Although percutaneous endoscopic gastrostomy may be complicated by iatrogenic bowel injury, most clinicians consider a small pneumoperitoneum on radiographs obtained after the procedure a benign finding of little clinical consequence. The possibility of a relationship between findings of early pneumoperitoneum after percutaneous endoscopic gastrostomy and subsequent iatrogenic bowel injury was examined.

**METHODS** Charts of 85 patients in a surgical intensive care unit who had undergone percutaneous endoscopic gastrostomy between 2000 and 2005 were retrospectively reviewed. All patients had a follow-up upright chest radiograph obtained after percutaneous endoscopic gastrostomy. The charts of 4 patients with radiographs that showed early pneumoperitoneum were reviewed.

**RESULTS** Findings were clinically significant in 1 of the 4 patients. That patient had a perforated transverse colon that required surgical repair. The other 3 patients had no complications.

**CONCLUSION** Pneumoperitoneum after percutaneous endoscopic gastrostomy may be a sign of possible bowel injury and requires further evaluation. It should not be dismissed as benign. Obtaining a chest radiograph after a patient has undergone percutaneous endoscopic gastrostomy is essential. (American Journal of Critical Care. 2007;16:132-136)

Percutaneous endoscopic gastrostomy (PEG) is a common procedure often performed in intensive care units (ICUs). Dysphagia in patients with cerebral injuries is one of the most frequent indications for PEG. In such a condition, gastrostomy becomes indispensable in providing long-term access for enteral nutritional supplementation. PEG is associated with a number of complications (see Table) and has a mortality rate of 0.5%. A major complication of PEG is inadvertent perforation of the small bowel or colon. Clinically, perforation of the small bowel or colon is associated with signs and symptoms of peritonitis and sepsis such as fever, leukocytosis, abdominal pain, and tenderness (the last 2 symptoms may be unreliable in patients with cerebral injuries), which can be followed by septic shock and death if not diagnosed and treated early. Pneumoperitoneum detected on plain radiographs may be an early sign of this potentially serious complication.

A small amount of free peritoneal air after PEG is commonly considered a benign finding by most surgeons. The air insufflated at the time of endoscopy escapes the lumen of the stomach and enters the peritoneal cavity through a puncture site on the gastric wall. However, perforation of the bowel, especially of the colon, also leads to pneumoperitoneum. The diagnostic challenge is to differentiate between benign
pneumoperitoneum and pneumoperitoneum caused by bowel perforation. That distinction is further complicated because findings associated with early sepsis (eg, fever, leukocytosis, tachycardia) are common in the general population of patients in the ICU.

We therefore elected to review our experience with PEG to explore a possible relationship between findings of early pneumoperitoneum and a potential for iatrogenic bowel injury.

### Materials and Methods

#### Background

The study was conducted at Cedars-Sinai Medical Center, an 850-bed teaching hospital and level I trauma center in Los Angeles, Calif. Percutaneous endoscopic gastrostomy was performed by attending surgeons, all of whom are certified by the American Board of Surgery in general surgery and surgical critical care.

#### Population of Patients and Study Design

Approval was obtained from the institutional review board to retrospectively review the charts of patients who underwent PEG in the surgical ICU between 2000 and 2005. Charts from 85 patients who met study criteria were identified and reviewed. The indication for PEG was an inability to have oral intake, primarily because of neurological injury. Data were collected from the hospital’s comprehensive computerized information system, which contains all the medical records, imaging studies, laboratory results, and ICU flow sheets for each patient.

The procedure for placement of a gastrostomy tube is standardized within the institution, and the “pull technique” is used routinely. With this method, an Olympus GIF-140 or GIF-160 endoscope (Olympus America Inc, Melville, NY) is introduced into the upper part of the gastrointestinal tract through the oropharynx. The endoscope is advanced into the lumen of the stomach, the stomach is insufflated, and the anterior part of the abdominal wall is checked for an area of maximal transillumination. This area is then prepared and draped in sterile fashion and injected with local anesthetic solution.

