

# Fatal aspiration of polyethylene glycol solution

P. de Graaf<sup>1</sup>, C. Slagt<sup>2</sup>, J.L.C.A. de Graaf<sup>3</sup>, R.J.L.F. Loffeld<sup>4\*</sup>

Departments of <sup>1</sup>Clinical Pharmacology and Pharmacy, <sup>2</sup>Anaesthesiology and Intensive Care, <sup>3</sup>Pulmonology, and <sup>4</sup>Internal Medicine, Zaans Medical Centre, PO Box 210, 1500 EE Zaandam, the Netherlands, \*corresponding author: tel.: +31 (0)75-650 27 79, fax: +31 (0)75-650 23 79, e-mail: r.loffeld@chello.n

## ABSTRACT

Endoscopy of the colon requires adequate cleansing of the entire bowel. Several laxative regimens have been propagated, but bowel preparation with polyethylene glycol (PEG) solution is popular because of the easy application and good cleansing results. Although very safe in daily use, complications of this bowel-cleansing procedure have been reported and aspiration of the PEG solution is a possible and serious hazard. A case report is presented of a patient who aspirated the PEG solution and ultimately died because of respiratory failure.

## KEYWORDS

Fatal aspiration, polyethylene glycol, respiratory failure

## INTRODUCTION

Endoscopy of the colon is widely applied and indications for this procedure are mostly abdominal symptoms, rectal bleeding, anaemia, diarrhoea or a family history of malignancy or colorectal adenomas. A successful procedure requires total visualisation of the colon and rectum. Therefore, complete bowel preparation is mandatory and several laxatives can be used for this purpose. The ideal bowel-cleansing preparation should be efficient, safe and tolerable for the patient and convenient in daily practice. Polyethylene glycol (PEG) solutions are generally used because they are efficient in cleansing the entire colon and meet the mentioned safety criteria concerning the patient. Although routinely applied without major side effects, unexpected complications can occur. This will be demonstrated in the following case history.

## CASE REPORT

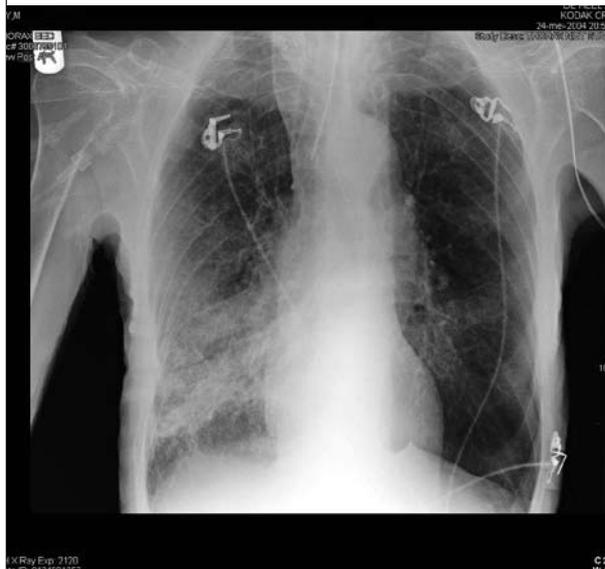
An 86-year-old male was admitted because of abdominal pain located in the right side of the abdomen, alterations in stool frequency and consistency, nausea and weight loss. His medical history revealed COPD, spondylarthrititis, a stenosis in the left carotid artery and recently a transient neurological deficit. He smoked ten cigarettes a day and did not use alcohol. On physical examination, a slim male was seen (length 182 cm, weight 68 kg) with normal blood pressure, pulse frequency and body temperature. Examination of the abdomen showed normal peristalsis. Laboratory examinations were normal except for a slightly elevated level of creatinine (96  $\mu\text{mol/l}$ ; normal 64 to 108  $\mu\text{mol/l}$ ), a decreased serum albumin (33.6 g/l; normal 35 to 50 g/l) and a microcytic anaemia (haemoglobin count 7.4 mmol/l; normal 8.7 to 10.7 mmol/l). Ultrasound examination of the abdomen only showed a small aneurysm of the aorta with a diameter of 4 cm and stones in the gallbladder. Chest X-ray (*figure 1*) showed bilateral pulmonary emphysema.

Malignancy in the ascending colon or caecum was suspected because of the microcytic anaemia and the abdominal symptoms. A colonoscopy was scheduled and bowel preparation was started conform the local procedure, consisting of four litres of PEG solution (Klean-Prep<sup>®</sup>, Norgine Pharma, Amsterdam, the Netherlands) usually administered in four to six hours. A nasogastric tube was used for administration of the solution because the patient was not able to drink this large amount of fluid. The patient complained of nausea after administration of two litres solution in three hours, vomited once and the administration of the PEG solution was immediately stopped. Two hours later, the patient became dyspnoeic with a respiration rate of 25 breaths/min. Physical examination revealed rhales, especially in the right lung. Blood gas analysis showed a combined respiratory and metabolic acidosis with hypoxaemia: pH 7.16; pCO<sub>2</sub> 8.3 kPa; pO<sub>2</sub> 5.3 kPa; HCO<sub>3</sub> mmol/l 21.4;

**Figure 1.** Chest X-ray of the patient on admission, with the pulmonary emphysema clearly visualised



**Figure 2.** Chest X-ray before starting the mechanical support, with a massive consolidation clearly visualised in the right lung



O<sub>2</sub> saturation 61% (normal pH 7.36 to 7.43; pCO<sub>2</sub> 35 to 45 mmHg; pO<sub>2</sub> 60 to 80 mmHg; HCO<sub>3</sub> 22-26 mmol/l; O<sub>2</sub> saturation 95 to 98%).

