The findings presented here are a subset of results from a larger study that examined critical care nurses’ adoption of the American Association of Critical-Care Nurses (AACN) practice alert on feeding tube placement and the clinical practices recommended therein.1 Insertion of feeding tubes to deliver enteral nutrition is a common intervention in critically ill patients; however, the methods used for feeding tube verification and the frequency of their use vary widely.2 Two verification methods that are not supported by research evidence, auscultation (air bolus)2 and water bubbling (no published evidence found), continue to be used. Unfortunately, adverse outcomes such as pneumonia, pneumothorax, and death have been associated with inconsistent practices for verifying feeding tube placement.
tube placement. The most common complication of blindly inserted feeding tubes is improper placement in the esophagus (21% of cases) or pulmonary system (4% of cases). Case studies of feeding tubes placed in the brain and spinal column also have been published. Incorrect placement of a feeding tube may be difficult for clinicians to assess at the bedside, because the patient can be asymptomatic initially. Because of this, radiographic confirmation is considered the gold standard for initial verification of placement of all blindly inserted feeding tubes.

Clinical practice guidelines such as the AACN practice alerts contain recommendations for practice that are evidence-based. Guidelines synthesize available evidence to assist clinicians in translating research findings into clinical practice. AACN’s practice alert on verification of feeding tube placement was originally published in 2005, revised in 2009, and is available on the AACN website (www.aacn.org). Several clinical practice guidelines supporting practices for verifying feeding tube placement have been published by other organizations, including the American Association of Parenteral and Enteral Nutrition, the American Gastroenterological Association, and England’s National Health Service.

### Objectives

Previously published data from our larger study examined the influence of Rogers’ diffusion of innovation variables on critical care nurses’ adoption of the AACN practice alert on feeding tube placement and its recommended clinical practices in adult patients with feeding tubes. The term adoption is commonly used to describe the processes of accepting and implementing an innovation such as the AACN practice alert. Implementation is a term commonly used in nursing practice and refers to the action of using an innovation. For the purpose of this article, the terms adoption and implementation will be used in reference to the use of a clinical practice unless otherwise stated.

Whereas our first article reported on factors that increased the likelihood of adoption of the practice alert, this article explores how the recommendations in the AACN practice alert were used by critical care nurses to verify feeding tube placement in clinical practice. No unique findings regarding radiographic confirmation are reported here.

The AACN practice alert on verification of feeding tube placement for blindly inserted tubes contains 3 major recommendations under the heading Expected Practice (Table 1). The practice alert identifies the unreliable auscultatory (air bolus) method as a subset of the first recommendation. Because auscultation is reported as a method commonly used by nurses to verify feeding tube location, we decided to measure auscultation practice

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### Table 1: American Association of Critical-Care Nurses practice alert on verification of feeding tube placement: expected practices

| 1. Use a variety of bedside methods to predict tube location during the insertion procedure. |
| • Observe for signs of respiratory distress. |
| • Use capnography if available. |
| • Measure pH of aspirate from tube if pH strips are available. |
| • Observe visual characteristics of aspirate from the tube. |
| • Recognize that auscultatory (air bolus) and water bubbling methods are unreliable. |

| 2. Obtain radiographic confirmation of correct placement of any blindly inserted tube before its initial use for feedings or medication administration. |

| 3. Check tube location at 4-hour intervals after feedings are started. |
| • Observe for a change in length of the external portion of the feeding tube. |
| • Review routine chest and abdominal radiography reports to look for notations about tube location. |
| • Observe changes in volume of aspirate from feeding tube. |
| • If pH strips are available, measure pH of feeding tube aspirates if feedings are interrupted for more than a few hours. |
| • Obtain a radiograph to confirm tube position if the tube’s location is in doubt. |

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separately from the 3 major practices recommended in the practice alert.

Methods

Design

This study had a cross-sectional, exploratory design that used survey methods. The online survey was hosted by the University of Georgia Survey Research Center. Study approval was provided by the institutional review board at Georgia Health Sciences University (now Georgia Regents University), and data collection occurred during September and October 2011.

