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Can a bowel preparation exacerbate heart failure?

ABSTRACT

Polyethylene glycol solutions, used for bowel preparation before colonoscopy, in theory pass through the colon without any absorption of water. However, several investigators have reported that these solutions do increase plasma volume. This review compares polyethylene and sodium phosphate bowel preparations and their effects on patients with heart failure, and also offers recommendations for patients with heart failure who need colonoscopy.

KEY POINTS

Hyperosmotic sodium phosphate preparations can cause significant volume contraction in vulnerable patients, along with a risk of hyperphosphatemia.

Low-volume (2-L) polyethylene glycol preparations are more tolerable than 4-L solutions.

Although increases in plasma volume can be detected with polyethylene glycol solutions, these solutions are still the safest choice in patients with heart failure.

doi:10.3949/ccjm.77a.10025

A 73-YEAR-OLD MAN presented to the emergency department with chest tightness and shortness of breath associated with diaphoresis. His symptoms began as he was taking the bowel preparation solution HalfLytely, 8 oz every 10 minutes as directed, in preparation for colonoscopy the next morning for asymptomatic hematochezia. He had consumed 1 L of the solution when he noticed the symptoms. He tried to continue, but stopped halfway through the second liter because of worsening shortness of breath.

He reported no nausea, vomiting, palpitations, or dizziness. The discomfort (chest tightness) was somewhat relieved with rest and by leaning forward.

His medical history included chronic congestive heart failure with an ejection fraction of 25%; coronary artery disease with multiple myocardial infarctions, coronary angioplasty of the left anterior descending artery, and placement of a cardiac defibrillator; gout; gastritis; glaucoma; hypertension; and hyperlipidemia. His was taking potassium chloride (microK), furosemide (Lasix), clopidogrel (Plavix), enalapril (Vasotec), carvedilol (Coreg), simvastatin (Zocor), folic acid, pantoprazole (Protonix), allopurinol (Zyloprim), colchicine (Colcrys), dorzolamide-timolol eye drops (Cosopt), atropine eyedrops (Atropine Care), and ofloxacin eyedrops (Ocuflox). He said he takes all medications as directed without missing any doses. He smoked 1 pack of cigarettes per day for 50 years (he quit several years ago), and he drinks two to three glasses of brandy weekly. He denied using illicit drugs.

On examination, he appeared alert and comfortable. His temperature was 97.3°F (36.3°C), blood pressure 154/71 mm Hg, heart rate 81 beats per minute, respiratory rate 24

breaths per minute, and oxygen saturation 93% while breathing 4 L of oxygen by nasal canula. His jugular venous pressure was approximately 10 cm. The cardiac examination revealed normal first and second heart sounds and regular rate and rhythm. A third heart sound was present. On lung examination, breath sounds were decreased in both bases. Both lower extremities had trace edema. The remainder of the examination was normal.

His laboratory values were as follows:

- White blood cell count 5.9 × 10^9/L (reference range 4.5–11.0)
- Hemoglobin 10 g/dL (14.0–17.5)
- Platelets 138 × 10^9/L (150–350)
- Sodium 142 mEq/L (136–142)
- Potassium 3.8 mEq/L (3.5–5.0)
- Chloride 108 mEq/L (96–106)
- Bicarbonate 23 mEq/L (21–28)
- Blood urea nitrogen 14 mg/dL (8–23)
- Creatinine 1 mg/dL (0.6–1.2)
- Glucose 107 mg/dL (70–110)
- Troponin I 0.21 ng/dL (0.0–0.4)
- Myoglobin 60 µg/L (19–92)
- Brain-type natriuretic peptide 3,169 pg/mL (< 167).

Electrocardiography showed an old anteroseptal myocardial infarction with ST-segment elevations of less than 1 mm in leads V_1, V_2, and V_3. Chest radiography showed vascular congestion, blunting of the right costophrenic angle likely due to small effusions, no focal consolidation, and no pneumothorax.

In theory, PEG solutions pass through the colon without net absorption or secretion; but an increase in plasma volume has been reported

WHAT EXACERBATED THIS PATIENT'S HEART FAILURE?

In this patient, causes of shortness of breath such as aspiration pneumonia and myocardial infarction should be considered. But the timing of the symptoms, the laboratory test results, and the chest radiographic findings point to an exacerbation of heart failure as a result of the bowel preparation solution. The physiology of what may have produced this exacerbation will be discussed later.

The ideal preparation for diagnostic and surgical procedures would do the following:

- Reliably remove stool from the colon without affecting its appearance
- Require only a short amount of time to administer
- Cause little or no discomfort for the patient
- Produce no significant shifts of fluids or electrolytes.[1–4]

POLYETHYLENE GLYCOL SOLUTIONS ARE THE MOST POPULAR PREPARATIONS

Polyethylene glycol solutions are by far the most commonly used method of bowel preparation. Polyethylene glycol is a nonabsorbable solution that, in theory, passes through the bowel without net absorption or secretion, thereby avoiding significant fluid and electrolyte shifts. Large volumes (4 L) are required to achieve a cathartic effect, and since many patients find this difficult to tolerate, instructing patients to divide the doses—eg, 3 L the night before and 1 L the morning of the procedure—increases compliance.

Low-volume polyethylene glycol preparations such as HalfLytely and MiraLax were developed to improve patient tolerance by reducing the amount of solution required, while still maintaining efficacy by adding bisacodyl or magnesium citrate. Studies have shown 2-L solutions to be as effective as 4-L solutions in terms of colon cleansing, and to be better tolerated.[5–8]

Is some water from polyethylene glycol solutions absorbed?

