No	31 (32)
Routine mechanical bowel preparation	
Yes	75 (81)
No	13 (14)
Sometimes	5 (5)
Routine preoperative nutritional supplementation	
Yes, including (all applicable)	38 (41)
Commercially available oral supplements	31 (82)
TPN	12 (32)
Multivitamins	10 (26)
PPN	8 (21)
NG/NJ feeding	6 (16)
Gastrostomy or jejunostomy tube feeding	2 (5)
No, conditional	55 (59)
Hypoalbuminemia	39 (72)
Bowel obstruction	32 (59)
Weight loss	39 (72)
Objective measures of malnutrition	20 (37)

TPN total parenteral nutrition, PPN peripheral parenteral nutrition,
NG nasogastric, NJ nasojejunal

Mechanical bowel preparation in CRC

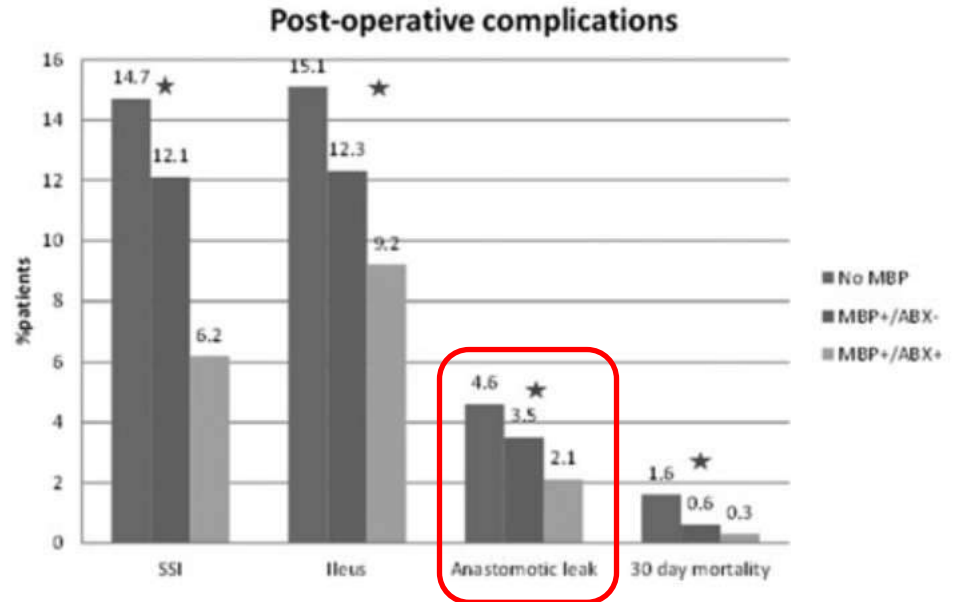
- Anastomotic leakage -

Variable	Univariable Logistic		Multivariable Logistic	
	OR (95% CI)	P	Adjusted OR (95% CI)	P
Mechanical bowel preparation		<0.0001		0.026
MBP+/ABX+	0.45 (0.32–0.64)	<0.0001	0.57 (0.35–0.94)	0.026
MBP+/ABX–	0.77 (0.59–0.99)	0.049	1.05 (0.72–1.54)	0.79
No prep/ABX– (reference)				
Race/ethnicity (white)	1.16 (0.77–1.73)	0.48	1.33 (0.76–2.33)	0.32
BMI (≥ 30 kg/m ²)	1.20 (0.94–1.54)	0.13	1.11 (0.78–1.58)	0.55
ASA (≥ 3)	1.23 (0.97–1.55)	0.090	1.20 (0.83–1.74)	0.32
Functional Status		0.89		0.77
Partially dependent	0.87 (0.32–2.36)	0.78	0.70 (0.16–3.00)	0.63
Totally dependent	1.48 (0.20–11.09)	0.70	1.80 (0.21–15.69)	0.59
Independent (reference)				
Hypertension	0.91 (0.72–1.15)	0.44	0.84 (0.59–1.19)	0.33
Dyspnea	1.10 (0.71–1.71)	0.68	1.48 (0.86–2.54)	0.15
Prior sepsis	1.18 (0.52–2.69)	0.70	1.05 (0.32–3.39)	0.93
Ascites	N/A*	N/A	N/A	N/A
Steroid use	0.99 (0.62–1.59)	0.96	1.13 (0.62–2.06)	0.68
Bleeding disorder	1.22 (0.66–2.25)	0.53	0.92 (0.39–2.17)	0.84
Disseminated cancer	1.21 (0.74–1.97)	0.45	1.23 (0.69–2.20)	0.50
Transfusion	0.62 (0.15–2.55)	0.51	N/A	
Prior wound infection	1.61 (0.74–3.47)	0.23	1.22 (0.42–3.54)	0.71
Laparoscopic	0.63 (0.50–0.80)	0.002	0.67 (0.47–0.95)	0.024
Hematocrit, %	1.02 (0.99–1.04)	0.15	1.04 (1.01–1.08)	0.018
WBC, $\times 10^9$ /L	1.04 (1.00–1.07)	0.034	1.02 (0.97–1.07)	0.51
Creatinine, mg/dL	1.04 (0.84–1.29)	0.71	1.25 (0.99–1.58)	0.064
Albumin, mg/dL	0.87 (0.68–1.12)	0.27	0.85 (0.61–1.17)	0.31
Colon vs rectum	0.67 (0.52–0.85)	0.001	0.61 (0.43–0.87)	0.006
Total operation time (≥ 180 min)	1.61 (1.27–2.04)	<0.001	1.63 (1.16–2.30)	0.005

