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Journal of Pediatric Nursing

journal homepage: [www.pediatricnursing.org](http://www.pediatricnursing.org)

## Evaluation of methods used to verify nasogastric feeding tube placement in hospitalized infants and children – A follow-up study



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### ARTICLE INFO

#### Article history:

Received 24 April 2021

Revised 19 October 2021

Accepted 22 October 2021

#### Keywords:

Evaluation methods

Nasogastric tube

Hospitalized children

Feeding tube placement

### ABSTRACT

**Background:** Nasogastric (NG) feeding tubes are used to deliver nutrition, hydration, and medications to hospitalized infants and children but the ongoing use of non-evidence-based practice (EBP) methods to confirm NG tube (NGT) placement has been associated with adverse patient events.

**Methods:** A study was undertaken to ascertain if practice changes have occurred since findings from a previous study were published by the New Opportunities for Verification of Enteral tube Location (NOVEL) project. The NOVEL project was an initiative of the American Society of Parenteral and Enteral Nutrition (ASPEN). A survey was distributed to member organizations participating in the NOVEL project. Respondents were also asked if and when a change in practice occurred in the policy for NGT placement verification, if there was variation within the institutional units and if there were barriers to practice change.

**Findings:** Respondents were primarily nurses (205/245) from 166 institutions that provided care to combined adult/pediatric/neonatal (122/166) patients. Respondents indicated a radiograph (64%) or pH measurement (24%) were best practice but in actual practice 42% use pH measurement and 23% use a radiograph to verify NGT placement. There was variability within institutions, with the Neonatal Intensive Care Unit (NICU) most often using aspiration and direct eye visualization to verify placement and the other units within the institutions using EBP method(s).

**Discussion:** Comparing these results to previous work by the NOVEL project shows an increase toward the use of EBP method(s) to verify NGT placement verification.

**Application to practice:** This study demonstrates variation within units at the same facility using methods unsupported by the literature, demonstrating that many centers still rely on non-EBP methods of NG placement confirmation, despite cautions issued by many major healthcare organizations.

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### Introduction

Nasoenteral tubes (NG), post pyloric, and orogastric (OG) are used in one quarter of all hospitalized neonates and children when they are

unable to orally consume medication, nutrition, and fluids (Lyman et al., 2016). Each tube insertion carries a risk of misplacement as the clinician placing the tube cannot discern where the tip of the tube is located during and after the insertion process. Hence, an extra step is required to verify tube tip location to ensure the tip is positioned in the intended location. Various methods are used by clinicians to determine NG/OG placement. The primary methods used to verify tube placement (Lyman et al., 2016) are:

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1. Aspiration of stomach contents to visualize gastric contents
2. Auscultation over the stomach while injecting air through a syringe into the tube
3. Measurement of the external tube length to determine if the tube has moved after placement
4. pH measurement of gastric contents confirming the tube is in an acidic environment
5. Abdominal radiograph to visualize the tube ending in the stomach.

Of the methods listed above, only pH measurement and abdominal radiographs are supported in the literature as valid, safe verification methods (Safety Alert, 2012; Child Health Patient Safety Organization, 2012; AACN Practice Alert, 2020; Patient Safety Movement Foundation, 2019a, 2019b; Irving et al., 2018). These are the standards that should be used as EBP methods.

Tube misplacement, defined as the tip of the tube not being positioned in the intended location in the gastrointestinal tract, is common occurring in 1.3–2.4% of tube placements with up to 20% of misplacements causing pulmonary complications and 0.5% resulting in death (Sarikin & Gottlieb, 2006; Aguilar-Nascimento & Kudsk, 2007). Pulmonary misplacements can occur in patients of all ages, and inappropriate placement in the gastrointestinal tract but not the stomach can also result in significant morbidity (Wallace, 2017), Quandt et al. (2009) in a study of neonates, demonstrated high rates of tube misplacement (59%) which they attributed to inappropriate measurement methods to ascertain the insertion depth.

