



## Digestive Endoscopy

# Complications and early mortality in percutaneous endoscopic gastrostomy placement in lombardy: A multicenter prospective cohort study

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## ABSTRACT

**Background:** Percutaneous endoscopic gastrostomy (PEG) is the most common endoscopic procedure used to provide nutritional support.

**Aim:** To prospectively evaluate the mortality and complication incidences after PEG insertion or replacement.

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**Keywords:**  
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**Methods:** All patients who underwent PEG insertion or replacement were included. Details on patient characteristics, ongoing therapies, comorbidities, and indication for PEG placement/replacement were collected, along with informed consent form signatures. Early and late (30-day) complications and mortality were assessed.

**Results:** 950 patients (47.1% male) were enrolled in 25 centers in Lombardy, a region of Northern Italy. Patient mean age was 73 years. 69.5% of patients had ASA status 3 or 4. First PEG placement was performed in 594 patients. Complication and mortality incidences were 4.8% and 5.2%, respectively. The most frequent complication was infection (50%), followed by bleeding (32.1%), tube dislodgment (14.3%), and buried bumper syndrome (3.6%). At multivariable analysis, age (OR 1.08 per 1-year increase, 95% CI, 1.0–1.16,  $p=0.010$ ) and BMI (OR 0.86 per 1-point increase, 95% CI, 0.77–0.96,  $p=0.014$ ) were factors associated with mortality.

PEG replacement was carried out in 356 patients. Thirty-day mortality was 1.8%, while complications occurred in 1.7% of patients.

**Conclusions:** Our data confirm that PEG placement is a safe procedure. Mortality was not related to the procedure itself, confirming that careful patient selection is warranted.

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## 1. Introduction

Enteral nutrition is the preferred route of feeding over parenteral nutrition for patients who require nutrition support therapy [1]. It can be administered using a nasogastric tube or via gastrostomy. If enteral nutrition needs to be provided for more than 6 weeks, a stoma is recommended. The gastrostomy can be performed surgically or percutaneously, the latter being considered the method of choice. Percutaneous gastrostomy can be achieved via interventional radiology or endoscopy. Although current data are insufficient to recommend one technique over the other [2], the endoscopic procedure is more commonly used [3]. The first percutaneous endoscopic gastrostomy (PEG) was described by Gauderer in 1980 [4]. The technical feasibility of PEG placement is very high, with an overall success rate between 95% and 100% [5]. Despite the long experience with this minimally invasive technique, mortality and complications are frequent.

The early or immediate PEG procedure-related mortality incidence is only 0–2%, whereas the 30-day mortality incidence is 2.4%–6.5% [6–8], and procedure-related complications have a high incidence, ranging between 12%–38% [9]. However, these data are mostly taken from retrospective studies and there is a general dearth of results regarding Italian settings.

Moreover, the factors that influence PEG use are not only patient-related, but broader aspects external to the patients are important for making the decision [10,11]. Of these, the characteristics and organizational aspects of nursing homes play a significant role in the decision-making process.

Therefore, PEG placement should be carefully considered, and the identification of all the risk factors for complications and short-term mortality is crucial.

The aim of this prospective multicenter observational cohort study was to evaluate the incidence and risk factors of mortality and complications in patients who underwent PEG placement or replacement.

## 2. Methods

### 2.1. Patients and study design

This multicenter prospective cohort study was conducted in 25 centers in the Lombardy region of northern Italy. The study included adult patients (age  $>$  or  $=$  18 years), both inpatients and outpatients, scheduled for PEG placement or replacement for any indication between 15th September 2015 and 15th September 2016. Exclusion criteria were 1) contraindication for

PEG placement/replacement, 2) inability or unwillingness to provide informed consent.

### 2.2. Study protocol and data recording

According to the non-interventional design of the study, no specified protocol for PEG placement/replacement was adopted. Also, the choice of device was at the discretion of the team that performed the procedure.

