



Hoon Jai Chun, MD, PhD, AGAF, Professor, Series Editor

Adjuncts to colonic cleansing before colonoscopy

Sanghoon Park, Yun Jeong Lim

Sanghoon Park, Department of Internal Medicine, KEPCO Medical Center, KEPCO Medical Foundation, Seoul 132-703, South Korea

Yun Jeong Lim, Department of Internal Medicine, Dongguk University Ilsan Hospital, Goyang 411-773, South Korea

Author contributions: Park S and Lim YJ performed the literature review and analyzed the collected data; Park S wrote the manuscript; Lim YJ supervised the review project.

Correspondence to: Yun Jeong Lim, MD, Professor of Medicine, Department of Internal Medicine, Dongguk University Ilsan Hospital, 814 Siksa-dong, Ilsandong-gu, Goyang 411-773, South Korea. limyj@dongguk.ac.kr

Telephone: +82-31-9617133 Fax: +82-31-9619339

Received: August 8, 2013 Revised: January 25, 2014

Accepted: February 20, 2014

Published online: March 21, 2014

these adjuncts showed that no single agent or method has yet achieved the goal of completely overcoming the limitations of the current gold standard preparation method, they at least provide endoscopists with an array of alternatives to help improve the suboptimal efficacy of the main cleansing solutions when used alone. To aid in this clinical endeavor, a subjective grade was assigned to each adjunct to indicate its practical value. In addition, the systematic review of the currently available agents and methods provides insight into the features of each that may be overcome or exploited to create novel drugs and strategies that may become adopted as effective bowel cleansing adjuncts or alternatives.

© 2014 Baishideng Publishing Group Co., Limited. All rights reserved.

Key words: Colonoscopy; Cathartics; Adjuncts; Purgative agents; Bowel preparation

Core tip: Fair bowel cleansing is a prerequisite for unobstructed visualization in colonoscopy. Since the gold standard self-managed preparation procedure and purgative agent-related complications can limit thorough cleansing, several adjunctive agents and methods have been developed. Clinical experience with these adjuncts have led to some being advocated by endoscopists as useful accessory drugs and to others being criticized for causing further adverse effects or providing insufficient additional benefit. In this article, we reviewed several of the agents that are currently used as colonic cleansing adjuncts and provide a subjective evaluation of their practical value based on their evidentiary strengths and drawbacks.

Abstract

Pre-procedural cleansing of the bowel can maximize the effectiveness and efficiency of colonoscopy. Yet, efficacy of the current gold standard colonic preparation method - high-volume oral administration of purgative agents 12-24 h prior to the procedure - is limited by several factors, such as patient compliance (due to poor palatability and inconvenience of the dosing regimen) and risks of complications (due to drug interactions or intolerance). Attempts to resolve these limitations have included providing adjunctive agents and methods to promote the colonic cleansing ability of the principal purgative agent, with the aim of lessening unpleasant side effects (such as bloating) and reducing the large ingested volume requirement. Several promising adjunctive agents are bisacodyl, magnesium citrate, senna, simethicone, metoclopramide, and prokinetics, and each are being investigated for their potential. This review provides an up to date summary of the reported investigations into the potencies and weaknesses of the key adjuncts currently being applied in clinic as supplements to the traditional bowel preparation agents. While the comparative analysis of

Park S, Lim YJ. Adjuncts to colonic cleansing before colonoscopy. *World J Gastroenterol* 2014; 20(11): 2735-2740 Available from: URL: <http://www.wjgnet.com/1007-9327/full/v20/i11/2735.htm> DOI: <http://dx.doi.org/10.3748/wjg.v20.i11.2735>

INTRODUCTION

A number of purgative agents are currently in clinical use for bowel preparation prior to colonoscopy. While none has provided optimal safety and efficacy profiles, each represents unique strengths and weaknesses (in terms of efficiency, ingested volume, taste, and time required for preparation) that may help to improve the chances of achieving more thorough bowel cleansing. For instance, polyethylene glycol (PEG) is generally considered an adequate colonic cleansing agent, but its salty taste is highly unpalatable and cited by patients as a key reason for not completing the dosing regimen; the resultant inadequate bowel preparation has led to these patients frequently requiring repeat colonoscopy, with the extent of unremoved fecal obstruction sometimes completely inhibiting visualization^[1].

