Doctor of Nursing Practice Project

entitled

Verification Methods of Nasogastric and Orogastric Tubes: Improved Patient Outcomes through Nurse Adherence to Practice Guidelines

by

Jennifer Kaple, BSN, RN, DNP Candidate

Submitted as partial fulfillment of the requirements for the
Doctor of Nursing Practice Degree

Huey-Shys Chen, RN, PhD, MCHES, FAAN
Doctoral Project, Co-Chair

Susan Sochacki, PhD, MSN, RN
Doctoral Project, Co-Chair

Martha Sexton, PhD, RN, CNS
Doctoral Project, Committee Member

The University of Toledo
December 2016

An Abstract of

Verification Methods of Nasogastric and Orogastric Tubes: Improved Patient Outcomes through Nurse Adherence to Practice Guidelines

by

Jennifer Kaple

Submitted as partial fulfillment of the requirements for the
Doctor of Nursing Practice Degree

The University of Toledo
December 2016

Although there are various methods that are used to confirm the placement of nasogastric (NG) and orogastric (OG) tubes prior to the administration of any substance, there is none that is used universally and with certainty of safety. Unreliable and contradictory methods for confirming tube placement ultimately leads to misplaced tubes and causes considerable adverse events including pneumonia, lung collapse, and fatality. In adult patients within a northcentral Ohio community hospital, greater than 18 years of age, requiring the placement of an NG or OG feeding tube [P], how does implementation of a systems-wide approach to update adherence guidelines for the most reliable NG and OG tube verification practices prior to the administration of tube feedings, medications, or H2O boluses based on EBP literature [I] compare to the current practice [C] in increasing adherence of updated practice guidelines, increasing the identification of misplaced NG and OG tubes, and decreasing adverse events to patients [O] over a three-month time frame [T]? Evidence suggests that auscultation of air bolus, visual inspection of gastric aspirate, water bubbling, litmus paper, ultrasonography, capnography/capnometry, bilirubin testing, and enzyme testing are unreliable methods to utilize for verification of initial NG and OG tube placement; while, pH measurement of gastric aspirate ≤ 5.5 is a

reliable method and radiographic confirmation remains the gold standard. The Johns Hopkins Nursing Evidence-Based Practice Model was utilized to guide the development and implementation of this evidence-based practice project. The current NG and OG tube practice guideline was revised based on synthesis of evidence and the revised NG and OG tube practice guideline was implemented throughout this community hospital. The adherence, misplacement rate, and adverse event rate of NG and OG tubes were measured over a three-month time period pre- and post-revised practice guideline implementation. The sample consisted of 230 insertions of NG or OG tubes pre-implementation and 236 insertions post-implementation. Adherence rate to practice guidelines increased from 0.0% pre-implementation to 92.7% ($p = .000$) post-implementation. Identified NG and OG tube misplacements increased from 7.1% pre-implementation to 14.6% ($p = .005$) post-implementation. Identified adverse events caused by misplaced NG and OG tubes decreased from 1.9% pre-implementation to 1.5% ($p = .703$) post-implementation. The revised practice guideline for NG and OG tube verification not only significantly improved nurse adherence and the identification of misplaced NG and OG tubes, but also decreased the rate of adverse events caused by misplaced NG and OG tubes. It is recommended that healthcare practitioners and facilities become aware of the consequences of inaccurately positioned NG and OG tubes caused by improper NG and OG tube verification practices.

Acknowledgements

I would like to extend my deepest gratitude and appreciation to my project committee co-chairs, Drs. Huey-Shys Chen and Susan Sochacki and my project committee member, Dr. Martha Sexton for your never-ending support and guidance throughout this journey. The invaluable lessons that I have ascertained along this journey and the instrumental experiences that I have gained were only made possible through the continuous encouragement and leadership afforded by the three of you.

To my husband, Joe, our son Jace, and my parents, Dave and Laurie, none of this would have been possible without your unconditional love and support. You have been my steady rock throughout this journey and have believed in me when often I did not believe in myself.

I would like to thank the entire healthcare team that allowed me to carry out this EBP project within their community hospital. I am further grateful for the assistance and patience that was afforded to me by my clinical mentor, Patty Martin, who was instrumental in allowing this EBP project to reach its full potential.