Relevant information was collected for each enrolled patient. Demographic, clinical, laboratory, and detailed procedural data, including informed consent form signatures, were collected and entered into a web-based electronic platform. During the post-procedural month, the occurrence of complications or death was assessed by trained nurses or medical doctors. The occurrence of the following complications was recorded: buried bumper syndrome, bleeding, infection, peristomal leakage, and tube dislodgement.

### 2.3. Study objectives and outcomes

The objectives of this study were to assess the incidence of early mortality and early complications, to evaluate the related risk factors, and to describe PEG placement or replacement in terms of indications and procedures.

The primary outcome was the incidence of 30-day mortality, defined as death occurring for any cause within 30 days from PEG placement or replacement.

The secondary outcome was the incidence of complications occurring within 30 days after PEG placement or replacement.

### 2.4. Ethical procedures

The study was approved by an independent Ethics Committee (Comitato Etico Indipendente, Humanitas Research Hospital – IRCCS, Rozzano, Italy) and subsequently by the Ethics Committees of all centers involved in the study.

The study was performed in accordance with the relevant guidelines and the Declaration of Helsinki.

All patients, or their representatives (legal guardian or next of kin, when indicated) provided written informed consent after receiving written and oral information about the study.

This was a no-profit study and the PEG manufacturers were not involved in the study.

**Table 1**  
Patient baseline characteristics.

Variables	All patients (n = 950)	PEG placement (n = 594)	PEG replacement (n = 356)
Age [mean (SD)], years	72.7 (16.0)	72.9 (15.5)	73.3 (16.8)
Gender [n (%)]			
Male	447 (47.1%)	307 (51.7%)	140 (39.3%)
Female	503 (52.9%)	287 (48.3%)	216 (60.7%)
BMI, kg/m <sup>2</sup> [mean (SD)]	22.1 (4.2)	22.2 (4.5)	21.8 (3.5)
ASA class [n (%)]			
1	38 (4.0%)	23 (3.9%)	15 (4.4%)
2	240 (25.3%)	141 (23.7%)	99 (28.8%)
3	533 (56.1%)	319 (53.7%)	214 (62.2%)
4	127 (13.4%)	111 (18.7%)	16 (4.7%)
Comorbidities [n (%)]			
Cardiovascular	395 (41.8%)	256 (43.1%)	139 (39.6%)
Oncologic	133 (14.1%)	107 (18.1%)	26 (7.4%)
Diabetes	97 (10.3%)	63 (10.4%)	34 (9.7%)
Neurologic	660 (69.7%)	384 (64.6%)	276 (78.6%)
Other	251 (26.6%)	163 (27.4%)	88 (25.1%)
Previous respiratory aspiration [n (%)]			
Yes	300 (31.8%)	149 (25.1%)	151 (43.1%)
No	644 (68.2%)	445 (74.9%)	199 (56.9%)
Recent admission to intensive care unit [n (%)]			
Yes	142 (14.9%)	477 (80.3%)	25 (7.2%)
No	798 (84.0%)	117 (19.7%)	321 (92.8%)
Previous abdominal surgery [n (%)]			
Yes	181 (19.1%)	131 (22.1%)	50 (14.2%)
Laparotomic	162 (89.5%)	115 (87.8%)	47 (94.0%)
Laparoscopic	19 (10.5%)	16 (12.2%)	3 (6.0%)
No	763 (80.3%)	462 (77.9%)	301 (85.8%)
Therapy [n (%)]			
Antiplatelet	242 (25.5%)	146 (24.6%)	96 (27.0%)
Anticoagulant	361 (38.0%)	266 (44.8%)	95 (26.7%)
Antibiotics	493 (51.9%)	443 (74.7%)	50 (14.2%)
Hospitalization [n (%)]			
Inpatient	410 (43.2%)	378 (63.6%)	32 (9.1%)
Outpatient	536 (56.4%)	216 (36.4%)	320 (90.9%)
Nursing home	329 (61.4%)	134 (62.0%)	195 (60.9%)
Home	171 (31.9%)	48 (22.2%)	123 (38.4%)
Other hospitals	36 (6.7%)	34 (15.7%)	2 (0.6%)

### 2.5. Sample size and statistical analysis

Categorical data are presented as proportions and percentage, whereas continuous data are reported as mean and standard deviation (SD).