To overcome the limitations of the main colonic cleansing agents, several adjunct purgative agents and methods have been developed. While some adjuncts have potential for use as independent colonic cleansing agents, they have typically been applied in clinical practice as additive means to complement the main agent; although, some reports exist in the literature of their use as a surrogate under narrow indications. In this article, we review the evidentiary information for several of the agents and methods that are currently used as colonic cleansing adjuncts and discuss the potential of each to facilitate or substitute the cleansing function of the main regimen.

COMMONLY USED ADJUNCTS OF COLONIC CLEANSING AGENTS

Bisacodyl

Bisacodyl is an unabsorbable diphenylmethane derivative with stimulant laxative properties. Adjunct administration of bisacodyl is routinely carried out to facilitate bowel preparation by high-volume balanced purgative solutions, such as PEG. However, systematic evaluations of bisacodyl's efficacy when used with full-volume PEG have yielded inconsistent results. One study showed that a bisacodyl regimen of 20 mg over a 2 d period shortened the duration of the main gut irrigation procedure and produced no side-effects^[2]. However, a study of the effective benefit of bisacodyl to the PEG-based regimen found that it provided no significant improvement in cleansing quality as compared with a PEG-only regimen^[3]. Another study suggested that the benefit of providing bisacodyl adjunct to the main regimens based on isosmotic solutions (such as PEG) was a reduction in the volume of purgative agent that needed to be ingested to achieve effective bowel cleansing^[4]. Similarly, when 15 mg of bisacodyl was administered with a PEG-based regimen not only was a lower volume of the main solution required (down to 2 L from the 4 L required for the PEG-only regimen) but the patients showed a better compliance rate and reported experiencing less nausea

during the preparative period^[5].

Comparative analysis of the adjunctive benefits of bisacodyl to another common adjunctive agent - magnesium citrate (MC, discussed below) - confirmed the positive feature of bisacodyl substantially reducing the PEG volume necessary for complete cleaning but indicated that patients preferred MC, likely due to its lower rate of side-effects^[6]. Indeed, bisacodyl administration carries a risk of inducing the life-threatening condition of ischemic colitis^[7,8], and this potential complication, though rare, is a serious consideration for cautious application. Further research is needed to determine the precise indications for bisacodyl use that will correspond with maximal efficacy and safety profiles of this adjunctive agent.

MC and MC-adjunctive regimens (oral sodium picosulfate/MC)

MC is a salt compound that functions as an osmotic laxative and is administered as a hyperosmolar saline solution. The solution draws water into the colonic lumen, thereby increasing intraluminal fecal volume and stimulating gut motility. Clinical application of MC as an adjunctive agent to the main isosmotic purgative solution regimens has been reported to provide effective cleansing with substantially reduced volumes. Similar to the volume-reducing effects of bisacodyl, MC adjunctive application increased cleansing efficacy of the main PEG solution so that only 2 L of the main agent was required (*vs* 4 L) and significantly enhanced patient tolerance of the cleansing regimen^[9]. As cited above, MC was also indicated by patients as preferable to bisacodyl, likely because of fewer unwanted side-effects^[6].

