Surgery
UNIVERSITY OF TORONTO

Mechanical Bowel Preparation

A Clinical Practice Guideline developed by the
University of Toronto's Best Practice in Surgery

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Section 1. General information

Aim
The aim of this guideline is to make recommendations for the use of mechanical bowel preparation (MBP) in patients having abdominal surgery. This includes colorectal, urological and gynaecologic procedures.

Outcomes of interest
The outcomes of interest are the rates of surgical site infections, anastomotic leaks and intra-abdominal abscesses. In addition, for gynaecologic procedures, the visibility at surgery and patient experience are reported.

Target population
Adult and pediatric patients undergoing elective colorectal, gynaecologic and urological surgery

Intended users
This guideline is intended for use by colorectal, general, urological and gynaecologic surgeons, residents and fellows.

Scope
The scope of this review includes recommendations for the use of MBP and enemas. In addition, recommendations on the use of oral antibiotics are also included.

Rationale
MBP before elective colorectal surgery has been the standard in surgical practice for over a century[1]. Surgeons have believed that MBP decreases intra-luminal fecal mass and thus also decreases bacterial load in the bowel. By decreasing fecal load and bacterial contents, it is thought to reduce the rates of infectious post-operative complications such as surgical site infections, deep intra-abdominal infections and anastomotic dehiscence. These theories, however, have been based largely on clinical experience and expert opinion[2,3]. Based on the rationale of using MBP in colorectal procedures, MBP has also been the standard in some gynaecological and urologic procedures too.

In recent years, the need for MBP in patients having elective colonic and rectal surgery has been challenged. MBP is generally safe but has been associated with serious complications in patients with existing cardiac and renal disease as well as previously healthy patients. Furthermore, most patients find taking a MBP to be unpleasant and often results in patients being dehydrated when they arrive in the operating room.

Overview of the process
This guideline was developed in 2012 and focussed only on recommendations for patients having elective colon and rectal surgery. The original guideline and methods used are available through the Canadian Journal of Surgery.[4] The guideline has been revised and the scope has expanded to include urological and gynaecological procedures as well as recommendations for pediatric patients. As well, recommendations on the use of oral antibiotics are also included in this revised guideline.

This revised guideline was developed by performing a literature search in Medline. Randomized-controlled trials, systematic review and meta-analyses published between 2009 and 2017 comparing outcomes with and without use of MBP before any type surgery were included. As well, both the academic and gray literature were searched for guidelines on MBP prior to surgery.

The recommendations were created and tailored for practice at the University of Toronto affiliated hospitals as part of the Best Practice in Surgery initiative. Feedback was obtained from local experts and representatives of all Surgical Divisions. The evidence was assessed in adherence to GRADE recommendations.[5]

Section 2. Guideline recommendations

1. Recommendations for MBP prior to elective surgery

1.1 MBP is not recommended for adult or pediatric patients having colorectal procedures including open or laparoscopic total or segmental colonic resections, Hartmann procedure, abdominoperineal resection (APR), total proctocolectomy (TPC), ileal pouch anal anastomosis (IPAA). The only exception is patients having anterior resection with an anastomosis at or below the sacral promontory (Level of evidence: High)

1.2 MBP is not recommended for patients undergoing urologic surgery (including prostate, kidney and bladder surgery) unless the colon will be used to construct a conduit or to augment the bladder. (Level of evidence: Moderate)

1.3 MBP is not recommended for patients having benign gynecological procedures (Level of evidence: Low)

1.3.1 There is insufficient evidence to provide a recommendation for gynecological procedures for cancer

1.4 Patients having an open or laparoscopic anterior resection defined as a rectal resection where the anastomosis is at or below the sacral promontory should have a MBP prior to surgery (Level of evidence: Moderate)

2 Recommendations for Fleet Enema prior to elective surgery

2.1 A Fleet Enema should not be prescribed prior to surgery (Level of evidence: Low)

3 Recommendations for oral antibiotics prior to surgery

3.1 If a patient does have a MBP, oral antibiotics should be given. In most instances, this will be only patients who are having an anterior resection (Level of evidence: High)

3.1.1 Metronidazole 500 mg and neomycin 500 mg should be prescribed and taken at 1 PM, 3 PM and 8 PM on the day before surgery. MBP should start at 3 PM. (Level of evidence: expert consensus)

Section 3. Guideline recommendations and supporting evidence

1. Recommendations for MBP prior to elective surgery

1.1 MBP is not recommended for patients having colorectal procedures including open or laparoscopic total or segmental colonic resections, Hartmann procedure, abdominoperineal resection (APR), total proctocolectomy (TPC), ileal pouch anal anastomosis (IPAA). The only exception is patients having anterior resection with an anastomosis at or below the sacral promontory (Level of evidence: Moderate with expert consensus)

In total, our search found 25 RCTs trials (Table 1). Of these, 18 included patients having either an elective colonic or rectal procedure, 4 with patients having colonic procedures only, 2 with patients having left side procedures or high rectal procedures and one with patients having rectal procedures only.