A 2012 alert by the Child Health Patient Safety Organization called for immediate discontinuation of auscultation as a method to verify NGT placement. This alert recommended use of gastric pH as the first line method to verify NGT placement (Child Health Patient Safety Organization, 2012). The use of gastric pH has also been recommended as the first line placement verification method by the United Kingdom National Health Service (National Health Service, 2016) and the Patient Safety Movement Foundation, 2019 with global representation from 51 countries and 4700 hospitals. While these organizations recommend pH as the first line location verification method, they also recommend abdominal radiographs in patients with no gag reflex, decreased level of consciousness, or who demonstrate clinical deterioration shortly after tube placement (Child Health Patient Safety Organization, 2012). These recommendations mirror the best practice recommendations for NGT and oral gastric tube (OGT) placement in infants and children published by Irving et al., 2018. This is the work of an international, interdisciplinary, and inter-organizational work group, the New Opportunities for Verification of Enteral tube Location (NOVEL) project started by the American Society for Parenteral and Enteral Nutrition (ASPEN) in 2012. The recommendations include a decision tree for checking pH and what to do if an aspirate cannot be obtained.

Despite the strong recommendation by several national and international professional organizations in support of pH measurement as the first line method to verify NGT and OGT placement based on supporting data for pH measurement of obtained aspirate, it is unclear how many institutions and other organizations have implemented this recommended practice. Additionally, most of the studies conducted include adult not pediatric patients. A survey completed by 2298 critical care nurses indicated that while 92.3% knew an abdominal radiograph is recommended in their adult ICU for NGT placement verification, only 57.5% requested an order for one when a non-stylet NGT was placed (Wertheny et al. (2012). This variation in the practice and the use of non-EBP method(s) to verify NGT placement is a patient safety issue, as these tubes can be misplaced causing negative patient outcomes.

The purpose of this study was to ascertain the policies and procedures related to NGT placement verification in acute care facilities that care for pediatric and neonatal patients aged up to 18 years of age. These data were compared with data from the original NOVEL project to evaluate what changes in practice have occurred (Lyman et al., 2016). Specific aims of this study were to:

1. Discern current methods used to verify NGT placement verification in pediatric acute care facilities.
2. Ascertain if policy and procedures changes related to NGT placement verification have occurred in acute care facilities in the past 5 years.
3. Determine any perceived barriers to changes in current policies related to NGT placement verification in acute care facilities.

## Methods

This descriptive study utilized a survey-based questionnaire platform (Survey Monkey, 2019, USA). The survey consisted of 15 numbered questions, 4 that required the participant to free text a response and 10 questions with open-ended options. The survey was distributed to health care professionals in acute care hospitals that provide care to infants and children up to 18 years old. The NOVEL project has representatives from American Association for Critical Care Nurses (AACN), Society of Pediatric Nurses (SPN), Association of Pediatric Gastrointestinal and Nutrition Nurses (APGNN), Child Health Patient Safety Organization, and a parent as a safety advocate. The survey was distributed via the electronic membership listing of each organization. The survey was available for four weeks with reminders sent every two weeks to increase participation.

Data collected included the following elements:

- a. The type of staff (e.g., nurses, physician assistants, dietitians, physicians, etc.)
  - b. The type of institution (e.g., free standing pediatric, pediatric within an adult hospital, etc.)
  - c. Current policy for NGT placement verification
  - d. Procedural variation based on patient location within the facility (e.g. NICU/ NICU stepdown), Pediatric Intensive Care Units (PICU/ PICU stepdown), Cardiac Intensive Care Units (CICU/CICU stepdown), inpatient pediatric unit, combined pediatric/medical surgical unit, other)
  - e. Identification of policy changes within the past 5 years related to NGT placement verification
  - f. Reasons that prompted any NGT placement verification policy and procedure changes
  - g. Identification of any perceived barriers to changing current policies to best practice. Data analysis consisted of a descriptive analysis to determine characteristics of participating facilities
- The University of Mississippi Medical Center Institutional Review Board reviewed and approved this project through exemption.

