Aspiration Complications Following Nasogastric Administration of Polyethylene Glycol (PEG) Solution

Polyethylene Glycol-Electrolyte Lavage Solution (PEG-ELS), “Golytely,” has been available since the early 1980s. It was developed as a safer alternative for traditional bowel cleansing solutions. We present a case of Acute Respiratory Distress Syndrome secondary to PEG-ELS aspiration during nasogastric administration and contrast it to other such reported cases. There are several possible mechanisms through which PEG-ELS may induce ARDS, including its high osmotic effect, structural similarities to lung surfactant, as well as direct alveolar membrane damage. In patients requiring administration of PEG-ELS via nasogastric tube, we suggest placing the patient in full aspiration precautions, reducing the rate of infusion, or use of another bowel cleansing solution.

INTRODUCTION

Polyethylene Glycol-Electrolyte Lavage Solution (PEG-ELS), “Golytely,” has been available since the early 1980s. Davis et al, developed it as a safer alternative for traditional bowel cleansing using balanced electrolyte solution. It provides rapid cleansing of the bowel with only minimal transmucosal movement of water or sodium (1). Polyethylene Glycol (PEG) is a linear polymer made up of repeating two-carbon length hydrocarbons joined by oxygen to form an ether linkage. This structure produces a hydrophobic and hydrophilic portion of the polymer. The hydrophilic oxygen molecules allow for bonding to surrounding water molecules. PEG 3350 is the most common form used in gastric lavage solutions. It is one of the larger PEG molecules made up of 68–84 units. Its large size keeps it from being absorbed by the
intestinal mucosa. It is used in gastric lavage solutions because its lack of absorption and highly osmotic structure helps to retain fluid in the gut (2). Since its introduction, PEG-ELS has become one of the most common methods of preparations for colonoscopy, barium enemas, and colon surgery. It is generally well tolerated with the most common adverse effects being disagreeable taste, minimal nausea and abdominal bloating. Rare cases have been reported of hypothermia, obstruction-perforation, lavage-induced pill, malabsorption, electrolyte-metabolic abnormalities, and cardiac arrhythmias (3). Among the side effects reported, there have been only five cases of PEG-ELS aspiration during bowel preparation for a colonoscopy and its effects. We present another such case in which the aspiration is believed to have caused Acute Respiratory Distress Syndrome (ARDS).

**CASE REPORT**

A 65-year-old woman with a past medical history of deep vein thrombosis on Coumadin treatment, COPD, and congestive heart failure presented to the emergency department with bright rectal bleeding occurring 24 hours prior to the presentation. She admitted to intermittent use of NSAIDs. She denied any hematemesis, melena, or abdominal pain. On admission her vital signs were: pulse 93, respirations 20, blood pressure 121/48, and temperature of 97.1°F. Gastric lavage did not show any evidence of blood. Initial laboratory data showed a hemoglobin of 6.3 and hematocrit of 19.9 and a PT of 34.4 and INR of 7.59. Her abdomen was soft and nontender with hyperactive bowel sounds. Her stool was grossly bloody.

The patient received packed red blood cells to correct her anemia and fresh frozen plasma for her coagulopathy. An EGD was performed and did not reveal a source of bleeding. The patient continued to have hematochezia with decreasing hematocrit. A colonoscopy was scheduled for the next day. Bowel prep was undertaken with PEG-ELS. A PEG-ELS composed of Polyethylene Glycol 31.3 mmol/L, sodium 65 mmol/L, chloride 53 mmol/L, bicarbonate 17 mmol/L, and potassium 5 mmol/L in 4 L of water was infused via nasogastric tube at the recommended rate of approximately 20-30 cc/minute (4). Approximately 1 hour after beginning the bowel prep, the patient began to have respiratory difficulty and chest pain. She quickly progressed to acute respiratory failure requiring intubation and mechanical ventilation. Post intubation greater then 500cc of clear fluid was suctioned from the patient’s lungs. This fluid was felt to be the PEG-ELS that was being given at the time of the event.

Chest x-rays preformed several hours prior to intubation compared with the morning post intubation showed increasing diffuse bilateral pulmonary infiltrates (Figure 1 and Figure 2). Myocardial infarction was ruled out and diuresis failed to improve her respiratory failure. Over the next few days, the patient con-

![Figure 1. Portable CXR prior to aspiration showing mild cardiomegaly and a small left pleural effusion.](image)

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continued to deteriorate with worsening infiltrates on chest x-ray and increasing difficulty in oxygenation. The patient was diagnosed with Acute Respiratory Distress Syndrome (ARDS). She was aggressively treated with little improvement and died on the 26th day of admission following a prolonged stay in the intensive care unit on the ventilator.

DISCUSSION

ARDS following aspiration of a PEG bowel preparation is a rare ARDS maybe caused by a chemical pneumonitis induced by aspiration of the PEG-ELS. PEG-ELS is the one of the most common bowel preparations used in the US. Their most common side effects are nausea and bloating which are seen in close to 50% of patients (3). A literature review shows only five reported cases of pulmonary complications from PEG-ELS. Of the cases reported, there were only two deaths. Three of the five cases required intubation. All of the cases reported follow the same natural history. The patient receives PEG-ELS via nasogastric tube. During administration, the patient begins to have respiratory distress with presumed aspiration of the PEG-ELS. Follow up x-rays then showed bilateral diffuse pulmonary infiltrates. One case was diagnosed as acute non-cardiac pulmonary edema, one as ARDS, and the others as toxic-allergic pulmonary edema(5,6).