The most recent Cochrane Review is from 2011. It included six new trials for a total of 18 RCTs and a total of 5,805 patients.[6] The conclusions are unchanged from those in the previous reviews: "there is no statistically significant evidence that patients benefit from MBP nor the use of rectal enemas". In patients having elective colonic or rectal surgery, the wound infection rate in the MBP group was 9.6% compared to 8.5% in the no MBP group (OR 1.06, 95%CI 0.95-1.42). Likewise, the anastomotic leak rate was not significantly different: 4.4% in the MBP group versus 4.5% in the no MBP group (OR 0.99, 95% CI 0.74-1.31). Thirteen trials reported mortality and again there was no significant difference between the two groups (3.0% in the MBP group vs 2.2% in the no MBP group; OR 0.93, 95% CI 0.58-1.47).

Table 1. Summary of evidence for anastomotic leaks and SSIs in patients undergoing colorectal surgery

Study	Inclusion criteria	N	Anastomotic Leaks		SSI	
			MBP	No MBP	MBP	No MBP
Brownson 1992[7]	Colon and rectal	134	8/67 (12%)	1/67 (1.5%)	5/86 (5.8%)	7/93 (7.5%)
Burke 1994[8]	Colon and rectal	169	3/82 (3.7%)	4/87 (4.6%)	4/82 (4.9%)	3/87 (3.5%)
Santos 1994[9]	Colon and rectal	149	7/72 (9.7%)	4/77 (5.2%)	17/72 (24%)	9/77(12%)
Fillmann 1995[10]	Colon and rectal	60	2/30 (6.7%)	1/30 (3.3%)	1/30 (3.3%)	2/30 (6.7%)
Miettinen 2000[11]	Colon and rectal	267	5/138 (3.6%)	3/129 (2.3%)	5/138 (4%)	3/129 (2%)
Tabusso 2002[12]	Colon and rectal	47	5/24 (21%)	0/23 (0%)	2/24 (8.3%)	0/23 (0%)
Fa-Si-Oen 2005[13]	Colon only	250	7/125 (5.6%)	6/125 (4.8%)	9/125 (7.2%)	7/125 (5.6%)
Zmora 2003[14]	Colon and rectal	380	7/187 (3.7%)	4/193 (2.1%)	12/187 (6.4%)	11/193 (5.7%)
Bucher 2005[15]	Left-sided colorectal surgery	153	5/78 (6.4%)	1/75 (1.3%)	10/78 (13%)	3/75 (4%)
Ram 2005[16]	Colon and rectal	329	1/164 (0.6%)	2/165 (1.2%)	16/164 (9.8%)	10/165 (6.1%)
Platell 2006[17]	Colon and rectal	294	3/147 (2.0%)	7/147 (4.8%)	19/147 (12.9%)	21/147 (14.3%)
Contant 2007[18]	Colon and rectal	1354	32/670 (4.8%)	37/684 (5.4%)	90/670 (13.4%)	96/684 (14.0%)

