1

Preparing for Colonoscopy

Rosalinda S. Hulse
Jordan Hospital
Plymouth, MA,
USA

1. Introduction

Colorectal cancer is the third leading cause of cancer-related mortality in the United States and the fourth most common cancer in men and women. Colonoscopy is the best screening test done to detect and prevent colorectal cancers. Abnormal growths such as a polyp, a tumor, or a suspicious-looking lesion in the colon or rectum can be biopsied or removed preventing the initiation of the carcinogenic process and potential metastases into other areas of the body, thereby, allowing patients to obtain a more effective treatment (s) with fewer side effects. Patients whose cancers are found early and treated in a timely manner are more likely to survive than those whose cancers are not found until symptoms appear (Atreja, A., Nepal, S. & Lashner, B., 2010; American Cancer Society [ACS], n.d, 2005). Figure 1 shows a picture of a polyp. Figure 1.a shows a picture of a cancerous tumor of the colon.

Fig. 1. Polyp in sigmoid colon

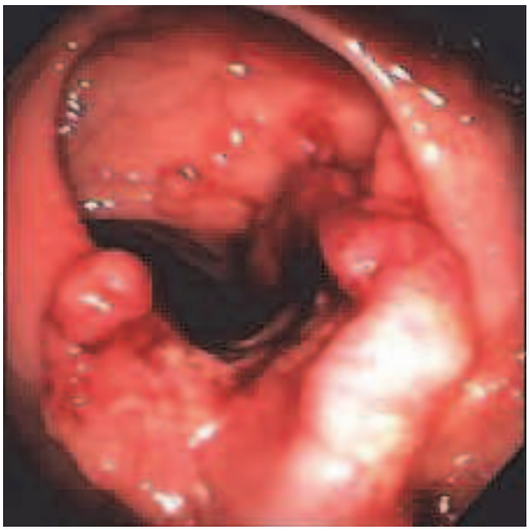


Fig. 1.a Cancerous tumor in the colon

The hardest part of the colonoscopy procedure is the preparation. It usually starts one-to-two weeks prior to the test depending on the recommendation of the physician. Careful planning and strict adherence to these instructions is crucial to the success of the test. Many individuals who have undergone this procedure will attest to the difficulty in complying

with these instructions and the harshness of taking the oral prep. As a result, many are hesitant to go through with it risking the possibility of missing diagnoses of cancerous or non-cancerous lesions, tumors or polyps in the colon or rectum.

The key to a successful colonoscopy is good bowel prep, which also depends on the right choice of bowel cleansing agent. The colon needs to be totally clean for good visualization to avoid missing any abnormal or suspicious-looking areas. A small polyp or lesion can hide behind a small piece of stool. Poor or inadequate bowel prep may lead to a prolonged and costly procedure and a potentially inaccurate exam. It may also increase the chance of being aborted; to be repeated at another time which may be at an interval sooner than what is called for or suggested in the standard guidelines. A repeated colonoscopy also increases the risks and complications, such as perforation and bleeding of the colon, and infection (Lawrence, E. & Pickhardt, P., 2010; Hendry, P., Jenkins, J. & Diament, R., 2007; Froehlich, F., et al, 2005). Preparing for colonoscopy may sound complicated, uncomfortable and time-consuming, but it doesn't have to be. Following the instructions carefully and being prepared ahead of time will help the individual tolerate the procedure with minimal discomfort.

This chapter will discuss the step-by-step process in preparing for this procedure for the adult population, explaining the different types of oral preps (including the adjuncts) to take as well as diet modification that will achieve the best results, taking into consideration any medical condition the individual might have. Special conditions that might be adversely affected by the prep, such as diabetes and any heart condition that require taking blood thinners will also be discussed. Tips to alleviate the discomfort while taking the prep will be outlined as well. The goal is to explain the process in a simple, non-intimidating fashion to encourage more individuals to avail of this life-saving screening procedure minimizing any fear and anxiety they may have. A well-informed individual is better able to follow directions carefully to ensure good results. Figure 2 shows an adequately clean transverse colon.

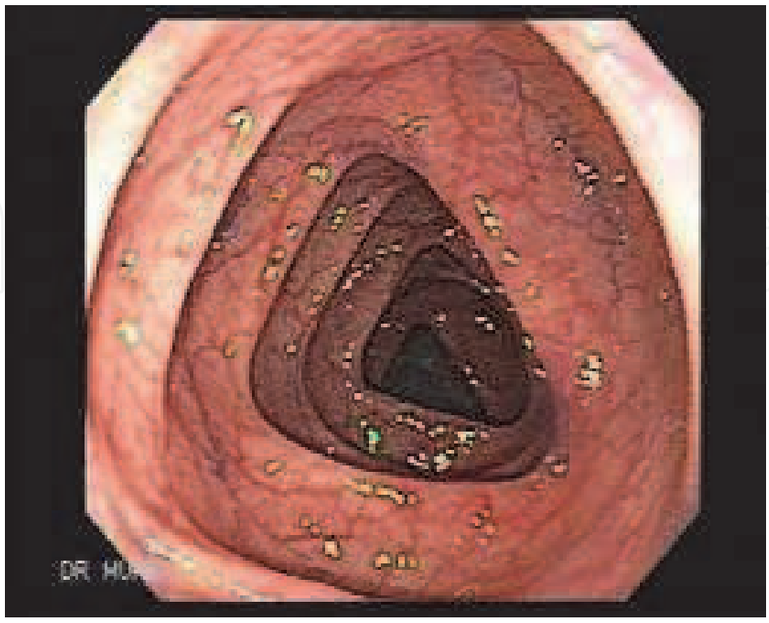


Fig. 2. Transverse Colon

2. Bowel cleansing preps

Some key questions need to be answered prior to selecting an appropriate bowel cleansing agent for the individual:

1. Does the individual have any condition (s) that is contraindicated to taking a bowel prep (i.e. bowel obstruction, perforation, and severe ileus)? If the answer is "yes," then another alternative diagnostic exam need to be considered.
2. Is the individual at risk for fluid and/or electrolyte imbalances? If the answer is "yes," then avoid the sodium phosphate group. Choose the polyethylene glycol.
3. Can the individual tolerate full volume solutions? If not at risk for fluid and electrolyte imbalance and cannot tolerate large doses, choose low-volume polyethylene glycol or sodium phosphate. Sodium picosulfate and magnesium citrate can also be another alternative to sodium phosphate. This is the choice in most European countries and is currently not available in the United States (Atreja, A., Nepal, S. & Lashner, B., 2010). Otherwise, a 4-L polyethylene glycol solution is the choice especially if the individual has a history of poor bowel prep or is worried about cost or insurance coverage.

Compliance to completing a bowel prep is also dependent on a number of factors, namely, poor palatability of the prep, concomitant medications, comorbitites affecting renal and hepatic functions, time of test i.e. early morning or late in the afternoon, sex, and cost (Atreja, A., Nepal, S. & Lashner, B., 2010 & ASGE, 2009). Colonoscopies performed in the afternoon have shown higher rates of poor bowel prep and lower rates of adenoma detection (Varughese, S., Kumar,A.,George, A., & Castro, F., 2010; Sanaka,M., Shah,N., Mullen,K. et al,2006; Ness,R., Manam, R., Hoen,H. et al, 2001). One study found males to have poorer preps than females and the authors recommended these individuals schedule their colonoscopies in the afternoon to take advantage of the split-dosage regimen. The authors also found that colonoscopies performed within 6-8 hours of the end of the bowel prep resulted in a better cleansing than those performed more than 8 hours after ingestion of the last prep dose (Marmo, R., Rotondano, G., Riccio, G. et al. 2010).