ARDS is due to inflammatory changes within the lung following a variety of insults. Inflammatory cytokines are released in response to these insults. Neutrophils are recruited to the lungs and are activated by these cytokines. The neutrophils release toxic mediators including oxygen free radicals, which cause damage to the capillary endothelium, and alveolar epithelium(7). The damaged alveoli cannot prevent protein escaping out of the vascular space. This shifts the osmotic gradient so fluid moves into the alveoli. The alveolar spaces fill with edema fluid and the debris from degenerating cells. Functional surfactant is lost which results in collapse of the alveoli(8). This initial “exudative” phase changes over the first week into a “proliferative” stage in which the pulmonary edema resolves and there is proliferation of type II alveolar cells, squamous metaplasia, interstitial infiltration by myofibroblasts, and early deposition of collagen. Some, then progress into a third “fibrotic” stage characterized by loss of normal lung architecture, diffuse fibrosis and formation of cysts (9).

There are several possible mechanisms by which PEG-ELS may cause ARDS. PEG-ELS is highly osmotic and functions to retain fluid in the GI tract during intestinal lavage. This prevents the shifts in volume caused by previously used balanced electrolyte solutions. Studies have shown that PEG produces a greater osmotic effect than accounted for by the number of mole-

Figure 2. Portable CXR twenty-four hours after aspiration showing endotracheal intubation and bilateral cover tube infiltrates, perihilar infiltrates and bilateral pleural effusion.

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cules in solution. PEG 3350 is a large molecule capable of ordering a relatively large region of water. This gives it a very high osmotic effect (2). Once introduced in the lung, this high osmotic potential may act to shift the osmotic gradient so that a large amount of fluid is moved out of the pulmonary vasculature and into the alveolar space causing pulmonary edema (6).

PEG-ELS may also interrupt the function of lung surfactant. During aspiration, the filling of the alveoli with fluid would interrupt the surfactant’s function similar to edema fluid. PEG also shares similar chemical properties to artificial surfactants used in the prevention of neonatal respiratory distress syndrome. Many of the artificial surfactants are classified as polyethylene glycols. The PEG could interrupt the normal interaction of natural surfactant and the alveolar membrane on a molecular level leading to more extensive collapse of the alveoli than by fluid interruption alone.

The PEG may also damage the alveolar membrane directly. Coskun et al, (10) has shown that PEG solution can cause both histological and oxidative stress to the mucosal membrane of rat colons. After instillation of a PEG solution, loss of superficial mucosa and epithelial denudation was noted histologically in the mucosal cells. Testing also indicated oxidative stress on the cells as demonstrated by elevated levels of malonyldialdehyde. Malonyldialdehyde is a chemical indicator of increased oxidant activity. It is likely that similar damage and oxidative stress could be seen in alveolar tissue, perhaps more because there are less protective mechanisms in the lung compared to the GI tract against direct contact with chemical agents.

In a study by Suzuki M et al, polyoxyethylene 9 lauryl ether (Laureth-9) was instilled intratracheally directly in the lung. Laureth-9 is another member of the PEG family and is similar in general structure to PEG 3350 used in intestinal lavage solutions. The first day after instillation, edema, hemorrhage, and inflammatory cell infiltration due to epithelial degeneration and desquamation was noted on histological sections. In later days, hyperplasia of epithelium and sporadic fibrosis was noted as part of the wound healing process of the lung (11). These changes are similar to those seen in ARDS.

Based on the chemical properties discussed above, PEG-ELS aspirated directly into the lungs is the most likely cause of the ARDS in our patient and similar ARDS-like pictures are seen in the other reported cases. The common feature in all the cases of pulmonary complications with PEG-ELS use has been administration via a nasogastric tube. PEG-ELS has been shown to be a safe and effective form of bowel preparation for procedures. The most common side effects are nausea and abdominal bloating (3). Most patients requiring administration via nasogastric tubes are likely to have other comorbidities. The most common being decreased mental status, impaired respiratory or cardiac status, and elevated age. These comorbidities would reduce the patient’s ability to tolerate or warn staff when nausea or bloating occurs. The nasogastric tube also increases their risk of aspiration further by violating the seal at the esophageal gastric junction (12). In these patients when bowel prep is necessary, consideration may be given to using sodium picosulphate plus magnesium citrate. Regev A et al (13), showed that sodium picosulphate plus magnesium citrate is better tolerated with statistically lower incidence of nausea and vomiting than PEG-ELS. If PEG-ELS is used, we would then suggest infusing the solution at half or less than the manufacturer’s suggested rate and over a longer period of time. The package insert for the PEG-ELS use does suggest reducing the rate of infusion if bloating or nausea occur (4). We would suggest a rate of ~10–15 cc per minute or less. The patient should also be placed on full aspiration precautions including close monitoring of the patient by nursing, checking residual stomach contents after one hour, and positioning the patient at 30–45 degrees of head elevation (14). Even the use of prokinetic agents such as metaclopramide may be contemplated.

No clinical trials or research has been done to assess the proper treatment of PEG-ELS solution aspiration. Should aspiration occur, the most common therapy noted among the surviving patients was aggressive suction of the aspirate and/or broncho-alveolar lavage. This may help by reducing the time the PEG-ELS remains in contact with lung tissue. Otherwise, only maximal supportive and symptomatic care can be recommended. Consideration may be given to providing antibiotic coverage for aspiration pneumonia should such signs or symptoms suggesting bacterial infection develop.
CONCLUSION
Our case illustrates the effects of PEG-ELS accidental aspiration during its administration. Review of the literature shows only five other cases of PEG-ELS aspiration reported. It is important to note that all the cases share the same route of administration—via a nasogastric tube. Overall PEG-ELS remains a safe and effective bowel preparation though caution needs to be exercised in its use in patients that require instillation via a nasogastric tube. If instilled in this fashion the patient needs to be on full aspiration precautions and under close observation to prevent unwanted adverse effects from the most common side effects of nausea and bloating. Alternatively, other bowel cleansing preparations may be considered. ■

References