**Name of Journal:** *World Journal of Gastrointestinal Surgery*

**Manuscript NO:** 60843

**Manuscript Type:** SYSTEMATIC REVIEWS

**Is colonic lavage a suitable alternative for left-sided colonic emergencies?**

Tham HY *et al*. Colonic lavage for left-sided colon surgery

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**Received:** November 16, 2020

**Revised:** February 16, 2021

**Accepted:** March 12, 2021

**Published online:** April 27, 2021

**Abstract**

BACKGROUND

The use of intra-operative colonic lavage (IOCL) with primary anastomosis remains controversial in the emergency left-sided large bowel pathologies, with alternatives including Hartmann’s procedure, manual decompression and subtotal colectomy.

AIM

To compare the peri-operative outcomes of IOCL to other procedures.

METHODS

Electronic databases were searched for articles employing IOCL from inception till July 13, 2020. Odds ratio and weighted mean differences (WMD) were estimated for dichotomous and continuous outcomes respectively. Single-arm meta-analysis was conducted using DerSimonian and Laird random effects.

RESULTS

Of 28 studieswere included in this meta-analysis, involving 1142 undergoing IOCL, and 634 other interventions. IOCL leads to comparable rates of wound infection when compared to Hartmann’s procedure, and anastomotic leak and wound infection when compared to manual decompression. There was a decreased length of hospital stay (WMD = -7.750; 95%CI: -13.504 to -1.996; *P* = 0.008) compared to manual decompression and an increased operating time. Single-arm meta-analysis found that overall mortality rates with IOCL was 4% (CI: 0.03-0.05). Rates of anastomotic leak and wound infection were 3% (CI: 0.02-0.04) and 12% (CI: 0.09-0.16) respectively.

CONCLUSION

IOCL leads to similar rates of post-operative complications compared to other procedures. More extensive studies are needed to assess the outcomes of IOCL for emergency left-sided colonic surgeries.

**Key Words:** Colon; Colonic irrigation; Intra-operative colonic lavage; Anastomosis; Emergency surgery; Colonic neoplasm

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**Citation:** Tham HY, Lim WH, Jain SR, Mg CH, Lin SY, Xiao JL, Foo FJ, Wong KY, Chong CS. Is colonic lavage a suitable alternative for left-sided colonic emergencies? *World J Gastrointest Surg* 2021; 13(4): 379-391

URL: https://www.wjgnet.com/1948-9366/full/v13/i4/379.htm

DOI: https://dx.doi.org/10.4240/wjgs.v13.i4.379

**Core Tip:** Comparing the intra and post-operative outcomes of primary resection and immediate reconstruction after either intra-operative colonic lavage (IOCL), manual decompression or without IOCL against Hartmann’s procedure and subtotal colectomy in the management of colorectal emergencies, intraoperative colonic lavage was found to have largely similar rates of post-operative complications compared to other procedures. The operative duration was observed to be statistically longer in IOCL than without IOCL. However, hospitalization stay was significantly shorter in duration in those with IOCL compared to Hartmann’s. Thus, there may be merits in choosing IOCL especially for patients who are hemodynamically stable.

**INTRODUCTION**

First described by Dudley in 1983[1], the use of intraoperative colonic lavage (IOCL) with primary anastomosis remains controversial in the colorectal emergency surgery. Large bowel obstruction represents up to 80% of emergencies associated with colorectal carcinoma while perforations, diverticulitis, and colonic volvulus accounts for the remaining[2,3]. The mechanics were intended to remove fecal material to reduce the chances of contamination and served to reduce colonic distention facilitating closure, improving colonic blood supply and reducing anastomotic tension[4]. Primary anastomosis after IOCL has since been thought to facilitate good bowel preparation for a safe anastomosis and avoid the disadvantages associated with staged operations[5,6].