The osmotic laxative action of MC is enhanced by co-administration of a stimulant laxative agent. Sodium picosulfate/MC combination preparations (marketed under the trade names Picolax, Picoprep, Prepopik, Picolax, Citrafleet, and Picolight) are well-established in clinical practice in the United Kingdom and Korea, and have recently been approved for use in the United States^[10]. Several studies have compared the efficacies of sodium picosulfate/MC preparations with conventional isosmotic cleansing agents, such as PEG, as well as another common saline laxative (sodium phosphate). In one comparative analysis of single-regimens of sodium phosphate, PEG, and sodium picosulfate/MC, the latter two agents were found to have similar bowel cleansing performance (as indicated by the Ottawa bowel preparation assessment tool)^[11]. Yet, another comparative analysis of single-regimen sodium picosulfate/MC (Picolax) and PEG showed the two to be comparable in preparation efficacy but indicated that the former was superior in promoting patient compliance since it produced significantly less nausea/vomiting and posed less difficulty for patient consumption^[12]. The lower level of nausea/vomiting was confirmed by another comparative analysis of a generic sodium picosulfate/MC preparation and PEG, but in this study former was shown to produce superior bowel cleansing than the 3 L of PEG^[13]. Still

another study revealed a higher rate of patient preference for the sodium picosulfate/MC preparation when repetitive administrations were required among subjects who experienced similar clinical side effects to the different regimens evaluated^[14].

In an attempt to gain a better understanding of the efficacy and safety profiles of sodium picosulfate/MC preparations as an independent cleansing regimen, a meta-analysis was performed by Tan and Tjandra^[15]. The sodium picosulfate/MC preparations were found to be superior to PEG-based regimens, as they produced the statistically significant benefit of fewer adverse events and a comparable level of bowel cleansing. Indeed, the European Society of Gastrointestinal Endoscopy (ESGE) guidelines for bowel preparation for endoscopy published in 2013 cited the comparable levels of bowel cleansing achieved between the different regimens, as reported in the collective literature^[16].

Despite the promising findings related to the bowel cleansing efficacy of MC, this osmotic laxative has some drawbacks. MC should be cautiously applied to patients with renal insufficiency or failure, who risk detrimental accumulation of magnesium due to inefficient clearance by the impaired kidney^[17]. Moreover, concurrent medications or medical conditions that can influence renal and intestinal function may also lead to elevated magnesium levels in serum, a condition known as hypermagnesemia that is accompanied fluid and electrolyte imbalance. Hypermagnesemia itself is a risk factor for cardiovascular and neuromuscular complications^[18], and particular caution should be taken in elderly patients who are already at risk for these types of disorders and have worse prognoses related to them. Indeed, age-related increases in blood levels of sodium, potassium, and urea have been shown following MC administration^[19]; it is theorized that these potentially detrimental responses may stem from age-related decrement of renal function and reduced intestinal peristalsis, as well as concurrent medications^[20].

Senna

Extracts from the *Senna* genus of plants have well-established stimulant laxative properties. The collective investigations into the various known senna glycosides have revealed that upon ingestion these derivatives are activated by intestinal flora and directly interact with the gut mucosa to stimulate bowel movement and to inhibit electrolyte and water absorption. *Senna* has proven useful as a bowel preparative agent when applied at high doses, both alone and as an adjunct. However, the side-effect of considerable abdominal pain has limited its use, and in the meantime balanced solution-type cleansing agents have largely substituted its role as a colonoscopy preparative agent^[21,22]. As an adjunct, senna is commonly applied with PEG, and the collective clinical experience has led to its being generally characterized as an effective agent to intensify the main agent's cleansing ability.

Adjunct senna has been shown to decrease the vol-

ume of PEG required to achieve effective bowel cleansing and to be associated with higher rate of patient tolerance than full-dose (4 L) PEG^[23]. Another study also reported improved compliance of subjects with senna adjuvant and low-volume PEG, but demonstrated it was less effective at bowel cleansing than full-dose PEG alone^[24]. It is important to note that senna is not widely used in the United States and has not gained approval from the nation's federal drug administration for its use as a colonic cleansing agent^[17]; as such, fewer studies on its efficacy and safety profiles are available, especially when compared to the extensive research findings that have been published for bisacodyl. Nonetheless, the collective findings on senna suggest that it is an adequate adjunct colonic cleansing agent in that it lessens the volume of PEG solution but may not be an effective bowel cleansing agent in isolation due to its side effect of abdominal pain. Comparative analyses with other adjuncts should be carried out in order to gain a better understanding of its efficacy and safety.

