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Confirmation of Nasogastric/Orogastric Tube (NGT/OGT) Placement

Clinical Question

P (population/problem) Among pediatric patients who require NGT/OGT placement
I (intervention) does auscultation, pH, enzyme, visual inspection of aspirate, and CO₂ testing
C (comparison) compared to radiological verification
O (outcome) provide an accurate confirmation of tube placement?

P (population/problem) Among pediatric patients who require NGT/OGT placement
I (intervention) are tube length predictions using age-related height –based (ARHB) methods
C (comparison) compared to nose-ear-xiphoid (NEX) morphological measurements
O (outcome) more accurate in predicting tube length?

Target Population Pediatric patients who require NGT/OGT placement for feeding or gastric decompression.

Recommendations (See Table of Recommendation Strength following references)

1. It is recommended that radiologic verification be used to determine NGT/OGT placement in pediatric patients who are at high risk of aspiration or when non-radiologic methods are not feasible, or results are unclear.

Note: Pediatric patients at risk for incorrect tube placement include those who have neurologic impairment and other conditions which may increase the difficulty of safe, effective tube placement and include patients who are obtunded, sedated, unconscious, critically ill and those with reduced gag reflex or static encephalopathy (Metheny, 1994a [3a], Phang, 2004 [3b], Ellett 1999 [4b]).

Note: Radiologic verification is considered the gold standard but may contribute to higher costs, decreased convenience, and increased radiation exposure (Metheny 1994a [3a], Metheny 2002 [3a], Nyqvist 2005 [4a], Peter 2008 [4a], Ellett 1999 [4b], Westhus 2004 [4b]).

2. It is recommended that non-radiological verification methods be used to confirm placement of NGT/OGT in pediatric patients who are not considered at high risk for aspiration as outlined above, using the following method:

Aspirate pH testing: Use aspirate pH ≤ 5 to confirm gastric placement (Ellett, 2005 [3a], Metheny, 1999b [4a], Metheny, 2002 [3a], Metheny, 1999a [4a], Metheny, 1993 [3a],) (See Table 1).

Note: Gastric aspirate pH mean is statistically lower (higher acidity) compared to intestinal aspirate mean pH (Metheny, 1999a [4a]).

Note: Mean pH of respiratory aspirate from the tracheobroncheal tree or plural space is statistically higher than gastric aspirate pH (Metheny, 1999a [4a]).

Note: pH testing can be accurately done with pH paper or pH meter (Ellett, 2005 [3a], Metheny, 1994a [3a], Westhus, 2004[4b]).

Note: Mean values for gastric aspirate are not significantly different when patients are fed or fasting (Metheny, 2002[3a], Metheny, 1999a [4a]).

Note: Mean values for aspirate are not significantly different when patients are on or off acid suppression medications (Ellett, 2005[3a], Metheny, 1994a [3a]).

Note: Auscultation has been shown to have poor reliability and is not recommended as a sole verification method. (Ellett, 1999[4b], Metheny, 2002 [3a], Metheny, 1990 [4a], Neumann, 1995 [3b]).

Note: Visual inspection of aspirate has not been shown to be a reliable sole method of verification; however, it may have some use when done in conjunction with pH testing (Garpure, 2000[4a], Metheny, 2002 [3a], Metheny, 1999b [4a], Metheny, 1994a [3a], Metheny, 1994b [4a], Phang, 2004 [3b], Westhaus 2004 [4b]).

Note: Aspirate testing of enzyme levels for bilirubin, pepsin, and trypsin also provide an alternate method of verification, but it is limited to laboratory assessment (Ellett 2005 [3a], Gharpure, 2000 [4a], Metheny, 2002 [3a], Metheny, 1999 a [4a], Westhaus, 2004 [4b]).

Note: While CO2 monitoring provides an alternate method of verification, it requires a capnograph monitor to determine incorrect tube placement (Ellett, 2005 [3a]).

3. It is recommended that NGT/OGT length be predicted as follows:

For children >2 weeks, age- related height-based (ARHB) methods are more accurate than other morphological measures such as nose-ear-xiphoid (NEX) or nose-ear-mid-xiphoid-umbilicus (NEMU) in predicting tube length and can be calculated using prediction equation tables (see Table 2) (Beckstrand, 2007 [4a], Ellett, 1992 [4b], Klausner, 2002 [2b], Putnam, 1991[4a], Strobel, 1979 [4b]).