Table of Contents

List of Tables

List of Figures

Description of the Clinical Issue

A frequent practice utilized within the hospital setting is the insertion of nasogastric (NG) and orogastric (OG) tubes in adult patients who cannot or who are unable to adequately swallow (Boeykens, Steeman, & Duysburgh, 2014). NG and OG tubes are employed to provide dietary tube feedings, medications, and H2O boluses to the patient who is unable to consume nutrition and medicine orally (Boeykens et al., 2014). Prior to the administration of dietary tube feedings, medications, and H2O boluses, the position of the NG or OG tube must be properly verified (Simons & Abdallah, 2012). The position of the NG and OG tube is verified through several different techniques some of which include: 1) auscultation of an air bolus, 2) observation of the aspirate, 3) verification by radiographic imaging, 4) pH measurement of aspirated fluids, and 5) carbon dioxide measurement through end-tidal monitoring (Haga et al., 2008). While there are many different methods that are used to confirm the placement of NG and OG tubes prior to the first administration of any substance, there is no one method that is used universally and with certainty of safety (Simons & Abdallah, 2012). These existing traditions and inappropriate verification practices that are rarely based on evidence guided by national standards place every adult patient that receives an NG or OG tube at risk for an adverse event (Simons & Abdallah, 2012).

The ACCN released in 2010, the *AACN Practice Alert: Verification of Feeding Tube Placement*, emphasizing what should be utilized as the most accurate verification method for initial NG and OG tube placement. The ACCN (2010) states that "radiographic confirmations should be obtained to accurately verify the correct placement of any blindly inserted tube prior to its initial use for feedings or medication

administration" (ACCN, 2010, p. 1). In 2005, the National Patient Safety Agency of the National Health Service (NHS) published instruction on the most accurate method for verification of NG feeding tubes (Haga et al., 2008). The most accurate method for verification of NG feeding tubes as recommended by the NHS states that pH of the aspirate should be measured before the initial administration of substances (Haga et al., 2008). In such instances that this confirmation method is unable to be attained, radiographic imaging is recommended (Haga et al., 2008). Unfortunately, many hospitals fail to utilize radiographic confirmations or measurements of the pH aspirate to verify placement of an NG or OG tube prior to the first administration of tube feed or medication administration (AACN, 2010).

Verifying the correct placement of NG and OG tubes in the hospital setting is imperative and is often the sole responsibility of the bedside nurse. Inappropriately positioned NG and OG tubes that do not terminate in the stomach, have the potential to hold grave consequences and often these harmful potential outcomes are taken too lightly in the hospital setting (Taylor, 2013). Bourgault et al. (2014) assert that unreliable and contradictory methods for confirming NG and OG tube placement ultimately leads to misplaced feeding tubes and causes considerable problems including pneumonia, lung collapse, and fatality. Sorokin and Gottlieb (2006) revealed 50 small-bore feeding tubes that had been misplaced into the lung while examining over 2,000 placed NG and OG tube insertions over a time span of four years. These 50 misplaced feeding tubes directly led to incidences of pneumothorax, pneumonia, and death (Sorokin & Gottlieb, 2006). Additionally, the American Association of Critical-Care Nurses (AACN) (2010) revealed that inaccurate placement of these tubes occurred in 1.3 to 3.2 percent of all insertions;

furthermore, 28 percent of inaccurate placements lead to pneumonia or pneumothorax. The introduction of an NG or OG tube into the pulmonary tract has been classified as a sentinel event by the Joint Commission of Healthcare Organizations (Metheny, Meert, & Clouse, 2007). Fortunately, it is important to note that the incidence of misplaced NG and OG feeding tubes can be easily avoided when proper evidence-based practices (EBP) are followed to confirm correct verification of these tubes (Eveleigh, Law, Pullyblank, & Bennett, 2011). When misplaced NG and OG tubes are identified prior to the initial administration of any substance, adverse events have the potential to be avoided all together. It is therefore imperative that practice guidelines outlining the proper verification methods for NG and OG tubes prior to the administration of any substance are not only in place in hospital settings that are clear, succinct, and based on EBP, but that these policies and procedures are adhered to by bedside nurses (Stepter, 2012).