Simethicone

As an anti-gas and anti-flatulent agent, simethicone has been suggested (and applied in clinic) as an accessory agent of colonic preparation using the standard bowel preparation regimens^[15]. When combined with the traditional PEG preparatory solution, simethicone significantly decreases the formation of foam and patients have less complaints of gas-related side-effects^[25,26]. Adjunctive administration also has been shown to eliminate bubbles and improve the cleansing quality of the sodium phosphate preparation^[27]. However, a meta-analysis of the overall studies of simethicone adjunctive efficacy failed to demonstrate a superior colonic cleansing ability^[26]. There is still no consensus in the field as to whether simethicone should be recommended for adjuvant use; for example, the American Society for Gastrointestinal Endoscopy recommended its use and the ESGE recommended against its routine application as part of the standard pre-procedural preparation^[28]. Undoubtedly, further investigations are needed to confirm the usefulness of simethicone as an adjunct agent for colonoscopy preparation.

Metoclopramide and other prokinetics

Metoclopramide is a well-established dopamine antagonist, which sensitizes tissues to the action of acetylcholine. This agent exerts an appreciable influence on peristalsis of the upper gastrointestinal regions but has no appreciable effect on the colon^[29]. Therefore, the clinical utility of adjunctive metoclopramide is limited to improvement of nausea or bloating side-effects related to the main colonic cleansing agent, but it is not itself a colonic preparation *per se*^[30]. Some investigators have expressed skepticism concerning the action of metoclopramide, reporting no apparent influence of this adjunct on the abdominal symptoms^[31,32]. In general, however, metoclopramide use is limited by its associated risk of

Table 1 Summary of the currently used colonic preparation adjuncts reviewed in this study

Adjunct	Substance/functions/mechanism	Strengths	Weakness	Conclusion
Bisacodyl ¹	Diphenylmethane; stimulant laxative	Useful for bowel preparation with low-volume polyethylene glycol (PEG) solution; reduces nausea and provides comparable cleansing potency ^[4,5]	Rare complication risk of ischemic colitis ^[7,8]	Controversial results on its efficacy as an adjunct
Magnesium citrate ²	Osmotic laxative	Useful for bowel preparation with low-volume PEG solution; superior to other adjuncts in efficacy ^[9] Cleansing effect is comparable to PEG; has fair patient compliance ^[12]	Use with caution in patients with poor renal function, due to increased risk of hypermagnesemia ^[17]	May be used to reduce the large-volume dose of PEG solution; generally considered a useful substitute to the main bowel cleansing agents ^[15]
<i>Senna</i> (sennoside) ²	Pod or leaf of <i>Senna alexandrina</i> , stimulant laxatives	Useful for bowel preparation with low-volume PEG solution ^[23]	Risk of abdominal pain with high-dose; possible complication risk of ischemic colitis	Generally considered an adequate adjunctive agent
Simethicone ¹	Anti-gas, anti-flatulent	May be useful for lessening bubble formation ^[25]	Limited usefulness for strengthening colonic preparation ^[26] ; some experts do not recommend its use ^[28]	Not widely used as an adjunct
Prokinetics ¹	Metoclopramide (dopamine antagonist)	Anti-emetic, anti-bloating effects	No apparent influence on colonic cleansing ^[29] ; extrapyramidal symptoms occur with high-dose	May be useful for preventing or relieving nausea and bloating sensation
	Mosapride (5-HT ₄ receptor agonist), itopride (dopamine D ₂ receptor antagonist)	Stimulates colonic peristalsis ^[33,34]	Unknown	Potential as an alternative adjunct in geographic regions with market availability
Sports drink ingredient (Gatorade)	MiraLAX/Gatorade	Superior palatability and higher bowel preparation rates (<i>i.e.</i> , cleaner bowel) ^[35,36]	Risk of inducing fluid-electrolyte disturbances due to its non-isosmolarity	Potential alternative in available area

¹Recommendable agent; ²Fairly recommendable agent based on the collective findings from this literature review.

causing extrapyramidal symptoms.