The criteria for good bowel prep include:

- Require a short period of ingestion and the ability to empty out the colon in a rapid fashion without grossly or microscopically altering the lining of the colon
- Will not cause undue shifts in fluid and electrolyte balances
- Are safe to administer in light of existing comorbidities
- Easy to complete regimen
- Reimbursed by health insurance company or is inexpensive

Unfortunately, none of the preparations currently available on the market meet all these criteria. As a result, several adjunctive methods have been added along with the main prep and are now available on the market to make it easier and tolerable for the individual to take (Lawrence, M. & Pickhardt, P., 2010).

Historically, bowel cleansing agents evolved from preparations prior to surgical and radiologic exams. These included enemas, ingestion of cathartics as well as dietary restriction of low residue diet for 2-3 days prior to the procedure (Wexner, S., et al. 2006). These were harsh regimens which were time consuming, uncomfortable and inconvenient for the patient; hence, compliance was difficult. In addition, the early preparations contained mannitol, which, when fermented by bacteria in the colon resulted in combustible methane and hydrogen, which created a high risk for gas explosion when cautery was used. This was also true for sorbitol preparations (ASGE, 2009). This led to the development of an

osmotically balanced solution with minimal water absorption or secretion into the colon by Davis and his colleagues in the 1980s (Davis, 1980). The solution was polyethylene glycol, "a high-molecular weight, nonabsorbable polymer in a dilute electrolyte solution that has an osmotic effect on the colon (Atreja, A., Nepal, S. & Lashner, B., 2010)." There are several commercially prepared bowel cleansers, and the compounds used in these preps generally fall into three major groups according to their mechanism of action: isosmotic (the polyethylene glycol group), hyperosmotic (the sodium phosphate group), and bowel stimulants (Atreja, A., Nepal, S. & Lashner, B., 2010; ASGE, 2009; Barkun, A. et.al, 2006; Wexner, S., Beck, D., Baron, T., et al., 2006). Other preparations have since been introduced to improve palatability and compliance, e.g. low volume prep such as PEG and Bisacodyl (Halflytely) and PEG and ascorbic acid (MoviPrep). The most commonly used bowel preparations in the United States are the oral sodium phosphate (NaP) solutions and the polyethylene glycol (PEG) solutions (Atreja, A., Nepal, S. & Lashner, B., 2010 & ASGE, 2009; Barkun, A., Chiba, N., Enns, R., et al., 2006). A summary is shown on Table 1.

Product	Active Ingredient	Approved Bowel Prep By FDA for Adults	Approved Bowel Prep by FDA for Pediatrics	Amount
Isosmotic FV*				
Colyte (Flavored & Nonflavored)	Polyethylene Glycol (PEG)	Yes	No	4000 ml (4L)
GoLYTELY (Flavored & Nonflavored)	Polyethylene Glycol (PEG)	Yes	No	4000 ml (4L)
TriLyte (Flavored)	Sulfate-free Polyethylene Glycol	Yes	>6 months	4000 ml (4L)
NuLYTELY (Flavored & Nonflavored)	Sulfate-free Polyethylene Glycol	Yes	>6 months	4000 ml (4L)
Isosmotic LV**				
MoviPrep	PEG & Ascorbic Acid	Yes	No	2000 ml (2L)
Halflytely	PEG & Bisacodyl	Yes	No	4 Bisacodyl Delayed-Release tablets plus 2000 ml (2L) PEG
Glycolax	PEG-3350 without electrolytes	No	No	255 grams
Miralax	PEG-3350 without electrolytes	No	No	255 grams
Hyperosmotic				
Osmoprep	Sodium phosphate (oral)	Yes +	No	32 tablets

Visicol	Sodium phosphate (oral)	Yes +	No	40 tablets
Fleet Enema	Sodium phosphate (enema)	Yes +	>12 years	135 ml
Magnesium Citrate	Magnesium citrate (oral)	Yes	>6 years	300 ml
Fleet Phospho-Soda EZ-Prep	Sodium phosphate (oral)	Available as prescription only±	No	75 ml
LoSoPrepKit	Magnesium citrate plus Bisacodyl oral & suppository	Yes	No	One package
Picolax	Sodium picosulfate & magnesium citrate	No. Available only in Europe & UK	Yes	Two sachets dissolved in 300 ml solution
CitraFleet	Sodium picosulfate & magnesium citrate	No. Available only in Europe & UK	No	Two sachets dissolved in 300 ml solution
Stimulant laxatives				
Picolax #	Sodium picosulfate & magnesium citrate	No. Available only in Europe & UK	Yes	Two sachets dissolved in 300 ml solution
CitraFleet#	Sodium picosulfate & magnesium citrate	No. Available only in Europe & UK	No	Two sachets dissolved in 300 ml solution
Senna	Senna	No	No	100 tablets

*Full Volume +Black Box warning included # Classified as osmotic and stimulant laxative
**Low Volume ±FDA recommends against over-the-counter use

Table 1. Commonly Used Bowel Preparation Agents

2.1 Isosmotic or the polyethylene glycol group

Polyethylene glycol solutions are nonabsorbable fluids that act as purgatives to evacuate the colon of stool. These are high volume gut lavage solutions that are osmotically balanced and do not induce a significant electrolyte and fluid shifts, hence, are more effective, better tolerated, and safer for individuals who have advanced liver or kidney disease, poorly compensated congestive heart failure, or have documented electrolyte imbalances. These also do not cause significant physiologic changes in the individual's vital signs, weight, and blood counts. However, some rare adverse events have been reported in association with polyethylene glycol ingestion. These include Mallory-Weiss tear, esophageal perforation, colitis, cardiac dysrhythmias, hyponatremia, aspiration, pancreatitis, and a syndrome of inappropriate antidiuretic hormone secretion (Lichtenstein, G., Cohen, L. & Uribarri, J., 2007). Commercially prepared polyethylene glycol solutions come in full volume: flavored and unflavored GoLYTELy, flavored and unflavored Colyte, NuLytely (sulfate-free), Trilyte flavored (sulfate-free); and low volume: Halflytely and MoviPrep (ASGE, 2009).

The standard large volume polyethylene glycol (PEG) solutions, Colyte and GoLYTELY have been studied extensively and were found to have the most evidence for safety and effectiveness. The sodium sulfate in PEG allow for a reduction in sodium absorption in the small intestine. These solutions are also inexpensive and most health insurance companies reimburse the cost. The conventional adult dose is 4L, given as 240ml of the solution every 10 minutes 12-15 hours prior to the procedure until the 4L is consumed and rectal output is clear and watery. If given through a nasogastric tube, 20 to 30ml is instilled every minute. However, because of the large volume required to cleanse the colon and its poor palatability (salty taste and smell of sulfates), about 15% of individuals do not complete the prep (Atreja, A., Nepal, S. & Lashner, B., 2010 & Wexner, S., Beck, D., Baron, T., et al., 2006). The main complaint was nausea, bloating, abdominal cramping, and vomiting. To remedy this, splitting the dose allowed for better compliance and tolerability by the patients; half the dose was ingested the night before the procedure and the other half taken 4-5 hours prior to the procedure (Marmo, R., Rotondano, G., Riccio, G. et al, 2010). This method resulted in a better cleansing of the colon. With the traditional method of single dosing, the long interval between the end of the prep and the start of the procedure allowed secretions from the small intestine to flow into the large intestine, obscuring the view of the cecum and ascending colon. A study conducted by Varughese and associates found that for colonoscopies scheduled in the afternoon, ingestion of the one gallon or 4 L solution of polyethylene glycol resulted in superior cleansing of the colon and was better tolerated by the study participants. There were fewer side effects, too. This method evacuated the contents of the large intestine in a timely manner and did not allow time for the contents of the small intestine to flow to the large intestine thereby obscuring the view (Varughese, S., Kumar,A.,George, A., & Castro, F., 2010). Stimulant laxatives or ascorbic acid were also added to low-volume PEG solutions (e.g. MoviPrep) to improve compliance and palatability (Atreja, A., Nepal, S. & Lashner, B., 2010).