## Results

Twenty-three of the 63 original institutions from the 2015 NOVEL project study participated in the follow up survey. Fig. 1 shows the actual practice reported by respondents to verify NGT placement as being pH, radiograph, aspiration and visualization, aspiration, and auscultation in order of most to least common. Thus, most respondents (63%) are using evidence-based method(s) to verify placement of an NGT. Auscultation is now the least often used method to verify NGT placement. When compared to the respondents' understanding of what best practice is for verifying NGT placement, radiography was the most common response with pH being a distant second choice and all other methods were selected much less frequently. Combining radiograph and pH measurement, 88% of pediatric nurses selected evidence-based methods for NGT placement verification. Fig. 1 suggests the majority of pediatric nurses both know and practice evidence-based method(s) to verify NGT placement.

Responses in the NICU population indicated that the use of auscultation and visualization are more common than the use of pH (which is most common response outside the NICU). This finding is consistent with findings in the previous study. The responses for the study described herein indicated several triggers for change in policies/

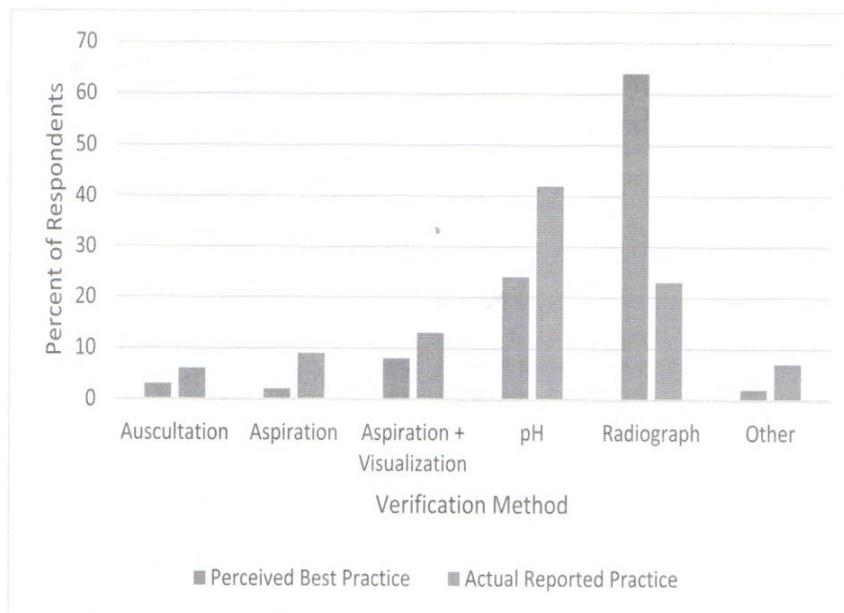


Fig. 1. Comparison of perceived best practice vs. actual practice to verify NG tube placement.

procedures, which included serious patient safety events, literature review, presence of a change champion/leader, attendance at a nursing conference where this issue was presented, and/or influence by a professional organization. Additionally, respondents indicated that barriers to implement EBP recommendations were related mostly to usage, access and accuracy of use of pH testing and supplies.

The specific areas addressed by this study are outlined below.

#### Staff surveyed

There are an estimated 354 pediatric hospitals in the US, and with this study there were responses from 166 hospitals (47%). The number of pediatric nurse members of AACN is not known. The number of ASPEN members is known, but not how many see pediatric patients. SPN has approximately 3400 members. The survey was sent to these general memberships. Of the 245 respondents to the survey; 205 were nurses with 95% indicating they are registered nurses or advanced practice nurses, 28 were physician assistants, 9 were registered dietitians and 3 were physicians. The primary work units of the respondents included NICU ( $n = 33$ ), PICU ( $n = 38$ ), Cardiac ICU ( $n = 9$ ), Inpatient pediatric floor ( $n = 136$ ), Inpatient rehabilitation unit ( $n = 3$ ) and other ( $n = 26$ ). Approximately 33% of the respondents work in critical care areas and 11% work in non-categorized areas such as education.

#### Type of institution

The hospitals represented in this study were primarily combined adult/pediatric/neonatal facilities ( $n = 122$ ) followed by free standing pediatric institutions ( $n = 77$ ). A small number were NICU units in an adult institution ( $n = 3$ ) and the remainder were other facilities such as rehabilitation centers ( $n = 4$ ). Not all 245 respondents answered this question ( $N = 39$ ). The 206 responses represent a total of 166 institutions. The mean bed size was 161 (range 5–500).