Mechanical bowel preparation in CRC

- *Anastomotic leakage* -

**Mechanical bowel preparation +
oral antibiotics reduces
Anastomotic leakage rate**





How to prevent Surgical Site Infections ?

Surgical Site Infections



Risk factors for SSI

- Obesity
- Immunosuppression
- Chemotherapy
- Comorbidity
- Malnutrition
- Duration of operation

Potential measures for prevention

- Wound irrigation
- Wound protection devices
- Negative pressure therapy
- Mechanical bowel preparation
- oral antibiotics

Incisional wound irrigation

- *Surgical Site Infections* -

Recommendations

The panel considers that there is insufficient evidence to recommend for or against saline irrigation of incisional wounds before closure for the purpose of preventing SSI.

The panel suggests considering the use of irrigation of the incisional wound with an aqueous PVP-I solution before closure for the purpose of preventing SSI, particularly in clean and clean-contaminated wounds.

(Conditional recommendations/low quality of evidence)

Wound protection devices

- Surgical Site Infections – BAFO trial -

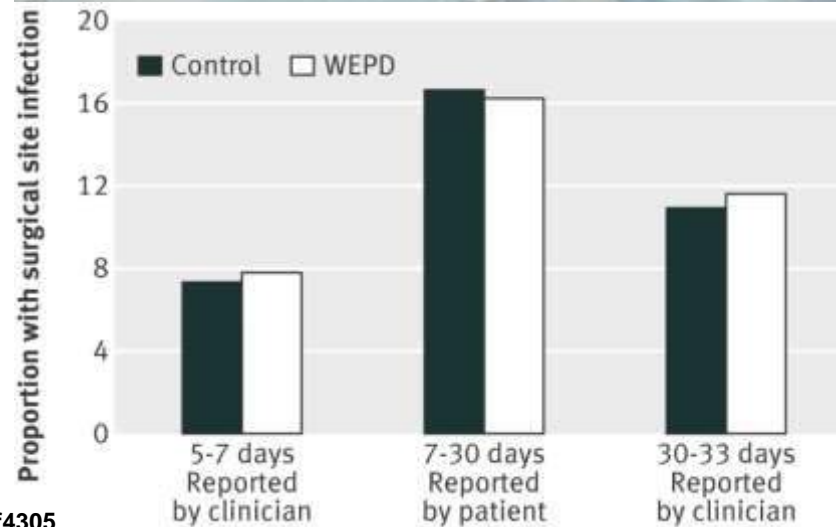
TABLE 2. Primary and Secondary Endpoints in Patients Undergoing Laparotomy With and Without a Circular Wound Edge Protector (CWEP)