Other suggestions to make ingestion of PEG solutions more tolerable are:

- Adding flavor enhancers, such as Crystal Light, Gatorade, lemon juice or lemon slices.
- Chilling the solution or adding ice cubes and drinking through a straw.
- Taking metoclopramide (Reglan) 5-10mg tablets prior, to prevent nausea.
- Adding one bottle of magnesium citrate (about 300 ml) or two to four tablets of bisacodyl 5mg/tab to decrease the volume ingested.
- Stopping ingestion of the prep once the stool is clear and watery on the day of the test.
- Administration of the prep via a nasogastic tube for individuals with altered mental status or with swallowing disability.
- Ingestion of sulfate-free or flavored PEG solutions, such as NuLytely and TriLyte (flavors come in cherry, pineapple, orange, lemon-lime, and citrus-berry).
- Ingestion of a low-volume solution (2 liters) plus a stimulant laxative, e.g. HalfLytely with two bisacodyl tablets and magnesium citrate; MoviPrep which is PEG plus ascorbic acid.

A sulfate-free PEG solution was developed by Fordtran et al in the 1990s to improve palatability and smell of PEG solutions. The improved taste is the result of a decreased amount of potassium, increased amount of chloride and no sodium sulfate. Examples of these products are NuLYTELY and TriLyte and come in different fruit flavors. Dosing is the same as the 4L PEG solution. It is comparable in terms of safety, tolerance, and effectiveness to the conventional PEG solutions (Wexner, S., Beck, D., Baron, T., et al. 2006). Low-volume

Fig. 3. Several commercially prepared polyrethylene glycol solutions:
Top left, GoLytely; top right, HalfLytely.
Bottom left, Colyte and bottom right, MoviPrep.

PEG preparations (e.g. PEG + ascorbic acid, PEG + electrolytes) were developed to improve patient tolerance by reducing the amount of solution required, and thus, reducing volume-related symptoms such as nausea, bloating, and abdominal cramping. Studies have shown equal efficacy with full volume PEG solutions but with improved compliance and tolerance by patients (Ell, C., Fischbach, W., Bronisch, H. et al. 2008; Bitoun, A., Ponchon, T., Barthet, M. et al., 2006; DiPalma, J., Wolff, B., Meagher, A. & Cleveland, M., 2003).

2.2 Hyperosmotic or the sodium phosphate solutions

Sodium phosphate is widely used worldwide and is an effective bowel cleansing agent. It is better tolerated than PEG preps due to its smaller volume (1.5 -2 liters compared with

polyethylene glycol's 4 liters) and better flavor. Its hyperosmotic property draws water into the colon stimulating peristalsis and eventually affecting a bowel movement. Unfortunately, this is the main disadvantage of NaP solutions, because it causes major fluid and electrolyte shifts in the body, such as hyperphosphatemia, hypocalcemia, hypokalemia, hyponatremia and/or hypernatremia, hypovolemia and increased plasma osmolality. This may lead to an acute phosphate nephropathy in patients with renal failure (ASGE, 2009; Balaban, D., 2008; Khurana, A., McLean,L, Atkinson, S. et al., 2008; Curran, M. & Plosker, G., 2004). Sodium phosphate solutions are therefore, not recommended in individuals with congestive heart disease, bowel obstruction, hepatic and renal disease, ascites, and megacolon. The following may also be at risk of injury to the kidneys if prescribed NaP: individuals over the age of 55, patients who are already dehydrated, patients with acute colitis, individuals taking diuretics, ACE (angiotensin converting enzyme) inhibitor drugs, ARB (angiotensin receptor blockers), and non-steroidal anti-inflammatory drugs (NSAIDS) (Ker, T., 2006; Hookey, L., Depew, W. & Vanner, S., 2002). A study done by Yakut and his associates found that in a selected group of elderly patients without comorbidities such as heart, kidney and liver failure, and diabetes, the administration of NaP preparation for colonoscopy was safe and well tolerated, with a low frequency of side effects (Yakut, M., Kubilay, C., Gülseren, S. et al., 2010). Dong Choon and associates conducted a retrospective study between August of 2005 and May of 2008 in patients with normal kidney function, undergoing colonoscopy at a health center in Korea using NaP solution as the bowel cleansing agent and found that it was safe and effective and no untoward renal injury was noted (Dong Choon, S., Sung Noh, H., Jeong Hwan, K. et al. 2010). Abaskharoun and colleagues also corroborated this findings with their own retrospective study in a Canadian health center (Abaskharoun, R., Depew, W. & Vanner, S., 2007). A prospective study by Casais et al. found that hyperphosphatemia in low-risk individuals was related to low weight and can be minimized with adequate hydration. It was their recommendation to prescribe an appropriate NaP dose according to the individual's weight (Casais, M., Guillermo, R-D., Perez, S, et al., 2009). In December 2008, the Federal Drug Administration (FDA) has recommended NaP preparations be removed as an over-the-counter bowel prep to avoid inappropriate use or overdosing, and a black box warning be included in the labels of prescription products warning consumers of the risk of acute phosphate nephropathy. C.B. Fleet Company voluntarily recalled its oral NaP products, Fleets Phospho-Soda and Fleet EZ-PREP. Sodium phosphate comes in tablet form or aqueous solution. The tablet form, Visicol and OsmoPrep, are the only two sodium phosphate prep available in the United States. The aqueous solution is no longer available (US FDA, 2008; Ainley, E., Winwood, P. & Begley, J., 2005). Figure 4 shows examples of sodium phosphate products available in the market.

The differences in efficacy and safety of PEG and NaP solutions in cleansing the bowel prior to colonoscopy have been studied extensively, and, in general, the histology of the normal colon has been shown to be preserved with PEG solutions.

Sodium phosphate solutions can alter the macroscopic as well as the microscopic appearance of the mucosa of the colon mimicking inflammatory bowel diseases. Thus, these preps are to be avoided in individuals with or suspected with colitis or inflammatory bowel diseases (Bucher, P., Gervaz, P., Egger, J., et al., 2006; Rejchrt, S., Bures, J., Siroky, M. et al. 2004).

Magnesium Citrate is a saline laxative and also a hyperosmotic, and like sodium phosphate, acts by drawing water into the colon. Since it contains magnesium, and elimination is

Fig. 4. Sodium phosphate products available in the US: OsmoPrep and Visicol. The aqueous formula is available only as a prescription.

through the kidneys, administer with extreme caution in individuals with renal insufficiency or failure (Atreja, A., Nepal, S. & Lashner, B., 2010). Magnesium citrate is often used as an adjunct to bowel prep. In addition to the PEG solution, adding magnesium citrate to the prep reduces the amount of PEG solution required to 2L. Taken the night before the procedure (one 300 ml bottle of magnesium citrate) plus two bisacodyl tablets and 2L of PEG solution, has shown to be just as effective as taking the full dose of PEG solution. Used alone, magnesium citrate is not an effective bowel cleansing agent prior to colonoscopy procedures. Magnesium citrate is often used as an adjunct to bowel prep (Atreja, A., Nepal, S. & Lashner, B., 2010; Wexner, S., Beck, D., Baron, T., et al., 2006).