Fisher's exact test or chi-square test and t-test were used to compare categorical outcomes and continuous variables, respectively.

To evaluate factors associated with mortality and complications, logistic regression models were applied. In the model we considered the following variables: age, gender, albumin value, international normalized ratio (INR), previous abdominal surgery, body mass index (BMI), broncoaspiration episodes, and hospitalization in the intensive care unit.

Due to the reduced number of events for both outcomes, in the multivariable models we first included factors with p-value <0.30 at the univariable analysis. Then a backward selection of included variables was performed, removing factors with p-value >0.10. The effects were reported with odds ratio (OR) with 95% confidence interval (CI).

All statistical tests were two-sided. Analyses were performed using Stata software, version 15 (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP).

## 3. RESULTS

### 3.1. Patients

A total of 950 patients undergoing PEG placement or PEG replacement were enrolled in the study (demographic details and clinical features in Table 1 and laboratory values in Table 2). There

was no prevalence in gender, and median age was 73 years. About half of the patients were outpatients, and the majority of them were from nursing homes (61.4%). Almost 70% of the patients had ASA status 3 or 4.

The most common indication was dysphagia due to stroke, followed by neurological disease, dementia, cancer, and organizational aspects of nursing homes. The majority of procedures were performed electively, and the most frequent applicants were internal doctors (36%) and nursing homes (33.4%) [Table 3]. Most of the enteral feeding was implemented by gastroenterologist (29.5%), nutritionist (24.3%), and internist (13.1%). Only 35.5% of procedures had a pre-procedure evaluation by a gastroenterologist. Informed consent was signed by the next of kin (not legal guardian) in more than 50% of procedures.

Less than 4% of the procedures were interrupted or uncompleted.

At follow-up, complications occurred in 34 patients (3.63%, CI 95%, 2.5%–5%), and the majority occurred within 7 days following the procedure. Twenty patients (2.93%, 95% CI, 1.8%–4.4%) died during the 30 days of follow-up.

#### 3.1.1. PEG placement

First PEG placement was performed in 594 (62.5%) patients [Tables 1 and 2]. The indications were: dysphagia due to stroke in 33.0%, neurological disease in 22.1%, cancer in 17.8%, dementia in 14.3%, and patient management in nursing home in 9.9% [Table 3]. PEG placement was performed as an elective procedure in 96.3% of patients, and the internal doctor and family doctor were the most frequent medical doctors requesting the procedure (96.6%). The informed consent form was signed by a relative (without legal

**Table 2**  
Laboratory tests.

Value, mean (SD)	All patients (n=950)	PEG placement (n=594)	PEG replacement (n=356)
WBC, $\times 10^3/\text{mm}^3$	8.615 (5.4)	9.0 (5.6)	7.5 (5.1)
Hemoglobin, g/dl	11.7 (2.1)	11.4 (2.1)	12.7 (1.7)
Platelet, $\times 10^3/\text{mm}^3$	278.6 (104.5)	290.2 (110.3)	248.2 (80.0)
C reactive protein	9.9 (19.0)	12.2 (21.0)	3.5 (8.9)
Albumin, g/l	3.3 (0.8)	3.3 (0.9)	3.4 (0.5)
Urea, g/l	42.7 (35.9)	43.8 (39.0)	39.1 (22.7)
INR	1.1 (0.5)	1.1 (0.6)	1.2 (0.2)