Current literature, however, suggests that complete cleaning of the colon from fecal matter may not be necessary to ensure anastomotic integrity[7,8]. Furthermore, there is evidence that IOCL may lead to greater proximal colonic mobilization, longer operating time, electrolyte abnormalities and hypothermia from infusion with large amounts of saline[9]. Alternative options thus include performing a primary anastomosis using unprepped colon, or manual decompression. For most left-sided emergencies, Hartmann’s procedure is commonly performed[10] although it has been associated with increased morbidity due to the need for a second operation to reestablish intestinal continuity[11] with up to 50% having permanent stomas[12]. Alternatively, subtotal and total colectomy are practiced in cases of impending cecal perforation or synchronous colonic neoplasms[13] but the post-operative increased frequency of motion relative to other colon sparing operations, may adversely affect quality of life[14].

Therefore, in light of the uncertainty concerning the necessity and efficacy of IOCL and alternative procedures, this study aims to compare the intra and post-operative outcomes of primary resection and immediate reconstruction after either IOCL, manual decompression or without IOCL against Hartmann’s procedure and subtotal colectomy in the management of colorectal emergencies.

**MATERIALS AND METHODS**

***Search strategy***

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered to in the synthesis of this review[15]. A systematic literature search was conducted on Medline, Embase and China National Knowledge Infrastructure from inception till July 13, 2020. The full search strategy for Medline is attached in Supplementary search strategy. Citations were then downloaded and reviewed in Endnote Reference Manager X9.

***Study selection and eligibility criteria***

Citations deemed potentially relevant were first screened by title and abstract, followed by full text for inclusion by two independent authors, with final inclusion of the articles based on consensus. Both comparative and non-comparative articles about IOCL for both benign and malignant conditions were included. Prospective and retrospective studies, and randomized controlled trials (RCTs) in English and Chinese were included. Studies were excluded if there was no mention of an IOCL or if the publication type was deemed unsuitable (conference abstract, case series, correspondence and reviews). Separate analysis was conducted on studies comparing IOCL and Hartmann’s procedure, manual decompression, subtotal colectomy and no IOCL.

***Data extraction and outcomes***

For each included article, data were extracted by two independent authors (Tham HY and Lim WH) onto a structured proforma. For each study, details of the author, publication year, country of origin, study design, indication for surgery, population demographics and study outcomes were extracted. Operative time, blood loss, hospital stay, mortality, and complications were collected for intra and post-operative outcomes. Transformation of values were carried out using pre-existing formulae, with mean and standard deviations being calculated from continuous variables of median and range using calculations from Wan *et al*[16].

***Statistical analysis and quality assessment***

Comparative analysis and meta-analysis of proportions was performed using STATA (16.1 StataCorp LLC). In single-arm meta-analysis, the “metaprop” function was used to calculate overall incidence and proportions using the Freeman-Tukey double arcsine transformation to stabilize variance[17], with DerSimonian and Laird random effects model used for pooled analysis[18]. For pairwise comparison, weighted mean differences (WMD) and odds ratio (OR) were estimated for continuous and dichotomous outcomes respectively. Random effects by Dersimonian and Laird were used regardless of heterogeneity measures (Cochrane Q test, *I2* and tau)[19,20]. Significance was considered when *P* < 0.05.

The quality of included articles was independently assessed by two authors using the Jadad Scale for RCTs and the Newcastle-Ottawa Scale(NOS) for cohort studies[21,22]. The Jadad Scale is a 5-point scale for measuring the quality of RCTs, assessing the randomization, blinding and withdrawals within the study[23]. A score of three or more points on the Jadad Scale indicates high quality. The NOS assesses the selection, comparability and outcomes in the relevant articles.

**RESULTS**

A systematic search of the literature utilizing the above search strategy yielded a total of 789 articles, with 637 remaining after duplicate removal. 500 were excluded based on the study title and abstract, and 137 full text articles were derived for a full text review, of which 29 articles were subsequently included in the meta-analysis. Nine studies originated from China, five studies arising from Spain, three studies from the United Kingdom, two from Italy, Egypt and Singapore as well as one from the United States of America, France, Japan, Lithuania, Turkey and Nigeria. Of the 29 included studies, 17 were single-arm studies[6,24-40], 2 were retrospective cohort studies[41,42], 9 were prospective cohort studies[4,31,43-49], and 1 was an RCT[50]. A summary of the selection strategy is presented in Figure 1.