New prokinetic drugs have been developed and introduced to the market over the past decades and systematic investigations into their usefulness as adjuncts for bowel preparation are beginning to accumulate in the literature. A study of mosapride, a selective 5-hydroxytryptamine-4 receptor agonist, administered at a dose of 15 mg immediately prior to ingestion of the 2 L of PEG solution provided superior colonic cleansing than the same PEG regimen administered with placebo^[33]. Itopride, another prokinetic, was also reported to decrease uncomfortable abdominal symptoms when used as an adjunctive to the standard PEG or MC colonic preparations^[34].

Others

Gatorade sports drink has been combined with PEG 3350 powder (MiraLAX[®]) to provide better tolerability of the PEG solution by decreasing the volume required. Gatorade is not an isosmotic solution and represents a risk of inducing electrolyte imbalance. Clinical studies have addressed its potential as a safe and effective adjunct and have shown that a split-dose of MiraLAX/Gatorade is an effective option for achieving adequate colonic cleansing^[35,36].

CONCLUSION

Adjunctive agents are used mainly to facilitate the cleansing efficacy of colon preparation performed by the main

purgative regimens applied in current clinical practice, such as those involving PEG or sodium phosphate solution. To aid in decision-making by treating endoscopists, the various adjunctive agents and methods described herein are summarized in Table 1. In addition, a grade has been assigned to each agent according to the collective findings from this literature review, with two asterisks indicating fairly recommendable and one asterisk indicating recommendable agents. The sodium picosulfate/MC regimen is gradually being accepted as a major bowel cleansing regimen, with its efficacy and safety profiles being maximized according to the individual patients indications (primarily, adequate renal function). *Senna*, metoclopramide, and bisacodyl have the advantage of reducing volume of the large-amount balanced solution that is required for bowel cleansing, thereby enhancing patients' compliance with the preparation procedure. However, the exact efficacy and safety profiles of these agents remain to be definitely established and cautious selection of adjuncts by endoscopists with ample experience remains necessary.

REFERENCES

- 1 **Lebwohl B**, Neugut AI. Post-colonoscopy recommendations after inadequate bowel preparation: all in the timing. *Dig Dis Sci* 2013; **58**: 2135-2137 [PMID: 23817926 DOI: 10.1007/s10620-013-2758-y]
- 2 **Rings EH**, Mulder CJ, Tytgat GN. The effect of bisacodyl on whole-gut irrigation in preparation for colonoscopy. *Endoscopy* 1989; **21**: 172-173 [PMID: 2776703 DOI: 10.1055/