**Table 3**  
Procedure characteristics.

Variables	All patients (n=950)	PEG placement (n=594)	PEG replacement (n=356)
Indication	n (%)		
Dementia	133 (14.2%)	85 (14.3%)	48 (13.9%)
Stroke	326 (34.7%)	196 (33.0%)	130 (37.7%)
Requested by nursing homes	93 (9.9%)	52 (8.8%)	41 (11.9%)
Head or neck cancers	99 (10.5%)	85 (14.3%)	14 (4.1%)
Other cancer site	25 (2.7%)	21 (3.5%)	4 (1.2%)
Neurological disease	216 (23.0%)	131 (22.1%)	85 (24.6%)
Gastric decompression	1 (0.1%)	1 (0.2%)	0
Therapy administration	22 (2.3%)	9 (1.5%)	13 (2.9%)
Amyotrophic lateral sclerosis	24 (2.6%)	14 (2.4%)	10 (2.9%)
Type of procedure	n (%)		
Elective	864 (91.1%)	572 (96.3%)	292 (82.5%)
Urgent	84 (8.9%)	22 (3.7%)	62 (17.5%)
Requested by	n (%)		
Surgeon	78 (8.2%)	70 (11.8%)	8 (2.3%)
Family doctor	139 (14.7%)	287 (48.3%)	97 (27.6%)
Nursing home	316 (33.4%)	0	190 (54.0%)
Intensivist	59 (6.2%)	59 (9.9%)	0
Palliative doctor	13 (1.4%)	10 (1.7%)	3 (0.9%)
Internal doctor	341 (36.0%)	287 (48.3%)	54 (15.3%)
Gastroenterologist	54	39 (13.6%)	15
Geriatrician	24	19 (6.6%)	6
Internist	121	98 (34.1%)	23
Neurologist	110	99 (34.5%)	11
Oncologist	12	32 (11.2%)	0
Enteral feeding activated by	n (%)		
Surgeon	29 (3.1%)	26 (4.4%)	3 (0.9%)
Gastroenterologist	277 (29.5%)	93 (15.7%)	184 (53.2%)
Geriatrician	164 (17.4%)	94 (15.8%)	70 (20.2%)
Internist	123 (13.1%)	90 (15.2%)	33 (9.5%)
Neurologist	62 (6.6%)	50 (8.4%)	12 (3.5%)
Oncologist	7 (0.7%)	6 (1.0%)	1 (0.3%)
Intensivist	30 (3.2%)	30 (5.1%)	0
Palliative doctor	20 (2.1%)	15 (2.5%)	5 (1.4%)
Nutritionist	228 (24.3%)	190 (32.0%)	38 (11.0%)
Preprocedural gastroenterologist evaluation	n (%)		
No	607 (64.5%)	316 (53.2%)	291 (83.9%)
Yes	334 (35.5%)	278 (46.9%)	56 (16.1%)
Days between request and execution [mean(SD)]	14.7 (8.5)	6.5 (6.2)	4.6 (4.2)
Informed consent signed by	n (%)		
Chief Medical Officer	58 (6.2%)	36 (6.1%)	22 (6.4%)
Next of kin (not legal guardian)	529 (56.6%)	298 (50.3%)	231 (67.5%)
Patient	201 (21.5%)	165 (27.8%)	36 (10.5%)
Legal guardian (not related)	147 (15.7%)	94 (15.9%)	53 (15.5%)
Location of procedure	n (%)		
Patient's home	1 (0.1%)	0	1 (0.3%)
Endoscopic room	851 (89.7%)	521 (87.7%)	330 (93.0%)
ER	14 (1.5%)	0	14 (3.9%)
Ward	13 (1.4%)	3 (0.5%)	10 (2.8%)
Intensive care unit	51 (5.4%)	51 (8.6%)	0
Operation room	19 (2.0%)	19 (3.2%)	0
Duration of procedure [mean(SD)], minutes	14.7 (8.5)	16.1 (8.8)	12.3 (7.5)
Team			
Number of endoscopists	n (%)		
1	381 (40.1%)	72 (12.1%)	309 (86.8%)
2	567 (59.7%)	520 (87.5%)	2 (13.2%)
3	2 (0.2%)	2 (0.3%)	0

Table 3 (Continued)