Of 15 studies were solely focused on patients with colorectal cancer, whilst 14 studies contained patients with both malignant and benign etiologies, and three studies involved patients with solely benign conditions. In total, 1142 patients underwent single-staged colonic resection with IOCL and primary anastomosis, 183 patients had colonic resection with primary anastomosis without IOCL, 128 patients underwent single-staged colonic resection, intraoperative manual colonic decompression with primary anastomosis, while 35 patients received subtotal colectomy and 288 patients underwent Hartman’s procedure. A summary of the characteristics of included studies can be found in Supplementary Table 1. Table 1 presents the summary of results of comparative and Table 2 presents the results of single-arm meta-analysis. Results of quality assessment are available in Supplementary Table 2.

***IOCL vs other procedures***

IOCL was compared between Hartmann’s procedure, manual decompression, subtotal colectomy and no intervention and the results are summarized in Table 1. The results of 30-d mortality across all procedures are presented in Figure 2.

***IOCL vs Hartmann’s procedure***

Hospitalization stay was observed to be significantly shorter in duration in those with IOCL (WMD = -7.750, 95%CI: -13.50 to -1.97, *P* = 0.008). However, there was no significant difference in the rates of 30-d mortality (OR = 0.525; 95%CI: 0.272-1.012; *P* = 0.054) and post-operative complications including wound infection (OR = 0.755; 95%CI: 0.433-1.314; *P* = 0.320), paralytic ileus (OR = 3.405; 95%CI: 0.791-14.644; *P* = 0.100), pneumonia (OR = 0.473; 95% CI: 0.168-1.332; *P* = 0.156), and re-operation (OR = 0.560; 95%CI: 0.094-3.324; *P* = 0.523) between those undergoing IOCL compared to Hartmann’s procedure.

***IOCL vs manual decompression***

Comparing between the two groups, there were no statistically significant differences in 30-d mortality (OR = 1.054 95%CI: 0.245-4.569; *P* = 0.943), anastomotic leak (OR = 0.585; 95%CI: 0.177-1.937; *P* = 0.380), wound infection (OR = 1.996; 95%CI: 0.402-9.926; *P* = 0.398), and reoperation rate (OR = 1.237; 95%CI: 0.366-4.185; *P* = 0.733).

***IOCL vs subtotal colectomy***

There were no statistically significant differences in the incidences of 30-d mortality (OR = 0.356; 95%CI: 0.035-3.608; *P* = 0.382). Postoperative complications such as anastomotic leak (OR = 13.462; 95%CI: 0.704-257.477; *P* = 0.718), intra-abdominal infection (OR = 0.266; 95%CI: 0.012-6.133; *P* = 0.408), pneumonia (OR = 0.266; 95%CI: 0.012-6.133; *P* = 0.408) and sepsis (OR = 2.30; 95%CI: 0.075-71.005; *P* = 0.634) were otherwise comparable amongst both groups. Pooled analysis did not demonstrate any significant differences in duration of hospitalization between IOCL and subtotal colectomy (WMD = 0.3; 95%CI: -6.146-6.746; *P* = 0.927).

***IOCL vs no IOCL***

The operative duration was observed to be statistically longer in IOCL than no IOCL (WMD = 27.553; 95%CI: 10.560-44.546; *P* = 0.001). However, 30-d mortality rates did not differ significantly between IOCL and no IOCL (OR = 0.625; 95%CI: 0.144-2.711; *P* = 0.53). Post-operative complications including anastomotic leak (OR = 0.549; 95%CI: 0.121–2.472; *P* = 0.434), wound infection (OR = 4.130; 95%CI: 1.112-15.338; *P* = 0.522) and paralytic ileus (OR = 0.474; 95%CI: 0.121-1.859; *P* = 0.285) were also found to be similar amongst both groups. Rates of intra-abdominal infection (OR = 1.012; 95%CI: 0.116 – 8.821; *P* = 0.991) and pneumonia (OR = 0.445; 95%CI: 0.114-1.737; *P* = 0.244), and re-operation (OR = 0.194; 95%CI: 0.008-4.407; *P* = 0.296) were observed to be comparable. There was no difference in duration of hospital stay (WMD = -25.911; 95%CI: -67.404-15.582; *P* = 0.221).