He was transferred to the intensive care unit, where he was treated with oxygen and antibiotics according local antibiotic practice for aspiration (clindamycin 600 mg and cefuroxim 750 mg, both three times a day). Chest X-ray showed massive consolidation in the right as well as the left lung (*figure 2*). The ongoing worsening of his respiratory function required intubation and respiratory assist. Bronchoscopy with application of NaCl 0.9% was performed to try to remove as much aspirated PEG solution as possible, but did not result in removing the aspirated fluids. During this procedure, diffuse mucosal inflammation and interstitial oedema was seen. Corticosteroids were added to temper the acute respiratory failure; intensive haemodynamic support with norepinephrine, dopamine and enoximone was necessary. Despite maximal supportive care, ongoing acute respiratory distress syndrome developed which resulted in multiorgan failure. Ultimately the patient died; a postmortem examination was not permitted.

## DISCUSSION

Because of the good results, PEG-based laxative regimens are increasingly being used in bowel cleansing before endoscopic examination. As can be expected the number of serious adverse events increases accordingly.<sup>1-15</sup>

A fatal case of aspiration of a PEG-based solution is presented here. Five case reports reporting a similar aspiration

comprised three children (aged 8, 11 and 8 years)<sup>1,2,4</sup> and three adults (aged 80, 59 and 78 years).<sup>3</sup> All patients were scheduled for colonoscopy and received PEG solution through a nasogastric tube in two to five hours. Aspiration occurred in all patients during or shortly after administration of the solution and support of respiratory functions was necessary shortly after the event. Five patients required transfer to the intensive care unit for mechanical ventilation. Apart from mechanical ventilation, treatment consisted of corticosteroids, antibiotics and diuretics. In one patient, the aspirated PEG solution could be removed successfully. During this procedure diffuse mucosal inflammation and interstitial oedema was seen, which was also the case in our patient.<sup>4</sup> Five patients recovered completely (including all the children), but one patient (a 78-year-old female) died after two weeks because of ongoing adult respiratory stress syndrome.<sup>3</sup>

Disadvantages of PEG are the large amount of fluid needed (up to four litres) and the unpleasant taste. A possible answer is to administer the solution by a nasogastric tube, which is considered an effective and safe method. However, all reported cases of aspiration occurred with the use of a nasogastric tube during administration of PEG solution. Use of prokinetics such as metoclopramide can be considered if the patient experiences nausea while the solution is being given.

Other reported adverse effects for PEG-based lavage solutions are abdominal pain and cramps, vomiting and absorption interactions with simultaneously ingested drugs, but these are inherent to the use of laxatives as a whole. Other more serious adverse events are drug-induced pulmonary oedema, asthma and bronchospasms,<sup>2,6,7,12,15</sup> angio-oedema<sup>8</sup> and pancreatitis.<sup>13</sup>

Aspiration of gastric contents is a serious risk for developing acute respiratory failure or ARDS. Probably one third of the patients who experience gastric aspiration develop acute respiratory syndrome.<sup>16</sup> The reported mortality in this group of patients is high and especially older patients are at risk.<sup>17,18</sup> Predisposing conditions for aspiration are diminished consciousness, dysphagia, neurological disorders and malfunctioning of the physiological mechanisms in the upper gastrointestinal tract that normally prevent aspiration.<sup>19</sup> Possible other mechanisms for aspiration include administration of large amounts of fluid in a short time (which can provoke a gastric spasm) and a recumbent position, which enhances regurgitation and aspiration.

Our patient had no underlying cardiac or neurological disease and only slight renal dysfunction. Severe emphysema was seen on the chest X-ray and is likely to have contributed to the rapid deterioration of his pulmonary function.

Excessive systemic water absorption leading to intravascular fluid overload is a possible cause of pulmonary oedema and has been described earlier after PEG administration.<sup>2,6,7</sup> However, our patient received only two litres of PEG solution and his respiratory condition did not improve after administration of furosemide. Furthermore, his pulmonary condition remained poor during his stay on the ICU as was seen on the repeated chest X-rays, and ventilation and laboratory parameters. This makes respiratory failure caused by intravascular volume overload less likely and points towards a local inflammatory reaction of lung tissue after aspiration of the PEG solution.