Variables	All patients (n = 950)	PEG placement (n = 594)	PEG replacement (n = 356)
[mean(SD)]	1.6 (0.5)	1.9 (0.3)	1.1 (0.3)
Number of surgeons	n (%)		
1	61 (6.4%)	52 (8.8%)	9 (2.6%)
2	13 (1.4%)	12 (2.0%)	1 (0.3%)
[mean(SD)]	0.1 (0.3)	0.1 (0.4)	0.03 (0.2)
Number of nurses	n (%)		
0	18 (1.9%)	3 (0.5%)	15 (97.1%)
1	284 (29.9%)	149 (25.1%)	1 (2.6%)
2	615 (64.7%)	416 (70.0%)	2 (0.3%)
3	29 (3.1%)	23 (3.9%)	0
4	2 (0.2%)	2 (0.3%)	0
5	2 (0.2%)	1 (0.2%)	0
[mean(SD)]	1.7 (0.6)	1.8 (0.5)	1.6 (0.6)
Anesthesiologist	n (%)		
Yes	314 (33.2%)	292 (49.2%)	329 (93.7%)
No	631 (66.8%)	302 (50.8%)	22 (6.3%)
Type of anesthesia	n (%)		
Sedation analgesia	444 (47.5%)	410 (69.0%)	34 (10.0%)
General anesthesia	124 (13.3)	117 (19.7%)	7 (2.1%)
Local anesthesia	366 (39.2%)	67 (11.3%)	299 (87.9%)
PEG diameter [mean(SD)]	18.9 (4.4)	18.5 (5.3)	19.5 (2.0)
Procedure completed	n (%)		
Yes	918 (96.7%)	566 (95.4%)	352 (98.9%)
No	31 (3.3%)	27 (4.5%)	4 (1.1%)
Cardiopulmonary event	1 (3.2%)	1 (3.7%)	0
Absence of transillumination	18 (58.1%)	17 (63.0%)	1 (0.3%)
Transillumination in wrong position	2 (6.4%)	2 (7.3%)	0
Gastric benign ulcer	1 (3.2%)	1 (3.7%)	0
Gastric neoplasia	1 (3.2%)	1 (3.7%)	0
Esophageal stenosis	5 (16.1%)	5 (18.5%)	0
Fistula of previous PEG	3 (9.7%)	0	3 (0.8%)

Table 4  
Complications.

Complications	All patients (n = 950) N (%)	PEG placement (n = 594) N (%)	PEG replacement (n = 356) N (%)
No	902 (96.4%)	557 (95.2%)	345 (98.3%)
Yes	34 (3.6%)	28 (4.8%)	6 (1.7%)
Buried bumper syndrome	1 (2.9%)	1 (3.6%)	0
Bleeding	10 (29.4)	9 (32.1%)	1 (16.7%)
Infection	14 (41.2%)	14 (50.0%)	0
Leakage	2 (5.9%)	0	2 (33.3%)
Tube dislodgment	7 (20.6)	4 (14.3%)	3 (50.0%)
Timing			
Periprocedural	5 (14.7%)	5 (17.9%)	0
Within 7 days after procedure	17 (50.0%)	16 (57.1%)	1 (16.7%)
Between 8 and 30 days after procedure	12 (35.3%)	7 (25.0%)	5 (83.3%)
Death at 30 <sup>th</sup> day	37 (4.4%)	31 (5.2%)	6 (1.8%)

guardianship) in 50.3%, patient in 27.2%, legal guardian in 15.9%, and chief medical officer in 6.1% of patients. An anesthetist was present in less than half of the procedures (49.2%), and sedation plus analgesia was the most common modality for anesthesia (69.0%). The procedure was completed in 95.4% of cases. In 27 patients, the procedure was uncompleted due to absence of transillumination in the majority of cases (63.0%). The complication rate was 4.8% [Table 4]. The most frequent complication was infection (50%), followed by bleeding (32.1%), tube dislodgment (14.3%) and buried bumper syndrome (3.6%).

The occurrence of infectious complications was not affected by the presence of antibiotic therapy: the rate of infection was 2.7% in patients with antibiotic therapy and 1.3% in patients without antibiotic therapy ( $p = 0.5$ ).

