



# Acute Myocardial Infarction Following Administration of Polyethylene Glycol Electrolyte Solution with Ascorbic Acid (MoviPrep®) at Home: A Case Report

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## Abstract

A male individual aged 82 years with hypertension who had a smoking history, but no history of cardiovascular events, developed acute myocardial infarction immediately after he took oral polyethylene glycol electrolyte solution with ascorbic acid as a pretreatment for a colonoscopy to examine anemia. He took polyethylene glycol electrolyte solution with ascorbic acid at twice (2 L/h) the rate recommended in the package insert and by the physician. The patient showed impaired consciousness 2 h after taking polyethylene glycol electrolyte solution with ascorbic acid and his family called the emergency medical service. Upon arrival of the emergency medical service, his systolic blood pressure was 60 mmHg and heart rate was 50 bpm. Systolic blood pressure and impaired consciousness were slightly improved, but compensatory shock remained, at arrival at the emergency outpatient service at our hospital. No dyspnea or rash was apparent. The patient had no subjective chest pain; however, ST-segment elevation was detected in the electrocardiogram at II, III, aVF, V3R, and V4R. He was diagnosed with ST-segment elevation myocardial infarction and underwent a coronary catheter intervention for total occlusion of the right coronary artery. His shock state was abolished by this intervention. The patient was pretreated with polyethylene glycol electrolyte solution with ascorbic acid under close watch in the coronary care unit 4 days later, with no relapse of symptoms. Advanced cancer was found in the ileocecum by colonoscopy; consequently, the patient underwent a colectomy and was discharged from our hospital and transferred to another hospital for rehabilitation on hospital day 74. A Naranjo assessment score of 4 was obtained, indicating a possible relationship of acute myocardial infarction with misuse of the suspect drug, polyethylene glycol electrolyte solution with ascorbic acid.

## Key Points

Acute myocardial infarction may occur as a serious reaction following administration of polyethylene glycol electrolyte solution with ascorbic acid (PGE-Asc) at a rapid rate that causes induction of sudden intracellular hydration.

Careful use of PGE-Asc is required in patients who have no history of cardiovascular events, but have cardiovascular risk factors.

Elderly male patients are more likely to not comply with administration instructions, and such patients should be given PGE-Asc under the supervision of a third party.

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## Introduction

Polyethylene glycol electrolyte solution with ascorbic acid (PGE-Asc; MoviPrep<sup>®</sup>) is a new intestinal detergent that is a solution of polyethylene glycol and ascorbic acid. The drug was launched in 2012 in Japan and is now widely used to cleanse the intestine before a colonoscopy [1]. The solution of PGE-Asc is made hyperosmotic by the addition of a large amount of ascorbic acid, and this causes water to move to the intestinal mucosa [2, 3]. Consequently, PGE-Asc at a low dose has similar cleansing effects on the intestine to conventional intestinal detergents [1, 4–6]. For elderly patients and patients with complications, PGE-Asc is as safe as these detergents [7] and there are few case reports of serious adverse reactions. Nausea and abdominal pain are relatively frequent adverse reactions of PGE-Asc, and rare serious reactions include anaphylactic shock, intestinal perforation, and hyponatremia. Hypotension, bradycardia, and arrhythmia have been described as cardiovascular adverse reactions [8, 9], but there is only one case report of suspected myocardial infarction (MI) after taking PGE-Asc [10]. We report a case in which acute MI and cardiogenic shock developed immediately after oral administration of PGE-Asc at a more rapid rate than usual.

## Case Report

An 82-year-old man developed cardiogenic shock followed by an acute right ventricular MI during colon cleansing with PGE-Asc before a colonoscopy for evaluation of prolonged anemia. He had no history of cardiovascular events, but had been taking an angiotensin receptor blocker for hypertension and had a long history of smoking. He had no other coronary risk factors, including family history, hyperlipidemia, obesity, and diabetes mellitus, and no history of an allergic reaction to any medicine or antigens. He had not previously undergone a colonoscopy. Based on the protocol for preparation for a colonoscopy in our hospital, the patient was instructed to take 24 mg of sennoside in the evening prior to digesting PGE-Asc in the morning. He was given the drug information document for PGE-Asc, which indicates that patients should swallow 1 L of MoviPrep in the first hour before drinking 0.5 L of water. However, the patient took 2 L of PGE-Asc in 1 h and did not hydrate. After 2 h, he developed nausea and soon became unconscious, after which his family called the emergency medical service.