Study	Inclusion criteria	N	Anastomotic Leaks		SSI	
			MBP	No MBP	MBP	No MBP
Ali 2007[19]	Colon and rectal	210	6/109 (5.5%)	1/101 (1.0%)		
Jung 2007[20]	Open colon only	1343	13/686 (1.9%)	17/657 (2.6%)	54/686 (7.9%)	42/657 (6.4%)
Pena-Soria 2007[21]	Colon or proximal rectal resection	97	4/48 (8.3%)	2/49 (4.1%)	6/48 (12.5%)	6/49 (12.2%)
Leiro 2008[22]*	Colon only	129	3/53 (5.7%)	9/59 (15.3%)	10/64 (29.4%)	10/65 (15.4%)
Moral 2009[23]*	Colon and rectal	139	5/69 (7.2%)	4/70 (5.7%)	8/69 (11.6%)	4/70 (5.7%)
Scabini 2010[24]*	Colon and rectal	244	7/120 (5.8%)	5/124 (4.0%)	11/120 (9.2%)	6/124 (4.8%)
Bretagnol 2010[25]*	Rectal only	178	8/89 (9.0%)	3/89 (3.4%)	3/89 (3.4%)	1/89 (1.1%)
Bertani 2011[26]	Colon and rectal	229	9/114 (8.0%)	9/115 (7.8%)	7/114 (6.1%)	14/115 (12.2%)
Sasaki 2011[27]	Colon only	79	1/38 (2.6%)	3/41 (7.3%)	0/38 (0.0%)	0/41 (0.0%)
Tahirkheli 2013[28]	Colon and rectal	98	8/48 (16.7%)	6/48 (12.5%)		
Aldrink 2015[29]	Colon and rectal (children 0-21yo)	44	1/24 (4.2%)	1/20 (5.0%)	5/24 (20.8%)	2/20 (10.0%)
Bhattacharjee 2015[30]	Colon and rectal	71	4/38 (10.5%)	2/33 (6.1%)	11/38 (28.9%)	6/33 (18.2%)
Hu 2017[31]	Colon and rectal	148	1/76 (1.3%)	0/72 (0.0%)	9/76 (11.8%)	2/72 (2.8%)

While the literature shows that there is no difference in outcomes between patients receiving MBP and IV antibiotics versus IV antibiotics alone, there are other RCTs comparing oral antibiotics, MBP and IV antibiotics to MBP and IV antibiotics only which have shown that the SSI rates are lower if patients receive oral antibiotics in addition to IV antibiotics (see 3.1 for a summary of the supporting evidence).[32-34]

The working group considered all of these options: MBP plus IV and oral antibiotics; MBP and IV antibiotics or IV antibiotics alone. The working group has recommended that patients receive IV antibiotics only without MBP and oral antibiotics. Our reasons are the following:

1. MBP is generally safe but has been associated with serious complications in patients with existing cardiac and renal disease as well as previously healthy patients.
2. MBP often results in patients being dehydrated when they arrive in the operating room and require more intraoperative fluids. There is some evidence that higher volumes of intra-operative fluid are associated with an increased anastomotic leak rate.
3. Most patients dislike taking mechanical bowel preparation. For these reasons, the working group recommends that MBP should not be prescribed in all patients, but if MBP is prescribed then patients should receive oral antibiotics concomitantly.

Interestingly, Bellows et al commented in the discussion of their paper that none of the trials included in their meta-analysis compared MBP, IV and oral antibiotics to IV and oral antibiotics only and made the plea that a trial is needed to determine whether MBP can be eliminated given the recent evidence that the SSI rate is not increased in trials omitting MBP when patients receive IV antibiotics alone.[32] Our working group, as stated above, agree that a randomized controlled trial is needed to address this question.

With regards to pediatric patients, there is limited evidence. Aldrink et al published the results of a clinical trial which included 44 patients.[29] Overall, there were 2 (5%) patients who had an anastomotic leak, 4

(9%) who had intra-abdominal infection and 7 (16%) who had wound infections. There was no significant difference between the two groups but the sample size was small. The American Pediatric Surgical Association Outcomes and Clinical Trials Committee made recommendations on the use of MBP.[35] The recommendations were based mainly on evidence from the adult population and thus, the recommendations were similar to those for adults. MBP alone is not recommended but if prescribed, the patient should receive oral antibiotics.

1.2 MBP is not recommended for adult and pediatric patients undergoing urologic surgery (including prostate, kidney and bladder surgery) unless the colon will be used to construct a conduit or to augment the bladder. (Level of evidence: Moderate)

While it is rare to open the bowel in kidney and prostate surgery, the bowel is often used in bladder surgery to either construct a conduit, neobladder or to augment the bladder. This may be done by using part of the colon although most often small bowel is used for these reconstructive procedures. If the colon is used for reconstruction, then MBP is recommended to ensure there is no stool in the colon, but if small bowel is used, MBP can be omitted.

