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Title: Ultrasonography-Guided Nasogastric Tube Placement and Verification: A Standardized Nursing Protocol

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Author Questionnaire

1. Microscopy: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or something similar? **No**

2. Software: Does the part of your protocol being filmed include step-by-step descriptions of software usage? **No**

3. Filming location: Will the filming need to take place in multiple locations? **No**

4. Testimonials (optional): Would you be open to filming two short testimonial statements **live during your JoVE shoot**? These will **not appear in your JoVE video** but may be used in JoVE's promotional materials. **No**

Current Protocol Length

Number of Steps: 20

Number of Shots: 38

Introduction

Videographer: Obtain headshots for all authors available at the filming location.

Authors: Please note that **the questions will not appear on screen**. Please answer in **stand-alone full sentence with sufficient context**

INTRODUCTION:

~~REQUIRED: Summarize your research focus and the main questions it aims to answer.~~

- 1.1. **Fernanda Gimenes:** Our study investigates whether nurse-led ultrasound can provide a safe, rapid, and reliable method for verifying nasogastric tube placement.
 - 1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera *Suggested B-roll: 2.9.2*

~~Describe the research gap or limitation in existing methods and how this protocol addresses them.~~

- 1.2. **Fernanda Gimenes:** Existing methods may be delayed, indirect, or radiation-dependent; this protocol standardizes bedside ultrasound verification for safer nursing practice.
 - 1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

CONCLUSION:

~~What does this protocol allow researchers to study or measure?~~

- 1.3. **Fernanda Gimenes:** This protocol enables measurement of ultrasound accuracy, verification time, feasibility, reproducibility, safety, and nursing implementation outcomes.
 - 1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

~~Describe the most important consideration or challenge when performing this protocol.~~

1.4. **Fernanda Gimenes:** The key challenge is obtaining clear cervical and epigastric images; inconclusive findings require radiographic confirmation.

1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

~~Are there any additional methods or analyses that can be performed following this procedure?~~

1.5. **Fernanda Gimenes:** Additional analyses may compare findings with gastric aspirate pH testing and chest X-ray, the reference standard for nasogastric tube verification.

1.5.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Videographer: Obtain headshots for all authors available at the filming location.

Ethics Title Card

This research has been approved by the Institutional Review Board (IRB) at the Ribeirão Preto College of Nursing, University of São Paulo.

Protocol

***Videographer:** Please always record an audio slate while filming each shot mentioned in the shotlist.*

2. Preparation for Ultrasonography-Guided Nasogastric Tube (NGT) Placement

Demonstrator: Fernanda Gimenes

- 2.1. To begin, turn on the ultrasound device [1].
 - 2.1.1. WIDE: Talent turning on the ultrasound device.
- 2.2. Select the **Soft tissues** or **Neck** preset and use a high-frequency linear transducer, typically 6 to 13 megahertz, for cervical esophageal imaging [1].
 - 2.2.1. Show the preset selection menu and choose Soft tissues or Neck while the high-frequency linear transducer is in view.
- 2.3. Next, select the **Abdominal** preset and use a low-frequency convex transducer, typically 2 to 5 megahertz, for epigastric scanning of the gastric antrum [1].
 - 2.3.1. Show the preset selection menu and choose Abdominal while the low-frequency convex transducer is in view.
- 2.4. Now, place the patient in a supine position [1].
 - 2.4.1. Talent positioning the patient lying flat on their back on the examination surface.
- 2.5. For cervical scanning, ensure the head is in a neutral or slightly extended posture to elongate the anterior neck and optimize esophageal visualization [1].
 - 2.5.1. Talent adjusting the patient's head into a neutral to slightly extended position.
- 2.6. For epigastric scanning, ensure the upper abdomen is exposed from the xiphoid process to the left costal margin [1].
 - 2.6.1. Talent exposing the patient's upper abdomen from the xiphoid process to the left costal margin.
- 2.7. Determine the estimated insertion depth of the nasogastric tube using a standardized external measurement method consistent with institutional policy before ultrasound confirmation [1].
 - 2.7.1. Talent determining the estimated insertion depth of the nasogastric tube using a standardized external measurement method.
- 2.8. Use the nose–ear–xiphoid or nose–ear–mid-umbilicus technique [1].
 - 2.8.1. Talent measuring the nasogastric tube using the nose–ear–xiphoid or nose–ear–mid-umbilicus technique.

2.9. Mark the selected measurement on the tube before insertion to guide advancement to the estimated gastric position [1]. Perform ultrasound scanning during tube advancement and or immediately after reaching the predetermined insertion depth [2].

2.9.1. Talent marking the selected measurement on the tube before insertion.

2.9.2. Talent performing ultrasound scanning during nasogastric tube advancement or immediately after reaching the predetermined insertion depth.