***Intra-operative colonic lavage only***

The pooled estimate of the 30-d mortality in patients with IOCL was 4% (CI: 0.03-0.05). Analysis of significant postoperative outcomes reported the incidence of anastomotic leak to be 3% (CI: 0.02-0.04, Figure 3), wound infection at 12% (CI: 0.09-0.16, Figure 4), intra-abdominal infection at 3% (CI: 0.01-0.04), and sepsis at 2% (CI: 0.01-0.05). The pooled estimate reported for the duration of surgery was 194.754 min (CI: 164.834-224.276) respectively. Pooled analysis of intraoperative blood loss and duration of hospital stay was 290.996 mL (CI: -184.98-766.973) and 15.935 d (CI: 12.927-18.944). Analysis of other outcomes are presented in Table 2. The results of single-arm meta-analysis for rates of anastomotic leak and wound infection are presented in Figures 3 and 4 respectively.

***Sensitivity analysis***

A sensitivity analysis was conducted on patients that only had cancer as the disease etiology. The 30-d mortality rate was reported to be 2% (CI: 0.01-0.04). Rates of complications such as anastomotic leak, wound infection, paralytic ileus, and pneumonia were found to be 3% (CI: 0.01-0.05), 11% (CI: 0.07-0.16), 7% (CI: 0.00-0.18), and 5% (CI: 0.00-0.12) respectively. Patients who had cancer had a sepsis rate of 2% (CI: 0.01-0.05). Re-operation rates in only patients who had malignant etiologies were found to be 2% (CI: 0.00-0.07).

**DISCUSSION**

With the evolution of colonic preparation and irrigation, this review serves to consolidate the existing knowledge regarding the need for and importance of IOCL in left-sided colonic emergencies. Conversion into a clean, decompressed colon improves the anastomotic healing process, but there is no consensus on its impact on anastomotic leak rates. IOCL has been hypothesized to decrease the rate of suture failure and its associated complications[49], while also being an acceptable one-stage procedure that avoids contamination. Previous literature suggests that IOCL can be performed based on the comfort level of the surgeon[51]. However, there are controversies with the current practice of IOCL when compared to alternatives such as manual decompression, Hartmann’s procedure and subtotal colectomy for emergency left-sided colorectal surgeries.

IOCL before a primary anastomosis enables the surgeon to prepare the colon and is thought to reduce the rate of anastomotic leak and wound dehiscence[6]. Studies have suggested that complete cleaning of the colon from fecal matter may not be necessary to ensure anastomotic integrity[7,8]. This review found that post-operative complications including anastomotic leak rates (OR = 1.168; 95%CI: 0.502-2.717; *P* = 0.718) and wound dehiscence (OR = 0.915; 95%CI: 0.161-5.192; *P* = 0.920) were largely comparable to other interventions. This is similar to previous studies that found that there is no significant benefit to bowel preparation in elective settings[52]. Although IOCL aids in the removal of fecal material, the colon is not completely sterile despite thorough lavage. Hence, IOCL during emergency colorectal surgery does not necessarily lead to a significant change in the rates of anastomotic leak or wound dehiscence after surgery, as supported by the results of this meta-analysis. While intraoperative complications were by and large similar between IOCL and other modalities, the use of IOCL consistently led to a decreased length of stay compared to other modalities, including Hartmann’s procedure (WMD = -7.750; 95%CI: -13.504 to -1.996; *P* = 0.008), and manual decompression (WMD = 3.500; 95%CI: 2.943-4.057; *P* < 0.001). A prolonged length of stay leads to increased use of healthcare resources, greater stress on the country’s healthcare system and is a predictor for readmission[53].