Aspirated liquids can theoretically lead to pulmonary oedema / ARDS by affecting the surface tension in the lungs (causing collapse the alveoli and lower bronchial airways) and diffusion of fluids into the alveolar and interstitial space. The performed lavage did not retrieve the aspirated fluid, which implicates that most of the aspirated fluid had already been absorbed in the pulmonary tissues. However, diffuse inflammation and mucosal oedema of the lower airways was seen during endoscopy and this has been reported earlier after aspiration of a PEG solution by Liangthanasarn *et al.*<sup>4</sup> Pneumonitis was also reported in our patient by the radiologist on basis of the repeated chest X-rays.

Therefore, it seems more likely that the PEG itself played a significant role in the acute inflammatory reaction of pulmonary tissue that developed in our patient. A similar hypothesis has been postulated by Paap *et al.*<sup>3</sup> They suggested that PEG solution has hyperosmotic instead of iso-osmotic properties. The solution may then be neutral in gut tissue but thus can lead to intra-luminary fluid shifts in lung tissue after aspiration, causing pulmonary oedema. Besides, it is likely that PEG itself can cause inflammation of pulmonary tissue after aspiration and subsequently a chemical pneumonitis. It is concluded that, although safe in general, PEG-based solutions administered via a nasogastric tube can lead

to aspiration. Administration should be started at a low infusion rate. When well tolerated, the flow can slowly increase to a recommended flow of 20 to 30 ml/minute.<sup>20</sup> During administration vital signs of the patient should be checked regularly. These actions have to be taken in order to prevent complications.

## REFERENCES

- Narsinghani U, Chadha M, Farrar HC, Anand KS. Life-threatening respiratory failure following accidental infusion of polyethylene glycol electrolyte solution into the lung. *J Toxicol Clin Toxicol* 2001;39(1):105-7.
- Paap CM, Ehrlich R. Acute pulmonary edema after polyethylene glycol intestinal lavage in a child. *Ann Pharmacother* 1993;27(9):1044-7.
- Marschall HU, Bartels F. Life-threatening complications of nasogastric administration of polyethylene glycol-electrolyte solutions (Golytely) for bowel cleansing. *Gastrointest Endosc* 1998;47(5):408-10.
- Liangthanasarn P, Nemet D, Sufi R, Nussbaum E. Therapy for pulmonary aspiration of a polyethylene glycol solution. *J Pediatr Gastroenterol Nutr* 2003;37(2):192-4.
- Van Gossum A, Adler M. Complications of bowel cleansing with polyethylene glycol-electrolyte solution. *Gastrointest Endosc* 1999;49(6):818.
- Argent A, Hatherill M, Reynolds L, Purves L. Fulminant pulmonary oedema after administration of a balanced electrolyte polyethylene glycol solution. *Arch Dis Child* 2002;86(3):209.
- Wong A, Briars GL. Acute pulmonary oedema complicating polyethylene glycol intestinal lavage. *Arch Dis Child* 2002;87(6):537.
- Stollman N, Manten HD. Angioedema from oral polyethylene glycol electrolyte lavage solution. *Gastrointest Endosc* 1996;44(2):209-10.
- Hastier P, Bellon S, Perrin C, et al. Acute respiratory distress syndrome with fatal outcome after inhalation of polyethylene glycol during preparation for colonoscopy. *Gastroenterol Clin Biol* 1996;20(2):216-7.
- Santoro MJ, Chen YK, Collen MJ. Polyethylene glycol electrolyte lavage solution-induced Mallory-Weiss tears. *Am J Gastroenterol* 1993;88(8):1292-3.
- McBride MA, Vanagunas A. Esophageal perforation associated with polyethylene glycol electrolyte lavage solution. *Gastrointest Endosc* 1993;39(6):856-7.
- Thiaucourt D, Bigard MA. Asthma and bronchospasm during a preparation for colonoscopy with polyethylene glycol aromatized solution. *Gastroenterol Clin Biol* 1993;17(3):230-1.
- Franga DL, Harris JA. Polyethylene glycol-induced pancreatitis. *Gastrointest Endosc* 2000;52(6):789-91.
- Aljanabi I, Johnston P, Stone G. Spontaneous rupture of the oesophagus after bowel preparation with polyethylene glycol. *ANZ J Surg* 2004;74(3):176-7.
- Halphen M, Masmejean J. Asthma and bronchospasm during preparation for colonoscopy with an aromatized solution of polyethylene glycol. *Gastroenterol Clin Biol* 1993;17(10):762.
- Garber BG, Hebert PC, Yelle JD, Hodder RV, McGowan J. Adult respiratory distress syndrome: a systemic overview of incidence and risk factors. *Crit Care Med* 1996;24(4):687-95.
- Marik PE, Kaplan D. Aspiration pneumonia and dysphagia in the elderly. *Chest* 2003;124(1):328-36.
- Kikawada M, Iwamoto T, Takasaki M. Aspiration and infection in the elderly: epidemiology, diagnosis and management. *Drugs Aging* 2005;22(2):115-30.
- Marik PE. Aspiration pneumonitis and aspiration pneumonia. *N Engl J Med* 2001;344(9):665-71.
- Norgine B.V. Product Information Klean-Prep. Website CBG ([www.cbg-meb.nl](http://www.cbg-meb.nl)) . 19-5-2005.