Recommendations regarding MBP for patients undergoing radical cystectomy are mainly based on evidence accrued from studies on patients having colorectal surgery. However, there is a meta-analysis assessing the role of MBP in patients having ileal urinary diversion.[36] In total, there were 2 randomized controlled trials included with a total of 116 patients. In addition, three other prospective cohort studies and two retrospective studies were included. The authors reported that there was no significant difference in wound complication rates between the two groups when results from all 7 studies were combined (OR 0.84, 95% CI 0.41-1.75). Five studies reported on urinary tract infection and urosepsis and there was no significant difference (OR 2.97, 95% CI 0.94-9.33). Other outcomes reported included the rates of Clostridium difficile colitis; abdominal abscess and peritonitis; bowel function and mortality.

There is very little evidence to make decisions about the need for MBP with regards to other procedures. In particular, there is little evidence whether MBP can be omitted in patients undergoing robotic prostatectomy. A retrospective study from Japan reviewed 151 rectal injuries in 35,099 patients (0.43% rate). Of these, 73 (48%) had MBP.[37] On multivariate analysis, there were no significant differences between those in the MBP and non MBP groups with infectious rates of 12 vs 10% and length of stay 28 days vs 30 days. In 2015, Chi and colleagues from Northwestern University in Chicago published guidelines on MBP in urologic surgery.[38] Most of the recommendations were based on expert opinion. They recommended that "evidence would suggest that MBP can be safely omitted in cystectomy and ileal urinary diversion" but they did not make a recommendation for prostatectomy or nephrectomy.

Furthermore, many urologists are embracing Enhanced Recovery after Surgery principles and in doing so, are eliminating mechanical bowel preparation. Again, however, the guideline recommendations refer to radical cystectomy.[39]

1.3 MBP is not recommended for patients having benign gynecological procedures (Level of evidence: Low)

1.3.1 There is insufficient evidence to provide a recommendation for other gynecological procedures

Three meta-analyses were identified in our search for patients having gynecological procedures. Overall, the evidence was poor. Unlike other specialties, the main outcome measures were the visualization of the surgical field, ability to handle the bowel, patient experience as well as surgical complications.

Zhang and colleagues included six RCTs comparing MBP to no MBP in 943 patients having benign gynaecologic procedures.[40] This included intraabdominal procedures as well as surgery for vaginal prolapse. The quality of the studies was rated as moderate. The authors found that there were no differences

between the MBP and no MBP groups using the following measures: visualization of the surgical field; bowel handling; and small and large bowel preparation. In addition, they found no difference in surgical complications (OR 1.3, 95% CI 0.46-3.67) or length of stay SMD 0, 95% CI -0.02-0.2) but the surgical time was a little longer in the no MBP group (SMD 0.21, 95% CI 0.06-0.35).

Another meta-analysis included three studies which were also in the Zhang analysis. They reported on post-operative nausea/vomiting and abdominal swelling and found no significant differences between the two groups. The authors also concluded that MBP should not be used routinely.[41]

Finally, a third meta-analysis included 43 studies of which only 5 were RCTs in gynaecology. In this analysis, there was no benefit in OR time or improvement in the surgical field in patients having MBP but there was a more unpleasant patient experience. Again the authors concluded that it is safe to abandon MBP in patients having surgery for benign gynecologic indications.[42]

1.4 Patients having an open or laparoscopic anterior resection defined as a rectal resection where the anastomosis is at or below the sacral promontory should have a MBP prior to surgery (Level of evidence: Moderate)

Low colorectal or coloanal anastomoses have been associated with high rates of morbidity and mortality due to the occurrence of anastomotic leaks.[43] For this reason, many surgeons performing these operations opt to protect the anastomosis with a diverting stoma. The use or omission of MBP in patients undergoing LAR with diverting stoma poses a difficult dilemna because it would leave a column of stool between the stoma and the anastomosis. In the event that this patient developed an anastomotic leak, there would still be risk of fecal contamination, despite the fact the anastomosis had been protected.

The French Greccar III Multicenter Trial is the only trial which included only patients who were scheduled for elective rectal cancer sphincter-saving resections.[26] Between October 2007 and January 2009, 178 patients were randomized to receive MBP or no MBP. The overall and infectious morbidity rates were significantly higher in the no MBP group (44 vs 27% p=0.0018 and 34 vs 16%, p=0.005 respectively). The anastomotic leakage rates were 19% vs. 10%, although the difference was not statistically significantly different (p=0.09). The authors concluded that the results of this trial "suggest continuing to perform MBP before elective rectal resection cancer".