### 3.1.2. PEG replacement

During the study period, 356 patients underwent PEG replacement (37.5%), with a mean age of 73.3 years and a prevalence of

female gender (60.7%) [Tables 1 and 2]. Most of them were outpatients (from home or nursing home). More than 80% of PEGs were replaced percutaneously. The indication was tube deterioration in 44.1% of patients, scheduled replacement in 25.1%, inadvertent PEG removal in 14.4%, malfunction in 7.6%, PEG dislodgment in 7.6%, and tube blockage in 1.2% [Table 5].

## 3.2. Mortality

### 3.2.1. First PEG placement

The mortality incidence of first PEG placement was 5.2% (N = 31 patients; 95% CI, 2.3%–6.8%). All deaths were unrelated to the procedure and/or complications. The causes of death for those patients were possible cardiac arrest (7 cases) and aggravation of previous disease (24 cases).

Mortality after first PEG placement was not related to patient's setting, ASA status, or procedure location [Table 6].

**Table 5**  
PEG replacement: indications and methods.

Indication	N (%)
Deterioration	156 (44.1%)
Malfunction	27 (7.6%)
Tube blockage	4 (1.2%)
Inadvertent PEG removal	51 (14.4%)
Scheduled replacement	89 (25.1%)
PEG dislodgment	27 (7.6%)
Method	N (%)
Percutaneous replacement of PEG tube	319 (89.6%)
Endoscopic insertion of PEG tube	37 (10.4%)

At multivariable analysis [Table 7], the risk of 30-day mortality increased with age (OR 1.08 for 1-year increase, 95% CI, 1.02–1.16,  $p=0.010$ ) and INR (OR 6.02, 95% CI, 1.54–23.5,  $p=0.010$ ), whereas it decreased with lower BMI (OR 0.86 for 1-point increase, 95% CI, 0.77–0.96,  $p=0.014$ ) and albumin value (OR 0.38, 95% CI, 0.14–1.08,  $p=0.070$ ).

### 3.2.2. PEG replacement

The 30-day mortality incidence after PEG replacement was 1.8% (N=6 patients, 95% CI, 0.5%–3.5%) and most of them occurred after the 7th day following the procedure (83.3%). All deaths were unrelated to the procedure and/or complications but were due to aggravation of previous disease. The mortality rate was not different according to ASA status or patient's setting [Table 6].

The multivariable logistic regression model was not applied due to the low number of deaths in this subgroup.

### 3.3. Complications

#### 3.3.1. First PEG placement

In this subgroup, complications occurred in 28 patients (4.79%, 95% CI, 3.2%–6.8%, Table 4). Occurrence of complications after first PEG placement was not related to patient's setting, ASA status, or procedure location [Table 6].

At multivariable analysis [Table 8], factors associated with complications after PEG placement were neurological disease (OR 0.23, 95% CI, 0.02–0.60,  $p=0.003$ ) and absence of bed rest (OR 0.40, 95% CI, 0.17–0.93,  $p=0.034$ ).

Moreover, the risk of developing complications increased with INR (OR 6.92, 95% CI, 1.53–31.1,  $p=0.012$ ), whereas it decreased with hemoglobin (OR 0.49, 95% CI, 0.22–1.10,  $p=0.087$ ) and albumin value (OR 0.25, 95% CI, 0.06–0.98,  $p=0.047$ ).

**Table 6**

Complications and mortality stratified according to patient setting, ASA status, location of procedure for patients undergoing PEG placement (a) and PEG replacement (b).

(a) PEG placement (n = 594)		Complications 28 (4.8%)	p Value	Death at 30 <sup>th</sup> day 31 (5.2%)	p Value
ASA Status	ASA 1, 23 (3.9%)	0	0.10	0	0.51
	ASA 2, 141 (23.7%)	9		5	
	ASA 3, 319 (53.7%)	18		21	
	ASA 4, 111 (18.7%)	1		5	
Inpatient, 378 (63.6%)		22	0.10	21	0.57
PEG performed in the intensive care unit or operating room, 70 (11.8%)			0.13	7	0.08
(b) PEG replacement (n = 356)		Complications 6 (1.7%)	p Value	Death at 30 <sup>th</sup> day 6 (1.8%)	p Value
ASA Status	ASA 1, 15 (4.4%)	0	0.28	1	0.447
	ASA 2, 99 (28.8%)	0		2	
	ASA 3, 214 (62.2%)	6		3	
	ASA 4, 16 (4.7%)	0		0	
Inpatients, 32 (9.1%)		2	0.09	2	0.082

**Table 7**

Multivariable logistic regression model for 30-day mortality. Results from a backward selection procedure with  $p>0.1$  for removal.

Outcome: mortality		
Variables	Adjusted odds ratio (95% CI)	Adjusted p value
Age	1.08 (1.02–1.16)	0.010
Body mass index	0.86 (0.77–0.96)	0.014
Albumin value	0.38 (0.14–1.08)	0.070
International normalized ratio	6.02 (1.54–23.5)	0.010

**Table 8**

Multivariable logistic regression model for 30-day complication incidence. Results from a backward selection procedure with  $p>0.1$  for removal.

Outcome: complications		
Variables	Adjusted odds ratio (95% CI)	p Value
Bedbound	0.40 (0.17–0.93)	0.034
Neurological disease	0.23 (0.02–0.60)	0.003
Albumin value	0.25 (0.06–0.98)	0.047
International normalized ratio	6.92 (1.53–31.1)	0.012
Hemoglobin value	0.49 (0.22–1.10)	0.087

### 3.3.2. PEG replacement

Complications after PEG replacement occurred in 6 patients (1.7%, 95% CI, 0.6–3.6%). The most frequent complication was tube dislodgment (N=3; 50.0%), followed by leakage (N=2; 33.3%) and bleeding (N=1; 16.7%). The complication rate was not different according to ASA status or patient's setting [Table 6].

The multivariable logistic regression model was not applied due to the low number of complications in this subgroup.

## 4. Discussion

Percutaneous endoscopic gastrostomy (PEG) is the preferred modality for enteral nutrition in patients requiring prolonged feeding support.

The first aim of this multicenter prospective study was to evaluate the incidence of complications and early mortality in PEG placement or replacement in Lombardy.

First PEG placement was performed in 594 patients. The mortality incidence was 4.8% in the 30 days following the procedure. At multivariable analysis, the risk of 30-day mortality was associated with age (OR 1.08), BMI (OR 0.86), albumin value (OR 0.38), and INR (OR 6.02). Other studies have shown similar results in terms of incidence of mortality and predictor variables [6,8,12–14]. Differently, we did not find significant associations with other variables such as C-reactive protein (CRP) and diabetes described as predictors of mortality in previous studies [6,8,12,15]. All deaths were unrelated

to the procedure and/or complications, so the procedure variables were not associated with mortality.

The complication incidence after first PEG placement was 4.8%. The most frequent complication was infection (2.4%), followed by bleeding (1.5%), tube dislodgment (0.7%), and buried bumper syndrome (0.2%). These frequency rates matched those reported in an article by Richter-Schrag et al. [7], which included prospectively 1041 patients who underwent PEG placement. Also, in our sample of patients, complications occurred mainly in the first 7 days, therefore we agree with the strong recommendation that a daily clinical assessment should be performed by a trained member of the team during the first week after the procedure.

In this cohort of patients, we also included and followed up patients who underwent PEG replacement ( $n = 356$ ). Removal and replacement of the PEG tube is necessary to prevent or treat tube malfunctions. Generally, it can be performed either percutaneously or via the endoscopic route. In our series, more than 89% of procedures were percutaneous, and scheduled replacement was the indication for replacement in 25% of patients. The procedure had a low incidence of complications and mortality, both less than 2%. In the literature, higher complication incidences have been described ( $>4\%$ ), probably due to the retrospective design of the studies and to the small sample sizes [16,17]. Based on the results of our study, its prospective design and the number of patients enrolled, we consider PEG replacement to be a very low-risk procedure and we would propose modifying the setting where the procedure is performed. In this study, most PEG replacements were performed in the endoscopic room, which entails a high cost for the community. Considering the technical feasibility and the very low complication rate of the procedure, we believe that, at least in selected cases, the PEG replacement could be performed at the patient's home or in the nursing home, avoiding the need for patient transportation. Alternatively, we could consider organizing a training program for the nurses who take care of these kinds of patients. Differently, first PEG placement requires aseptic care and sterile instruments, so it should be necessarily performed in a hospital setting, also in order to be able to promptly manage any eventual complications.

The second aim of this study was to characterize the organizational factors of the procedure in a large Italian region. We found several organizational characteristics that had never been described before in an Italian setting. First, less than 50% of PEG placements had a gastroenterological evaluation prior to the procedure. This evaluation should be strongly advised, considering that the requests for PEG placement come from very different professionals (from family doctor to intensivist) and the indications are not uniformly shared. Regarding the indication for first PEG placement, the need for easier management of feeding for nursing home patients was the main criterion in 10% of patients. This figure is higher than expected, showing a widespread custom in our region of considering logistical factors more than clinical factors. We believe that the decision regarding PEG use should take into account its potential benefits and risks, as well as the patient's medical condition, and the gastroenterologist should be involved in the decision from the outset. Several studies have confirmed that artificial nutrition and hydration (ANH) can improve survival in multiple clinical settings, such as permanent vegetative state, stroke or head injury, or with advanced cancer [11]. At the same time, ANH in general and PEG placement in particular carry a considerable risk of complications. Therefore, organizational and logistical reasons should not enter into the decision-making process about ANH, or they should be considered at the very end of the process. A careful pre-procedure evaluation is important, also because mortality is not related to the procedure itself but depends on the patient's status, and the gastroenterologist could help to avoid unwarranted (and risky) interventions. Secondly, the procedure itself was performed in different ways: the number of medical

doctors and nurses, the presence of an anesthesiologist, and the type of sedation/analgesia varied between the hospitals included in the study. Moreover, our data showed that the informed consent form was signed by a relative (without legal guardianship) in more than half of first PEG placements. Considering the risks of the procedure, the absence of guidelines, and the logistical indications, the legal aspects should be more carefully evaluated. Although pre-procedural gastroenterologist evaluation is not correlated with a lower rate of complications or mortality, we believe a preliminary gastroenterologist evaluation should be considered as the first step of the procedure. During this evaluation, the patient or his/her caregiver could be more thoroughly informed about the benefits and complications, after which the patient/caregiver could give a true informed consent for the procedure. At the same time, the patient could be evaluated by the practitioner will perform the procedure before the procedure is scheduled.

The third aspect that is important to underscore is the time between the request and the execution of the procedure. In our study, the mean time was 6.5 days for first PEG placement and 4.6 days for PEG replacement. For both, the wait time seems too long, because it increases the length of patient hospitalization and the consequent risk of infection, but also the cost for the National Health System.

The present study has some limitations. First, according to the non-interventional design of the study, no specified protocol for PEG placement/replacement was adopted. Moreover, we did not collect information on the location of the internal bolster of the PEG tube or the level of the operator's experience, both variables that were associated with complications in a recent paper by Lee et al. [18]. Consequently, the value of the comparison of the data could be hampered by these limitations. Secondly, we had 11.3% of incomplete data, which partially reduced the effectiveness of the study, also introducing a possible (though likely limited) selection bias. A third limitation is the lack of data regarding the management of complications and how this could affect the length of hospitalization.

Nevertheless, the strengths of our study are the prospective design with a high patient number and the high number of variables collected regarding the patients and the procedures. Moreover, the organizational and logistical aspects of PEG placement/replacement were collected for the first time in an Italian setting.

## 5. Conclusions

Our data confirm that PEG placement and replacement are safe procedures, and 30-day mortality was unrelated to the procedure and/or complications, depending on the patient's general status. However, the present study underscored the importance of organizational factors associated with the procedure, in addition to the clinical features, in a large northern Italian region. Therefore, further data regarding this feature should be collected and analyzed in a national prospective survey in order to improve the clinical and the organizational aspects of the procedure.

## Conflict of interest

None declared.

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