#### Current NGT placement verification policy

There were 138 institutions with one respondent; 13 with 2 respondents and 15 with 3 or more respondents for a total of 166 institutions. Of the hospitals with 2 respondents, 8 had complete agreement on placement verification, 3 reported a difference in NICU or PICU practice versus inpatient units, and 2 respondents had different answers within the same unit type. Of the 15 institutions with 3 or more respondents; 6

institutions reported 100% agreement on NGT placement verification methods with 5 using pH and 1 reported auscultation + visualization. Four institutions with 3 or more respondents indicated different practice in the NICU compared with other areas in the organization. Of those responses, 1 institution reported a radiograph and mark and measure as NICU methods. Another hospital, with a total of 10 responses, reported 5 different methods. For example, inpatient units were identified as using pH or radiographs, but the NICU used aspiration and visualization. One hospital, with 33 respondents, had 22 indicating pH for inpatient units and 11 indicated the use of auscultation in the NICU.

#### Procedural variations

When respondents were asked if there are differences in NGT placement verification methods within their institution, 40% selected no, 38% selected yes and 22% did not know. Eighty-four respondents answered yes to the question regarding inter-unit variability of placement methods within the same institution. Another 12 respondents did not know if there are differences and 16 indicated there are differences but they did not know what or where the differences occur. Two institutions with 3 or more respondents had placement verification differences based on type of unit. These responses tended to again focus on NICUs using auscultation and visualization while the use of pH being the most common response outside the NICU. Not all respondents answered this question.

#### Policy changes

When asked how long the primary placement verification method has been used; 30% of respondents did not know, 16% selected within the past 2 years, 23.3% indicate within the past 2–5 years and another 31% indicated the change had occurred within the past 5 years or longer.

#### Prompts for change

When asked what triggered the change in practice the most common answer was "I don't know" (46%), followed by nursing administration (34.5%), other "such as a patient safety event" (12%), NOVEL project (10%) and then attendance at a conference (3%). This question had a free text box for respondents to elaborate on their answers and respondents could check all that apply to the question meaning some selected more

than one answer. Themes in these free text comments included, serious patient safety event, literature review, presence of a change champion/leader, attendance at a nursing conference where this issue was presented, or influence by a professional organization. Among the professional organizations listed as influencing change were the American Association of Critical Care Nurses, Society of Pediatric Nurses, and the American Society for Parenteral and Enteral Nutrition.

### Barriers

When asked if barriers exist within their institution that might prevent change to the use of pH measurement to evaluate NGT placement 83% responded no, 34% responded yes and 11% responded does not apply. Barriers within an institution to using pH or a radiograph were identified as radiation exposure ( $n = 86$ ), cost ( $n = 53$ ), challenges associated with point of care testing ( $n = 51$ ), no need to change current practice ( $n = 31$ ) and current policies do not support these methods ( $n = 18$ ). Seventy-five respondents indicated there are no barriers to change with 20 respondents not sure if barriers exist and 51 respondents selected the “other” response. For those that responded with “other” to this item, they were asked to provide additional information within a free text box. Analyses of these responses resulted in the identification of themes. These themes included concerns related to the accuracy of pH measurement to evaluate NGT placement. Accuracy was questioned due to the use of gastric acid reducing medications and/or timing of last feeding and with specific populations (NICU). The feasibility of using this practice in some settings (e.g. home care) was identified as a barrier. Other themes included lack of available supplies to conduct pH testing and the need for staff to be tested for color blindness to accurately interpret pH results. A few respondents indicated they saw no reason to change and described a reluctance to change a long-standing practice.

### Discussion

Patient safety and practice alerts have warned against the use of auscultation and visual inspection of gastric aspirate as a means of NGT location verification (Child Health Patient Safety Organization, 2012; Lipman et al., 1985). Despite these warnings and practice alerts, methods vary widely by nurses caring for pediatric patients. The results of this study indicate a continuing but narrowing gap in the perception vs actual practice of pediatric nurses.