Platell and colleagues did a subgroup analysis of patients having LAR with diverting stomas.[18] Patients were randomized to receive oral MBP (polyethylene glycol) or a single phosphate enema only. One hundred forty-seven patients were randomized to MBP group and 147 patients to no MBP group. Sixty-four percent (94 of 147) of patients in the MBP group and 55% (81 of 147) of patients in the no MBP group underwent an anterior resection. Furthermore, 39% (57/147) of patients in the MBP group and 32% (47/147) of patients in the no MBP group had a diverting stoma. The authors stated that patients undergoing a low or ultralow anterior resection were "routinely covered with a defunctioning loop ileostomy". There were three anastomotic leaks in the MBP group and seven in the no MBP group (2% and 4.8% respectively, p=0.198). However, none of the patients in the MBP group compared to six patients in the no MBP group required reoperation (0% and 4.1% respectively, p=0.013). These results led to the trial being closed prematurely. The mortality rate in the MBP group was 2.7% as compared to 0.7% in the no MBP group with an OR of 1.62 (95%CI 0.45-36.98, p=0.176). There was no statistically significant difference in the rate of superficial SSIs between the MBP and no MBP groups. [18]

In 2010, Van't Sant and colleagues published a subgroup analysis of patients who had a LAR and primary anastomosis below the peritoneal reflection.[44] In this subgroup, 236 patients received MBP whereas 213 did not. The researchers found no significant differences in the rates of anastomotic leakage (7.6% in patients who received MBP vs 6.6% in patients who did not, difference 1% (95% CI -3.7% to -5.7%, p=0.803), SSI ('severe' 9% vs 7%, 'medium' 8% vs 10%) or intraabdominal abscess (3% vs 4%, p=0.43).

In addition to these published results of patients having rectal cancer, data from 5 trials were provided for subgroups of patients who had rectal procedures. As shown in the Table below, 12 of 106 (10.6%) patients had anastomotic leaks in the MBP group vs. 12 out of 113 (10.6%) patients in the no MBP group

Table 2. Summary of evidence for anastomotic leaks in patients undergoing rectal surgery

Study	Anastomotic Leaks	
	MBP	No MBP
Burke 1994[9]	3/39 (7.7%)	4/36 (11.1%)
Santos 1994[10]	2/21 (9.5%)	2/29 (7.0%)
Miettinen 2000[12]	3/9 (33.3%)	2/14 (14.3%)
Jung 2006[45]	3/27 (11.1%)	0/17 (0.0%)
Leiro 2008[23]	1/10 (10.0%)	4/17 (23.5%)

In addition to the randomized controlled trials, there are two meta-analyses. Courtney and colleagues performed a meta-analysis of 11 studies from which they could analyze the outcomes of patients having rectal resections.[46] Seven of the included studies were randomized controlled trials while the other four were retrospective studies. All 11 studies were included in the assessment of anastomotic leakage. There was no significant difference in the anastomotic leak rate: 8.7% in the MBP group vs 10.3% in the non MBP group, OR 1.144, 95% CI 0.767-1.708. Similarly, there were no significant differences in SSI (10.8% vs 9.9%); or mortality (2.1% vs 2.8%) rates.

In the 2011 Cochrane Review, Guenaga and colleagues undertook a meta-analysis of the subgroup of patients who had a low anterior resection.[6]The anastomotic leak rate was 8.8% in patients having MBP compared to 10.3% in the group who did not receive a MBP (OR 0.88, 95% CI 0.55-1.40).

The working group considered the evidence for the use of MBP in patients having rectal resections and recommends that patients having a rectal resection should have MBP because of the concern that if not, patients may have stool in the rectum which may cause difficulties passing a stapler. In addition, while overall the SSI and anastomotic leak rates are similar whether patients do or do not have MBP, concerns remain about leaving a column of stool distal to the defunctioning stoma. While anastomotic leak rates are similar in most trials, data on the need for reoperation are not presented.

2 Recommendations for Fleet Enema prior to elective surgery

2.1 A Fleet Enema should not be prescribed prior to surgery (Level of evidence: Low)

The authors of the 2011 Cochrane review evaluating the effect of MBP also looked at the impact of MBP compared to an enema in patients undergoing colon or rectal surgery.[6] This subgroup analysis included 1210 participants from 5 RCTS; 601 patients were randomized to receive a MBP and 609 to a rectal enema. For patients having colonic surgery, 4% of in the MBP group had an anastomotic leak compared to 2.0% in the enema group (Peto OR 2.15; 0.79-5.84). For patients having rectal surgery, 7.4% of patients in the MBP group had an anastomotic leak compared with 7.9% in the enema group (Peto OR 0.93; 0.34-2.52). There was also no difference in wound infection rates between the MBP group (9.9%) and enema group (8.0%) (Peto OR 1.26; 0.85-1.88).