3. Cervical Esophageal Scanning (High-Frequency Linear Probe, 6–13 MHz)

3.1. Apply an adequate amount of ultrasound gel to the linear transducer to avoid air interference and ensure proper acoustic coupling [1]. Place the probe transversely on the neck just superior to the suprasternal notch and lateral to the trachea at the level of the cricoid cartilage [2]. Ensure the probe marker corresponds to the left side of the ultrasound screen [3].

3.1.1. Talent applying ultrasound gel onto the linear transducer.

3.1.2. Talent positioning the probe transversely on the patient's neck at the specified anatomical location.

3.1.3. Talent adjusting the probe to align the marker with the left side of the ultrasound screen.

3.2. To identify the trachea, locate a hyperechoic anterior wall with posterior acoustic shadowing [1]. Then, identify the esophagus as a compressible structure typically posterior and slightly left of the trachea that may appear hypoechoic unless distended [2]. Next, identify the carotid artery and internal jugular vein as lateral reference points to confirm orientation [3].

3.2.1. View showing the trachea with a bright anterior wall and posterior shadowing.

3.2.2. View showing the esophagus positioned posterior and slightly left of the trachea being compressed.

3.2.3. View showing the carotid artery and internal jugular vein lateral to the trachea.

3.3. Now, adjust the ultrasound settings to improve visualization of the esophageal lumen by setting the depth to 3 to 5 centimeters for cervical structures [1]. Set the gain to a moderate level to avoid saturation that obscures hyperechoic tube patterns [2]. Optimize the focus to enhance image sharpness [3].

3.3.1. Display the depth control on the ultrasound interface and adjust it to 3 to 5 centimeters.

3.3.2. Show the gain control being adjusted to a moderate level on the ultrasound interface.

3.3.3. Show the focus setting being optimized for image clarity on the ultrasound

interface.

3.4. During nasogastric tube insertion, maintain real-time visualization of the advancing tube [1]. Observe the appearance of a hyperechoic linear structure within the esophagus [2]. Instruct a cooperative patient to swallow during tube advancement to enhance esophageal peristalsis [3] and facilitate identification of the characteristic ultrasonographic flash artifact associated with esophageal passage [4].

3.4.1. View showing the advancing nasogastric tube in real time within the esophagus.

3.4.2. View showing a hyperechoic linear structure appearing within the esophagus.

3.4.3. Talent instructing the patient to swallow during tube advancement.

3.4.4. View showing ultrasonographic flash artifact.

4. Epigastric/Gastric Antrum Scanning (Low-Frequency Convex Probe, 2–5 MHz)

4.1. Select the convex transducer and apply an adequate amount of gel [1].

4.1.1. Talent selecting the convex transducer and applying gel onto its surface.

4.2. Position the probe in a longitudinal orientation over the epigastric or subxiphoid region with the probe marker directed toward the patient's head [1].

4.2.1. Talent positioning the probe longitudinally over the epigastric region with the marker oriented toward the patient's head.

4.3. Identify the left lobe of the liver as the anterior acoustic window [1]. Then, identify the gastric antrum posterior to the liver [2]. Confirm the presence of the aorta and the superior mesenteric artery as posterior structures relative to the gastric antrum [3].

4.3.1. View showing the left lobe of the liver serving as the anterior acoustic window.

4.3.2. View showing the gastric antrum located posterior to the liver.

4.3.3. View showing the aorta and superior mesenteric artery posterior to the gastric antrum.

4.4. Observe for the appearance of a hyperechoic linear or double-line structure within the gastric antrum [1].

4.4.1. View showing a hyperechoic linear or double-line structure within the gastric antrum.

4.5. Optionally, inject 10 to 20 milliliters of air rapidly through the tube using a syringe while maintaining real-time ultrasound visualization of the gastric antrum [1]. Observe the gastric lumen for brief turbulent echogenicity or dynamic fogging, seen as a transient hyperechoic cloud or swirling artifact immediately after air injection [2]. If no turbulence is observed, reassess probe positioning and repeat the maneuver once [3].

4.5.1. Talent injecting air through the tube using a syringe while holding the probe in

place.

- 4.5.2. View showing transient turbulent echogenicity or a hyperechoic cloud within the gastric lumen.
- 4.5.3. Talent adjusting the probe position and preparing to repeat the maneuver.
- 4.6. Press **Freeze** and capture representative images once optimal visualization is achieved [1]. Capture images of the tube within the esophagus [2] and within the gastric antrum in a longitudinal view [3].
 - 4.6.1. Display the ultrasound interface and press **Freeze** to capture the image.
 - 4.6.2. Show captured image of the tube within the esophagus in transverse or longitudinal view.
 - 4.6.3. Captured image of the tube within the gastric antrum in longitudinal view.
- 4.7. Label the images according to institutional and research standards [1]. Save the captured images in the patient record [2].
 - 4.7.1. Show the labeling field on the ultrasound system and entering the specified image label.
 - 4.7.2. Show saving the images into the patient record on the ultrasound system.

Results

5. Results

5.1. In successful examinations, the nasogastric tube was clearly visualized in the cervical esophageal window as a hyperechoic linear or double-line structure within the esophageal lumen, posterior and slightly lateral to the trachea [1].