For neonates less than 2 weeks of age, patients with short stature, or if unable to obtain an accurate height, use morphological measurements such as NEX or NEMU (Beckstrand, 2007 [4a]).

Note: Measurement using the NEMU method for tube length prediction versus the NEX method is slightly more reliable for tube length prediction (Beckstrand, 2007[4a], Gallaher, 1993 [3a] Weibley, 1987[4a]).

Note: Short stature is defined as a standing height more than 2 standard deviations (SDs) below the mean (or below the 2.5 percentile) for sex (Cohen, 2008, [5]).

Note: Mark tube length at the nare for NGT, or corner of the mouth for OGT with indelible permanent marker and document amount of tube remaining (external visible length) (EVL) outside the patient in the patient record (Weibley, 1987 [4a]).

| See Figure 1 for Algorithm: Confirmation of NGT/OGT Placement

Grade for the Body of Evidence is moderate.

Relevant CCHMC policies/procedures:

I-229 Confirmation of Proper Position of NG/NJ Tubes

Mosby Skill: *Nasogastric/Orogastric Tube: Insertion and Removal; Marking and Verification***Discussion/summary of evidence**

Radiologic verification of NGT/OGT is considered the gold standard. However, non-radiologic verification methods provide an accurate alternative in patients who are not considered at high risk for aspiration. Bedside pH testing of gastric aspirate can be used to confirm placement (Ellett, 2005 [3a], Metheny, 1999b [4a], Metheny, 2002 [3a], Metheny, 1999a [4a], Metheny, 1993 [3a]). Although widely used, the auscultatory method of tube verification has been shown to have poor reliability and is not recommended as a sole verification method (Ellett, 1999[4b], Metheny, 2002 [3a], Metheny, 1990 [4a], Neumann, 1995 [3b]). In addition, visual inspection of aspirate has not been shown to be a reliable sole method of verification; however, it may have some use when done in conjunction with pH testing (Garpure, 2000[4a], Metheny, 2002 [3a], Metheny, 1999b [4a], Metheny, 1994a [3a], Metheny, 1994b [4a], Phang, 2004 [3b], Westhaus 2004 [4b]). Aspirate testing of enzyme levels for bilirubin, pepsin, and trypsin also provide an alternate method of verification, but are limited to laboratory assessment (Ellett, 2005 [3a], Gharpure, 2000 [4a], Metheny, 2002 [3a], Metheny, 1999 a[4a], Westhaus, 2004 [4b]). While CO₂ monitoring provides an alternate method of verification, it requires a capnograph monitor to determine incorrect tube placement (Ellett, 2005 [3a]). There is moderate evidence that improving the accuracy of NGT/OGT length prior to insertion will enhance the precision of successful tube placement (Beckstrand, 2007 [4a], Ellett, 1992 [4b], Gallaher, (1993) [3a], Klausner, 2002 [2b], Putnam, 1991 [4a], Strobel, 1979 [4b]). Magnet tracking systems have been shown to be accurate but the clinical feasibility of their use needs further investigation (Bercik, 2005).

Health Benefits, Side Effects and Risks

Non-radiological NGT/OGT placement methods contribute to decreased radiation exposure for pediatric patients (Metheny, 2002 [3a], Peter, 2008 [4a], Westhus, 2004 [4b], Nyqvist, 2005 [4a], Metheny, 1994a [3a], Ellett, 1999 [4b]). Side effects include improperly placed tube due to measurement or placement error. Risks of improperly placed tubes include aspiration, feeding into the wrong place, and irritation.

References/citations (evidence grade in []; see *Table of Evidence Levels following references*)