On arrival of the emergency medical service, the patient was in a shock state, with a systolic blood pressure of 60 mmHg and a heart rate of 50 bpm. When he

was brought to the emergency department of our hospital, he was still in shock and his vital signs were a respiratory rate of 25/min, oxygen saturation 98% with a 6-L/min reservoir mask, heart rate 50 bpm, systolic blood pressure 100 mmHg, and Glasgow Coma Scale E3V5M6. His peripheral skin was cold and wet, and the capillary refilling time was prolonged. He complained of nausea, but had no dyspnea or chest discomfort. Other findings on physical examination include normal breath sound without stridor and wheezing, no significant heart murmurs, no tenderness in the abdomen, and no skin rash. Laboratory data were as follows: white-cell count 12,900/ $\mu$ L, hemoglobin 11.0 g/dL (9.9 g/dL 17 days earlier), hematocrit 35.6% (32.3% 17 days earlier), creatinine kinase 119 U/L, urea nitrogen 20 mg/dL, creatinine 1.16 mg/dL, sodium 140 mEq/L, potassium 4.5 mEq/L, and troponin T 0.049 ng/mL. Arterial blood gas analysis under 6 L/min oxygen with a reservoir mask showed pH 7.181, PaCO<sub>2</sub> 36.7 mmHg, PaO<sub>2</sub> 262.6 mmHg, lactate 7.64 mmol/L, HCO<sub>3</sub><sup>-</sup> 13.4 mmol/L, base excess - 14.9 mmol/L, and anion gap 20.1 mmol/L.

Soon after the initial examination, we found the patient had developed acute MI with ST elevation on an electrocardiogram, which revealed sinus bradycardia with ST elevations in II, III, aVF, V3R, and V4R. Cardiac ultrasound showed severe hypokinesis in the inferior wall of the left ventricle. Coronary artery angiography revealed total occlusion in the right coronary artery, 90% stenosis in the left arterial descending coronary artery, and 90% stenosis in the left circumflex coronary artery, and the patient underwent a percutaneous coronary artery intervention in the right coronary artery. The door to balloon time was 80 min and the maximum creatinine kinase level was 1432 U/L. After the intervention, shock improved within the day, and after 4 days, the patient underwent a colonoscopy with correct administration of PGE-Asc under careful monitoring and appropriate hydration in the Cardiac Care Unit. Because transparent fluid was drained before administration of 1 L of PGE-Asc, the drug was discontinued within 1 h. Progressive colon cancer in the cecum was found. Laboratory data on day 4 showed decreases compared with the day of admission of creatinine kinase, hematocrit, urea nitrogen, and creatinine levels to 128 U/L, 27.0%, 11 mg/dL, and 0.73 mg/dL, respectively. There were no adverse effects after taking the colon preparation. After a month, the patient underwent a colectomy at our hospital, and was transferred to another hospital for rehabilitation on day 74. A Naranjo score [11] of 4 was obtained in this case (see the “Appendix”).

## Discussion

This case suggests that PGE-Asc can cause MI and cardiogenic shock and shows the importance of compliance with the rate of oral administration, even if PGE-Asc is taken

at a regular dose. There is only one previous case report of MI after oral administration of PGE-Asc [10]; however, in this case, MI occurred after colonoscopy and no direct causal relationship was confirmed. This is in contrast to the occurrence of MI prior to the colonoscopy in our case. Therefore, the current report is the first to describe a complication of MI immediately after oral administration of PGE-Asc. The lack of an increase in creatinine kinase in a blood test at hospital arrival shows that the patient was transferred to our hospital immediately after developing MI.

Polyethylene glycol electrolyte solution with ascorbic acid contains more ascorbic acid than conventional intestinal detergents, which produce a hyperosmotic solution that increases water in the intestine [2, 3]. As a result, PGE-Asc is likely to induce intracellular hydration in comparison with conventional detergents, which makes it important to maintain appropriate hydration regardless of age [12]. Our patient had no history of cardiovascular events, but had a smoking history and hypertension (i.e., cardiovascular risk factors), and findings of general coronary atherosclerosis in coronary angiography. In addition, the patient was an elderly person with cancer and had a high risk of development of thrombus. Therefore, he had a high possibility of developing MI without a stimulus. Nevertheless, the onset of MI immediately after administration of PGE-Asc is unlikely to be coincidental. It is reasonable that an originally weak coronary artery circulation was broken by acute progression of dehydration owing to inappropriate administration of PGE-Asc. In comparison with blood test data before oral administration of PGE-Asc, hemoconcentration and markedly increased urea nitrogen were found immediately after administration. Given the improvement after treatment, it is probable that acute dehydration induced coronary artery occlusion. It is important to note that many elderly patients may be at risk for the events in this case because older patients often have cardiovascular risks and many elderly patients with gastrointestinal cancer undergo colonoscopies.