Over the years and with the creation of new techniques in management of colonic emergencies, the practice of IOCL has been gradually been forgotten, with current guidelines in management either recommending alternative procedures depending on the skill level of the surgeon[2], or advising against the use of IOCL in emergent left-sided colorectal surgeries[54,55]. This can also be due to the possibility of complications such as electrolyte abnormalities and hypothermia from infusion with large amounts of saline[9], increase in operative time and supporting this, the results of this meta-analysis found an increase in operative time compared to without lavage (WMD = 27.553; 95%CI: 10.560-44.546; *P* = 0.001) and with manual decompression (WMD = 22.593; 95%CI: -6.364-51.550; *P* = 0.126) resulted from IOCL requiring a significantly longer time to prepare (WMD = 15.00; 95%CI: 9.746-20.254; *P* < 0.001).

It is worth noting that surgeons surveyed preferred performing an on-table lavage when performing a resection with primary anastomosis for a left-sided obstruction[3,56,57]. Where on-table lavage was concerned, the single-arm meta-analysis found the rate of 30-d mortality to be 4% (CI: 0.03-0.05), intra-abdominal infection to be 3% (CI: 0.01-0.04), and re-operation to be 5% (CI: 0.02-0.07) across the included articles. A sensitivity analysis for cancer as the only indication for left-sided colonic emergencies was conducted as cancer is the cause of 80% of colorectal emergencies[2,3]. The sensitivity analysis found a decrease in 30-d mortality to 2% (CI: 0.01-0.04), intra-abdominal infection 1% (CI: 0.00-0.03), and re-operation to 2% (CI: 0.00-0.07). However, while there was a lower rate of complications for malignant etiologies, the mechanism of which remains unknown and further studies are required to explore studies are required to explore the impact of benign and malignant etiologies in table lavage. Additionally, when compared other procedures in managing left-sided colorectal emergencies, especially a manual decompression and subtotal colectomy, an IOCL procedure confers a benefit in terms of proximal colon preservation and reduced intraluminal bacterial load, possibly leading to better outcomes including anastomotic leak and post-operative bowel function. The use of IOCL especially in obstructed colorectal cancer thus may facilitate on-table colonoscopy to detect synchronous lesions, which may alter surgical plans if deemed significant. Hence, in situations where IOCL may not be considered due to surgeon or other factors, its merits of decreased short-term mortality, a shortened length of stay, and comparable short-term complications are not to be dismissed, and it is worth reconsidering the use of IOCL in left-sided colonic emergencies. As more studies are conducted on the outcomes of management of left-sided colorectal emergencies, larger and more extensive, randomized, prospective studies need to be conducted to effectively assess the effectiveness of IOCL in such emergent cases.

***Limitations***

Limitations of this study should be considered when interpreting the results. A majority of the included papers were written more than a decade ago and hence this study may not be representative of the current standard of practice for IOCL. Newer strategy in managing left sided colonic obstruction such as colonic stenting followed by elective surgery is also not discussed in this paper. Due to a limited sample size in the comparison between IOCL and subtotal colectomy, results of this analysis need to be interpreted with caution. Additionally, the inherent quality of study designs with a large majority presented by observational cohort studies (*n* = 27) lack the rigor of RCTs. Furthermore, only papers in English and Chinese were included due to linguistic constraint.

**CONCLUSION**

Despite the gradual phasing out of practice, IOCL leads to a shortened hospital stay and comparable post-operative complications compared to other modalities of managing left-sided colonic emergencies in patients who are hemodynamically stable and are hence able to tolerate a longer time under general anesthesia. Added with the ability to conduct an on-table colonoscopy, the merits of IOCL should not be dismissed while keeping in mind its disadvantages in increased operative time. However, due to a lack of randomized trials, further studies need to be conducted to fairly assess the outcomes of IOCL in the present-day management of emergent left-sided colonic surgeries.

**ARTICLE HIGHLIGHTS**

***Research background***

The use of intra-operative colonic lavage (IOCL) with primary anastomosis remains controversial in the emergency left-sided large bowel pathologies. There is little literature present that concludes the effectiveness of IOCL over its alternatives, including Hartmann’s procedure, manual decompression and subtotal colectomy.