- Beckstrand, J., Ellett, M. L. C., & McDaniel, A. (2007). Predicting internal distance to the stomach for positioning nasogastric and orogastric feeding tubes in children. *JAN: Journal of Advanced Nursing*, February, 274-289. [4a]
- Bercik, P., Schlageter, V., Mauro, M., Rawlinson, J., Kucera, P., & Armstrong, D. (2005). Noninvasive verification of nasogastric tube placement using a magnet-tracking system: A pilot study in healthy subjects. *Journal of Parenteral and Enteral Nutrition*. 29,305.
- Cohen P, Rogol AD, Deal CL, et al. (2008). Consensus statement on the diagnosis and treatment of children with idiopathic short stature: a summary of the Growth Hormone Research Society, the Lawson Wilkins Pediatric Endocrine Society, and the European Society for Paediatric Endocrinology Workshop. *Journal of Clinical Endocrinology and Metabolism*, 93(11):4210-7. [5]
- Ellett, M. L. C., & Beckstrand, J. (1999). Examination of gavage tube placement in children. *Journal of the Society of Pediatric Nurses*, 4(2), 51-60. [4b]
- Ellett, M. L. C., Beckstrand, J., Welch, J., Dye, J., & Games, C. (1992). Predicting the distance for gavage tube placement in children. *Pediatric Nursing*, 18(2), 119-23-127. [4b]
- Ellett, M. L. C., Croffie, J. M. B., Cohen, M. D., & Perkins, S. M. (2005). Gastric tube placement in young children. *Clinical Nursing Research*, 14(3), 238-52. [3a]
- Gallaher, K. J., Cashwell, S., Hall, V., Lowe, W., & Cizek, T. (1993). Orogastric tube insertion length in very low birth weight infants. *Journal of Perinatology*, 13(2), 128-31. [3a]

- Garpure, V., Meert, K.L., Sarnaik, A.P. & Metheny, N.A. (2000). Indicators of post pyloric feeding tube placement in children. *Critical Care Medicine*, 28(8) 2962-6. [4a]
- Klasner, A.E., Luke, D.A., & Scalzo, A.J. (2002). Pediatric orogastric and nasogastric tubes: a new formula evaluated. *Annals of Emergency Medicine*, 39, 3. [2b]
- Metheny, N., McSweeney, M., Wehrle, M., & Wiersema, L. (1990). Effectiveness of the auscultatory method in predicting feeding tube location. *Nursing Research*, 39(5), 262-7. [4a]
- Metheny, N., Reed, L., Berglund, B., & Wehrle, M. A. (1994B). Visual characteristics of aspirates from feeding tubes as a method for predicting tube location. *Nursing Research*, 43(5), 282-7. [4a]
- Metheny, N. A., Clouse, R.E. Clark, J.M., Reed, L., Wehrle, M. A., & Wiersema, L. (1994A). Techniques & procedures: pH testing of feeding-tube aspirates to determine placement. *Nutrition in Clinical Practice*, 9(5), 185-90. [3a]
- Metheny, N. A., Eikov, R., Rountree, V., & Lengettie, E. (1999B). Indicators of feeding-tube placement in neonates. *Nutrition in Clinical Practice*, 14(6), 307-14. [4a]
- Metheny, N. A., Meert, K. L. (2004). Monitoring feeding tube placement. *Nutrition in Clinical Practice*. 19(5), 487 – 495 [5].
- Metheny, N. A., & Stewart, B. J. (2002). Testing feeding tube placement during continuous tube feedings. *Applied Nursing Research*, 15(4), 254-8. [3a]
- Metheny, N. A., Stewart, B. J., Smith, L., Yan, H., Diebold, M., & Clouse, R. E. (1999A). pH and concentration of bilirubin in feeding tube aspirates as predictors of tube placement. *Nursing Research*, 48(4), 189-97. [4a]
- Metheny, N., Reed, L., Wiersema, L., McSweeney, M., Wehrle, M., & Clark, J. (1993). Effectiveness of pH measurements in predicting feeding tube placement: An update. *Nursing Research*, 42(6), 324-331. [3a]
- Neumann, M. J., Meyer, C. T., Dutton, J. L., & Smith, R. (1995). Hold that X-ray: Aspirate pH and auscultation prove enteral tube placement. *Journal of Clinical Gastroenterology*, 20(4), 293-295. [3b]
- Nyqvist, K. H., Sorell, A., & Ewald, U. (2005). Litmus tests for verification of feeding tube location in infants: Evaluation of their clinical use. *Journal of Clinical Nursing*, 14, 486-495. [4a]
- Peter, S. & Gill, F.(2008). Development of a clinical practice for testing nasogastric tube placement. *Journal of the Society of Pediatric Nurses*, 14, (1), 3-11. [4a]
- Phang, J. S., Marsh, W. A., Barlows, T. G. I., & Schwartz, H. I. (2004). Determining feeding tube location by gastric and intestinal pH values. *Nutrition in Clinical Practice*, 19(6), 640-4. [3b]
- Putnam, P.E., & Orenstein, S.R. (1991). Determining esophageal length from crown-rump length. *Journal of Pediatric Gastroenterology and Nutrition*, 13, 354-359. [4a]
- Strobel, C., Byrne, W., Ament, M., & Euler, A. (1979). Correlation of esophageal lengths in children with height: Application to the Tuttle test without prior esophageal manometry. *Journal of Pediatrics*, 94(1), 81-84. [4b]
- Weibley, T. T., Adamson, M., Clinkscales, N., Curran, J., & Bramson, R. (1987). Gavage tube insertion in the premature infant. *MCN: The American Journal of Maternal/Child Nursing*, 12, 24-27. [4a]
- Westhus, N. (2004). Methods to test feeding tube placement in children. *MCN: The American Journal of Maternal/Child Nursing*, September/October, 283-291. [4b]