Instrument

The survey tool consisted of 86 categorical and Likert-style questions that measured adoption of the AACN practice alert, adoption of the practice alert’s recommended clinical practices, perceived guideline characteristics, personal innovativeness, communication behaviors, and collaboration. Only data from the Nursing Practice Questionnaire (NPQ), a subscale that measured clinical practices related to the practice alert, are reported here. NPQ items received minor customization to capture recommended practices from the practice alert. Our NPQ scale had an internal reliability coefficient (Cronbach’s $\alpha$) of 0.82. The NPQ consisted of 8 items for each individual practice and required mostly yes/no categorical answers. Respondents were asked to indicate whether they use a practice: yes, sometimes; yes, always; no, not aware of practice; or no, aware of practice. No definition was provided for performing a practice “yes, sometimes,” and thus selection of a response was left to the interpretation of the participant.

For questions about specific verification methods, only methods recommended by the practice alert were included as survey options. Therefore, auscultation and water bubbling methods were not included as survey options because these methods are not empirically based. All items were related to the care of blindly inserted nasogastric or feeding tubes. A blindly inserted tube was defined as a feeding tube that is inserted without imaging guidance such as fluoroscopy, endoscopy, or sonography. No distinction was made between small-bore (styleted) and large-bore (nonstyleted) feeding tubes.

Original wording in the practice alert under the heading of Expected Practice states “Obtain radiographic confirmation . . .” Radiographic confirmation is not an independent practice for generalist nurses, so we revised the language in our survey and asked if nurses recommend/encourage radiographic confirmation. Survey questions were reviewed by expert nurses for face validity, and a pilot test of the online survey was performed by 27 AACN members.

Recruitment

Invitations to participate were included in AACN’s Critical Care Newsline for 4 consecutive weeks. Detailed recruitment methods have been described previously.

Results

Sample

Descriptive statistics were used to present demographics and clinical practice data. The final sample consisted of 370 critical care nurses (Table 2). A complete description of the sample was previously published. Participants were 23 to 65 years old (mean, 43 years) and had 1 to 40 years (mean, 13 years) of critical care nursing experience. About 83% were AACN members, 51% were CCRN certified, and 14% worked in a Beacon unit. Baccalaureate or higher nursing degrees were held by 74% of the nurses.

Use a Variety of Methods To Predict Initial Location of Feeding Tube

Seventy-eight percent of participants (n=287) used a variety of methods to verify initial feeding tube placement all of the time, and 12% (n=45) implemented this practice only some of the time. Ten percent of nurses (n=38) were unaware of this practice recommendation.

Table 2 Characteristics of 370 nurses in sample

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), years</td>
<td>42.5 (10.9)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>36 (9.7)</td>
</tr>
<tr>
<td>Female</td>
<td>334 (90.3)</td>
</tr>
<tr>
<td>Years worked in critical care, mean (SD)</td>
<td>12.8 (7.9)</td>
</tr>
<tr>
<td>Nursing certification</td>
<td></td>
</tr>
<tr>
<td>CCRN</td>
<td>187 (50.5)</td>
</tr>
<tr>
<td>AACN Beacon unit</td>
<td>50 (13.5)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Values represent number (percentage) unless otherwise indicated.
A total of 332 respondents answered the question about the specific methods that were used to verify tube placement. Verification methods reported to be used all of the time included observing for signs of respiratory distress (95%, n = 315/332), observing feeding tube aspirate (82%, n = 272/332), and marking the feeding tube at the exit site (72%, n = 239/332; Figure 1). Capnography and pH measures were used less frequently (8%, n = 26/332 and 9%, n = 30/332, respectively). In the open comment field, participants identified the use of 2 additional methods for verification of initial tube placement: auscultation (20%, n = 67/332) and the water bubbling technique (0.6%, n = 2/332).

Check Feeding Tube Location at 4-Hour Intervals

Fourteen percent (n = 50) of nurses were unaware that feeding tube location should be reassessed every 4 hours. A total of 309 respondents answered questions about the specific methods they used to reassess tube position at 4-hour intervals. Methods always used included observing change in aspirate volume (89%, n = 276/309), observing the appearance of feeding tube aspirate (81%, n = 251/309), observing change in external length of the feeding tube (80%, n = 248/309), obtaining a radiograph (66%, n = 203/309), reviewing the radiography report (52%, n = 162/309), and pH measurement (7%, n = 21/309; Figure 2). Five percent (n = 16/309) of nurses reported in an open comment field that they also used auscultation for ongoing verification of feeding tube location.