A large-bore catheter is introduced over the needle through the anterior part of the abdominal wall. Under direct visualization through the endoscope, the catheter is introduced into the gastric lumen and securely grasped with the endoscopic loop snare. The needle is then withdrawn. A segment of a long looped guidewire is introduced into the gastric lumen, grasped with the snare, and withdrawn through the mouth along with the endoscope. In this manner, the distal end is left to protrude through the anterior part of the abdominal wall, while the proximal end of the guidewire protrudes through the patient’s mouth. The proximal end of the loop is secured to the tapered end of the gastrostomy tube. Steady traction is then applied to the distal end of the loop, allowing the surgeon to pull the PEG tube’s tapered end first through the esophagus, then through the stomach, and finally through the anterior part of the abdominal wall. At this point, the endoscope is reintroduced into the upper part of the gastrointestinal tract to confirm the position of the mushroom tip on the anterior gastric wall. The catheter is then secured to the abdominal wall with the standard crosspiece and a sterile dressing is applied to the site.

The “safe tract method” (as described by Foutch et al) is not used in our institution. In this method, a fluid-filled syringe is attached to an angiographic catheter or trocar. As the needle is passed through the abdominal wall, suction is applied to the syringe by pulling on the plunger. If bubbles are seen in the

### Complications of percutaneous endoscopic gastrostomy

#### Major complications
- Bowel injury
- Peristomal leakage with peritonitis
- Necrotizing fasciitis of the anterior abdominal wall
- Gastric hemorrhage

#### Minor complications
- Minor wound infections
- Stomal leaks
- Tube extrusion
- Tube migration
- Aspiration
- Gastrocolic fistula
- Ileus
- Fever

The presence of a pneumoperitoneum may be benign, but also may occur with bowel perforation.
syringe before the trocar is visible in the gastric lumen, the presence of bowel between the abdominal and gastric wall is assumed, and the attempt is aborted.\(^9\)

Almost all patients in the surgical ICU have upright chest radiographs obtained as part of their daily care for reasons such as placement of a pulmonary artery catheter or an endotracheal tube, follow-up of pulmonary or thoracic abnormalities (eg, pneumothorax, lung infiltrates), or routine examination after a procedure (eg, placement of a central catheter). Members of the surgical ICU team review the radiographs as soon as the images are available. The surgeons’ interpretation is then compared with the review by a board-certified radiologist. Upon this review, all patients in this series had plain chest radiographs obtained within 24 hours after PEG.

**Statistical Analysis**

All data including age and sex of the patient, date of PEG, results of chest radiographs, presence of bowel injury, and date of surgical repair of the bowel injury were entered into worksheet software. Patients were divided into 2 groups: those with and those without pneumoperitoneum. The prevalence of bowel injury was compared between these 2 groups. The sensitivity and specificity of free air in predicting bowel injury were calculated. The positive and negative predictive values of pneumoperitoneum in predicting bowel injury were calculated in the same fashion.

**Results**

**Demographics**

Of the total of 85 patients, 50 (59%) were men and 35 (41%) were women. The mean age was 51.8 years; 47.2 years for men and 58.6 years for women. The diagnoses of the patients who underwent PEG were traumatic injuries \((n = 42, 49\%)\), stroke \((n = 22, 26\%)\), and cancer \((n = 13, 15\%)\). Eight other patients \((9\%)\) comprised a more heterogeneous group with a number of other conditions that required prolonged mechanical ventilatory support. These included patients with sepsis, pneumonia due to recurrent aspiration, and altered mental status after various neurosurgical procedures.

The trauma patients had had motor vehicle collisions, gunshot wounds, falls, or assaults. Most of the trauma patients \((30\text{ cases})\) had central nervous system injuries (eg, intracranial bleeding or contusion).

**Outcome**

In 81 patients \((95\%\text{ of all cases})\), no pneumoperitoneum was noted on the radiograph obtained after PEG. A total of 4 patients \((5\%)\) had pneumoperitoneum, and 3 of the 4 \((4\%)\) had minimal pneumoperitoneum. One patient \((1\%)\) had “significant” pneumoperitoneum defined as “subdiaphragmatic air pockets larger than 2 cm” (Figure 1).

Of the 3 cases in which the pneumoperitoneum was interpreted as minimal, in the first case the findings on radiographs resolved within 24 hours after the procedure. In the second case, a small amount of free subdiaphragmatic air immediately after the procedure was progressively smaller on follow-up radiographs and finally disappeared 3 days after the procedure. In the third case, a small amount of intraperitoneal air was noted on a single radiograph on the third day after the procedure. No pneumoperitoneum was noted on any of the follow-up radiographs.