Several bowel preparation methods expand the intravascular volume, which can in turn exacerbate heart failure, since patients with left ventricular systolic dysfunction are unable to adjust to changes in volume.

High-volume gut lavage uses high volumes of saline solution or balanced electrolye solution, leading to significant fluid and electrolyte shifts. Because of these significant side effects, high-volume gut lavage is no longer recommended.[9]

Goldman and Reichelderfer[10] evaluated 43 patients in whom polyethylene glycol was used for bowel preparation; they measured body weight, hematocrit, and serum electrolyte levels before and after the preparation to detect fluid and electrolyte shifts, but they observed no shifts.

Several authors proposed that this method was insensitive for detecting changes in

plasma volume. Turnage et al[11] used an isotope dilution technique involving iodine-125-labeled human serum albumin to measure plasma volume before and after whole-gut irrigation with a polyethylene glycol solution. Although there was no significant change in body weight or electrolytes, the mean plasma volume increased by 5.88 ± 2.4%, with an increase in plasma volume of 12.9 ± 2.6% in patients over age 70 years and 17.45 ± 5% in patients taking more than 20 mg of furosemide daily. Thus, patients physiologically unable to compensate for an acute change in intravascular fluid, such as those with left ventricular dysfunction, are the ones most likely to have an increase in plasma volume after bowel preparation.[11,12] However, this phenomenon appears to be rare, as a literature search on Medline found only one other case report of a heart failure exacerbation with a polyethylene glycol preparation.[12]

SODIUM PHOSPHATE PREPARATIONS CAN CAUSE FLUID DEPLETION

Aqueous sodium phosphate preparations such as Fleet are low-volume hyperosmotic solutions containing monobasic and dibasic sodium phosphate. They clean the colon by osmotically drawing plasma water into the bowel lumen.

However, this osmotic shift can cause serious volume contraction, electrolyte abnormalities such as hyperphosphatemia, and even death.[1] Serious problems are more likely to occur in elderly patients, but also in patients with bowel obstruction, poor gut motility, renal failure, liver failure, or congestive heart failure.

Studies have shown hemodynamic changes indicating hypovolemia during sodium phosphate ingestion.[13,14] One reported that 28% of patients had decreases in systolic blood pressure of more than 10 mm Hg, and 12% had decreases in systolic blood pressure of more than 20 mm Hg.[13,14]

In a study by Barclay et al,[15] the concomitant use of a carbohydrate-electrolyte rehydration solution with the sodium phosphate limited the amount of fluid contraction.[15] A similar study by Tjandra and Tagkalidis[16] using a carbohydrate-electrolyte replacement solution called E-lyte showed a reduction in the degree of intravascular volume contraction, hypokalemia, and need for intravenous rehydration, although there was no effect on hyperphosphatemia resulting from ingestion of sodium phosphate.[16]

Phosphate nephropathy has also been reported after use of these solutions in patients with renal insufficiency, dehydration, or hypercalcemia, as well as in patients taking angiotensin-converting enzyme inhibitors or angiotensin receptor blockers.[9]

Current recommendations of the American Society of Colon and Rectal Surgeons, the American Society of Gastrointestinal Endoscopy, and the Society of American Gastrointestinal and Endoscopic Surgeons state that aqueous sodium phosphate is the preferable form of sodium phosphate and is an equal alternative to polyethylene glycol solutions except in pediatric and elderly patients, patients with bowel obstruction and other structural intestinal disorders, and patients with poor gut motility, renal failure, liver failure, or congestive heart failure.[9] In fact, because of the significant volume contraction and electrolyte abnormalities that can occur, these groups list sodium phosphate preparations as contraindicated in patients with congestive heart failure.[9]

POLYETHYLENE GLYCOL IS STILL SAFER FOR THOSE WITH HEART FAILURE

Polyethylene glycol preparations have been shown to cause an increase in plasma volume in patients with disease states that predispose them to fluid retention.[11] It has been postulated that these adverse effects may occur less often with preparations that use a lower volume, such as the 2-L polyethylene glycol regimen (HalfLytely) combined with bisacodyl or the 2-L polyethylene glycol 3350 solution (MiraLax). However, our patient experienced a heart failure exacerbation while drinking a reduced-volume preparation.

Another concern with polyethylene glycol solutions, especially HalfLytely, is hyperkalemia. Although no clinical reports have shown this finding, the small amount of potassium in this solution could be worrisome in patients with heart failure who are taking potassium-sparing diuretics or angiotensin-converting enzyme inhibitors.[9]

We have found only one other case report of heart failure exacerbation with a polyethylene glycol preparation

Nonetheless, when one considers the risks of fluid shifts with sodium phosphate preparations (which are in any event contraindicated for patients with congestive heart failure), the safest preparation for patients with congestive heart failure would be either a low-volume polyethylene glycol preparation or a split-dose standard-volume polyethylene glycol preparation with careful monitoring during and after use. Clinicians should emphasize to these patients the importance of continuing their cardiac medications during bowel preparation. The patients should also be instructed to notify their doctor about a change in body weight, difficulty breathing, chest tightness, and lower-extremity edema as they are taking the bowel preparation solution.[12]

Patients with severe left ventricular dysfunction may require short-term intensive care monitoring to manage plasma volume during and after bowel preparation.

Phosphate bowel preparations are as effective as polyethylene glycol, but have several contraindications

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