This case of MI caused by the misuse of PGE-Asc underscores the significance of correct administration of PGE-Asc in accordance with the package insert. Standard instructions for the use of PGE-Asc in Japan are described in the package insert as follows. After oral administration at a rate of approximately 1 L/h, the patient should drink approximately 0.5 L of water or green tea. However, if transparent fluid is drained, drug administration should be withdrawn and the patient should drink water or green tea at a volume of half of the administered volume of PGE-Asc. If drained fluid is not transparent, the remaining PGE-Asc should be administered until transparent fluid is drained and the patient should then drink water or green tea at a volume of half of the administered volume of PGE-Asc. Protocols at our hospital specify oral administration

of sennoside (24 mg) the night before administration of PGE-Asc, which is a common pretreatment for endoscopy in Japan [1, 12].

In the current case, PGE-ASC was initially administered in accordance with the package insert, but the patient took PGE-Asc at 2 L/h, which is twice the recommended rate, and did not drink water, although the instructions were to drink 0.5 L of water. Acute dehydration may have been induced by this process because there was no relapse of symptoms while taking PGE-Asc according to the protocol during the hospital stay, with hydration maintained by strict monitoring and infusion in the Cardiac Care Unit. Therefore, if compliance is strictly monitored before the onset of MI, this should prevent MI after acute progression of dehydration. This case suggests that a warning of the danger of rapid oral administration of PGE-Asc should be added to those concerning overdose-induced dehydration [8, 9]. Elderly men are most likely to prepare for colonoscopy inappropriately [13–15] and it may be beneficial for these patients to take MoviPrep under monitoring.

Kounis syndrome is an acute MI caused by a coronary artery spasm following anaphylactic shock [16], which is reported as a serious adverse reaction of PGE-Asc. However, the patient had no symptoms indicating anaphylactic shock (upper airway obstruction, rash, flush in peripheral skin, and tachycardia), but had skin coldness and bradycardia. Therefore, it seems reasonable that sinus bradycardia was caused by cardiogenic shock and infarction in the right coronary artery following acute MI. Based on these assessments, a Naranjo score [11] of 4 was obtained in this case (see the “Appendix”), indicating a possible relationship of acute MI with the misuse of the suspect drug, PGE-Asc.

## Conclusion

This case shows that oral administration of PGE-Asc at a rate that is more rapid than recommended can induce the onset of MI as a result of acute dehydration in vessels, especially in elderly people with cardiovascular risk factors. It is important for patients to comply with the dosage and rate of administration specified in the package insert, even if they have no history of cardiovascular events. In particular, we recommend that elderly male patients should take PGE-Asc under supervision of a third party because many such patients may be at risk for events similar to those in the current case. However, this is the first report of MI following administration of PGE-Asc and further cases should be accumulated to evaluate the characteristics of patients who have a MI complication after administration of PGE-Asc.

## Compliance with Ethical Standards

**Funding** No sources of funding were used to assist in the preparation of this case report.

**Conflict of interest** Naruaki Imoto, Miho Hatanaka, Osamu Nomura, Makoto Hiki, Shin Watanabe, and Naoyuki Hashiguchi have no conflicts of interest that are directly relevant to the contents of this case report.

**Ethics approval** This case report was approved by the Ethics Committee of Juntendo University Hospital. All patient data were de-identified.

**Consent to participate** Written informed consent was obtained from the patient for publication of this case report. A copy of the written consent may be requested for review from the corresponding author.

**Data availability** The datasets generated and analyzed during the current case report are not publicly available because of the protection of individual privacy, but are available from the corresponding author on reasonable request.

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## Appendix: Naranjo score according to the findings in this case

| No. | Questions  | Score |
|-----|--|-------|
| Q1  | Are there previous conclusive reports on this reaction?  | + 1   |
| Q2  | Did the adverse event appear after the suspected drug was administered?                                    | + 2   |
| Q3  | Did the adverse reaction improve when the drug was discontinued or a specific antagonist was administered? | + 1   |
| Q4  | Did the adverse event reappear when the drug was readministered?   | - 1   |
| Q5  | Are there alternative causes (other than the drug) that could on their own have caused the reaction?       | - 1   |
| Q6  | Did the reaction reappear when a placebo was given?  | 0     |
| Q7  | Was the drug detected in the blood (or other fluids) in concentrations known to be toxic?                  | 0     |
| Q8  | Was the reaction more severe when the dose was increased or less severe when the dose was decreased?       | + 1   |
| Q9  | Did the patient have a similar reaction to the same or similar drugs in any previous exposure?             | 0     |
| Q10 | Was the adverse event confirmed by any objective evidence?   | + 1   |