Fig. 5. Magnesium Citrate bottle

2.3 Stimulant preparations

Stimulant laxatives such as bisacodyl (Dulcolax) have been added to low volume PEG solutions and have achieved comparable results to those given the standard dose of PEG solutions (Atreja, A., Nepal, S. & Lashner, B., 2010). It is poorly absorbed in the small intestine and its active ingredients stimulate colon motility, with an onset of action between 6-10 hours (ASGE, 2009).

Fig. 6. Dulcolax tablets

Sodium picosulfate is another cathartic with osmotic action on the bowel similar to NaP. It is a saline laxative used in combination with magnesium citrate. An observational study done in Canada by Love and his colleagues found that administration of sodium picosulfate and magnesium citrate yielded a high percentage positive rate for efficacy (Yakut, M., Kubilay, Ç., Gülseren, S. et al., 2010). This preparation is mostly used in Europe and Canada and is not available in the United States (ASGE, 2009).

Fig. 7. Sodium picosulfate products. Not available in the US

Senna, an anthracene derivative also helps stimulate colon peristalsis by increasing smooth muscle wall activity. A low dose senna (four 8.6 mg tablets of Sennakot) added to a low-volume solution of polyethylene glycol have been found to be just as effective as taking the full-volume PEG solution. It is usually taken within 2 to 6 hours of starting the PEG solution. A study found that there was better visualization of the right colon when senna was added to the magnesium citrate prep and was also better tolerated by the subjects (Vradelis, S., Kalaitzakis, E., Sharifi, Y. et al 2009).

Fig. 8. Senna products

2.4 Adjunct bowel preparation agents

Enemas are useful in cleansing the distal colon in preparation for a sigmoidoscopy, but not recommended as prep for a full colonoscopy. They are used as adjuncts when patients come poorly prepped. The common types are: tap water enemas, soap suds enemas, sodium biphosphate (Fleet), and oil-based enemas such as, cottonseed oil plus docusate (Colace) and diatrizoate sodium (Hypaque). The last one is an iodinated water-soluble contrast agent used in radiographic exams that has a cathartic property. It slows absorption of water from the bowel so that the stool is softer. One study found that combining diatrizoate sodium with a low-volume saline laxative prep (preferably magnesium citrate) was just as effective as, if not better, than the other regularly prescribed preps. It consistently outperformed the standard high-volume PEG solutions in terms of effectiveness as a bowel cleanser and patient compliance and tolerance (Lawrence, E. & Pickhardt, P., 2010). One disadvantage to using this prep was that some individuals developed severe allergic reactions such as anaphylaxis and angioedema. Others have experienced muscle cramps and intermittent leakage of stool in their undergarments for up to 24 hours after the test (Atreja, A., Nepal, S. & Lashner, B., 2010; Lawrence, E. & Pickhardt, P., 2010 & Sohn, N. & Weinstein, M., 2008; Wexner, S., Beck, D., Baron, T., et al., 2006).

Dietary modifications alone are inadequate prep for colonoscopy, but are a beneficial adjunct, by decreasing the formation of solid residue. Drinking clear liquids is recommended in **ALL** bowel preps and helps maintain adequate hydration (Atreja, A., Nepal, S. & Lashner, B., 2010; ASGE, 2009; Dykes, C. & Cash, B., 2007; National Guideline Clearinghouse, 2006).

Carbohydrate-electrolyte solutions such as Gatorade and E-Lyte have been added to both PEG and NaP solutions to improve palatability and to avoid severe fluid and electrolyte shifts (Wexner, S., Beck, D., Baron, T., et al., 2006).

Antiemetic agents such as metoclopramide (Reglan 5-10mg) are commonly used to prevent nausea and vomiting associated with taking bowel preparations.

Antifoaming agents, such as Simethicone (three 80 mg tablets), an anti-gas, anti-flatulent agent, has been added to the prep to reduce the bubbles and improve visibility during colonoscopy (Tongprasert, S., Sobhonslidsuk, A. & Rattansiri, S., 2009).

Nasogastric or orogastric tube installation is usually reserved for inpatients that are unable to drink the polyethylene glycol solutions, for patients who are unresponsive or those on mechanical ventilators.

Rectal Pulsed Irrigation administered immediately prior to the colonoscopy preceded by intake of magnesium citrate the night before is also another alternative, though this is time consuming, expensive and requires expert nursing skill to be efficiently performed (Wexner, S., Beck, D., Baron, T., et al., 2006).
Clebopride is another adjunct that has gained some interest among endoscopists. It is a D-2 dopamine antagonist with antiemetic and prokinetic properties which can improve the efficacy of bowel cleansing. A study was done to evaluate the efficacy, safety, tolerability, and acceptance of Clebopride as an adjunct to PEG solution as prep for colonoscopy. The authors found that Clebopride was better accepted by patients and was better tolerated as well. It diminished the symptom of nausea, abdominal distention, and borborygmus (Abdullah, M., Aziz Rani, A., Fauzi, A. et al., 2010).

3. Special considerations

Diabetes Mellitus. Diabetic patients need to follow certain pre- and post- colonoscopy instructions to prevent hyper- or hypoglycemia episodes. The individual needs to discuss his/her medications with the physician at least two weeks prior to the test. Individuals taking insulin may need to have their regular dosages adjusted the day before and the day of the procedure. See tables 2 and 3 for general guidelines.
Cardiac conditions. Individuals taking blood thinners will need to consult their physician as to when to stop taking these medications prior to colonoscopy. A blood test to check the PT/INR will need to be drawn in the morning the day before the exam. He or she **should not** stop taking his or her other cardiac medications without consulting his or her physician. Blood pressure medications are generally allowed to be taken even on the day of the procedure.
The elderly. The elderly often have poorer bowel preps which may be attributed to a decrease or alteration in intestinal motility secondary to the aging process or other comorbidities. Constipation contributes to the poor quality of the colonoscopy which may be associated with the elderly's sedentary lifestyle, inadequate intake of fiber, depression, and dementia (Yakut, M., Kubilay, Ç., Gülseren, S. et al., 2010). They are also at risk for fluid and electrolyte imbalance, especially phosphate intoxication, due to concomitant medication use, comorbidities, poor kidney function or other gastrointestinal disorders. Adequate hydration without compromising cardiac function is of utmost importance with this population.
Pregnancy. The need for colonoscopy during pregnancy is rare, hence the safety and efficacy of the bowel preps have not been studied. If it is deemed that the potential benefit of colonoscopy outweigh the small, but possible risks, then the pregnant woman may be cleansed with PEG solutions. NaP preps may be used with caution in select patients (ASGE, 2009; National Guideline Clearing House, 2006).
The *pediatric* population will be discussed in another chapter.

4. Colonoscopy bowel preparations: general patient instruction guidelines

Two weeks prior to your procedure:

- You need to speak with or see the physician who will be performing your colonoscopy to go over your medical and surgical history, medications you take on a regular basis, allergies, any other pertinent information relevant to your procedure or concerns you may have. For women, please let the physician know if you are pregnant or maybe

pregnant. If you have kidney or liver disease and are on fluid restriction, your prep and diet may need to be adjusted.