The results of this study of pediatric clinicians (mostly nurses) indicate a trend toward more EBP methods to verify NGT placement. To date, most of the literature related to EBP regarding NGT placement and verification is found in the adult literature. A recent national survey of NGT feeding verification practices among 408 adult based critical care nurses also suggests gaps in use of EBP methods. In this survey, auscultation was reported by 76% of respondents as their first line method to verify NGT placement. Interestingly however, 72% of the nurses indicated they use the AACN Practice Alert on NGT placement which specifically recommends against the use of auscultation (AACN Practice Alert, 2020).

The original NOVEL project, a one-day prevalence study, evaluated the policies and procedures related to NGT placement verification in acute care facilities that cared for neonatal and pediatric patients up to 18 years of age (Lyman et al., 2016). The purpose of this current study was to discern any changes in the current practice to verify NGT placement compared to findings from the original study as well as, to determine any perceived barriers to changes in current policies related to NGT placement verification in pediatric acute care facilities. While the first study focused on the specific institution policy for NGT placement verification, this study asked individual participants about their understanding and actual practice.

### Barriers to practice change

A possible barrier to adoption of the use of pH as a technique to evaluate NGT placement in infants is the concern for its accuracy in this population. Kemper et al. (2019) conducted a large retrospective study to evaluate pH measurement in a NICU population with consideration of different feeding methods and exposure to acid suppressing medications. Close to 7000 gastric pH measurements were evaluated with the majority (97.5%) of pH samples measuring a pH of 5 or less across all variables. The use of pH as a useful bedside method of NGT location has been demonstrated by Metheny et al. (2017) showing that pH values under 5.0 have strong positive predictive values for NG placement in the stomach and this increases as pH values decrease to the 4.0 level. Similarly, Meert et al. (2015) have demonstrated that while feeding frequency and use of acid suppressing medications influence the pH measurement of gastric secretions in neonates, the effects are not significant enough to negate pH use as the best practice technique in children and neonates of any age. As with previous studies, this study indicated that pH is not the preferred method in NICU's, but rather the use of visualization and auscultation. Despite the findings in the literature, there does not appear to be a trend toward a change to EBP guidelines in NICU infants.

Respondents also addressed additional barriers to changing from non-EBP methods within their institutions. The most common barrier was the concern associated with radiation exposure. While radiograph confirmation of NGT placement is identified as the gold standard, it is also recognized that repeated radiation exposure poses health risks (Irving et al., 2018). In addition, the cost and time required to obtain and confirm NGT placement via radiograph is a legitimate concern. Cost of radiography was identified as a barrier and one respondent even commented on the cost of pH paper.

Barriers associated with the point of care process used to test pH of NGT aspirate were identified. Point of care testing requires specific validation and competency assessment required by regulatory and accrediting bodies (Point of Care Testing and Joint Commission International, 2021). This can be challenging but should not be the reason to forego implementation of an EBP standard. The potential risk to patients and the risk associated with not following recommended practice standards should be the primary consideration.

Two other barriers were identified by respondents that are potentially troubling. Those were: “No need to change practice” and “Current Policies do not Support these methods”. Possibly, respondents chose the “No need to change practice” option having already implemented radiologic verification and/or pH measurement within their organizations. However, it is also possible the respondents were using other non-EBP to evaluate NGT placement. The practice of using auscultation or visualization of NGT aspirate was taught to many currently practicing clinicians and they subsequently may not have directly experienced a misplacement event. This could contribute to some clinicians not recognizing a reason for practice change. Also, policies within organizations may be outdated and not reflect the most recent EBP.

Research evaluating the adoption of EBP standards provides insight regarding overcoming these barriers. Brown et al. (2009) identified the top perceived barriers for nurses in implementing EBP as lack of time and lack of nursing autonomy. Learning opportunities, availability of resources, and a culture that supports, encourages and rewards nursing autonomy were reported as facilitating adoption of EBP. These researchers recommended ensuring nurses have time to access evidence and guidance on the implementation process. Using an established framework such as Everett Rogers' Diffusion of Innovation Theory has been recommended to guide implementation of EBP. Specific factors such as knowledge and work experience that were identified as contributing to adoption of EBP, and the researchers suggested including interventions associated with these components (Rogers, 2003). Hanrahan et al. (2015) identified old habits in practice that they characterized as “sacred cows” and recommended a systematic review of the literature

to identify EBP and eliminate unvalidated practices. These various identified barriers emphasize the need to establish easy, quick, and accurate bedside methods to evaluate NGT placement.