***Research motivation***

To establish safety and effectiveness of IOCL, compared to Hartmann’s procedure, manual decompression and subtotal colectomy

***Research objectives***

To review the perioperative outcomes of IOCL compared to other modalities of bowel preparation for left-sided colorectal surgery.

***Research methods***

Electronic databases were searched for articles employing IOCL. Studies meeting inclusion criteria were reviewed and information regarding variables of interest were extracted. Odds ratio and weighted mean differences were estimated for dichotomous and continuous outcomes respectively. Single-arm meta-analysis was conducted using DerSimonian and Laird random effects.

***Research results***

Of 28 studieswere included in this meta-analysis. IOCL leads to comparable rates of wound infection when compared to Hartmann’s procedure, and anastomotic leak and wound infection when compared to manual decompression. There was a decreased length of hospital stay (weighted mean differences = -7.750; 95%CI: -13.504 to -1.996; *P* = 0.008) compared to manual decompression and an increased operating time. Overall mortality rates with IOCL were 4% (95%CI: 0.03-0.05). Rates of anastomotic leak and wound infection were 3% (95%CI: 0.02-0.04) and 12% (95%CI: 0.09-0.16) respectively.

***Research conclusions***

IOCL leads to similar rates of post-operative complications compared to other procedures.

***Research perspectives***

More extensive studies are needed to assess the outcomes of IOCL for emergency left-sided colonic surgeries.

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**Footnotes**

**Conflict-of-interest statement:** The authors declare no conflicts of interest.

**PRISMA 2009 Checklist statement:** The authors have read the PRISMA 2009 Checklist, and the manuscript was prepared and revised according to the PRISMA 2009 Checklist.

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**Manuscript source:** Invited manuscript