- s-2007-1012935]
- 3 **Brady CE**, Dipalma JA, Beck DE. Effect of bisacodyl on gut lavage cleansing for colonoscopy. *Ann Clin Res* 1987; **19**: 34-38 [PMID: 3555277]
 - 4 **DiPalma JA**, Wolff BG, Meagher A, Cleveland Mv. Comparison of reduced volume versus four liters sulfate-free electrolyte lavage solutions for colonoscopy colon cleansing. *Am J Gastroenterol* 2003; **98**: 2187-2191 [PMID: 14572566 DOI: 10.1111/j.1572-0241.2003.07690.x]
 - 5 **Adams WJ**, Meagher AP, Lubowski DZ, King DW. Bisacodyl reduces the volume of polyethylene glycol solution required for bowel preparation. *Dis Colon Rectum* 1994; **37**: 229-233; discussion 233-234 [PMID: 8137669]
 - 6 **Sharma VK**, Chockalingham SK, Ugheoke EA, Kapur A, Ling PH, Vasudeva R, Howden CW. Prospective, randomized, controlled comparison of the use of polyethylene glycol electrolyte lavage solution in four-liter versus two-liter volumes and pretreatment with either magnesium citrate or bisacodyl for colonoscopy preparation. *Gastrointest Endosc* 1998; **47**: 167-171 [PMID: 9512283 DOI: 10.1016/S0016-5107(98)70351-7]
 - 7 **Bechtold ML**, Choudhary A. Bowel preparation prior to colonoscopy: a continual search for excellence. *World J Gastroenterol* 2013; **19**: 155-157 [PMID: 23345936 DOI: 10.3748/wjg.v19.i2.155]
 - 8 **Ajani S**, Hurt RT, Teeters DA, Bellmore LR. Ischaemic colitis associated with oral contraceptive and bisacodyl use. *BMJ Case Rep* 2012; **2012**: pii: bcr1220115451 [PMID: 22843752 DOI: 10.1136/bcr-12-2011-5451]
 - 9 **Sharma VK**, Steinberg EN, Vasudeva R, Howden CW. Randomized, controlled study of pretreatment with magnesium citrate on the quality of colonoscopy preparation with polyethylene glycol electrolyte lavage solution. *Gastrointest Endosc* 1997; **46**: 541-543 [PMID: 9434223]
 - 10 **Hoy SM**, Scott LJ, Wagstaff AJ. Sodium picosulfate/magnesium citrate: a review of its use as a colorectal cleanser. *Drugs* 2009; **69**: 123-136 [PMID: 19192941 DOI: 10.2165/00003495-200969010-00009]
 - 11 **Lawrance IC**, Willert RP, Murray K. Bowel cleansing for colonoscopy: prospective randomized assessment of efficacy and of induced mucosal abnormality with three preparation agents. *Endoscopy* 2011; **43**: 412-418 [PMID: 21547879 DOI: 10.1055/s-0030-1256193]
 - 12 **Hamilton D**, Mulcahy D, Walsh D, Farrelly C, Tormey WP, Watson G. Sodium picosulphate compared with polyethylene glycol solution for large bowel lavage: a prospective randomised trial. *Br J Clin Pract* 1996; **50**: 73-75 [PMID: 8731641]
 - 13 **Regev A**, Fraser G, Delpre G, Leiser A, Neeman A, Maoz E, Anikin V, Niv Y. Comparison of two bowel preparations for colonoscopy: sodium picosulphate with magnesium citrate versus sulphate-free polyethylene glycol lavage solution. *Am J Gastroenterol* 1998; **93**: 1478-1482 [PMID: 9732929 DOI: 10.1111/j.1572-0241.1998.00467.x]
 - 14 **Worthington J**, Thyssen M, Chapman G, Chapman R, Geraint M. A randomised controlled trial of a new 2 litre polyethylene glycol solution versus sodium picosulphate + magnesium citrate solution for bowel cleansing prior to colonoscopy. *Curr Med Res Opin* 2008; **24**: 481-488 [PMID: 18179734 DOI: 10.1185/030079908X260844]
 - 15 **Tan JJ**, Tjandra JJ. Which is the optimal bowel preparation for colonoscopy - a meta-analysis. *Colorectal Dis* 2006; **8**: 247-258 [PMID: 16630226 DOI: 10.1111/j.1463-1318.2006.00970.x]
 - 16 **Hassan C**, Bretthauer M, Kaminski MF, Polkowski M, Rembacken B, Saunders B, Benamouzig R, Holme O, Green S, Kuiper T, Marmo R, Omar M, Petruzzello L, Spada C, Zullo A, Dumonceau JM. Bowel preparation for colonoscopy: European Society of Gastrointestinal Endoscopy (ESGE) guideline. *Endoscopy* 2013; **45**: 142-150 [PMID: 23335011 DOI: 10.1055/s-0032-1326186]
 - 17 **Adamcewicz M**, Bearely D, Porat G, FriedenberG FK. Mechanism of action and toxicities of purgatives used for colonoscopy preparation. *Expert Opin Drug Metab Toxicol* 2011; **7**: 89-101 [PMID: 21162694 DOI: 10.1517/17425255.2011.542411]