	Control (towels)	Intervention (CWEP)	OR (95% CI) NNT (95% CI)	P*
Primary outcome (SSI within 30–45 d)				
Intention to treat†	n = 294, 74 (25.2%)	n = 300, 53 (17.7%)	0.638 (0.429–0.949) 13.3 (7.1, 107.8)	0.026
Sensitivity of primary endpoint				
Complete case	n = 272, 52 (19.1%)	n = 274, 27 (9.9%)	0.462 (0.281–0.762) 10.8 (6.6, 29.3)	0.002
Per-protocol (as treated)	n = 267, 52 (19.5%)	n = 240, 25 (10.4%)	0.481 (0.288–0.803) 11.0 (6.6, 34.1)	0.005
“Worst case”§	n = 294, 67 (22.8%)	n = 300, 53 (17.7%)	0.727 (0.486–1.088) 19.5 (8.6, 75.3)	0.120
Secondary endpoint (body temperature)	P†			
Start of surgery	36.1 (34.4–37.7)	36.0 (34.3–37.3)		>0.05
End of surgery	36.0 (34.0–37.8)	36.1 (33.0–38.8)		>0.05
Change	–0.1 (–2.4 to 1.9)	0.0 (–2.2 to 2.8)		>0.05

Reduction of SSI with Circular Wound Edge Protector

Wound protection devices

- *Surgical Site Infections – ROSSINI trial* -



Prophylactic negative pressure therapy

- *Surgical Site Infections* -

N (%) or Mean \pm SD	Overall	SSDs	NPT	P value
Number of patients*	189	87	104	
Age at operation (y)	57.1 \pm 13.0	57.1 \pm 13.4	57.1 \pm 12.7	.980
BMI (kg/m ²)	27.6 \pm 5.6	26.8 \pm 5.5	28.3 \pm 5.7	.072
Diabetes mellitus	29 (15)	12 (14)	17 (16)	.624
Smoking status				.077
Nonsmoker	118 (62)	46 (53)	72 (69)	
Ex-smoker	34 (18)	18 (21)	16 (15)	
Smoker	38 (20)	22 (26)	16 (15)	
Neoadjuvant chemotherapy	76 (40)	27 (31)	49 (47)	.024
Neoadjuvant radiation	16 (8)	7 (8)	9 (9)	.880
Preoperative albumin (g/dL)	3.7 \pm .6	3.8 \pm .6	3.7 \pm .6	.191
Operation type				.018
Colorectal	60 (31)	32 (37)	28 (27)	
Right colectomy	20	16	4	
Left colectomy	19	8	11	
Subtotal colectomy	3	1	2	
Low anterior resection	11	4	7	
Abdominoperineal resection	4	0	4	
Other	0	3	0	
Cytoreduction/HIPEC	87 (46)	30 (34)	57 (55)	
With colon resection	60	12	48	
Without colon resection	27	18	9	
Pancreas	44 (23)	25 (29)	19 (18)	
Whipple	24	8	16	
Distal	16	14	2	
Other	4	3	1	



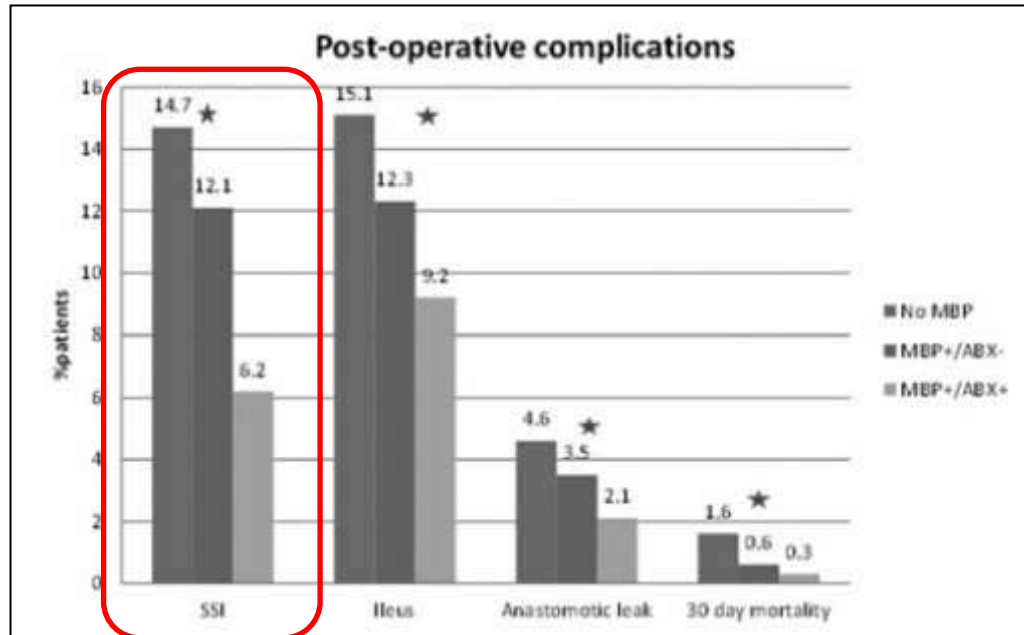
Mechanical Bowel Preparation and oral antibiotics