Dahabreh et al. conducted a meta-analysis and also assessed the impact of MBP plus enema compared to enema only in 4 studies.[47] Overall, they found 4.6% of patients in the MBP group developed an anastomotic leak compared to 4.0% in the enema only group (OR 1.24; 0.38-4.72). The rate of wound infections was 9.0% in the MBP group compared to 9.3% in the enema group (OR 1.04; 0.37-3.34). The authors concluded that they found no evidence that MBP with or without an enema differs from patients who have an enema or no preparation at all.

In a systematic review undertaken by Arnold et al assessing MBP in gynaecological procedures, the authors included 5 studies comparing the use of an MBP to a rectal enema. Overall, the authors found no benefit to the use of enema over MBP.[42]

3 Recommendations for oral antibiotics prior to surgery

3.1 If a patient does have MBP, oral antibiotics should be given. In most instances, this will be only patients who are having an anterior resection (Level of evidence: High)

3.1.1 Metronidazole 500 mg and neomycin 500 mg should be prescribed and taken at 1 PM, 3 PM and 8 PM on the day before surgery. MBP should start at 3 PM. (Level of evidence: expert consensus)

In the 1970's several randomized controlled trials comparing a combination of MBP and oral antibiotics to MBP alone showed that the combination was effective in decreasing the rate of surgical site infections in patients undergoing elective colonic and rectal operations. Indeed, Clarke and colleagues showed a decrease in septic complications from 43% to 9%.[48] The rationale for this regimen is that the MBP rids the bowel of feces and decreases the total number of bacteria. However, MBP does not reduce the concentration of bacteria and thus, the need for antibiotics.

Subsequently, multiple randomized controlled trials showed that intravenous antibiotic prophylaxis is effective in decreasing SSI and as IV antibiotics were adopted, oral antibiotics were used more sparingly.[33-35] As well, trials comparing MBP alone to no MBP showed no significant differences in surgical site infections or anastomotic leaks in patients having a colon resection and who received intravenous antibiotics. Thus, the standard, at the University of Toronto and other institutions, has been to omit MBP (in all but rectal resections) as well as oral antibiotics and instead, give patients intravenous antibiotics prior to surgery with redosing of antibiotics in longer operations.

More recently, this has been a controversial subject with regards to whether mechanical bowel preparation, oral antibiotics or the combination of both should be prescribed in addition to IV antibiotics in patients undergoing colorectal resections. SSI guidelines have made various recommendations.

The World Health Organization (WHO) Guideline for the prevention of surgical site infection was published in 2016.[49] In developing the recommendations, 24 randomized controlled trials were analyzed. Eleven trials compared MBP and oral antibiotics to MBP with no oral antibiotics. Both groups received IV antibiotics. Of the 11 trials, six showed no significant difference and five showed a significant decrease in the SSI rate with the addition of oral antibiotics. A meta-analysis of the 11 trials showed a decreased SSI rate with the combination of MBP and oral antibiotics (OR 0.56; 95% CI 0.37-0.86). There was no difference in the anastomotic leak rate.

The WHO also reviewed the role of MBP and found that there was no significant difference in the SSI rate (OR 1.31, 95% CI 1.00-1.72) or anastomotic leak rate (OR 1.03, 95% CI 0.73-1.44) whether patients received or did not receive MBP. In these studies, patients in both groups received intravenous antibiotics but no oral antibiotics. Based on this evidence, the WHO recommended that "MBP alone (without the administration of oral antibiotics) should NOT be used in adult patients undergoing elective colorectal surgery". However, they did not make recommendations as to if or when patients should have MBP.

There are three meta-analyses which have been published recently. The trials included in these meta-analyses vary but the conclusions are similar in the three reviews. Bellows and colleagues published a meta-analysis in 2011.[32] They included 16 clinical trials published between 1979 and 2007 in which patients were randomized to oral and intravenous antibiotics versus IV antibiotics alone. In all trials, patients in both groups received MBP. The prescribed oral antibiotics varied with combinations of mainly neomycin, kanamycin, erythromycin and metronidazole. They found that the risk of SSI was decreased with the

combination of oral and intravenous antibiotics (RR 0.57, 95% CI 0.43-0.76). Interestingly, they commented in the discussion that none of these trials compared MBP and oral antibiotics to oral antibiotics alone and made the plea that a trial is needed to determine whether MBP can be eliminated given the recent evidence that the SSI rate is not increased in trials omitting MBP when patients receive IV antibiotics alone.