Avoid Auscultatory (Air Bolus) Method

Twelve percent (n = 46) of participants indicated that they avoided using the auscultatory (air bolus) method all of the time. Ten percent (n = 38) avoided auscultation some of the time, and 77% (n = 286) never avoided using the auscultatory (air bolus) method to verify feeding tube location (Figure 3). Forty percent of nurses (n = 149) were unaware that the auscultatory method is considered unreliable.

Discussion

Fifty-five percent of participants (n = 203) were aware of the practice alert, yet only 45% (n = 167) indicated that they had used the practice alert when caring for a patient...
receiving enteral feeding.\textsuperscript{1} The methods used by nurses with CCRN certification or who were employed in a unit with Beacon award status did not differ from the methods used by other nurses. CCRN is an acute/critical care specialty certification through AACN.\textsuperscript{20} The Beacon award for excellence is presented by AACN to units that meet rigorous criteria related to patients’ outcomes and work environment.\textsuperscript{21}

The main goal when inserting feeding tubes blindly is to place the tube within the gastrointestinal tract, in either the stomach or the small bowel, and avoid insertion of the tube into the pulmonary system or other inappropriate locations. One of the challenges of feeding tube verification at the bedside is that none of the nonradiographic verification methods identifies incorrect positioning of the feeding tube within the gastrointestinal tract, such as tubes placed in the esophagus or the gastroesophageal junction.\textsuperscript{22} Administration of formula or medications through a feeding tube with ports positioned above the lower esophageal sphincter (esophageal or gastroesophageal placement) may place the patient at higher risk for aspiration of gastric fluid, medications, and/or formula into the pulmonary system.\textsuperscript{12,23,24} Because other methods do not allow identification of the exact tube position within the gastrointestinal tract, radiography is considered the gold standard for verification of blindly inserted feeding tubes before administration of formula or medications.\textsuperscript{11,12} Electromagnetic placement devices have been suggested as a replacement for radiographic confirmation of feeding tube placement at the bedside, although adverse outcomes have been reported, implying that a high level of user expertise may be necessary to obtain consistently positive results.\textsuperscript{25}

The 2 verification methods used most often by critical care nurses for initial verification of feeding tube placement in our study were observation for signs of respiratory distress and visual observation of aspirate from the feeding tube. These 2 methods are less reliable than capnography and pH methods. Although signs of respiratory distress such as decreased oxygen saturation, coughing, and dyspnea have been reported, pulmonary placement has occurred without any signs of respiratory distress.\textsuperscript{4} Critical care nurses should also be aware that cuffs from endotracheal and tracheostomy tubes do not prevent pulmonary placement of feeding tubes.\textsuperscript{3} Visual observation of the color and consistency of gastric aspirate has also been used to verify feeding tube placement. Fluid from gastric placement has been reported as green, tan, off-white and cloudy, or brown or bloody.\textsuperscript{26} Aspirates from tubes with pulmonary placement are yellow and serous or off-white/tan and mucous.\textsuperscript{26} In 1 study,\textsuperscript{26} aspirate from a number of feeding tubes with pulmonary placement resembled the color and consistency of gastric aspirate, and nurses accurately identified tubes with pulmonary placement only 57% of the time.

In our study, capnography and pH measures were infrequently used for initial verification of feeding tube placement, a finding similar to results of another national US study of critical care nurses.\textsuperscript{2} Although these 2 methods can be performed independently by nurses, barriers that may inhibit use of either technique include the need for additional supplies, equipment, and training.\textsuperscript{3} Additional barriers to the use of pH methods for ongoing tube verification include the use of formula or medications that lower gastric acid, such as H\textsubscript{2} blockers and proton pump inhibitors.\textsuperscript{27,30} Owing to the effects of medications and formula on pH measures, using the pH method to verify tube placement after feeding has been started requires that formula be withheld.\textsuperscript{30} The optimal length of time that feeding should be suspended for accurate pH measurement was suggested as “more than a few hours” in the practice alert, although in 1 research protocol, pH measures were delayed for only 1 hour after medication administration or formula being stopped.\textsuperscript{30} Researchers have also reported difficulty obtaining gastric aspirate from feeding tubes, which may pose an additional challenge to pH measurements.\textsuperscript{29} In 1 study,\textsuperscript{29} researchers recommended that 30 mL of air be instilled into the feeding tube via a syringe to clear the tube of formula before aspirating fluid.