- Your physician will advise you what medications you need to discontinue and when to discontinue these prior to the test. These include all types of blood thinners or antiplatelet medications, anti-inflammatory drugs, multivitamin with iron and any other medication containing iron preparation, and bulk-forming agents.
- If you have diabetes, it is advisable to schedule an appointment early in the day so that you can eat after and take your medications as close to your usual time as possible. You will be asked to bring your blood glucose meter and test strips and any treatment you use when you experience low blood sugar levels on the day of the exam.
- For asthma sufferers, you need to bring your inhaler (s) the day of the exam.
- For individuals using a CPAP or BiPAP machines, you will be asked to bring these on the day of the exam as well.
- You will be asked to arrange for a ride to your colonoscopy as you will not be allowed to drive a car, take the bus or taxi home after the procedure. You will be given sedation medications for the procedure and the effects usually linger for a few hours after the test is completed. You will spend about 1-2 hours in the endoscopy suite, which includes the pre-procedure prep, the colonoscopy itself, and post-procedure recovery time. You will go home after to rest and allow the rest of the sedatives to wear off. If you arrive without an escort, your test will be cancelled or rescheduled.

Seven days prior to your procedure:

- Stop taking the following medications:
  - Iron, vitamin E and medications containing either component
  - Garlic, Ginko Biloba, ginger
  - Blood thinners (anticoagulant) such as warfarin (Coumadin), Fondaparinux (Arixta), enoxaparin (Lovenox)
  - Antiplatelets such as prasugrel (Effient), clopidogrel (Plavix), cilostazol (Pletal), anagrelide (Agrylin), pentoxifyline (Trental), dipyridamole (Persantine), dipyridamole with aspirin (Aggrenox), aspirin and any other products containing aspirin (Anacin, Alka Seltzer, Bufferin).

Note: You must have your PT/INR checked in the morning the day before your test if you are on Coumadin or Warfarin, Plavix or Jantovan.

Five to three days prior to your test:

- Confirm your ride.
- If you need to cancel or reschedule your appointment, this is the time to do so. Call the office where you booked your appointment.
- Review the diet you need to follow as well as medication schedule if you are a diabetic. Most heart medications such as ones for high blood pressure are generally allowed to be taken even on the day of the exam. Diuretic medications are usually asked to be taken after the procedure is completed.
- Purchase your prescription bowel prep, but **DO NOT MIX or PREPARE** the solution until the day before the exam, if not taking the pill form.
- Stop taking bulk-forming agents such as Metamucil or Citrucel.

Two days before the procedure:

- Stop taking **ALL** anti-inflammatory drugs such as ibuprofen and ibuprofen products (Advil, Motrin, Nuprin), Voltaren, naproxen (Aleve, Anaprox, Midol Extended Relief, Naprelan, Naprosyn), Indocin, Relafen, Voltaren. Acetaminophen (Tylenol) is okay to take for any headache or discomfort you might be experiencing.
- Stop eating seeds, nuts, corn, popcorn, whole grains.
- Drink a minimum of eight glasses of water throughout the day.
- Do not eat any solid food after midnight.

Day before the procedure:

- Beginning at breakfast, **DO NOT EAT ANY SOLID FOOD**. Instead, start a clear liquid diet which means drinking liquids that you can see through, e.g. apple juice, white grape juice, ginger ale, lemon-lime soda, Gatorade, Kool-Aid, Jello, coffee (without the creamer), tea, Seltzer, broth, bouillon or consommé. **Do not drink liquid that is red, blue, or purple (cherry, purple grape, or berry flavors).** Also avoid milk, milk products, non-dairy creamers, or alcohol.
- For diabetics, the following are suggested clear food choices:
  - Apple juice (4 oz.) 15 Gm carbohydrate
  - Plain Jello without fruit (regular sweetened, ½ C.) 15 Gm carbohydrate
  - Grape juice (white, 4 oz.) 20 Gm carbohydrate
  - Any sports drink such as Gatorade (8 oz.) 15 GM carbohydrate
  - Italian Ice 3 0 Gm carbohydrate
  - Ice pops, orange or yellow popsicles 15 Gm carbohydrate
  - Coffee or tea with 1 tsp. sugar (one packet) 4 Gm carbohydrate
  - Fat-free beef or chicken broth, bouillon or consomme´ no carbohydrate
  - Clear diet soda, such as ginger ale no carbohydrate
  - Seltzer (flavored or nonflavored) no carbohydrate
  - Flavored water no carbohydrate
  - Tea with slice of lemon

*Note: Aim for 45 grams of carbohydrate during mealtimes and 15-30 grams for snacks. Read the label of commercially prepared drink items for carbohydrate measurement per serving. Refer to Table 2 for diabetic medication guidelines.

- In addition to water, drink a variety of liquid throughout the day (recommended every hour while awake). Your body needs a combination of water, sugar, and electrolytes. It will keep you from being dehydrated, weak, and hungry and you will be better able to tolerate the bowel prep. A new product on the market, called Colonoscopy Prep Assistant, helps individuals keep track of their hydration status. It is a web application that tracks the number of glasses of fluid the patient has taken, the time interval between drinks, and notifies the patient when it's time to take the next glass of fluid. This application is available for free in the Android market and iTunes and can also be downloaded at www.wellapps.com.
- For individuals taking polyethylene glycol (PEG) prep, do the following:
  - In the morning, mix the PEG solution as directed and refrigerate.
  - Around 1:30 PM, take one tablet of metoclopramide (Reglan), if prescribed, to prevent or relieve the nausea that accompanies ingestion of the PEG solution.

Medications	Morning	Lunch	Dinner/Supper	Bedtime
Actos, Actoplus Met, Avandamet, Avandia, Metformin, Janumet, and Januvia	Take your usual dose	Take your usual dose	Take your usual dose	
Amaryl, Avandaryl, Duetact, Glipizide, Glucovance, Glyburide, Metaglip, Prandin, and Starlix	**Do not take**	**Do not take**		
Humalog, Regular or Novolog Insulin	If prescribed a fixed dose, take ½ the regular amount OR cover your carbs with usual carb ratio	If prescribed a fixed dose, take ½ the regular amount OR cover your carbs with usual carb ratio		
Lantus or NPH Insulin	Take your usual dose			Take your usual dose
Novolog Mix 70/30, Novolin 70/30, Premixed insulin75/25	Take half the usual dose at breakfast		Take half the usual dose at dinner time	

Table 2. General guidelines for diabetic medications the **day before** colonoscopy

Fig. 9. Varieties of clear liquid: broth, Jello, apple juice or white grape juice, Gatorade, and ginger ale

- If prescribed the 4-L GoLytely, take one glass (8 oz) every 15-20 minutes half-an-hour after taking the metoclopramide tablet, until half gallon is gone. Remember to drink clear liquids or water in between until you go to bed. Be sure to stay close to the bathroom. The rest of the half gallon will be taken the next day, about 3-4 hours prior to the scheduled procedure. If you have a morning appointment, you may need to get up in the middle of the night to complete your prep. If your test is in the afternoon, you may start taking the rest of the prep at 6 AM, one glassful every 15-20 minutes until the half gallon is consumed.
- If nausea continues, take a second tablet of metoclopramide around 5 or 6 PM. Let your physician know if you are having difficulty completing the prep or uncomfortable side effects such as nausea, vomiting continues.
- Another approach would be to take 3L the night before and 1L the day of the procedure.