A second meta-analysis was published in 2016 by Chen et al. Seven randomized controlled trials that compared oral and IV antibiotics and MBP to patients who received IV antibiotics and MBP alone. They reported similar results as the others with a significant decrease in all surgical infection rates (7.2% vs 16.0%, p<0.00001) as well as SSI rates (4.6% vs. 12.1%, p=0.00001).[33]

A third meta-analysis was published in 2017 by Koullouros and colleagues. They included 23 randomized controlled trials in their meta-analysis. In addition, they reviewed the data from eight cohort studies.[34] The results of the analyses are shown below:

Table 3. Summary of evidence for comparisons of oral antibiotics with IV antibiotics and MBP

Combinations	# studies	Results	Results
Oral* vs IV antibiotics	11 RCTs	IV antibiotics were more effective than oral antibiotics	OR 1.82, 95% CI 1,28-2.58
Oral and IV vs oral antibiotics*	12 RCTs	Combination oral and IV antibiotics were more effective than oral antibiotics alone	OR 0.44, 95% CI 0.33-0.58
Oral and IV* vs IV antibiotics	6 Cohort studies	Combination oral and IV antibiotics were more effective than IV antibiotics alone	RR 0.52, 955 CI 0.46-0.59
Oral and IV and MBP* vs IV and MBP	5 Cohort studies	Combination oral and IV and antibiotics and MBP favoured vs IV antibiotics and MBP	RR 0.48, 95% CI 0.44-0.52
Oral plus IV antibiotics* vs oral and IV antibiotics plus MBP	3 Cohort studies	No statistically significant differences	RR 0.94, 95% CI 0.73-1.20

* Reference

As shown in the table above, there is very little evidence comparing oral and IV antibiotics without MBP to oral and IV antibiotics with MBP. It should be noted that two of the three cohort studies identified by Koullouros and colleagues used the same NSQIP data[50,51] while the third used VASQIP data.[52] Indeed, most of the current articles on this topic are based on the same NSQIP cohort (2010 to 2012). There is a limitation to these studies because data on IV antibiotics are not collected in NSQIP and an assumption is made that patients received IV antibiotics. Furthermore, even if patients did receive IV antibiotics, the dose, timing and redosing information is not available.

In the cohort study by Cannon et al, data from 9,940 patients who underwent elective colorectal resections between 2010 and 2012 were analyzed.[52] Of these. 3,400 (34.2%) patients received oral antibiotics and MBP and 723 (7.3%) patients received oral antibiotics without MBP. The group who received oral antibiotics and MBP had an SSI rate of 8.3% compared to 9.2% in those who received only oral antibiotics. There were two other groups: one which had no MBP and the other which had MBP only and the SSI rates were 18.1% and 20% respectively.

In the second cohort study, Scarborough and colleagues used NSQIP data from 2012-2013.[50] Out of a cohort of 4,999 patients having colorectal surgery, 1,494 (29.9%) received combined MBP and oral antibiotics while 91 (1.8%) patients received only oral antibiotics. Again, data on the compliance with IV antibiotic usage was not reported. While the cohort who received oral antibiotics only is small, there was

no significant difference in the SSI rates in patients having MBP and oral antibiotics (9.2%) compared to those who had oral antibiotics alone (8.3%).

Finally, Moghadamyeghaneh and colleagues published another study which used NSQIP data from 2012 to 2013. Again, they found no significant difference in the SSI rates between those patients who received oral antibiotics and MBP and those who received oral antibiotics only (9.1% versus 12%).[51]

In addition to the WHO Guideline mentioned previously, the American Society for Enhanced Recovery and Perioperative Quality Initiatives published a joint consensus statement on prevention of postoperative infection in 2017.[53] They recommended "the routine use of a combined isosmotic mechanical bowel prep with oral antibiotics before elective colorectal surgery. They do not make recommendations about the use of IV antibiotics but reference a Cochrane Review from 2009 which concluded that both IV and oral antibiotics should be given routinely and can reduce SSIs.[54]

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