 - 18 **Nyberg C**, Hendel J, Nielsen OH. The safety of osmotically acting cathartics in colonic cleansing. *Nat Rev Gastroenterol Hepatol* 2010; **7**: 557-564 [PMID: 20736921 DOI: 10.1038/nrgastro.2010.136]
 - 19 **Ryan F**, Anobile T, Scutt D, Hopwood M, Murphy G. Effects of oral sodium picosulphate Picolax on urea and electrolytes. *Nurs Stand* 2005; **19**: 41-45 [PMID: 16050231]
 - 20 **Dillon CE**, Laher MS. The rapid development of hyponatraemia and seizures in an elderly patient following sodium picosulfate/magnesium citrate (Picolax). *Age Ageing* 2009; **38**: 487 [PMID: 19406975 DOI: 10.1093/ageing/afp054]
 - 21 **Amato A**, Radaelli F, Paggi S, Terruzzi V. Half doses of PEG-ES and senna vs. high-dose senna for bowel cleansing before colonoscopy: a randomized, investigator-blinded trial. *Am J Gastroenterol* 2010; **105**: 675-681 [PMID: 19844199 DOI: 10.1038/ajg.2009.598]
 - 22 **Radaelli F**, Meucci G, Imperiali G, Spinzi G, Strocchi E, Terruzzi V, Minoli G. High-dose senna compared with conventional PEG-ES lavage as bowel preparation for elective colonoscopy: a prospective, randomized, investigator-blinded trial. *Am J Gastroenterol* 2005; **100**: 2674-2680 [PMID: 16393219 DOI: 10.1111/j.1572-0241.2005.00335.x]
 - 23 **Iida Y**, Miura S, Asada Y, Fukuoka K, Toya D, Tanaka N, Fujisawa M. Bowel preparation for the total colonoscopy by 2,000 ml of balanced lavage solution (Golytely) and sennoside. *Gastroenterol Jpn* 1992; **27**: 728-733 [PMID: 1468604]
 - 24 **Hookey LC**, Depew WT, Vanner SJ. Combined low volume polyethylene glycol solution plus stimulant laxatives versus standard volume polyethylene glycol solution: a prospective, randomized study of colon cleansing before colonoscopy. *Can J Gastroenterol* 2006; **20**: 101-105 [PMID: 16482236]
 - 25 **Lazzaroni M**, Petrillo M, Desideri S, Bianchi Porro G. Efficacy and tolerability of polyethylene glycol-electrolyte lavage solution with and without simethicone in the preparation of patients with inflammatory bowel disease for colonoscopy. *Aliment Pharmacol Ther* 1993; **7**: 655-659 [PMID: 8161673]
 - 26 **Matro R**, Tupchong K, Daskalakis C, Gordon V, Katz L, KastenberG D. The effect on colon visualization during colonoscopy of the addition of simethicone to polyethylene glycol-electrolyte solution: a randomized single-blind study. *Clin Transl Gastroenterol* 2012; **3**: e26 [PMID: 23238113 DOI: 10.1038/ctg.2012.16]
 - 27 **Tongprasert S**, Sobhonslidsuk A, Rattanasiri S. Improving quality of colonoscopy by adding simethicone to sodium phosphate bowel preparation. *World J Gastroenterol* 2009; **15**: 3032-3037 [PMID: 19554657]
 - 28 **Mathus-Vliegen E**, Pellisé M, Heresbach D, Fischbach W, Dixon T, Belsey J, Parente F, Rio-Tinto R, Brown A, Toth E, Crosta C, Layer P, Epstein O, Boustiere C. Consensus guidelines for the use of bowel preparation prior to colonic diagnostic procedures: colonoscopy and small bowel video capsule endoscopy. *Curr Med Res Opin* 2013; **29**: 931-945 [PMID: 23659560 DOI: 10.1185/03007995.2013.803055]
 - 29 **Wexner SD**, Beck DE, Baron TH, Fanelli RD, Hyman N, Shen B, Wasco KE. A consensus document on bowel preparation before colonoscopy: prepared by a task force from the American Society of Colon and Rectal Surgeons (ASCRS), the American Society for Gastrointestinal Endoscopy (ASGE), and the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). *Gastrointest Endosc* 2006; **63**: 894-909 [PMID: 16733101 DOI: 10.1016/j.gie.2006.03.918]
 - 30 **Rhodes JB**, Engstrom J, Stone KF. Metoclopramide reduces the distress associated with colon cleansing by an oral electrolyte overload. *Gastrointest Endosc* 1978; **24**: 162-163 [PMID: 348558]
 - 31 **Golub RW**, Kerner BA, Wise WE, Meesig DM, Hartmann RF, Khanduja KS, Aguilar PS. Colonoscopic bowel prepara-