Unlike the 3 patients who had a minimal amount of subdiaphragmatic air after the procedure, findings
of significant pneumoperitoneum in the fourth patient did not change over time. The appearance and amount of free subdiaphragmatic air did not change in the 72 hours after the procedure. Findings on the patient’s physical examination were thought to be unreliable because of the patient’s altered mental status. Although this patient did not have any signs of abdominal sepsis (eg, fever, leukocytosis, hemodynamic alterations), the plain radiographic findings prompted further investigation with computed tomography of the abdomen and pelvis. This study revealed that the gastrostomy tube was inserted through the transverse colon (Figure 2). The patient immediately underwent an exploratory laparotomy with repair of the injured colon and open tube gastrostomy. None of the 4 patients in our review died.

Discussion

Follow-up of patients who have undergone PEG may present a series of clinical challenges in ICU populations. Many ICU patients have impaired mental status or receive analgesics that cause the findings on physical examination to be unreliable because of the patient’s altered mental status. Although this patient did not have any signs of abdominal sepsis (eg, fever, leukocytosis, hemodynamic alterations), the plain radiographic findings prompted further investigation with computed tomography of the abdomen and pelvis. This study revealed that the gastrostomy tube was inserted through the transverse colon (Figure 2). The patient immediately underwent an exploratory laparotomy with repair of the injured colon and open tube gastrostomy. None of the 4 patients in our review died.

Findings of pneumoperitoneum after PEG should not be consistently dismissed as a benign byproduct of gastric insufflation. Presence of pneumoperitoneum should alert clinicians to the possibility of iatrogenic bowel injury, especially in cases in which pneumoperitoneum does not resolve over time (in our series, within 72 hours) or is thought to be significant (defined as subdiaphragmatic air pockets of greater than 2 cm in our institution).

Our observations differ significantly from those of other investigators who concluded that in the absence of signs or symptoms of peritonitis, pneumoperitoneum after PEG is a benign finding and requires no further diagnostic or therapeutic intervention. We found that pneumoperitoneum, even without peritoneal signs and symptoms, may indicate iatrogenic bowel injury and requires follow-up, possible further diagnostic studies, and, if indicated, operative intervention.

We also think that the presence of peritoneal signs and symptoms as a marker of iatrogenic bowel injury has been overemphasized. Such early symptoms of peritoneal irritation as abdominal pain and tenderness may not be easily observed in patients who require long-term sedation (eg, patients receiving mechanical ventilatory support) or patients with altered mental status (eg, patients after cranial neurosurgery). In these patients, other indications of peritonitis, such as hemodynamic alterations and abdominal rigidity, herald late and advanced sepsis leading to markedly increased operative morbidity and mortality. On the basis of these observations, we advocate vigilance on the part of clinicians when pneumoperitoneum is noted after PEG.

In our review, lack of pneumoperitoneum was highly consistent with a successful and complication-free procedure (negative predictive value 100%). Visualization of free abdominal air on radiographs obtained after the procedure, on the other hand, should arouse suspicion for iatrogenic bowel injury. This finding had a high sensitivity (100%) and specificity (96%) in our series.

Figure 2  Computed tomography scan shows stomach (b), free air (e), and gastrostomy tube (d) inserted through the transverse colon (a, c).
Conclusion

On the basis of our experience we recommend abdominal radiographs for all patients who have undergone PEG. Findings of pneumoperitoneum, under such circumstances, should not be summarily dismissed as benign. We also think that peritoneal signs and symptoms cannot be consistently relied upon for detecting early peritonitis in surgical ICU patients.

Persistent or significant pneumoperitoneum carries a substantial risk of iatrogenic bowel injury and should arouse suspicion in clinicians who perform PEG. Computed tomography of the abdomen and pelvis or a contrast-enhanced study through the gastrostomy tube can be used for further workup.

REFERENCES

Early Pneumoperitoneum After Percutaneous Endoscopic Gastrostomy in Intensive Care Patients: Sign of Possible Bowel Injury
Siamak Milanchi and Alexander Allins

Am J Crit Care 2007;16 132-136
Copyright © 2007 by the American Association of Critical-Care Nurses
Published online http://ajcc.aacnjournals.org/

Personal use only. For copyright permission information:
http://ajcc.aacnjournals.org/cgi/external_ref?link_type=PERMISSIONDIRECT

Subscription Information
http://ajcc.aacnjournals.org/subscriptions/

Information for authors
http://ajcc.aacnjournals.org/misc/ifora.xhtml

Submit a manuscript
http://www.editorialmanager.com/ajcc

Email alerts
http://ajcc.aacnjournals.org/subscriptions/etoc.xhtml