- Surgical Site Infections -

Variable	Univariable Logistic		Multivariable Logistic	
	OR (95% CI)	P	Adjusted OR (95% CI)	P
Mechanical bowel preparation		<0.0001		<0.0001
MBP+/ABX+	0.39 (0.32–0.48)	<0.0001	0.40 (0.31–0.53)	<0.0001
MBP+/ABX– No prep/ABX– (reference)	0.80 (0.69–0.93)	0.004	0.88 (0.72–1.09)	0.25
Race/ethnicity (white)	1.09 (0.87–1.36)	0.45	1.02 (0.77–1.34)	0.91
BMI (≥ 30)	1.73 (1.51–1.98)	<0.0001	1.66 (1.37–2.00)	<0.0001
ASA (≥ 3)	1.49 (1.30–1.71)	<0.0001	1.21 (0.99–1.48)	0.064
Functional status		0.60		0.49
Partially dependent	0.76 (0.42–1.38)	0.36	0.87 (0.43–1.75)	0.69
Totally dependent	1.32 (0.39–4.48)	0.66	0.30 (0.04–2.42)	0.26
Independent (reference)				
Hypertension	1.05 (0.92–1.21)	0.45	0.91 (0.75–1.11)	0.35
Dyspnea	1.18 (0.92–1.52)	0.19	0.99 (0.72–1.39)	0.99
Ascites	0.86 (0.31–2.41)	0.77	0.41 (0.12–1.42)	0.16
Steroid use	1.48 (1.16–1.88)	0.001	1.31 (0.96–1.79)	0.089
Bleeding disorder	1.08 (0.74–1.56)	0.71	0.95 (0.59–1.52)	0.82
Disseminated cancer	1.54 (1.19–2.01)	0.001	1.20 (0.87–1.67)	0.26
Transfusion	0.94 (0.48–1.81)	0.84	0.83 (0.36–1.89)	0.65
Prior sepsis	1.25 (0.79–1.99)	0.35	0.99 (0.53–1.89)	0.99
Prior wound infection	1.88 (1.21–2.92)	0.005	1.03 (0.55–1.93)	0.94
Hematocrit	0.99 (0.98–1.01)	0.39	1.02 (1.00–1.04)	0.091
WBC $\times 10^9/L$	1.04 (1.02–1.06)	0.001	1.03 (1.00–1.06)	0.050
Creatinine, mg/dL	0.98 (0.85–1.13)	0.74	0.95 (0.78–1.15)	0.57
Albumin, mg/dL	0.74 (0.64–0.84)	<0.0001	0.81 (0.68–0.97)	0.019
Laparoscopy	0.51 (0.45–0.59)	<0.0001	0.54 (0.45–0.65)	<0.0001
Colon vs rectum	0.79 (0.69–0.92)	0.002	0.75 (0.62–0.91)	0.004
Total operation time (≥ 180 min)	1.68 (1.47–1.92)	<0.001	1.56 (1.30–1.88)	<0.0001

Mechanical Bowel Preparation and oral antibiotics

- *Surgical Site Infections* -



Conclusions

- Early complications -

- **Stoma creation reduces morbidity, mortality and rate of clinical relevant anastomotic leakages**
- **Comeback of mechanical bowel preparation: reduction of anastomotic leakage and SSI**
- **Negative pressure devices may reduce SSI in high risk wounds**
- **Inconclusive data about wound protection devices**



Thank you for your attention