Note: Full tables of evidence grading system available in separate document:

- [Table of Evidence Levels of Individual Studies by Domain, Study Design, & Quality](#) (abbreviated table below)
- [Grading a Body of Evidence to Answer a Clinical Question](#)
- [Judging the Strength of a Recommendation](#) (abbreviated table below)

Table of Evidence Levels (see note above)

<i>Quality level</i>	<i>Definition</i>
1a† or 1b†	Systematic review, meta-analysis, or meta-synthesis of multiple studies
2a or 2b	Best study design for domain
3a or 3b	Fair study design for domain
4a or 4b	Weak study design for domain
5	Other: General review, expert opinion, case report, consensus report, or guideline

†a = good quality study; b = lesser quality study

Table of Recommendation Strength (see note above)

<i>Strength</i>	<i>Definition</i>
“Strongly recommended”	There is consensus that benefits clearly outweigh risks and burdens (or visa-versa for negative recommendations).
“Recommended”	There is consensus that benefits are closely balanced with risks and burdens.
No recommendation made	There is lack of consensus to direct development of a recommendation.

Dimensions: In determining the strength of a recommendation, the development group makes a considered judgment in a consensus process that incorporates critically appraised evidence, clinical experience, and other dimensions as listed below.

1. Grade of the Body of Evidence (see note above)
2. Safety / Harm
3. Health benefit to patient (*direct benefit*)
4. Burden to patient of adherence to recommendation (*cost, hassle, discomfort, pain, motivation, ability to adhere, time*)
5. Cost-effectiveness to healthcare system (*balance of cost / savings of resources, staff time, and supplies based on published studies or onsite analysis*)
6. Directness (*the extent to which the body of evidence directly answers the clinical question [population/problem, intervention, comparison, outcome]*)
7. Impact on morbidity/mortality or quality of life

Supporting information

Introductory/background information

Error rates for placement of enteral tubes in any location, other than the intended location, can be up to 43.5% in pediatric settings (Ellett, 1999). A small percentage of enteral tubes, reported as 1%-4% in adult intensive care settings but unknown in pediatrics, are incorrectly placed within the respiratory tract with potentially serious consequences (Ellett, 2005, Metheny, 1999b, Metheny, 1994a). Children who are comatose, semi-comatose, or have swallowing problems have higher placement errors outside the intended location (Ellett, 1999) and ought to be considered at higher risk for incorrect placement. Radiography is considered the gold standard for documenting tube placement (Ellett, 1999, Metheny, 2004). However, routine radiologic tube verification in pediatric and adolescent patients increases the risk of excessive radiation exposure, increases patient and healthcare costs, and slows the delivery of clinical care (Ellett, 1999, Neumann, 1995). Due to these patient and healthcare risks, the evidence for the best methods to accurately verify NG/OG placement was reviewed.

Group/team members

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Search strategy

OVID Databases

Medline, CINAHL, PubMed and the Cochrane Database for Systematic Reviews (CDSR)

OVID Filters

Publication Date: 1996 to present

Limits: Humans and English Language

Study Type: Highest quality evidence

Search Terms and MeSH Terms

Children, nasogastric tube, NG tube, aspirate, auscultation, radiology, morphological, age-related height based, accuracy, prediction, length.

Additional articles identified from reference lists and clinicians

Applicability issues

Can be applied to pediatric and adolescent patients in a hospital setting.

Methods which can be performed at the bedside allow greater convenience for the patients, families and staff, and may contribute to decreased costs.

Required equipment is minimal and includes pH strips which are sensitive enough to make a determination of ≤ 5 . A pH meter was not found to be more accurate than pH strips for measuring gastric pH. (Westhaus, 2004) [4b].