## References

- Sagawa T, Sato K, Tomizawa T, Mizuide M, Yasuoka H, Shimoyama Y, et al. A prospective randomized controlled trial of AJG522 versus standard PEG + E as bowel preparation for colonoscopy. *Biomed Res Int*. 2015;2015:521756. <https://doi.org/10.1155/2015/521756>.
- Fujita I, Akagi Y, Hirano J, Nakanishi T, Itoh N, Muto N, et al. Distinct mechanisms of transport of ascorbic acid and dehydroascorbic acid in intestinal epithelial cells (IEC-6). *Res Commun Mol Pathol Pharmacol*. 2000;107(3-4):219-31.
- Wilson JX. Regulation of vitamin C transport. *Annu Rev Nutr*. 2005;25:105-25. <https://doi.org/10.1146/annurev.nutr.25.050304.092647>.
- Pontone S, Angelini R, Standoli M, Patrizi G, Culasso F, Pontone P, et al. Low-volume plus ascorbic acid vs high-volume plus sime-thicone bowel preparation before colonoscopy. *World J Gastroenterol*. 2011;17(42):4689-95. <https://doi.org/10.3748/wjg.v17.i42.4689>.
- Ponchon T, Boustiere C, Heresbach D, Hagege H, Tarrerias AL, Halphen M. A low-volume polyethylene glycol plus ascorbate solution for bowel cleansing prior to colonoscopy: the NORMO randomised clinical trial. *Dig Liver Dis*. 2013;45(10):820-6. <https://doi.org/10.1016/j.dld.2013.04.009>.
- Marmo R, Rotondano G, Riccio G, Marone A, Bianco MA, Stroppa I, et al. 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. *Gastrointest Endosc*. 2010;72(2):313-20. <https://doi.org/10.1016/j.gie.2010.02.048>.
- Yoshida N, Naito Y, Murakami T, Hirose R, Ogiso K, Inada Y, et al. Safety and efficacy of a same-day low-volume 1 L PEG bowel preparation in colonoscopy for the elderly people and people with renal dysfunction. *Dig Dis Sci*. 2016;61(11):3229-35. <https://doi.org/10.1007/s10620-016-4262-7>.
- US Food and Drug Administration. Medication guide: MoviPrep®. Available from: <https://www.fda.gov/downloads/Drugs/DrugSafety/UCM253840.pdf>. Accessed 24 Mar 2018.
- MoviPrep®. Highlights of prescribing information. Available from: <https://shared.salix.com/shared/pi/moviprep-pi.pdf>. Accessed 24 Mar 2018.
- Mathus-Vliegen EM, van der Vliet K. Safety, patient's tolerance, and efficacy of a 2-liter vitamin C-enriched macrogol bowel preparation: a randomized, endoscopist-blinded prospective comparison with a 4-liter macrogol solution. *Dis Colon Rectum*. 2013;56(8):1002-12. <https://doi.org/10.1097/DCR.0b013e3182989f05>.
- Gallagher RM, Kirkham JJ, Mason JR, Bird KA, Williamson PR, Nunn AJ, et al. Development and inter-rater reliability of the Liverpool Adverse Drug Reaction Causality Assessment Tool. *PLoS One*. 2011;6(12):e28096. <https://doi.org/10.1371/journal.pone.0028096>.
- Tajika M, Tanaka T, Ishihara M, Mizuno N, Hara K, Hijioka S, et al. A randomized controlled trial evaluating a low-volume PEG solution plus ascorbic acid versus standard PEG solution in bowel preparation for colonoscopy. *Gastroenterol Res Pract*. 2015;2015:326581. <https://doi.org/10.1155/2015/326581>.
- Hassan C, Fuccio L, Bruno M, Pagano N, Spada C, Carrara S, et al. A predictive model identifies patients most likely to have inadequate bowel preparation for colonoscopy. *Clin Gastroenterol Hepatol*. 2012;10(5):501-6. <https://doi.org/10.1016/j.cgh.2011.12.037>.
- Lebwohl B, Wang TC, Neugut AI. Socioeconomic and other predictors of colonoscopy preparation quality. *Dig Dis Sci*. 2010;55(7):2014-20. <https://doi.org/10.1007/s10620-009-1079-7>.

15. Ness RM, Manam R, Hoen H, Chalasani N. Predictors of inadequate bowel preparation for colonoscopy. *Am J Gastroenterol.* 2001;96(6):1797–802. <https://doi.org/10.1111/j.1572-0241.2001.03874.x>.
16. Kounis NG. Coronary hypersensitivity disorder: the Kounis syndrome. *Clin Ther.* 2013;35(5):563–71. <https://doi.org/10.1016/j.clinthera.2013.02.022>.