Significance of the Problem

Currently, at a 227-bed community hospital in northcentral Ohio, there is a practice guideline that unclearly outlines the steps needed to confirm the placement of an NG or OG tube prior to the administration of tube feedings, medications, and H2O boluses (Smith, Duell, & Martin, 2012). The practice guideline for this community hospital states that pH measurement of gastric aspirate should be checked prior to the initial administration of tube feedings, medications, or H2O boluses (Smith et al., 2012). Unfortunately, because this practice guideline is not clear, well-defined, or adhered to by all hospital nursing staff, a discrepancy in what is stated in the practice guideline and what is being performed by bedside nurses in this community hospital setting is taking place. The verification method that is mentioned in the practice guideline for the initial

confirmation of an NG or OG tube is not being implemented or adhered to by bedside nurses because the practice guideline is not clear and not known by all bedside nurses. The pH measurement of gastric aspirate is not being checked by bedside nurses for verification of NG or OG tube placement as the practice guideline states. Instead, color of aspirate and auscultation of air bolus is being utilized by nurses at the bedside to confirm NG and OG tube placement prior to initial administration of tube feedings, medications, and H2O boluses. The discrepancy in practice was identified by direct observation of the primary investigator (PI) of this study. A needs assessment performed in this community hospital identified the following: 1) a discrepancy is occurring between what is stated in the practice guideline at this community hospital for the verification of NG and OG tubes and what is being performed by bedside nurses and 2) the practice guideline for verification practices of NG and OG tubes is not based on current EBP guidelines. The overall purpose and goals of this EBP project was established based on the results of this needs assessment.

Purpose and PICOT

The purpose of this EBP project was to institute a systems-wide approach to update adherence guidelines for the most reliable and safest NG and OG tube verification practices in adults within a community hospital located in northcentral Ohio. Specifically, this study aimed to improve nurse adherence to practice guidelines, increase the identification of misplaced NG and OG tubes, and decrease the adverse events caused by misplaced NG and OG tubes; ultimately, improving patient health outcomes. The clinical inquiry utilizing the PICOT construct is as follows:

In adult patients within a northcentral Ohio community hospital, greater than 18 years of age, requiring the placement of an NG or OG feeding tube **[P]**, how does implementation of a systems-wide approach to update adherence guidelines for the most reliable NG and OG tube verification practices prior to the administration of tube feedings, medications, or H2O boluses based on EBP literature **[I]** compare to the current practice **[C]** in increasing adherence of updated practice guidelines, increasing the identification of misplaced NG and OG tubes, and decreasing adverse events to patients **[O]** over a three-month time frame **[T]**?

Theoretical Framework

The selected framework guiding this EBP project was the Lewin's Change Management Model (CMM). Lewin's CMM is comprised of three stages (Lewin, 1947). These stages are known as the unfreezing stage, the moving stage, and the refreezing stage (Lewin, 1947). Stage one, the unfreezing stage, consists of recognizing the necessity for a change and then proper arrangements are formulated to create the road for change (Lewin, 1947). Specific steps within the unfreezing stage include the following: 1) establish what needs a change, 2) confirm that there is solid encouragement from higher management, 3) construct the necessity for change, and 4) control and recognize worries and anxieties of employees (Lewin, 1947). Stage two, the moving stage, consists of the change itself along with recognizing and dealing with problems as they occur (Lewin, 1947). Specific steps within the moving stage include the following: 1) frequent communication, 2) dissipate untrue speculations, 3) inspire engagement, and 4) involve employees and stakeholders in the practice change process (Lewin, 1947). Stage three, the refreezing stage, consists of the practices needed to guarantee the change will continue to be adhered to (Lewin, 1947). Specific steps within the refreezing stage include the following: 1) secure the practice change within the culture, 2) create methods to maintain the practice change, and 3) deliver encouragement and guidance through education (Lewin, 1947).

Rationale for Selection of Theoretical Framework

Lewin's change model was chosen to guide the framework of this EBP project as it delivers a basis and foundation for the change process along with the quality improvement process (Lewin, 1947). Lewin's change model posits that there is a need

for support with any practice change implementation in a healthcare setting (Lewin, 1947). Selecting the Lewin's change model as a framework for this practice change project assisted in ameliorating difficulties that were met while implementing this EBP change within the community hospital setting (Lewin, 1947).