As previously mentioned, methods such as capnography and pH do not allow users to discriminate between different tube positions within the gastrointestinal tract.\textsuperscript{4,31} These methods are sensitive to differentiating between the pulmonary and gastrointestinal systems,\textsuperscript{27,28} which may reduce risk of pulmonary placement. For example, a pH less than 5.0 typically indicates gastric placement, and a pH greater than 6.0 indicates intestinal or pulmonary placement.\textsuperscript{30,35} Unfortunately, feeding tube placement in the esophagus or gastroesophageal junction cannot be confirmed, making pH and capnography...
Nurses are encouraged to use practice alerts. 

The location of the feeding tube should be verified every 4 hours once feeding has been established to assess for change in tube position. Methods for ongoing verification may include monitoring the length of the externally marked feeding tube from the exit site (nare or lip) or monitoring gastric residual volumes for changes. Nurses are encouraged to inspect the external tube mark at 4-hour intervals to check for a change in length of the external portion of the tube. Although this method is not empirically based, the premise is that an increase in external length of the tube may prompt the nurse to perform additional verification methods such as radiographic confirmation to assess for a change in tube position. Moreover, radiographic confirmation is recommended any time that improper placement of a feeding tube is suspected.

Only 12% of nurses avoided using auscultation all of the time when verifying feeding tube placement, suggesting that 88% of nurses continued to use auscultation for feeding tube verification (all or some of the time), even though accuracy of this method is disputed. Our results are in agreement with other studies that reported auscultation was used by 73% to 93% of critical care nurses to verify initial feeding tube placement. Of the practices examined in our survey, auscultation required the least amount of specialized equipment or supplies, which may be one of the reasons this practice continues to be widely used.

It is disconcerting that auscultation continues to be one of the most commonly used methods for feeding tube verification. More than 20 years ago, Metheny et al. reported that auscultation methods were only 34% accurate, a message that was repeated by Rauen et al. Use of auscultation may compromise patient safety by failure to distinguish feeding tube locations both within and outside of the gastrointestinal tract. Nurses should replace auscultation practice with evidence-based methods for feeding tube verification.

Nursing Implications for Practice and Policy

Nurses can also play a role in increasing their knowledge of practices for verifying feeding tube location by reviewing AACN’s practice alert, presentation, and audit tool (www.aacn.org). At the unit level, audits are recommended to increase awareness of local practices for verifying feeding tube location so that a practice improvement plan can be implemented if necessary. To support local practices, institutional practice policies should be evidence-based and developed by an interdisciplinary team.

On the basis of our findings, we recommend 3 revisions of the practice alert under the headings of Expected Practice and Actions for Nursing Practice. A variety of methods are recommended for initial confirmation of feeding tube location, yet the exact number is not explicitly identified. It would be helpful to confirm the expected number of methods/techniques to be used, by including a statement such as “2 or more.” The current practice alert states that auscultation is unreliable, but it does not include an action statement for nursing practice. Because a majority of the nurses in our sample continue to use auscultation in their practice, a bold action statement should be added, such as “Do not use unreliable methods such as auscultation and water bubbling. Evidence does not support these methods and suggests risk for patient harm if used.” The third recommendation is to modify the language used for radiographic confirmation. Instead of “obtain radiographic confirmation,” a revised statement such as “encourage or recommend radiographic confirmation” would be actionable by all nurses because it is within the scope of practice for a generalist registered nurse. It is important to note that the current practice alert suggests that nurses work with an interdisciplinary team to obtain radiographic confirmation.

Limitations

Limitations of this study have been previously reported.

Conclusions

This study is the first to explore one of the AACN practice alerts in detail to determine how practice recommendations are being followed by critical care nurses. Although the majority of critical care nurses in our sample were aware of the practice alert on verification of feeding tube placement, implementation of the expected clinical practices from this guideline varied. We encourage nurses to become familiar with AACN’s practice alerts. Practice alerts are evidence-based, peer-reviewed clinical practice guidelines that are developed by content experts.
Implementing expected practices from this practice alert will bring research evidence to the bedside and minimize risk for patient harm. CCN

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