- For low-volume PEG preparations plus bisacodyl tablets, the clear liquid diet the day before is also followed.
  - Around noon time, take four (5mg) bisacodyl delayed-release tablets.
- Start taking the PEG solution after a bowel movement occurs following taking the bisacodyl tablets. Keep drinking a glassful of the prep every 10-15 minutes until the 2 liters is consumed. You may take a break in-between dose if bloating, nausea, or vomiting ensues. Resume after the symptom (s) subsides.
- For low-volume PEG prep (MoviPrep) with magnesium citrate, do the following:
- Upon waking up the day before the exam, prepare the solution by mixing pouches 1 & 2 into the disposable container provided. Add lukewarm to the top line and mix until completely dissolved. Refrigerate. At around 5 PM, start drinking a cupful of the solution (about 8 oz.) down to the first mark on the container. Make sure you follow this with clear liquid of your choice. Keep drinking the solution down to the next line and so forth every 15 minutes until the liter is consumed.
  - The process will be repeated again for dose #2, but will not be taken until around 7:30 PM the same evening.
- For individuals taking the sodium phosphate (NaP) prep, do the following:
  - Only clear liquids are consumed the day before the procedure.
  - For the aqueous NaP prep, take a 30 to 45 ml solution with at least 8 oz. of water (or any other preferred clear liquid) 10-12 hours prior to your scheduled exam. The second dose will be ingested at least 3-4 hours prior to your test the next day.
  - Continue to drink clear fluids until you go to bed.
  - Another recommended approach is to take the two doses of NaP, three hours apart in-between dose, starting at 4 PM or 5 PM for the first dose followed by the second dose around 9 PM, and supplemented around 10 PM by four bisacodyl (5mg) tablets.
  - For individuals prescribed the pill form (Osmo-Prep or Visicol: The recommended dose is 3 tablets every 15 minutes for 6 doses and then 2 tablets for a total of 20 tablets, the day before the procedure. This is again repeated the next day, 3 to 5 hours before the scheduled test. Osmo-Prep uses only 32 tablets in divided doses similar to Visicol. Again, these are taken with water or clear liquid. Dulcolax or magnesium citrate may also be added as an adjunct to ensure clear bowel return.

Tips: Do not be surprised if you do not have a bowel movement soon after ingesting your prep. It usually takes about 2-4 hours before you have your first bowel movement. Stay close to the bathroom as you will spend most of your day on the toilet. Try to use moistened wipes or a water spray instead of toilet paper to clean yourself to minimize irritation of the anal area. If you have a colostomy, be prepared to empty out your pouch often and liquid stool may leak around your pouch as well. Remember to keep drinking plenty of clear liquids to prevent dehydration. Follow your instructions for the prep as you do not want to repeat this procedure all over again because you did not get it right the first time.

Day of the procedure:

- Take your regular medications allowed by the physician with a small sip of water. You may have clear liquids three hours before your test. Refer to Table 3 for medication guidelines if you are a diabetic and remember to check your blood sugar in the morning before coming to the colonoscopy. Also bring your glucometer, extra test strips and your treatment for any hypoglycemic (low blood sugar) episodes.
- Have your driver drive you to the colonoscopy place half-an-hour before your scheduled procedure or whatever time you were instructed to arrive. Remember to bring your paper work, medications, inhalers, CPAP or BiPAP machine, and health insurance card.
- Make sure you wear comfortable clothing and bring extra clothes, underwear or peri-pads in case you have an accident and soil your clothes or underwear.

Medications	Morning	Lunch	Dinner/Supper	Bedtime
Actos, Actoplus Met, Avandamet, Avandia, Metformin, Janumet, and Januvia	Take your usual dose	Take your usual dose	Take your usual dose	
Amaryl, Avandaryl, Duetact, Glipizide, Glucovance, Glyburide, Metaglip, Prandin, Starlix	**Do not take**	Resume regularly prescribed dose if allowed to eat		
Humalog, Regular or Novolog Insulin	**Do not Take**	Resume regularly prescribed dose if allowed to eat	Resume regularly prescribed dose if allowed to eat	
Lantus or NPH Insulin	Take **half** of your regularly prescribed dose			Take your regularly prescribed dose
Novolog Mix 70/30, Novolin 70/30, Premixed insulin 75/25	**Do not Take**	Resume regularly prescribed dose if allowed to eat	Resume regularly prescribed dose if allowed to eat	

Table 3. General guidelines for diabetic medications **day of** the colonoscopy

Post procedure recovery:

- You will be cared for by a nurse or a nurse's aide and your vital signs monitored for about half-an-hour to an hour immediately after the procedure in the recovery area. This will also allow for most of the effects of the sedatives to wear off.
    - During this time, your doctor will talk to you about the results of your colonoscopy. If a biopsy was performed, the results are usually not available until a few days later as the sample (s) will be sent to the lab for analysis. He will also provide you with any pertinent additional information or instructions for follow-up.
- You will be discharged home with your designated driver once you are feeling okay and are able to tolerate oral fluids without being nauseous or vomiting. If you are diabetic, it is a good idea to check your blood sugar before going home.
- Plan to rest for the remainder of the day.
- Eat foods that are easy to digest to minimize or avoid nausea and vomiting which is mostly due to the lingering side effects of the sedatives received. Examples are, toast, soup, light sandwich (e.g. grilled cheese), tea, and coffee.
- You may occasionally feel some bloating or be flatulent. This is normal and should disappear within 24 hours. If you had a biopsy done, it is not uncommon to see some flecks of blood in your stool for a couple of days following your colonoscopy. This is usually dark in color. Call your physician if you have bright red blood in your stool, experiencing persistent nausea, vomiting, and abdominal pain or bloating.

5. Safety and efficacy

All colonoscopy bowel preparations are generally considered safe when properly dosed in individuals without contraindications to the specific product, but are not completely immune to the adverse reactions, and on occasion, severe negative outcomes. The safety of the bowel cleansing agent is related to the safety profile of the base agent, i.e, polyethylene glycol or sodium phosphate. The most commonly encountered side effects are bloating, abdominal pain, borborygmus, nausea, vomiting, dizziness, and fluid and electrolyte imbalance. Often the symptoms of nausea, vomiting and abdominal pain disappear once bowel movement commences. These symptoms have also been minimized and safety improved by splitting the dosages, adding adjuncts, administering low-volume preps, and increasing the interval time in-between dosages to 10-12 hours (ASGE, 2009; NGCH, 2006).

Generally, the administration of isotonic polyethylene glycol solutions do not cause significant physiologic changes in vital signs, individual's weight, laboratory results (complete blood count, blood chemistries, and serum electrolytes). It has been safely administered in individuals with advanced liver and kidney failure, congestive heart failure, and fluid and electrolyte imbalances. Some concerns were raised with the use of some PEG solutions, HalfLytely, in particular, in patients taking angiotensin converting enzyme drugs (ACE) or potassium-sparing drugs such as aldactone, because of the small amount of potassium found in the solution. However, there were no clinical reports noted to date (ASGE, 2009; NGCH, 2006).

Sodium phosphate, on the other hand, has been shown to alter both the macroscopic and microscopic (aphthoid erosions) mucosal lining of the intestine, which may mimic inflammatory bowel disease. This prep should then be avoided in individuals with or suspected to have inflammatory bowel disease. Serum electrolyte and fluid imbalances have

also been reported with sodium phosphate use. Hyperphosphatemia was seen in 40% of healthy individuals taking NaP. This could be significant for patients with renal failure. About 20% of individuals taking NaP preps have developed hypokalemia, elevated blood urea nitrogen, increased plasma osmolality, decreased exercise endurance, significant hyponatremia, hypocalcemia, and seizures. A rare adverse event, nephrocalcinosis, has been reported in patients with acute renal failure (Balaban, D., 2008; Gonlusen, G., Akgun, H., Ertan, A., et al., 2006; NGCH, 2006). As a result, the Federal Drug Administration (FDA) has recommended that over-the-counter use of sodium phosphate solutions be discontinued and a black box warning be included in prescription products. Manufacturers of sodium phosphate products were also required to perform a "risk evaluation and mitigation strategy, including a post marketing trial," to further assess occurrence of renal injury (ASGE, 2009).