#### Addressing variation

Despite the changes noted in this study, there is a concern for the level of variation in the practice of verifying NGT placement. Helfrich et al. (2018) state that change is the process of un-learning, requiring educators to consider both automatic and reflective cognition when designing de-implementation strategies to bring about the changes necessary. The results of another study highlight several key concepts of de-implementation theory including acceptability, appropriateness, cost, feasibility and penetration (Prusaczyk et al., 2020). Respondents indicated non-EBP methods such as auscultation and visualization were unacceptable but were not sure if in certain settings it was appropriate or feasible to change, for example in the NICU. This dichotomy of practice between the NICU and other nursing units highlights the natural tension that occurs between feasibility of de-implementation and concerns for patient safety. One barrier identified to de-implementation of non-EBP methods in our study was the cost of change to the use of pH or radiograph.

Penetration refers to the ability of a system to assure de-implementation occurs in all areas of a service setting. The results of our study validate the challenges in accomplishing de-implementation of low value, unsafe practices for NGT placement verification.

Differences in verification techniques within units are interesting and require attention. These differences could signal that individual staff nurses rely on personal experiences and not on EBP for NGT placement. Contrasting opinions expressed by colleagues in different units can also create confusion and undermine safety initiatives. Both the standardization of practice across different units within hospitals and the use of EBP for verifying NGT placement should be viewed as important safety initiatives by individual teams, institutional administrations, nursing organizations, and safety committees.

Additionally, our study demonstrates the challenges to changing a tradition-based practice of many years using the process of de-implementation or letting go of practices that are deemed of low value, no longer necessary or unsafe. A study by Bourgault et al. (2020) found that the de-implementation of auscultation as a method to verify NGT placement is influenced by several factors. These include direct observation of others using the auscultation method, institutional policies that use other methods to check NGT placement, the awareness of these policies by nurses, the type of nursing education, facility type, and psychological biases. In our follow-up study by the NOVEL project, the question of what triggered the change in practice found that the majority of the respondents (46%) replied that they did not know what prompted the change. A policy change by nursing administration was selected by one third of the respondents as the impetus for change. An additional 11% of the respondents indicated that events, such as a serious safety event or personal or family knowledge of a misplaced NGT triggered a practice change. The NOVEL project itself, was credited as having brought about a change in practice from about 10% of the respondents. This suggests the work done by the NOVEL project over the last five years is having an impact on practice.

#### Limitations of the study

Participation in this study was voluntary and not all pediatric hospitals that previously participated in the 2015 study had a staff member willing to champion this cause again. Also, it is not possible to verify data submitted by respondents, thus accuracy of all respondents may be limited.

#### Conclusion

The variability noted in these findings point to a lack of standardization of an important patient safety practice. This variability in practice for NGT verification has long been a challenge and has been addressed for nearly a decade as a significant concern by various major nursing and patient safety organizations including the NOVEL project of ASPEN (Lyman et al., 2016). While progress has been made toward using the EBP methods of pH measurement and/or abdominal x-ray to verify NGT placement, further education is needed to establish this as a standard of care among nursing organizations.

#### Author statement

None.

#### Financial disclosures

There is only one author with a financial disclosure. The remaining authors have no disclosures or competing interests.

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*Financial disclosure:* Nothing to disclose.

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*Financial disclosure:* consultant for Avanos.

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*Financial disclosure:* Nothing to disclose.

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*Financial disclosure:* Nothing to disclose.

Carol Kemper, PhD, RN, CPHQ, CPPS, FAAN (Children's Mercy -Kansas City) Kansas City, MO representing Children's Healthcare Association Patient Safety Officers.

*Financial disclosure:* Nothing to disclose.

Deahna Visscher; Parent Representative and Safety Advocate Littleton, CO.

*Financial disclosure:* Nothing to disclose.

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*Financial disclosure:* Nothing to disclose.

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*Financial Disclosure:* Nothing to disclose.

## Declaration of Competing Interest

None.

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