5.1.1. LAB MEDIA: Figure 1. *Video editor: Highlight the bright linear or double-line structure indicated by the red arrow within the esophageal area next to the labeled trachea*

5.2. Correct gastric placement was confirmed by direct visualization of the nasogastric tube within the gastric antrum, posterior to the left lobe of the liver [1].

5.2.1. LAB MEDIA: Figure 2.

5.3. In inadequate examinations, neither a direct sonographic sign of nasogastric tube placement could be reliably identified [1].

5.3.1. LAB MEDIA: Figure 3. *Video editor: Show both panels and point to the red arrow areas where no clear tube structure can be identified*

Esophageal

Pronunciation link: <https://www.merriam-webster.com/dictionary/esophageal>

IPA: /ɪˌsoʊfəˈdʒiːəl/

Phonetic Spelling: ih·soh·fuh·jee·uhl

Transducer

Pronunciation link: <https://www.merriam-webster.com/dictionary/transducer>

IPA: /trænzˈduːsər/, /trænsˈduːsər/

Phonetic Spelling: tranz·doo·ser

Cervical

Pronunciation link: <https://www.merriam-webster.com/dictionary/cervical>

IPA: /'sɜːvɪkəl/

Phonetic Spelling: sur·vih·kuhl

Epigastric

Pronunciation link: <https://www.merriam-webster.com/dictionary/epigastric>

IPA: /,epɪ'gæstriːk/

Phonetic Spelling: eh·pee·gas·trik

Gastric

Pronunciation link: <https://www.merriam-webster.com/dictionary/gastric>

IPA: /'gæstriːk/

Phonetic Spelling: gas·trik

Nasogastric

Pronunciation link: <https://www.merriam-webster.com/dictionary/nasogastric>

IPA: /,neɪzoo'gæstriːk/

Phonetic Spelling: nay·zoh·gas·trik

Xiphoid

Pronunciation link: <https://www.merriam-webster.com/dictionary/xiphoid>

IPA: /'zaɪ,fɔɪd/

Phonetic Spelling: zy·foyd

Umbilicus

Pronunciation link: <https://www.merriam-webster.com/dictionary/umbilicus>

IPA: /ʌm'bɪlɪkəs/

Phonetic Spelling: um·bil·ih·kuhs

Suprasternal

Pronunciation link: <https://www.merriam-webster.com/medical/suprasternal>

IPA: /,suːprə'stɜːnəl/

Phonetic Spelling: soo·pruh·stur·nuhl

Cricoid

Pronunciation link: <https://www.merriam-webster.com/medical/cricoid>

IPA: /'kraɪ,kɔɪd/

Phonetic Spelling: kry·koyd

Hyperechoic

Pronunciation link: <https://www.howtopronounce.com/hyperechoic>

IPA: /,haɪpə'riːkoʊk/

Phonetic Spelling: hy·per·ih·koh·ik

Hypoechoic

Pronunciation link: <https://www.howtopronounce.com/hypoechoic>

IPA: /ˌhaɪpəʊɪˈkɔɪk/

Phonetic Spelling: hy·poh·ih·koh·ik

Carotid

Pronunciation link: <https://www.merriam-webster.com/dictionary/carotid>

IPA: /kəˈrɑːtɪd/

Phonetic Spelling: kuh·rah·tid

Jugular

Pronunciation link: <https://www.merriam-webster.com/dictionary/jugular>

IPA: /ˈdʒʌɡjələr/

Phonetic Spelling: jug·yuh·ler

Peristalsis

Pronunciation link: <https://www.merriam-webster.com/dictionary/peristalsis>

IPA: /ˌperəˈstɑːlsɪs/

Phonetic Spelling: peh·ruh·staal·suhs

Ultrasonographic

Pronunciation link: <https://www.howtopronounce.com/ultrasonographic>

IPA: /ˌʌltrəˈsɑːnəˈɡræfɪk/

Phonetic Spelling: ul·truh·sah·nuh·graf·ik

Longitudinal

Pronunciation link: <https://www.merriam-webster.com/dictionary/longitudinal>

IPA: /ˌlɑːndʒəˈtuːdənəl/

Phonetic Spelling: lon·juh·too·duh·nuhl

Mesenteric

Pronunciation link: <https://www.merriam-webster.com/dictionary/mesenteric>

IPA: /ˌmezənˈterɪk/

Phonetic Spelling: mez·uhn·ter·ik

Echogenicity

Pronunciation link: <https://www.howtopronounce.com/echogenicity>

IPA: /ˌekəʊdʒəˈnɪsəti/

Phonetic Spelling: eh·koh·juh·nih·suh·tee

Sonographic

Pronunciation link: <https://www.merriam-webster.com/medical/sonographic>

IPA: /ˌsɑːnəˈɡræfɪk/

Phonetic Spelling: sah·nuh·graf·ik