All bowel preps are contraindicated in individuals with known or suspected bowel obstruction, perforation or ileus. Bowel cleansing agents containing magnesium and phosphate should be used with caution or avoided in individuals with kidney failure. To minimize or avoid fluid and electrolyte imbalance, it is necessary to screen patients carefully and to instruct them to hydrate themselves, pre- and post-procedure. Intravenous fluids are usually given during the procedure.

6. Conclusion

Colonoscopy remains the gold standard in the screening and evaluation of the colon for colorectal disorders and diseases. For maximum visualization of the colon, it is imperative that the bowel is thoroughly cleaned. Several commercially prepared agents are available on the market, but the most commonly used ones are the polyethylene glycol and sodium phosphate preps. Adjuncts have also been recommended in addition to the main prep to make it easier to administer. The choice of an appropriate bowel cleansing agent is influenced by its safety, ease of administration and completion, cleansing effectiveness, patient tolerance, adverse effects, palatability, reimbursed by health insurance, will not interact with regularly prescribed medications, and cost. It should be tailored to every individual based on his or her state of health, comorbidities, and medications taken on a regular basis. Kidney function should be evaluated prior to choosing a bowel cleansing agent particularly in the elderly. Thus, careful screening of the patients prior to colonoscopy, prescribing the appropriate dose and bowel cleansing agent, patient education and adequate hydration before and after colonoscopy will help ensure the safety and efficacy of the procedure.

7. Acknowledgement

The author wishes to thank Kira Hulse, BS for her review of the article, Dr. Jonathan Russo, Chief of Endoscopy, for his expert advice regarding colonoscopy, and to my good friend, Marian de la Cour, BSN, MLS, for all her efforts in obtaining most of the literature referred to in this chapter.

8. References

Abaskharoun, R., Depew, W. & Vanner, S. (2007, April). Changes in renal function following administration of oral sodium phosphate or polyethylene glycol for colon cleansing before colonoscopy. *Canadian Journal of Gastroenterology,* 21(4), 227-231. ISSN 0835-7900

Abdullah, M., Aziz Rani, A., Fauzi, A., et al. (2010, January). A randomized, controlled, double-bind trial of the adjunct use of clebopride in polyethylene glycol electrolyte (PEG) solution for colonoscopy preparation. *Acta Med Indones-Indonesian Journal of Internal medicine*, 42(1), 27-30.ISSN 0125-9326

Ainley, E., Winwood, P. & Begley, J. (2005, July). Measurement of serum electrolytes and phosphate after sodium phosphate colonoscopy bowel preparation: An evaluation. *Digestive Diseases and Sciences,* 50(7), 1319-1323. ISSN 0163-2116

American Cancer Society. Colon and rectal cancer. Retrieved Feb. 14, 2011 from http://www.cancer.gov/cancertopics/types/colon-and-rectal

American Cancer Society. Cancer trends progress report-2005 update. Retrieved Feb. 14, 2011 from http://progressreport.cancer.gov/doc.asp?pid=1&did=2005&mid=vcol&chid=22

American Society for Gastrointestinal Endoscopy (ASGE) (2009, June) . Technology status evaluation report. Colonoscopy preparation. *Gastrointestinal Endoscopy,* 69(7), 1201-1209. ISSN 0016-5107

Atreja, A., Nepal, S. & Lashner, B. (2010, May). Making the most of currently available bowel preparations for colonoscopy. *Cleveland Clinic Journal of Medicine,* 77(5), 317-326. ISSN 0891-1150

Balaban, D. (2008, September/October). Guidelines for the safe and effective use of sodium phosphate solution for bowel cleansing prior to colonoscopy. *Gastroenterology Nursing*, 31(5),327-334. ISSN 1042-895x

Barkun, A., Chiba, N., Enns, R., et al. (2006, November). Commonly used preparations for colonoscopy: Efficacy, tolerability and safety – A Canadian Association of Gastroenterology position paper. *Canadian Journal of Gastroenterology,* 20(11), 699-710. ISSN 0835-7900

Bitoun, A., Ponchon, T., Barther, M. et al. on behalf of the Norcol Group (2006, December). Results of a prospective randomized multicenter controlled trial comparing a new 2-L ascorbic acid plus polyethylene glycol and electrolyte solution vs. sodium phosphate solution in patients undergoing elective colonoscopy. *Alimentary Pharmacology & Therapeutics*, 24 (11-12),1631-1642. ISSN 1365-2036

Bucher, P., Gervaz, P., Egger, J., et al., (2006 January). Morphologic alterations associated with mechanical bowel preparation before elective colorectal surgery: A randomized trial. *Diseases of the Colon and Rectum,* 49(1), 109-112.ISSN 0012-3706

Casais, M., Guillermo, R-D., Perez, S. et al. (2009, December). Hyperphosphatemia after sodium phosphate laxatives in low risk patients: Prospective study. *World Journal of Gastroenterology*, 15(47), 5960-5965. ISSN 1007-9327

Curran, M. & Plosker, G. (2004,). Oral phosphate solution: A review of its use as a colorectal cleanser. *Drugs*, 64(15), 1697-1714. ISSN 0012-6667

Davis, G., Santa Ana, C., Morawski, S. & Fordtran, J. (1980, May). Development of a Lavage solution associated with minimal water and electrolyte absorption or secretion. *Gastroenterology,* 78, 991-995. ISSN 0016-5085

DiPalma, J., Wolff, B., Meagher, A. & Cleveland, M., (2003, October). Comparison of reduced volume versus four liters sulfate-free electrolyte lavage solutions for colonoscopy colon cleansing. *American Journal of Gastroenterology*, 98(10), 2187-2191. ISSN 0002-9270

Dong Choon, S., Sung Noh, H., Jeong Hwan, K. et al. (2010, April). Change in renal function after sodium phosphate preparation for screening colonoscopy. *World Journal of Gastroenterology*, 16(16), 2010-2016.ISSN 1007-9327

Dykes, C. & Cash, B. (2007, January). Key safety issues of bowel preparations for colonoscopy and importance of adequate hydration. *Gastroenterology Nursing*, 31(1), 30-37. ISSN 1042-895x

Ell, C., Fischbach, W., Bronisch, H. et al. (2008, April). Randomized trial of low-volume PEG solution versus standard PEG + electrolytes for bowel cleansing before colonoscopy. *American Journal of Gastroenterology,* 103(4), 883-893. ISSN 0002-9270

Froelich, F., Wietlisbach, V., Gonvers, F., et al. (2005,March). Impact of colonic cleansing on quality and diagnostic yield of colonoscopy: The European Panel of Appropriateness of Gastrointestinal Endoscopy European multicenter study. *Gastrointestinal Endoscopy*, 61(3), 378-384. ISSN 0016-5107

Gonlusen, G., Akgun, H., Ertan, A. et al. (2006, January). Renal failure and nephrocalcinosis associated with oral sodium phosphate bowel cleansing: Clinical patterns and renal biopsy findings. *Archives of Pathology and Laboratory Medicine*, 130(1) 101-106. ISSN 0003-9985