Copies of this Best Evidence Statement (BES_t) are available online and may be distributed by any organization for the global purpose of improving child health outcomes. Website address: <http://www.cincinnatichildrens.org/svc/alpha/h/health-policy/ev-based/default.htm>
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- copies may be provided to anyone involved in the organization's process for developing and implementing evidence based care;
- hyperlinks to the CCHMC website may be placed on the organization's website;
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Note

This Best Evidence Statement addresses only key points of care for the target population; it is not intended to be a comprehensive practice guideline. These recommendations result from review of literature and practices current at the time of their formulation. This Best Evidence Statement does not preclude using care modalities proven efficacious in studies published subsequent to the current revision of this document. This document is not intended to impose standards of care preventing selective variances from the recommendations to meet the specific and unique requirements of individual patients. Adherence to this Statement is voluntary. The

clinician in light of the individual circumstances presented by the patient must make the ultimate judgment regarding the priority of any specific procedure.

Reviewed against quality criteria by two independent reviewers

Table 1: Summary of findings for Gastric, Intestinal and Respiratory pH

Study	Sample	Gastric Aspirate pH mean (SD)	Intestinal Aspirate pH mean (SD)	Respiratory Aspirate pH mean (SD)
Ellett, 2005[3a]	3days -7 years n=72	4.5 (1.4)	No data	No data
Metheny, 1999b[4a]	Neonates n=90	4.32 (0.20)	7.80	No data
Metheny, 2002[3a]	18 years-87 years n=80	5.7 (0.1) *	6.6 (0.1)*	No data
Metheny, 1999a[4a]	14yrs-adult n=587	3.90 (0.15)	7.35 (0.06)	7.73 (0.04) (tracheobronchial tree)
Metheny, 1993[3a]	18yrs-94 yrs n=794	3.52 (2.02)	7.05 (1.26)	No data
Phang, 2004[3b]	25yrs-92yrs n=181	4.8 (2.3) Acid supp 5.0 (2.3) No acid 4.0 (2.5)	7.1 (1.0) Acid supp 7.2+-1.0 No acid 6.7+-1.1	No data
Metheny, 1994a[3a]	n=800	3.52 (2.02) Acid 3.84 (2.06) No acid 3.12 (1.90)	7.05 (1.26)	7.38 (0.59) (plural space)
Westhus,2004[4b]	Birth-14yrs n=56	4.1 (0.32)	7.5 (0.33)	No data
Garpure, 2000[4a]	8 days -19yrs n=96	4.1 Fed 5.0 Not fed 4.0	6.8 Fed 6.6 Not fed7.0	No data

*standard error of the mean rather than SD

Table 2: Age-related height-based (ARHB) prediction equations for the internal distance to the body of the stomach for use in clinical practice, by route of insertion and age in children.

Route	Age Group (months)	Predicted internal distance to the body of the stomach
Oral	Age ≤ 28	$9.1\text{cm} + 0.183 (\text{height cm}) + 6\text{ cm} + 1.5\text{ cm} = 16.6 + 0.183 (\text{height cm})$
	28 < age ≤ 100	$9.1\text{cm} + 0.183 (\text{height cm}) + 8\text{ cm} + 3\text{ cm} = 20.1 + 0.183 (\text{height cm})$
	100 < age ≤ 121	$4.5\text{cm} + 0.218 (\text{height cm}) + 7.5\text{ cm} + 5\text{ cm} = 17 + 0.218 (\text{height cm})$
	Age > 121	$4.5\text{cm} + 0.218 (\text{height cm}) + 9\text{ cm} + 5\text{ cm} = 18.5 + 0.218 (\text{height cm})$
Nasal	Age < 28	$10.1\text{cm} + 0.197 (\text{height cm}) + 6\text{ cm} + 1.5\text{ cm} = 17.6 + 0.197 (\text{height cm})$
	28 < age < 100	$10.1\text{cm} + 0.197 (\text{height cm}) + 8\text{ cm} + 3\text{ cm} = 21.1 + 0.197 (\text{height cm})$
	100 < age < 121	$4.5\text{cm} + (2.7) + 0.218 (\text{height cm}) + 6.5\text{ cm} + 5\text{ cm} = 18.7 + 0.218 (\text{height cm})$
	Age > 121	$4.5\text{cm} + (2.7) + 0.218 (\text{height cm}) + 9\text{ cm} + 5\text{ cm} = 21.2 + 0.218 (\text{height cm})$

Note: the distance measured is to the bottom of the distal pore on the tube
Beckstrand, (2007) [4a] Used with permission

Figure 1: Confirmation of Nasogastric or Orogastric (NG/OG) Tube Placement