- tions--which one? A blinded, prospective, randomized trial. *Dis Colon Rectum* 1995; **38**: 594-599 [PMID: 7774469]
- 32 **Brady CE**, DiPalma JA, Pierson WP. Golytely lavage--is metoclopramide necessary? *Am J Gastroenterol* 1985; **80**: 180-184 [PMID: 3976636]
- 33 **Tajika M**, Niwa Y, Bhatia V, Kawai H, Kondo S, Sawaki A, Mizuno N, Hara K, Hijioka S, Matsumoto K, Kobayashi Y, Saeki A, Akabane A, Komori K, Yamao K. Efficacy of mosapride citrate with polyethylene glycol solution for colonoscopy preparation. *World J Gastroenterol* 2012; **18**: 2517-2525 [PMID: 22654449 DOI: 10.3748/wjg.v18.i20.2517]
- 34 **Mishima Y**, Amano Y, Okita K, Takahashi Y, Moriyama N, Ishimura N, Furuta K, Ishihara S, Adachi K, Kinoshita Y. Efficacy of prokinetic agents in improving bowel preparation for colonoscopy. *Digestion* 2008; **77**: 166-172 [PMID: 18577886 DOI: 10.1159/000141040]
- 35 **Samarasena JB**, Muthusamy VR, Jamal MM. Split-dosed MiraLAX/Gatorade is an effective, safe, and tolerable option for bowel preparation in low-risk patients: a randomized controlled study. *Am J Gastroenterol* 2012; **107**: 1036-1042 [PMID: 22565162 DOI: 10.1038/ajg.2012.115]
- 36 **Shieh FK**, Gunaratnam N, Mohamud SO, Schoenfeld P. MiraLAX-Gatorade bowel prep versus GoLyteLy before screening colonoscopy: an endoscopic database study in a community hospital. *J Clin Gastroenterol* 2012; **46**: e96-e100 [PMID: 23060223 DOI: 10.1097/MCG.0b013e3182617bfb]

P- Reviewers: Tajika M, Velayos B **S- Editor:** Gou SX
L- Editor: A **E- Editor:** Liu XM





百世登

Baishideng®

Published by **Baishideng Publishing Group Co., Limited**

Flat C, 23/F., Lucky Plaza,

315-321 Lockhart Road, Wan Chai, Hong Kong, China

Fax: +852-65557188

Telephone: +852-31779906

E-mail: bpgoffice@wjgnet.com

<http://www.wjgnet.com>



ISSN 1007-9327



9 771007 932045