**Peer-review started:** November 16, 2020

**First decision:** February 14, 2021

**Article in press:** March 12, 2021

**Specialty type:** Gastroenterology and hepatology

**Country/Territory of origin:** Singapore

**Peer-review report’s scientific quality classification**

Grade A (Excellent): A

Grade B (Very good): 0

Grade C (Good): 0

Grade D (Fair): 0

Grade E (Poor): 0

**P-Reviewer:** Shah OJ **S-Editor:** Fan JR **L-Editor:** A **P-Editor:** Li JH

**Figure Legends**



**Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart.**



**Figure 2 Meta-analysis of 30-d mortality.**



**Figure 3 Single-arm meta-analysis of anastomotic leak rates in intra-operative colonic lavage.**



**Figure 4 Single-arm meta-analysis of wound infection rates in intra-operative colonic lavage.**

**Table 1** **Summary of comparative results**

|  |
| --- |
| **Intra-operative colonic anastomosis for left-sided colonic emergencies (dichotomous)** |
| **Outcome** | **Hartmann’s procedure** | **Manual decompression** | **Without lavage** | **Subtotal colectomy** |
| **OR; 95%CI** | ***P* value** | **OR; 95%CI** | ***P* value** | **OR; 95%CI** | ***P* value** | **OR; 95%CI** | ***P* value** |
| 30-d mortality  | 0.525; 0.272-1.012 | 0.054 | 1.054; 0.245-4.569 | 0.943 | 0.625; 0.144-2.711 | 0.530 | 0.356; 0.035-3.608;  | 0.382 |
| Anastomotic leak  | - | - | 0.585; 0.177-1.937 | 0.380 | 0.548; 0.121-2.472 | 0.434 | 13.462; 0.704-257.466 | 0.718 |
| Wound infection | 0.755; 0.433-1.314 | 0.320 | 1.996; 0.402-9.926 | 0.398 | 4.130; 1.112-15.338 | 0.522 | -  | - |
| Paralytic ileus | 3.405; 0.791-14.655 | 0.100 | - | - | 0.474; 0.121-1.859 | 0.285 | - | - |
| Intra-abdominal infection | 0.434; 0.067-2.814 | 0.381 | 0.794; 0.284-2.216 | 0.659 | 1.012; 0.116-8.821 | 0.991 | 0.266; 0.012-6.133 | 0.408 |
| Pneumonia | 0.473; 0.168-1.332 | 0.156 | - | **-** | 0.445; 0.114-1.737 | 0.244 | 0.266; 0.012-6.133 | 0.408 |
| Wound dehiscence | 2.560; 0.219-29.869 | 0.453 | 1.042; 0.020-54.629 | 0.984 | 0.160; 0.007-3.638 | 0.250 | - | - |
| Evisceration | 0.773; 0.146-4.080 | 0.761 | - | - | 4.241; 0.207-86.954 | 0.348 | - | - |
| Sepsis | 0.348; 0.096-1.257 | 0.107 | - | - | - | - | 2.300; 0.075-71.005 | 0.634 |
| Re-operation | 0.560; 0.094-3.324 | 0.523 | 1.237; 0.366-4.185 | 0.733 | 0.184; 0.008-4.407 | 0.296 | - | - |
| **Intra-operative colonic anastomosis for left-sided colonic emergencies (continuous)** |
| **Outcome** | **WMD; 95%CI** | ***P* value** | **WMD; 95%CI** | ***P* value** | **WMD; 95%CI** | ***P* value** | **WMD; 95%CI** | ***P* value** |
| Duration of surgery (min)  | -4.890; 34.708-24.928 | 0.748 | 22.593; -6.364-51.550 | 0.126 | 27.553; 10.560-44.546 | 0.001b | 45.000; 25.475-64.525 | < 0.001c |
| Time to carry out intervention (min) | - | - | 15.000; 9.746-20.254 | < 0.001c | - | **-** | - | **-** |
| Intraoperative blood loss (ml)  | 93.222; -103.779-290.223 | 0.354 | - | - | - | - | - | - |
| Duration of hospital stay (days)  | -7.750; -13.504- -1.996 | 0.008b | 3.500; 2.943-4.057 | < 0.001c | -25.911; -67.404-15.582 | 0.221 | 0.300; -6.146-6.746 | 0.927 |

b*P* < 0.01.

c*P* < 0.001.

OR: Odds ratio; WMD: Weighted mean differences.

**Table 2 Results of intra-operative colonic lavage only**

|  |  |  |
| --- | --- | --- |
| **Outcome** | **All indications** | **Cancer only** |
| **Sample size** | **Incidence** | **CI** | **Sample size** | **Incidence** | **CI** |
| **Intra-operative colonic anastomosis for left-sided colonic emergencies (dichotomous)** |
| 30-d mortality | 1091 | 0.04 | 0.03-0.05 | 517 | 0.02 | 0.01-0.04 |
| Anastomotic leak | 1070 | 0.03 | 0.02-0.04 | 485 | 0.03 | 0.01-0.05 |
| Wound infection | 1018 | 0.12 | 0.09-0.16 | 498 | 0.11 | 0.07-0.16 |
| Paralytic ileus | 342 | 0.06 | 0.03-0.11 | 143 | 0.07 | 0.00-0.18 |
| Intra-abdominal infection | 630 | 0.03 | 0.01-0.04 | 249 | 0.01 | 0.00-0.03 |
| Pneumonia | 444 | 0.07 | 0.02-0.15 | 219 | 0.05 | 0.00-0.12 |
| Sepsis | 341 | 0.02  | 0.01-0.05 | 131 | 0.02 | 0.00-0.05 |
| Re-operation | 420 | 0.05 | 0.02-0.07 | 78 | 0.02 | 0.00-0.07 |
| **Intra-operative colonic anastomosis for left-sided colonic emergencies (continuous)** |
| Duration of surgery (min) | 513 | 194.555 | 164.834- 224.276 | 361 | 189.565 | 145.293-233.837 |
| Intra-operative Blood loss (mL) | 52 | 290.996 | -184.98-766.973 | 37 | 104.170 | -72.227-280.567 |
| Duration of hospital stay (d) | 563 | 15.935 | 12.927-18.944 | 135 | 15.720 | 9.233-22.207 |



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