Hendry, P., Jenkins, J. & Diament, R. (2007, October). The impact of poor bowel preparation on colonoscopy: a prospective single centre study of 10,571 colonoscopies. *Colorectal Diseases,* 9(8), 745-748. ISSN 1463-1318

Hookey, L., Depew, W. & Vanner, S. (2002,December). The safety profile of oral sodium phosphate for colonic cleansing before colonoscopy in adults. *Gastrointestinal Endoscopy*, 56(12), 895-902. ISSN 0016-5107

Khashab, M & Rex, D. (2005,February). Efficacy and tolerability of a new formulation of sodium phosphate tablets and a reduced sodium phosphate dose, in colon cleansing: A single center open-label pilot trial. *Alimentary Pharmacology & Therapeutics*, 21(4), 465-468. ISSN 1365-2036

Ker, T. (2006, October). Comparison of reduced volume versus four-liter electrolyte lavage solutions for colon cleansing. *American Surgeon,* 72(10), 909-911. ISSN 0003-1348

Khurana, A., McLean, L., Atkinson, S. et al. (2008, March 24). The effect of oral sodium phosphate drug products on renal function in adults undergoing bowel endoscopy. *Archives of Internal Medicine*, 168(6) 593-597.ISSN0003-9926

Lawrence, E. & Pickhardt, P. (2010, August).Low volume hybrid bowel preparation combining saline laxatives with oral contrast agents versus standard polyethylene glycol lavage for colonoscopy. *Diseases of the Colon & Rectum,* 53(8), 1176-1181. ISSN 0012-3706

Lichtenstein, G., Cohen, L. & Uribarri, J. (2007,September). Review article: Bowel preparation for colonoscopy-the importance of adequate hydration. *Alimentary Pharmacology & Therapeutics*, 26(5), 633-641. ISSN 1365-2036

Marmo, R., Rotondano, G., Riccio, G. et al. (2010,August). Effective bowel cleansing before colonoscopy: A randomized study of split-dosage versus non-split dosage regimens of high-volume versus low-volume polyethylene glycol solutions. *Gastrointestinal Endoscopy*, 72(2), 313-320. ISSN 0016-5107

Makkar, R. & Shen, B. (2008, March). What are the caveats to using sodium phosphate agents for bowel preparation? *Cleveland Clinic Journal of Medicine,* 75(3), 173-176. ISSN 0891-1150

National Guideline Clearinghouse (NGCH), (2006). A consensus document on bowel preparation before colonoscopy. Retrieved on Feb. 24, 2011 from http://www.guideline.gov/content.aspx?id=9619&search=colonoscopy.

Ness ,R., Manam, R., Hoen,H. et al (2001, June). Predictors of inadequate bowel preparation for colonoscopy. *American Journal of Gastroenterology*, 96(6), 1797-1802. ISSN 0002-9270

Rejchrt, S., Bures, J., Siroky, M. et al. (2004,May). A prospective, observational study of colonic mucosal abnormalities associated with orally administered sodium phosphate for colon cleansing before colonoscopy. *Gastrointestinal Endoscopy,* 59(5), 651-654. ISSN 0016-5107

Rex,D., Di Palma, J.,Rodriguez, R. et al. (2010, August). A randomized clinical study comparing reduced-volume oral sulfate solution with standard 4-liter sulfate-free electrolyte lavage solution as preparation for colonoscopy. *Gastrointestinal Endoscopy*, 72(2), 328-336. ISSN 0016-5107

Rex, D. (2007, September). Dosing considerations in the use of sodium phosphate bowel preparations for colonoscopy. *Annals of Pharmacotherpy,* 41(9), 1466-1475. ISSN 1060-0280

Sanaka, M., Shah,N., Mullen,K. et al (2006 December). Afternoon colonoscopies have higher failure rates than morning colonoscopies. *American Journal of Gastroenterology*, 101(12), 2726-2730. ISSN 0002-9270

Sohn, N. & Weinstein, M. (2008,April). Management of the poorly prepared colonoscopy patient: Colonoscopic colon enemas as a preparation for colonoscopy. *Diseases of the Colon & Rectum,* 51(4), 462-466. ISSN 0012-3706

The Harvard Medical School Family Health Guide (2006). Retrieved February 14, 2010 from http://www.health.harvard.edu/fhg/updates/preparing-for-a-colonoscopy.shtml

Tongprasert, S., Sobhonslidsuk, A. & Rattanasiri, S. (2009, June 28). Improving quality of colonoscopy by adding simethicone to sodium phosphate bowel preparation. *World Journal of Gastroenterology*, 15(24), 3032-3037.ISSN 1007-9327

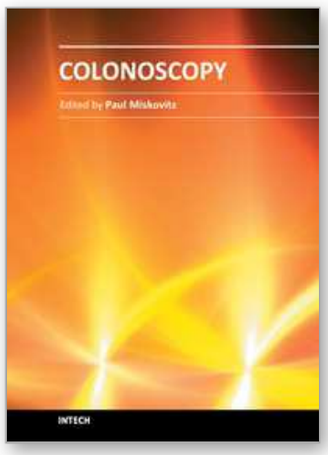
US Food and Drug Administration (FDA) (2008, December 11). Oral sodium phosphate (OSP) products for bowel cleansing (marketed as Visicol and OsmoPrep, and oral sodium phosphate products available without a prescription. *FDA Alert.* Retrieved March 01, 2011 from http://www.fda.gov/Safety/MedWatch/SafetyInformation/SafetyAlertsforHumanMedicalProducts/ucm094900.htm.

Varughese, S., Kumar,A.,George, A., & Castro, F., (2010,November). Morning-only one-gallon polyethylene glycol improves bowel cleansing for afternoon colonoscopies: A randomized endoscopist-blinded prospective study. *The American Journal of Gastroenterology*, 105(11), 2368-2374. ISSN 0002-9270

Vradelis, S., Kalaitzakis, E., Sharifi, Y. et al (2009,April 14). Addition of senna improves quality of colonoscopy preparation with magnesium citrate. *World Journal of Gastroenterology*, 15(14), 1759-1763. ISSN 1007-9327

Wexner, S., Beck, D., Baron, T., et al. (2006,June). 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 Gastrointesinal and Endoscopic Surgeons (SAGES). *Diseases of the Colon and Rectum,* 49(6), 792-809. ISSN 0012-3706

Yakut, M., Kubilay, Ç., Gülseren, S. et al. (2010,June). The efficacy and safety of colonoscopy with oral sodium phosphate in elderly patients. *Turkish Journal of Gastroenterology*. 21(2), 140-145. ISSN 1300-4948



Colonoscopy

Edited by Prof. Paul Miskovitz

ISBN 978-953-307-568-6

Hard cover, 326 pages

Publisher InTech

Published online 29, August, 2011

Published in print edition August, 2011

To publish a book on colonoscopy suitable for an international medical audience, drawing upon the expertise and talents of many outstanding world-wide clinicians, is a daunting task. New developments in videocolonoscope instruments, procedural technique, patient selection and preparation, and moderate sedation and monitoring are being made and reported daily in both the medical and the lay press. Just as over the last several decades colonoscopy has largely supplanted the use of barium enema x-ray study of the colon, new developments in gastrointestinal imaging such as computerized tomographic colonography and video transmitted capsule study of the colonic lumen and new discoveries in cellular and molecular biology that may facilitate the early detection of colon cancer, colon polyps and other gastrointestinal pathology threaten to relegate the role of screening colonoscopy to the side lines of medical practice. This book draws on the talents of renowned physicians who convey a sense of the history, the present state-of-the art and ongoing confronting issues, and the predicted future of this discipline.

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen