

Moving Beyond Blind Nasogastric Tube Insertion: A Narrative Review of Assisted Techniques and Their Clinical Role

Calvin Constantine Yang¹, Juan Farrel Wongso¹,
Ave Zangkila Langit¹, Eka Arum Cahyaning Putri^{2*}

¹Medical Undergraduate Programme, Faculty of Medicine,
Universitas Airlangga, Jl Prof. Dr. Moestopo 47 Surabaya, East Java, Indonesia

²Department of Physiology and Biochemistry,
Universitas Airlangga, Jl Prof. Dr. Moestopo 47 Surabaya, East Java, Indonesia

E-mail: calvin.constantine.yang-2023@fk.unair.ac.id;
juan.farrel.wongso-2023@fk.unair.ac.id; ave.zangkila.langit-2023@fk.unair.ac.id

*Corresponding author details: Eka Arum Cahyaning Putri; eka-arum-cp@fk.unair.ac.id

ABSTRACT

Nasogastric tube (NGT) insertion is a common bedside procedure, yet conventional blind placement confirms tube position only after insertion, when misplacement may already have caused harm. Assisted techniques that guide the tube during insertion have emerged, but evidence comparing them with blind placement remains fragmented. This review compares blind insertion with optical, electromagnetic, imaging-guided and endoscopy-guided insertion in terms of placement success, insertion and confirmation time, respiratory misplacement, local trauma, post-pyloric access and practical feasibility. Clinical studies, systematic reviews and guidelines were reviewed narratively. Blind insertion relies on the inaccurate nose-earlobe-xiphoid estimate. In anaesthetized patients, it achieves first-attempt success of only 56.7–82.7%, and it carries airway misplacement in 1.9–2.9% and in-procedure pneumothorax in 0.52% of placements. Assisted techniques detected airway entry in real time, with zero or near-zero unrecognized respiratory misplacement. Optical, ultrasound, fluoroscopic, and endoscopic guidance achieved 94–99% placement success. Electromagnetic guidance matched blind gastric placement (63.1% vs 65.5%) but had no airway misplacement. Assisted methods shortened confirmation time, reduced repeated attempts, and clearly outperformed blind insertion for post-pyloric placement. Their limitations include cost, training needs, operator dependence, and, for fluoroscopy and endoscopy, radiation, sedation, and patient transport. Most evidence comes from small, single-center studies. Blind insertion remains reasonable for low-risk, cooperative patients. Assisted techniques should be prioritized for patients with impaired airway reflexes, contraindications to blind passage, previous failed attempts, or a need for post-pyloric feeding, with the modality chosen according to the clinical situation and local resources.

Keywords: assisted tube insertion; blind insertion; nasogastric tube

INTRODUCTION

Nasogastric feeding tube (NGT) placement is one of the most common yet invasive procedures, with approximately 10 million NGT placements being done in Europe annually [1]. NGT serves three main purposes: enteral feeding to provide nutrition, a route for medication administration, and gastric decompression. These are used across all age groups, including adults, elderly, children, and neonates, both in acute and chronic care [2,3]. While some case reports show that it is safe to be used for the long term, many guidelines recommend using NGT for a maximum of 4-6 weeks before changing to a gastrostomy [4].

The conventional NGT placement technique is usually blind, relying only on external landmarks as an estimate rather than direct visualization. The operator advances the NGT through the nasal cavity, nasopharynx, pharynx, into the esophagus, and ends in the stomach without any real-time visualization [5,6,7]. This technique also depends on clinical cues, a mild resistance near the posterior nasopharynx, indicating that the patient needs to swallow to help it go through into the esophagus. In a conscious patient, a sip of water encourages them to help swallow the tube. In a sedated/unconscious patient, the absence of airway reflexes and patient feedback makes it more dangerous, as the operator loses the clinical cues to guide them [8,9].

To address these risks, several assisted NGT placement techniques have appeared to help guide the operator during insertion. They provide direct visualization to the operator rather than relying on tactile feedback and external landmark estimation [9]. This includes optical/light-guided, electromagnetic-assisted, imaging-guided, and endoscopy-guided insertion. While each technique reduces misplacement risks caused by conventional insertion, it differs in training needs and clinical settings [8,10,11,12].

Evidence comparing conventional and assisted NGT insertion techniques is scattered diversely, across many clinical settings, both in conscious and sedated/unconscious patients. Most studies are small and single-centered, comparing only single assisted devices to the conventional blind method. Therefore, this review aims to compare the new assisted-NGT insertions with the conventional technique on placement success, insertion time, misplacement and complications, local trauma during insertion, post-pyloric access, and use in clinical settings.

Blind Nasogastric Tube Insertion and Its Limitations

Nasogastric tube (NGT) insertion is among the most frequently performed bedside procedures in hospital practice. In its conventional form the tube is passed blindly: it is introduced through the nostril and advanced towards the stomach without direct visualisation of its path and without any guidance device. The operator depends on external anatomical landmarks to estimate how far the tube should be inserted, on the patient's swallowing to carry the tip into the oesophagus, and on the resistance felt by hand. Because no imaging or specialised equipment is required at the moment of insertion, the blind technique remains the default approach on general wards and in intensive care units. Its central weakness follows directly from the same feature. The position of the tube tip is established only after insertion is complete, so that a tube which has coiled, stopped short in the oesophagus or entered the airway is not recognised while the error is being made [13]. This section reviews the indications, contraindications and standard technique of conventional NGT insertion, the rates and mechanisms of failed placement, and the burden of complications attributable to the blind approach.

• Indications, contraindications, and standard technique

Blind NGT insertion is performed for enteral nutrition and medication administration, for gastric aspiration and decompression, and for diagnostic purposes [14]. Decompression of the stomach in the setting of ileus or small bowel obstruction is one of the most common indications, and a tube may also be placed in patients with intractable nausea or vomiting in order to reduce the risk of aspiration. Routine prophylactic placement in patients undergoing abdominal surgery, however, is not recommended [15,16]. The indication matters for the

present review because it determines how much harm a misplaced tube can do: a tube intended for decompression that lies in the wrong position fails to drain, whereas a tube intended for feeding delivers its contents to wherever the tip happens to be.

The most widely cited contraindication concerns the nasal route itself. In patients with a suspected or confirmed basal skull fracture, a tube advanced blindly through the nose may pass through the fracture into the cranial cavity. Spurrier and Johnston reviewed the literature on NGT use in trauma patients and found numerous case reports of intracranial placement, which was associated with patient death, although the causal relationship was not always clear [17]. For this reason, the Advanced Trauma Life Support protocol recommends that the tube be passed through the mouth, as an orogastric tube, in such patients. Oesophageal obstruction, for example by a neoplasm or a foreign body, is a further contraindication, and facial trauma, coagulopathy and altered mental status are recognised as factors that increase the risk of complications and should be assessed before the procedure [16,18].

The standard technique begins with an estimate of the insertion length. The method in most common use is the nose-earlobe-xiphoid (NEX) measurement, in which the tube is held against the patient and the distance from the tip of the nose to the earlobe and then down to the xiphoid process is taken as the length to be inserted. With the patient sitting upright, the lubricated tube is passed along the floor of the nose; when it reaches the oropharynx the patient is asked to swallow, and the tube is then advanced to the predetermined depth [18]. In anaesthetised and intubated patients, who cannot swallow on request, the conventional manoeuvre is head flexion combined with lateral pressure on the neck [19].

The evidence indicates that the NEX measurement is an unreliable guide to gastric placement. In a randomised controlled trial of 215 adult inpatients, Torsy (2018) compared NEX with a corrected formula, $(\text{NEX} \times 0.38696) + 30.37$ cm, using radiography to verify the tip position [20]. Both methods underestimated the required length in more than 20% of patients, and NEX additionally overestimated it in 17.2% compared with 4.8% for the corrected formula. The authors concluded that both methods carried a high risk of leaving the tip near the lower oesophageal sphincter or in the distal oesophagus. A subsequent systematic review of twelve studies identified ten different methods for determining insertion length and found that the proportion of correctly positioned tubes ranged from 13% to 99% [14]. The best-performing formulas, $\text{NEX} + 10$ cm and $(\text{NEX} \times 0.38696) + 30.37 + 6$ cm, achieved accuracy of up to 97.4% and 99.0%, respectively. Even so, the reviewers concluded that no method guarantees correct placement, that blind insertion cannot be considered safe without additional verification of the tip position, and that none of the measurement methods reduces the risk of the tube entering the lung.

• Success rate and mechanism of failure

Reported success rates for conventional insertion vary considerably, and most of the available figures come from anaesthetised and intubated surgical patients (Table 1). In the largest trial, involving 480 patients undergoing abdominal surgery, the conventional technique of head flexion with lateral neck pressure succeeded at the first attempt in only 56.7% of cases, compared with 99.2% when the tube

was passed over an oesophageal guidewire [19]. Hsieh (2017) reported a higher first-attempt success rate of 82.7% for blind insertion in 104 patients, with 29 misplacements across 130 insertion attempts [21]. Even where a laryngoscope was used to assist insertion, first-attempt success with a conventional Macintosh blade reached only 58.3% [22]. Taken together, these studies suggest that between roughly one in six and four in ten first attempts fail in this population.

TABLE 1: First-attempt success of conventional NGT insertion in anaesthetised, intubated adults.

Study	Design (n)	First-attempt success, conventional technique	Comparator technique
Kirtania et al. (2012) [19]	RCT (480)	56.7% (head flexion with lateral neck pressure)	99.2% with oesophageal guidewire and forward laryngeal displacement
Wan Ibadullah et al. (2016) [22]	RCT (96)	58.3% (Macintosh laryngoscope assistance)	74.5% with GlideScope video laryngoscope
Hsieh et al. (2017) [21]	Prospective observational (104)	82.7% (blind insertion)	None

RCT, randomised controlled trial.

The first mechanism of failure is mechanical. NGTs are made of soft, non-reinforced polymer and are therefore prone to coiling, in which the tube curls back on itself, and to kinking, in which it folds sharply and will not advance [19]. Wan Ibadullah (2016) found coiling to be the most common complication of insertion, followed by bleeding and kinking [22]. The site at which the tube goes astray is most often the mouth: of the 29 misplacements recorded by Hsieh (2017), 23 were in the oral cavity, three in the trachea, and three in the distal esophagus [21].

The second mechanism, entry into the airway, is less frequent but far more dangerous. Hsieh (2017) observed airway misplacement in 2.9% of surgical patients and concluded that it was not an uncommon event [21]. A similar figure emerges from critical care: in a retrospective analysis of 512 radiographs taken to check NGT position, 10% showed an incorrect position, including 2.2% in which the tube lay in the airway and 1.0% in which it was coiled in the proximal oesophagus [23]. Certain patients are especially vulnerable. In the review by Sparks (2011) [24], 60.4% of tracheobronchial malpositions occurred in mechanically ventilated patients, a finding the authors described as unexpected, and elderly patients with a diminished cough reflex and impaired communication are also at particular risk because the usual warning signs may be absent [25].

The third mechanism is placement that is too shallow. A tube whose tip lies near the lower oesophageal sphincter or in the distal oesophagus has not entered the airway and may escape notice, yet it increases the risk of reflux and pulmonary aspiration once feeding begins [20]. In the critical care series described above, 35 tubes were imaged in such a suboptimal position, and only 51% of these were subsequently advanced by the clinical team [23]. It should be noted that the success rates

summarised here derive largely from anaesthetised patients, in whom insertion is most difficult, and comparable data for awake patients are scarcer.

• Complication burden

The most serious complications of blind insertion arise when the tube enters the respiratory tract. Sparks (2011) [24] pooled five studies comprising 9,931 blind placements of narrow-bore nasoenteric tubes and identified 187 placements in the tracheobronchial tree, a mean malposition rate of 1.9%. Of these 187 misplacements, 35 (18.7%) resulted in pneumothorax, and at least five patients died. The risk was not confined to the first attempt, since malposition recurred in 13% to 32% of subsequent repositioning attempts. More recent data point in the same direction. Taylor (2024) [13] reported that 0.52% of tube placements led to pneumothorax during the procedure itself and that such events accounted for 97% of lung complications. This observation exposes a structural limitation of the conventional approach: checks of tube position by aspirate pH or radiography are performed after insertion and therefore detect a respiratory misplacement too late to prevent the injury that has already occurred.

When a misplaced tube goes unrecognised and is then used, the consequences are aspiration and direct instillation of fluid into the lung. Metheny and Meert (2017) [26] reviewed twelve published cases in which polyethylene glycol electrolyte solution was administered through an NGT without radiographic confirmation of its position; pulmonary complications contributed to the death of five of these patients. Matsuda et al. (2025) [25] described an 82-year-old woman in whom a replacement NGT entered the left lower lobe bronchus and penetrated the pleural cavity. Two tube feeds were delivered before respiratory failure was recognised, and she required

chest drainage and surgery for a fistulous empyema. Injury to the upper airway and oesophageal mucosa is more common and less severe: in the trial by Kirtania (2012) [19], nasal and pharyngeal bleeding and moderate injuries were significantly more frequent with the conventional technique than with guidewire-assisted insertion. Intracranial placement in patients with basal skull fracture, discussed above, completes the spectrum of harm [17].

The gravity of these outcomes is reflected in patient safety policy. In England, the administration of nutrition or medication into the lungs or pleura through a misplaced nasogastric feeding tube is classified as a never event, that is, a serious incident regarded as preventable when national guidance is followed [27]. Despite repeated national guidance, such events continue to be reported regularly, and a scoping review of 43 records and 22 hospital policies found large variation in how tube position is confirmed in practice [27]. A patient safety alert issued in 2016 identified 95 incidents between 2011 and 2016 in which a misplaced tube was used to administer fluids or medication, 32 of which resulted in death [28], and misinterpretation of the check radiograph has been identified as the leading cause of NGT-related never events [29]. Taylor (2024) [13] estimated the incidence of undetected respiratory misplacement at 0.013% and noted that it has been rising.

In summary, conventional blind insertion is simple to perform but offers the operator no information about where the tube is travelling. The length estimate on which it relies is frequently inaccurate, first-attempt failure is common, and a small but consistent proportion of tubes enter the airway, where they may cause pneumothorax before any verification step can intervene. These limitations provide the rationale for assisted techniques that guide or visualise the tube during insertion, which are considered in the following section.

Assisted Nasogastric Tube Insertion: Modalities and Evidence

Assisted NGT is any technique in which a device is utilized for the operator to acquire information about the position of the tube while it is being inserted. There are several devices that are often used to help insertion easier, including optical systems, which use a camera inside the tube to show the lumen, electromagnetic systems that track the tip and draw its path on a screen, ultrasound and fluoroscopy that visualize the tube outside the body, as well as endoscopy system visualizing under direct vision. All these modalities solve the same flaw in blind insertion: the tube is located only after the mistake has happened (Taylor, 2024) [13]. Blind NGT placement relies on external length estimates and tactile sensation, which do not guarantee a safe tube placement. Thus, assisted NGT is preferred when the patients are presented with contraindication criteria, usually hazardous or previous insertion failure. Contraindications in conventional NGT may be alleviated by the use of assisted NGT.

Contraindications and risk factors described earlier may be classified into three groups. First, the tube can pass through a basal skull fracture into the cranial cavity [17] as well as esophageal lumen pathologies, including obstruction, strictures, fistula, varices, or recent surgery that are highly vulnerable for perforation, entering a false tract, and bleeding; patients with these conditions are often excluded for conventional NGT placement [30]. Second, sedated, ventilated, comatose, and elderly patients do not have a proper cough reflex, so conventional tube complications may be masked [24,25]. Third, patients that have failed for insertion, assisted NGT may avoid further mucosal trauma [31].

These contraindications are important because each modality may only guard a certain indication. For instance, optical guidance and endoscopy are able to visualize real-time mucosa, so the operator can identify a lesion and avoid it. On the contrary, electromagnetic and ultrasound can only show the path of the tube, so they are useful to avoid false lumen and wrong final position without necessarily mucosa visualization. In a randomized trial of 80 patients with cirrhosis, feeding through a 14 Fr NGT begun one hour after endoscopic treatment of variceal bleeding did not increase rebleeding compared with oral sips [32].

- **Optical and light guidance**

Optical guidance puts a camera at the tube tip or inside a standard NGT (video probe), allowing the operator to see the mucosa while advancing. While camera-tipped feeding tubes (Kangaroo IRIS) carry a miniature camera and light source at the tip and send the image to the monitor [33], video probes are optical devices threaded inside a standard tube with the same principle as ordinary large-bore NGT [34]. This helps to visualize important anatomical landmarks, including the nasopharynx, vocal cord, tracheal rings, esophageal folds, gastric rugae, and pylorus as well as spotting whether the position is already correct or not.

IRIS tubes can reach the stomach in 96.8% of ICU patients [35], and a video-probe system succeeded in 96.7% of cases with a median of 3.8 minutes [34]. Tracheal insertion can be supported; furthermore, with 27-28% of cases were seen and then withdrawn safely before the carina [33].

This modality is highly preferred when the patient presents with a skull base fracture to have a direct vision of the nasal mucosa and to keep the tube within the lumen, bleeding or fragile mucosa to avoid bleeding polyps and mucosa and sedated and ventilated patients so to visualize the airway entry clearly [33,35]. This modality is highly safe in sedated patients because airway entry can be recognized visually rather than by symptoms [36].

However, several substances, including mucus, bile, and other bodily secretions may contribute to obscuring the view. Signal loss also may occur [34,35].

Post pyloric success varies, ranging from 58% to 75%, although one RCT reached 95.5% success rate during the first time compared to 69.6% blind group [37]. In addition, a case of pneumobilia and pancreatitis is reported and may be one of the complications [38]. Camera-tipped tubes are also single-use and costly, which keeps them out of routine use in resource-limited situations [39].

• **Electromagnetic-guided tubes (CORTAK)**

An electromagnetic-guided NGT utilizes an electromagnetic stylet in the tube to send a continuous signal to a receiver in the patient's chest, which draws the tip's path on screen in real time [40]. The operator then can watch the trajectory of the tube down the midline into the stomach or move off towards the bronchus.

According to Sakuramoto et al., 2026 [40], nurse-led electromagnetic insertion matched physician blind insertion for success (63.1% vs 65.5%), with no airway misplacements (vs 1.4% blind), fewer reinsertions, and shorter insertion time (3.3 vs 4.5 minutes). Gastric tube placement can be done successfully in 99.5% of cases with sufficient training [41]. Davis & Grandic (2026) [42] also reports a dietitian-led electromagnetic service produces no lung placement and cuts the confirmation radiographs by 20%. Meanwhile, according to another study, a resident-led placement eliminated feeding-tube pneumothorax at one hospital [43].

The operator may choose electromagnetic-guided tubes if the patient has an impaired breath reflex to avoid pleura injury [13]. The device is also portable, so the tubes can be inserted and checked bedside in ventilated, prone, or unstable patients [42]. Two systematic reviews further found success for post-pyloric feeding comparable to endoscopy at a lower cost, although it takes longer time, and discomfort has been reported [44,45].

Contrary to the video-guided tube, electromagnetic-guided NGT does not show mucosa appearance, so it poses a significant threat to patients having esophageal varices, stricture, or other bleeding-prone situations [10]. Safety depends on expertise; low-use centres had more undetected lung placements than expert centres [41,42].

• **Imaging-guided insertion: real-time ultrasound and fluoroscopy**

Real-time ultrasound shows the tube passing through the cervical oesophagus during insertion. A second view over the epigastricum can show the tube or injected fluid arriving in the stomach [11]. In an emergency-department RCT, 98.2% of ultrasound-guided tubes were gastric on X-ray, versus 86.6% with the conventional method, which also had one lung placement. It is bedside, radiation-free, and low-cost [11]. Since most of the emergency departments are equipped with ultrasound devices, this modality becomes more affordable and preferable when the radiograph is slow or unavailable [39].

Ultrasound is highly preferable when airway reflexes are impaired or when conventional x-ray is not available, as in the case of emergency or resource-limited settings. Unfortunately, the use of ultrasound is highly operator-dependent and requires expertise, thereby making visualization difficult, as in the case of one study in which the esophagus cannot be visualized in 3.4% of patients [11]. Ultrasound signals can be lost in the chest, therefore, there is a risk of unnoticed coiling in the thoracic esophagus. Additionally, several conditions, such as obesity, cervical collars, dressings, and bowel gas may reduce the quality of image sent to the monitor.

Meanwhile, fluoroscopy uses x-ray to guide the course of the tube to visualize the tube from the nose to stomach or even small bowel. A study conducted by Kolbeinsson (2022) [46] reports 94.3% successful insertion of prone patients with COVID-19-related respiratory failure and supine patients. Zhang (2024) [47] also reports the use of fluoroscopy-guided NGT in a disease or surgery that has altered the anatomy. This modality is also utilized to place nasogastric and nasogastric tube with thoracogastric airway fistula after esophagectomy and 100% success without complications [37]. Guided methods including fluoroscopy report about 93% success for post-pyloric placement, and fluoroscopy is a recommended alternative to blind insertion in safety guidelines. The modality may be used in case of anatomy distortion, strictures, or failure of bedside management. However, for this modality using x-ray, the patient may be exposed to a certain degree of radiation. In addition, it requires patient transport and radiology staff [46].

• **Endoscopy-guided insertion**

Endoscopic placement passes the tube under direct vision, usually over a guidewire, and is mainly used for post-pyloric feeding. In post-COVID ICU patients, endoscopic placement had higher success, shorter insertion time, less dislodgement, and less discomfort than blind bedside placement [12].

It can be chosen if the patients have esophageal fistula, strictures, or other luminal pathologist to visualize esophageal mucosa clearly, bleeding lesions or varices, or the necessity to diagnose and treat in the same session. Costa (2024) [48] uses endoscopy-guided tubes to place tubes in patients with esophageal fistulas without incident. Varices or bleeding can be identified and treated before the tube is passed beyond them, making it a reasonable alternative if safety is the goal [32]. It is highly preferred when anastomosis needs to be seen and protected.

It needs an endoscopist, sedation, and often transport, which raises cost and can delay feeding. Electromagnetic guidance achieves similar post-pyloric success at lower cost [45]. Sedation can be a risk factor in critically ill patients, and withdrawing the endoscope can drag the tube back, thereby needing the operator to fix the final position before withdrawing.

Comparison of Conventional NGT vs Assisted-NGT Placement

• *First Attempt and Overall Placement Success*

The successful attempts of conventional NGT placement vary in several studies. Most data collected were from anaesthetised and intubated patients, in whom the operator cannot fully rely on external landmarks and the patient's cooperation. In those conditions, conventional NGT insertion with head flexion and lateral neck pressure only succeeds in 56.7% of cases for first attempt [19]. Another study reported a higher first-attempt success, achieving the number of 82.7% in 104 patients, with 29 misplacements across 130 insertions, giving an overall misplacement rate of 22.3% [21]. This rate reflects the mechanical difficulty of the procedure for the conventional technique; the tube must enter through the pharynx, esophagus, and end in the gastric body, all without coiling or kinking.

Contrary to the conventional technique, assisted-NGT placement shows a higher rate of success on its first attempts. In the same study, NGT placement with esophageal guidewire showed a rate of 99.2% on first attempts, achieving approximately 40 points higher than the conventional technique [19]. In light-guided NGT placement, a consistently high success rate was obtained from various studies. IRIS tubes could successfully reach the gastric body in ICU patients with a rate of 96.8% [36]. In another study, a video-probe system achieved a successful first-attempt rate of 96.7% of all cases [34].

An electromagnetic-guided tube, namely CORTAK, has a similar rate of successful attempts compared to blind insertion, 63.1% and 65.5%, respectively. On the other hand, a study showed that an electromagnetic-assisted placement can achieve a successful rate of 99.5% among all cases with sufficient training [41]. Another study also reported that a dietitian-led electromagnetic use cuts radiographic confirmation by 20% [42]. The use of imaging modalities shows overall higher success compared to the conventional technique. An ultrasound-assisted NGT placement in the emergency department achieved a successful rate of 98.2%, versus 86.6% with the conventional technique [11]. A fluoroscopy-assisted NGT placement study reported 94.3% successful placement in prone patients with COVID-19-related respiratory failure and supine patients [46]. Another study also reported a 100% success without complications in using the fluoroscopy modality to place NGT with thoracogastric airway fistula after esophagectomy [37]. The use of endoscopy in NGT placement had higher success, achieving the number of 96.7% [34] with zero complications. Another study reported a much higher success rate, up to 98.8% compared to blind insertion, which was only 81% of all cases [12].

These comparisons demonstrate that the conventional method remains reasonably successful in conscious patients. However, in sedated/unconscious patients, the assisted method studies reported higher success rate, particularly in

optical/light-guided technique, approaching 95% of success among all cases.

• *Insertion Time, Number of Attempts, and Confirmation Time*

The insertion time and number of attempts matter in NGT placement as prolonged insertion attempts cause more mucosal trauma [49] while delayed confirmation of position delays the further action done post-insertion, especially during enteral feeding of nutrition in critically ill patients. For the blind insertion technique, the insertion time varies among many studies as it depends on the operator skills and experience. On the other hand, various studies reported, while not explicitly written, repeated number of attempts to successfully place the NGT [19,21,49]. Despite the varied range of insertion time, it is heavily influenced by the operator's experience and skills.

Each assisted method offers similar or even shorter needed time compared to the blind technique. However, confirmation time differs between approaches. Electromagnetic guidance is reportedly efficient. It shows that the mean time for insertion is 3.3 minutes for nurse-led electromagnetic placement compared to 4.5 minutes for physician-led blind placement [40]. Besides that, the electromagnetic group needed fewer reinsertions (median 0 vs 1). Electromagnetic guidance (CORTAK) also significantly reduced confirmation time, from approximately 120 minutes to under 10 minutes [50]. The use of optical guidance (IRIS and video probes) provided immediate real-time visualization with confirmation time of zero to 1.5 minutes, with zero reinsertion attempts in most cases [33,34], while blind insertion frequently needed multiple attempts [40]. Ultrasound-guided insertion achieved similar results, a confirmation time of 2-3 minutes [11]. While endoscopy-guided insertion needed more time for insertion, it is still faster compared to the conventional method, 12.3 minutes vs 17.6 minutes, respectively [12], and provides real-time confirmation.

The difference in confirmation translates directly into feeding initiation time. Slower confirmation time delays feeding initiation. Blind insertion delays feeding initiation up to 120 minutes while waiting for radiographic verification, while electromagnetic guidance cuts this to only 1.5 minutes [34,50]. Thus, all assisted techniques reduce the delay to enteral feeding up to 1-2 hours compared to blind insertion relying on radiographic confirmation.

• *Respiratory Misplacement and Pneumothorax Risk*

Respiratory misplacement represents one of the most dangerous complications in NGT insertion. Blind insertion causes respiratory misplacement at a rate of 1.9%, with pneumothorax occurring in at least 18.7% of all misplacements, and 5 patients died as a result [24]. In another study, airway misplacement was reported in 3 of 104 patients (2.9%) in their surgical series [21]. In a retrospective study of 512 radiographs post-NGT insertion, it was found that

10% showed an incorrect position, including 2.2% in which the tube lay in the airway and 1% which the tube coiled in the proximal esophagus [23]. Even with the help of post-procedure x-ray confirmation, it failed to prevent the undetected respiratory misplacements (0.013%), with 0.52% of tube placements leading to pneumothorax [13]. The same study also documented that pneumothorax accounts for 97% of lung-related complications from tube placements.

In contrast, assisted techniques significantly reduce the incidence by detecting tracheal entry during or before insertion, allowing safe insertion without further misplacement. A study reported that optical guidance (IRIS) achieves zero unrecognized respiratory misplacement by detecting tracheal entry during insertion, allowing safe withdrawal of wrong insertion before the carina [10]. Another study reported that IRIS-guided insertion successfully identified 27-28% tracheal entries and prevented further misplacement [33]. Electromagnetic guidance using CORTRAK also demonstrates near-zero unrecognized pneumothorax compared to blind tube placement (0.52%) [51]. Ultrasound-guided insertion achieved 98.2% confirmed gastric placement compared to 86.6% with blind insertion, with one lung misplacement in the blind group [11]. Fluoroscopy-guided insertion achieved approximately 94% successful insertion in prone patients and up to 100% in supine patients [45]. Endoscopy-guided placement enables direct visualization to prevent unrecognized airway entry, as demonstrated in post-COVID ICU patients where endoscopy-guided placement showed fewer complications than blind placement [12].

Real-time detection capability explains why assisted NGT placements could achieve zero or near-zero unrecognized pneumothorax cases despite similar misplacement attempts. For sedated/unconscious patients who lack protective airway reflexes, this advantage is essential and could be considered a new standard procedure compared to the conventional method.

• **Local Trauma During and Post Placement**

Mucosal trauma is proportional to the number of insertion attempts. Repeated attempts after failure to place NGT properly increased the incidence of procedure-related injuries [19]. In a study comparing conventional insertion with guidewire-assisted insertion in 480 surgical patients, nasal and pharyngeal bleeding were more likely to occur in conventional insertion technique [19]. Another study reported that tube coiling to be the most common complication of blind insertion, followed by bleeding and kinking [21]. The piriform sinuses and arytenoid cartilages were the most common sites of tube coiling, while the bleeding was mostly from the mucosal surface. A cohort study comparing smooth vs difficult NGT placement patients reported that repeated attempts of NGT insertion have a significantly higher total injury score compared to non-repeated attempts [30]. It was also reported that laryngopharyngeal mucosal injury was likely to

occur in repeated and prolonged blind insertion attempts compared to video laryngoscopy-assisted insertion.

On the other hand, the use of assisted guidance does not perfectly prevent all mucosal injury during the insertion. Instead, it lowers the risk of trauma by increasing the first attempt success and direct visualization on the tube path. Optical guidance using a video-probe system achieved approximately 96% first attempt success [32,33], while video-laryngoscopy guided insertion significantly reduced mucosal bleeding compared to the blind group [30]. Electromagnetic guidance achieved 63-99.5% first-attempt success rates [39,40], depending on operator experience, relating to fewer reinsertion attempts and less cumulative trauma. Ultrasound-guided insertion achieved a 98.2% success rate [11], and fluoroscopy-guided insertion achieved a 94.3% success rate [45], both with fewer attempts than blind insertion. Endoscopic guidance provides the lowest mucosal injury risk because the operator has direct visualization and can manipulate the tube under direct vision, avoiding mucosal fragility areas. A study documented a safe and successful NGT placement in patients with esophageal fistulas [47]. In summary, mucosal trauma is reduced indirectly with all assisted techniques through successful placement on fewer attempts. Additionally, real-time visualization helps operators to avoid anatomical hazards that blind insertion cannot identify.

• **Post-Pyloric Reach for Patients in Needs**

Post-pyloric tube placement is required in patients with high risk for aspiration and/or gastric feeding intolerance not solved with prokinetic agents [52]. This access allows patients to achieve nutritional goals while reducing the respiratory and gastrointestinal complications [53]. Gastric placement relies on swallowing and tactile feedback, while post-pyloric placement requires the tip to cross the pylorus, which blind insertion cannot simply achieve. Blind insertion of post-pyloric feeding success rate varies from 35% to 100% [53]. Another study also reported a lower post-pyloric placement success rate, only up to 42.8% on first attempts in critically ill patients [54].

Assisted NGT techniques give the operator a real-time visualization of the tube position, offering a higher chance of successful placement, which the blind method failed to achieve. Electromagnetic-assisted post-pyloric NGT placements achieve a higher first-attempt success rate compared to the blind method (81.36% vs 65.85%) [55]. The use of IRIS camera guidance shortened the time needed (3.19 min vs 22.52 min) and resulted in a higher success rate (95.45% vs 68.57%) compared to the post-pyloric blind insertion [37]. Another study also reported a similar successful attempt comparing electromagnetic-guided vs endoscopy-guided placement [44,45]. However, a study reported that endoscopy use needs longer insertion time (4.3 min longer) and higher patient discomfort level compared to electromagnetic use [44]. It also reported little to no difference in adverse events between electromagnetic

and endoscopic-guided use [45]. Ultrasound guidance also enhanced post-pyloric placement success and

accuracy, while reducing complications in critically ill patients [57].

When to Choose Each Modality? A Clinical Decision Framework

TABLE 2: Situations unsuitable for conventional NGT and the preferred assisted modality.

Situation	Main risk with blind insertion	Preferred assisted modality	Key sources
Basal skull fracture, midface trauma	Intracranial or false passage	Optical	Taylor et al. (2021a, 2021b) [33,35]
Impaired gag or cough (sedated, ventilated, comatose)	Silent airway entry, pneumothorax	Electromagnetic, optical, ultrasound	Sakuramoto et al. (2026); Yaseen et al. (2022); Taylor (2024) [11,13,40]
Oesophageal fistula, stricture, diverticulum	Perforation, false tract	Endoscopy, fluoroscopy	Costa et al. (2024); C. Zhang et al. (2024) [47,48]
Varices, bleeding or fragile mucosa	Bleeding	Endoscopy, optical	Taylor et al. (2021b); Jatin et al. (2024) [32,35]
Recent upper gastrointestinal surgery	Anastomotic injury, misdirection	Fluoroscopy, endoscopy	C. Zhang et al. (2024); S. Zhang et al. (2026) [37,47]
Repeated failed blind attempts	Cumulative mucosal trauma	Electromagnetic, optical, ultrasound	Miyamoto et al. (2024); Podder et al. (2025) [31,43]
Patient cannot be transported	Risk of transfer for imaging	Electromagnetic, optical	Davis & Grandic (2026) [42]
Post-pyloric feeding required	Low blind success	Optical, electromagnetic, endoscopy, fluoroscopy	C. Zhang et al. (2024); Watanabe et al. (2022); Kang et al. (2025) [12,45,47]
No ready access to radiography	Delayed or absent confirmation	Ultrasound	Yaseen et al. (2022); Singer & Setton (2025) [2,11]

Table 2 pairs each situation in which conventional insertion is unsuitable with the assisted modality best placed to deal with it. No modality covers every case, and in several of them more than one would be reasonable.

Assisted NGTs apparently are safer than conventional blind NGTs mainly because they detect airway misplacement during insertion rather than after it. Across studies, guided tubes showed zero or near-zero tracheobronchial misplacement, while blind insertion carried a measurable risk of lung placement and pneumothorax. Meanwhile, gains in success rate and speed are less uniform. Camera-guided and videolaryngoscope-assisted methods improved first-attempt success and shortened insertion in several trials. Electromagnetic guidance matched, but did not beat, blind success rates, and some videolaryngoscope techniques took longer than simple manoeuvres. For post-pyloric feeding, guided tubes clearly outperform blind placement, though camera tubes struggle to reach the jejunum.

CONCLUSIONS

Conventional blind NGT insertion is simple and widely available, but tube position is confirmed only after insertion, when airway misplacement and pneumothorax may already have occurred. Assisted techniques provide real-time information on tube position, and their most consistent benefit is safety, with zero or near-zero unrecognised respiratory misplacement across studies. Gains in placement success were less uniform. Optical, ultrasound, fluoroscopic, and endoscopic guidance generally outperformed blind insertion, electromagnetic guidance only matched it for gastric placement, and all guided methods were clearly superior for post-pyloric access. These benefits must be weighed against equipment, training, radiation, sedation and transport requirements, and the evidence remains limited by small, heterogeneous, mostly single-centre studies. Blind insertion therefore remains reasonable for low-risk, cooperative patients, whereas assisted techniques should be prioritised for high-risk patients and post-pyloric feeding, pending larger multicentre trials with standardised outcomes.

REFERENCES

- [1] Boeykens, K., Holvoet, T., & Duysburgh, I. (2023). Nasogastric tube insertion length measurement and tip verification in adults: a narrative review. *Critical Care*, 27(1), 317. <https://doi.org/10.1186/s13054-023-04611-6>
- [2] Singer, P., & Setton, E. (2025). Technology advances in the placement of naso-enteral tubes and in the management of enteral feeding in critically ill patients: A narrative study. *Clinical Nutrition ESPEN*, 68, 515-522. <https://doi.org/10.1016/j.clnesp.2025.05.022>
- [3] Duerksen, J. M., Ramjiawan, B., & Duerksen, D. R. (2025). Long-term enteral nutrition with a nasogastric tube can be safe and effective: A case report. *Nutrition in Clinical Practice*, 40(2), 492-495. <https://doi.org/10.1002/ncp.11263>
- [4] Tae, C. H., Lee, J. Y., Joo, M. K., Park, C. H., Gong, E. J., Shin, C. M., Lim, H., Choi, H. S., Choi, M., Kim, S. H., Lim, C. H., Byeon, J. S., Shim, K. N., Song, G. A., Lee, M. S., Park, J. J., Lee, O. Y., & Korean Society of Gastrointestinal Endoscopy Task Force on Clinical Practice Guidelines. (2023). Clinical practice guidelines for percutaneous endoscopic gastrostomy. *Clinical Endoscopy*, 56(4), 391-408. <https://doi.org/10.5946/ce.2023.062>
- [5] Worcestershire Acute Hospitals NHS Trust. (2022). Nasogastric feeding tube insertion and care guidelines - Adult (WAHT-NUR-065, Version 9). Worcester: Worcestershire Acute Hospitals NHS Trust. <https://apps.worcsacute.nhs.uk/KeyDocumentPortal/Home/DownloadFile/2866>
- [6] Ministry of Health, Singapore. (2022). National guidelines on nursing management of nasogastric tube in adult patients. Singapore: Ministry of Health. https://isomer-user-content.by.gov.sg/75/b8940583-685c-4d41-96af-7a2dbfa82adf/digital_fa_221130_ngt-guideline.pdf
- [7] Spring Grove Hospital Center. (2025). Clinical guidelines for enteral feeding with nasogastric tube (Department of Nursing Policy and Procedure SGHCNP0387). Maryland Department of Health. <https://health.maryland.gov/springgrove/Policy/Nursing/Clinical%20Guidelines%20Enteral%20Feeding%20with%20NGT.7.24.2025.pdf>
- [8] Zhu, G., Wen, Y., Ling, T., Chen, W., & Geng, G. (2026). Efficacy of the 1 mL water-swallowing induction method for nasogastric tube placement in patients with stroke and impaired consciousness. *Journal of Craniofacial Surgery*, 37(7/8), e690-e695. <https://doi.org/10.1097/scs.00000000000012312>
- [9] Kini, P., Salian, R., Chacko, A., & Shetty, K. (2025). Comparison of different techniques of nasogastric tube insertion in anaesthetized, intubated patients in terms of rate of success, time taken and complications: An observational study [version 1; peer review: 3 approved with reservations]. *F1000Research*, 14, 1218. <https://doi.org/10.12688/f1000research.169786.1>
- [10] Taylor, S., Sayer, K., Milne, D., Brown, J., & Zeino, Z. (2021). Integrated real-time imaging system, 'IRIS', Kangaroo feeding tube: a guide to placement and image interpretation. *BMJ Open Gastroenterology*, 8(1), e000768. <https://doi.org/10.1136/bmjgast-2021-000768>
- [11] Yaseen, M., Kumar, A., Bhoi, S., Sinha, T. P., Jamshed, N., Aggarwal, P., Murmu, L. R., & Ekka, M. (2022). Point-of-care ultrasonography-assisted nasogastric tube placement in the emergency department: a randomized controlled trial. *European Journal of Emergency Medicine*, 29(6), 431-436. <https://doi.org/10.1097/MEJ.0000000000000962>
- [12] Kang, Y., Wu, Y., & Chen, Y. (2025). Safety and efficacy of endoscopy-guided nasojejunal feeding tube placement in ICU post-COVID-19 patients: a retrospective study. *European Journal of Medical Research*, 30(1), 933. <https://doi.org/10.1186/s40001-025-03149-3>
- [13] Taylor, S. J. (2024). Feeding tube safety: National guidance ignores the 'elephant in the room'. *International Journal of Risk & Safety in Medicine*, 36(2), 85-97. <https://doi.org/10.1177/0924647924129556>
- [14] Torsy, T., van Noort, H. H. J., Taylor, S., Eriksson, M., Verhaeghe, S., & Beeckman, D. (2022). The accuracy of methods for determining the internal length of a nasogastric tube in adult patients: a systematic review. *The American Journal of Clinical Nutrition*, 116(3), 798-811. <https://doi.org/10.1093/ajcn/nqac146>
- [15] Verma, R., & Nelson, R. L. (2007). Prophylactic nasogastric decompression after abdominal surgery. *Cochrane Database of Systematic Reviews*, 2007(3), CD004929. <https://doi.org/10.1002/14651858.CD004929.pub3>
- [16] Vadivelu, N., Kodumudi, G., Leffert, L. R., Pierson, D. C., Rein, L. K., Silverman, M. S., Cornett, E. M., & Kaye, A. D. (2023). Evolving therapeutic roles of nasogastric tubes: Current concepts in clinical practice. *Advances in Therapy*, 40(3), 828-843. <https://doi.org/10.1007/s12325-022-02406-9>
- [17] Spurrier, E. J., & Johnston, A. McD. (2008). Use of nasogastric tubes in trauma patients: a review. *Journal of the Royal Army Medical Corps*, 154(1), 10-13. <https://doi.org/10.1136/jramc-154-01-04>
- [18] Alverdy, J. C., Boermeester, M. A., Salminen, P., & Zuckerbraun, B. S. (2026). Nasogastric tubes: Indications, placement, and management. *JAMA Surgery*, 161(10), 1085. <https://doi.org/10.1001/jamasurg.2026.3223>

- [19] Kirtania, J., Ghose, T., Garai, D., & Ray, S. (2012). Esophageal guidewire-assisted nasogastric tube insertion in anesthetized and intubated patients: a prospective randomized controlled study. *Anesthesia & Analgesia*, 114(2), 343-348. <https://doi.org/10.1213/ANE.0b013e31823be0a4>
- [20] Torsy, T., Saman, R., Boeykens, K., Duysburgh, I., Van Damme, N., & Beeckman, D. (2018). Comparison of two methods for estimating the tip position of a nasogastric feeding tube: A randomized controlled trial. *Nutrition in Clinical Practice*, 33(6), 843-850. <https://doi.org/10.1002/ncp.10112>
- [21] Hsieh, S. W., Chen, H. S., Chen, Y. T., & Hung, K. C. (2017). To characterize the incidence of airway misplacement of nasogastric tubes in anesthetized intubated patients by using a manometer technique. *Journal of Clinical Monitoring and Computing*, 31(2), 443-448. <https://doi.org/10.1007/s10877-016-9860-6>
- [22] Wan Ibadullah, W. H., Yahya, N., Ghazali, S. S., Kamaruzaman, E., Yong, L. C., Dan, A., & Md Zain, J. (2016). Comparing insertion characteristics on nasogastric tube placement by using GlideScope™ visualization vs. MacIntosh laryngoscope assistance in anaesthetized and intubated patients. *Brazilian Journal of Anesthesiology (English Edition)*, 66(4), 363-368. <https://doi.org/10.1016/j.bjane.2014.11.013>
- [23] Watkin, D., Farrell, C., McGee, M., & Welters, I. (2025). Complications of nasogastric tube insertion in critical care: a retrospective analysis of radiographs performed for determination of tube position. *Radiography*, 31(3), 102941. <https://doi.org/10.1016/j.radi.2025.102941>
- [24] Sparks, D. A., Chase, D. M., Coughlin, L. M., & Perry, E. (2011). Pulmonary complications of 9931 narrow-bore nasoenteric tubes during blind placement: a critical review. *Journal of Parenteral and Enteral Nutrition*, 35(5), 625-629. <https://doi.org/10.1177/0148607111413898>
- [25] Matsuda, R., Kou, Y., Kogita, Y., & Sakamaki, Y. (2025). Fistulous empyema due to bronchopulmonary laceration with a misintubated nasogastric tube: a case report. *General Thoracic and Cardiovascular Surgery Cases*, 4(1), 15. <https://doi.org/10.1186/s44215-025-00201-w>
- [26] Metheny, N. A., & Meert, K. L. (2017). Administering polyethylene glycol electrolyte solution via a nasogastric tube: pulmonary complications. *American Journal of Critical Care*, 26(2), e11-e17. <https://doi.org/10.4037/ajcc2017522>
- [27] Hamdaoui, D., Ashworth, J., & Thompson, J. D. (2023). A scoping review of clinical practices and adherence to UK national guidance related to the placement and position confirmation of adult nasogastric feeding tubes. *Radiography*, 29(1), 178-183. <https://doi.org/10.1016/j.radi.2022.10.032>
- [28] NHS Improvement. (2016). Patient safety alert: Nasogastric tube misplacement: continuing risk of death and severe harm (Alert reference NHS/PSA/RE/2016/006, Stage two: Resources). NHS Improvement. https://www.england.nhs.uk/wp-content/uploads/2019/12/Patient_Safety_Alert_Stage_2_-_NG_tube_resource_set.pdf
- [29] Healthcare Safety Investigation Branch. (2021). Placement of nasogastric tubes (Investigation report). Healthcare Safety Investigation Branch. <https://www.hssib.org.uk/patient-safety-investigations/placement-of-nasogastric-tubes/investigation-report/>
- [30] Earley, T., Young, A., Pringle, S., Clarkson, Y., Williams, A., Howell, R., & Ineson, M. (2022). Fibre-optic, electronic pH test device compared with current NHS guidance to confirm nasogastric tube placement. *BMJ Nutrition Prevention & Health*, 5(2), 306-312. <https://doi.org/10.1136/bmjnp-2022-000506>
- [31] Miyamoto, K., Takayasu, H., Katsuki, S., Maeda, A., Suzuki, K., Nakamura, M., Hida, N., Sambe, T., Yagi, M., Sasaki, J., Hayashi, M., Dohi, K. (2024). Laryngopharyngeal Mucosal Injury Due to Nasogastric Tube Insertion during Cardiopulmonary Resuscitation: A Retrospective Cohort Study. *Journal of Clinical Medicine*, 13(1), 261. <https://doi.org/10.3390/jcm13010261>
- [32] Jatin, Y., Sharma, S., Singh, N., Qamar, S., Agarwal, S., Gopi, S., Gunjang, D., Saraya, A. (2023). An open-label randomized controlled trial of early initiation of nasogastric feeding after endotherapy in variceal bleeding: a proof-of-concept study. *Journal of Clinical and Experimental Hepatology*, 14(1), 101260. <https://doi.org/10.1016/j.jceh.2023.07.413>
- [33] Taylor, S. J., Sayer, K., Terlevich, A., & Campbell, D. (2021a). Tube placement using 'IRIS': A pilot assessment of its utility and safety. *Intensive and Critical Care Nursing*, 66, 103077. <https://doi.org/10.1016/j.iccn.2021.103077>
- [34] Lo, Y., Kang, J., Hsieh, C., Chen, C., Yang, K., Tsai, W., Chian, H., Chen, C., Shih, I., Chen, P., Yang, E., Kuo, H., Chen, C., Chuang, C. (2025). Real-time visualization of the gastrointestinal tract during nasogastric tube placement: Pilot study of new video-Assisted system. *Endoscopy International Open*, 13(CP), a24947454. <https://doi.org/10.1055/a-2494-7454>
- [35] Taylor, S. J., Sayer, K., Terlevich, A., & Campbell, D. (2021b). Tube placement using 'IRIS': A pilot assessment of its utility and safety. *Intensive and Critical Care Nursing*, 66, 103077. <https://doi.org/10.1016/j.iccn.2021.103077>

- [36] Slingerland-Boot, R., Bouw-Ruiter, M., Van Manen, C., Arbous, S., & Van Zanten, A. (2021). Video-assisted placement of enteral feeding tubes using the Integrated Real-Time Imaging System (IRIS)-technology in critically ill patients. *Clinical Nutrition*, 40(8), 5000–5007. <https://doi.org/10.1016/j.clnu.2021.07.026>
- [37] Zhang, S., Zhang, J., Liu, T., Ma, Y., Yang, Z., Ma, Y., Yin, M., Li, C., Wu, G. (2026b). The three-tube method under fluoroscopy guidance for post-gastrectomy gastric fistula. *Quantitative Imaging in Medicine and Surgery*, 16(3), 219. <https://doi.org/10.21037/qims-2025-1778>
- [38] Alresheq, A., Shahrory, M. A., & Almqdadi, M. (2026c). A rare case of pneumobilia and pancreatitis following difficult IRIS-Guided nasoenteric tube placement with additional air insufflation: a case report and literature review. *Case Reports in Gastrointestinal Medicine*, 2026(1), 1251527. <https://doi.org/10.1155/crgm/1251527>
- [39] Singer, P., & Setton, E. (2025). Technology advances in the placement of naso-enteral tubes and in the management of enteral feeding in critically ill patients: A narrative study. *Clinical Nutrition ESPEN*, 68, 515–522. <https://doi.org/10.1016/j.clnesp.2025.05.022>
- [40] Sakuramoto, H., Nakamura, K., Kamogawa, M., Note, H., Mori, K., Tatsuno, J., Tatsuno, J., Yamaguchi, D., Miki, T., Ikezawa, T., Hashimoto, H., Okamoto, S., Tsugu, H., Shirasaka, M., Sai, K., Sakamoto, S., Yoshida, T., Kajiwar, S. (2026). Electromagnetic-Guided nasogastric tube insertion by Nurses: A Multicenter Non-Inferiority Study. *Annals of Nutrition and Metabolism*, 82(4), 1–11. <https://doi.org/10.1159/000552563>
- [41] Mori, K., Sakuramoto, H., Ikezawa, T., Kamogawa, M., Note, H., Miki, T., Okamoto, S., Motoki, M., Hashimoto, Hideki, Tatsuno, J., Yoshida, T., Kajiwar, S., Shirasaka, M., Mukouyama, M. Tsugu, H., Nakamura, K. (2026). Learning curve of nurse-performed electromagnetic-guided nasogastric tube placement in adult ICU patients: A multicenter prospective study. *Nutrition in Clinical Practice*. <https://doi.org/10.1002/ncp.70181>
- [42] Davis, M., & Grandic, J. (2026). Dietitian-Led Feeding tube placement: reducing nursing workload and enhancing patient safety in the intensive care unit. *Critical Care Nurse*, 46(3), 24–34. <https://doi.org/10.4037/ccn2026599>
- [43] Podder, S., Cowan, S., Koeneman, S., Pavis, E., Park, D., Schleider, C., Shindle, K., Bowen, M., Johnson, A. (2025). Resident-Driven Guideline to Reduce Iatrogenic Pneumothoraxes from Small-Bore Feeding Tubes: A quality and Safety improvement project. *American Journal of Medical Quality*, 40(1), 8–14. <https://doi.org/10.1097/jmq.0000000000000215>
- [44] Wei, Y., Jin, Z., Zhu, Y., & Hu, W. (2020). Electromagnetic-guided versus endoscopic placement of post-pyloric feeding tubes: a systematic review and meta-analysis of randomised controlled trials. *Journal of Intensive Care*, 8(1), 92. <https://doi.org/10.1186/s40560-020-00506-8>
- [45] Watanabe, J., Kakehi, E., Okamoto, M., Ishikawa, S., & Kataoka, Y. (2022). Electromagnetic-guided versus endoscopic-guided postpyloric placement of nasoenteral feeding tubes. *Cochrane Database of Systematic Reviews*, 2022(10), CD013865. <https://doi.org/10.1002/14651858.cd013865.pub2>
- [46] Kolbeinsson, H. M., Veldkamp, J., & Paaauw, J. D. (2022). Fluoroscopic placement of nasojejunal feeding tubes in COVID-19 patients in the prone position. *Journal of Parenteral and Enteral Nutrition*, 46(3), 556–560. <https://doi.org/10.1002/jpen.2192>
- [47] Zhang, C., Li, X., He, Z., Wang, S., Yin, M., Ma, Y., & Wu, G. (2024). The Two-Tube method for treating thoracogastric airway fistula. *The Thoracic and Cardiovascular Surgeon*, 72(02), 156–161. <https://doi.org/10.1055/a-2122-7149>
- [48] Costa, M. S., Gravito-Soares, E., Gravito-Soares, M., Agostinho, C., & Figueiredo, P. (2024). When eating becomes a real nightmare. *Revista Española De Enfermedades Digestivas*, 116(9), 513–514. <https://doi.org/10.17235/reed.2023.10025/2023>
- [49] Miyamoto, K., Takayasu, H., Katsuki, S., Maeda, A., Suzuki, K., Nakamura, M., Hida, N., Sambe, T., Yagi, M., Sasaki, J., Hayashi, M., Dohi, K. (2022). Blind nasogastric tube insertion performed within one minute or for a maximum of two or three attempts during resuscitation may minimize laryngopharyngeal mucosal injury: a prospective observational study. *Research Square*. <https://doi.org/10.21203/rs.3.rs-1601386/v1>
- [50] Lei, K., Smith, J., Camporota, L., & Beale, R. (2007). Using the Cortrak magnetic device to facilitate early enteral nutrition in critically ill patients. *Critical Care*, 11(Suppl 2), P151. <https://doi.org/10.1186/cc5311>
- [51] Taylor, S. J., Sayer, K. R., & Brown, J. (2025). Interpreting Cortrak™ feeding tube position: Safety assessment of manufacturer training guides. *International Journal of Risk & Safety in Medicine*, 37(1), 67–77. <https://doi.org/10.1177/09246479251377592>
- [52] Miyamoto, K., Takayasu, H., Katsuki, S., Maeda, A., Suzuki, K., Nakamura, M., Hida, N., Sambe, T., Yagi, M., Sasaki, J., Hayashi, M., Dohi, K. (2024b). Laryngopharyngeal Mucosal Injury Due to Nasogastric Tube Insertion during Cardiopulmonary Resuscitation: A Retrospective Cohort Study. *Journal of Clinical Medicine*, 13(1), 261. <https://doi.org/10.3390/jcm13010261>

- [53] Singer, P., Blaser, A. R., Berger, M. M., Alhazzani, W., Calder, P. C., Casaer, M. P., Hiesmay, M., Mayer, K., Montejo, J., Pichard, C., Preiser, J., Zanten, A., Oczkowski, S., Szczeklik, W., Bischoff, S. C. (2018). ESPEN guideline on clinical nutrition in the intensive care unit. *Clinical Nutrition*, 38(1), 48–79.
<https://doi.org/10.1016/j.clnu.2018.08.037>
- [54] Wang, Q., Xuan, Y., Liu, C., Lu, M., Liu, Z., & Chang, P. (2021). Blind placement of postpyloric feeding tubes at the bedside in intensive care. *Critical Care*, 25(1), 168.
<https://doi.org/10.1186/s13054-021-03587-5>
- [55] Kurisawa, K., Yokose, M., Tanaka, H., Mihara, T., Takaki, S., & Goto, T. (2021). Multivariate analysis of factors associated with first-pass success in blind placement of a post-pyloric feeding tube: a retrospective study. *Journal of Intensive Care*, 9(1), 59.
<https://doi.org/10.1186/s40560-021-00577-1>
- [56] Yuan, Y., Fu, J., Wang, B., Zhong, M., Luo, X., Wang, Y., Luo, Q., Zhang, X., Hu, R. (2026). Comparison of electromagnetic navigation-guided and conventional blind nasojejunal tube placement in mechanically ventilated patients: a prospective non-randomized controlled study with two stages. *Frontiers in Nutrition*, 12, 1674298.
<https://doi.org/10.3389/fnut.2025.1674298>
- [57] Li, Z., Cao, L., Zhong, X., Yang, Q., Tian, D., Sun, Y., Hai, B., Siming, X. (2026). A Meta-Analysis of the efficacy of Ultrasound-Guided nasojejunal tube placement. *Nursing in Critical Care*, 31(2), e70382. <https://doi.org/10.1111/nicc.70382>