Evidence-Based Practice Model

The selected EBP model for guiding this project was the Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) Model. The JHNEBP process consists of 18-steps which transpire into three phases (Dearholt, 2012). The three phases are defined as the Practice question, Evidence, and Translation (PET) (Dearholt, 2012). The recognition of the practice difficulty, topic, or interest is the initial step of this process (Dearholt, 2012). This stage of the process is the most crucial since the way in which the practice difficulty is presented will guide the latter stages of the process (Dearholt, 2012). Built upon the practice difficulty statement, the practice question is acquired, simplified, and enhanced (Dearholt, 2012). The first five steps of the JHNEBP found within the practice question phase are as follows: 1) draft an interprofessional team, 2) acquire, simplify, and enhance the EBP question, 3) describe the scope of the EBP question and distinguish stakeholders, 4) establish accountability for project leadership, and 5) arrange team meetings (Dearholt, 2012). The next stage in the process that is accomplished is an investigation for evidence concerning the practice question (Dearholt, 2012). The evidence that is obtained is then assessed and integrated (Dearholt, 2012). Built upon this integration of evidence, a decision must be reached as to whether the evidence substantiates a need for a modification or enhancement in practice (Dearholt, 2012). The next five steps of the JHNEBP found within the evidence phase are as follows: 6) perform internal and external examination for evidence, 7) appraise the level and quality of each piece of evidence, 8) review and condense the individual evidence, 9) synthesize overall strength and quality of evidence, and 10) develop recommendations for change based on evidence synthesis (Dearholt, 2012). If the evidence substantiates the need for a modification or

enhancement in practice, a translation of the evidence starts and the change in practice is scheduled, employed, and appraised (Dearholt, 2012). The concluding step in translation is diffusion of the findings to patients and their family members, hospital employees, the stakeholders within the hospital, and, if applicable, the local and state communities (Dearholt, 2012). The last eight steps of the JHNEBP found within the translation phase are as follows: 11) determine fit, feasibility, and appropriateness of recommendation for translation pathway, 12) produce an action plan, 13) secure support and resources to employ action plan, 14) employ the action plan, 15) assess outcomes, 16) report outcomes and findings to stakeholders, 17) recognize and distinguish next steps, and 18) distribute findings (Dearholt, 2012).

Rationale for Selection of EBP Model

The JHNEBP Model was chosen for the evidence-based framework model of this project because of the model's effectiveness and practicality in addressing practice problems within a hospital setting and the model's notable ability to move evidence into practice (Gawlinski & Rutledge, 2008). As stated previously, the goal of this EBP project was to institute a systems-wide approach to update adherence guidelines for the most reliable and safest NG and OG tube verification practices in adults within a community hospital located in northcentral Ohio to improve nurse adherence to practice guidelines, increase the identification of misplaced NG and OG tubes, and decrease the adverse events caused by misplaced NG and OG tubes; ultimately, improving patient health outcomes. The JHNEBP Model provides a framework for disseminating current research findings through utilization of the best available evidence as a core component into the community hospital setting (Gawlinski & Rutledge, 2008). Through

employment of the 18 steps within the JHNEBP Model, a practice change guideline was developed through research of the best evidence, critical assessment, and evaluation of the evidence (Gawlinski & Rutledge, 2008). Once the practice change guideline was developed, it was implemented into practice at this community hospital setting and an evaluation of practice change outcomes and findings were performed and communicated as stated by the JHNEBP Model (Dearholt, 2012). This model is unique in that it serves as an everyday guide for the bedside nurse to utilize the best possible evidence for clinical decision making (Schaffer, Sandau, & Diedrick, 2013). In addition, this model can be employed in a diversity of hospital settings (Schaffer et al., 2013). Since the practice change within this project affected a practice change in bedside nursing procedures in the community hospital setting, this evidence-based model fit ideally in the overall creation of the EBP change guideline.

Review of the Research Evidence

The review of the research evidence for this EBP project was performed in such a manner as to acquire the most pertinent evidence-based and research journal articles to aide in answering the previously stated clinical problem. The purpose of this review of the research evidence was to identify the most reliable and safest NG and OG tube verification practices to correctly verify the placement of the NG and OG tube prior to initial administration of tube feedings, medications, and H2O boluses in adults.

Search Strategy

An evidence search of the Cochrane Library, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and the United States National Library of Medicine (PubMED) databases was performed between the winter of 2015 and the fall of 2016. Keywords utilized were: 1) nasogastric tube and placement, 2) nasogastric feeding tube and placement, 3) nasogastric feeding tube, 4) feeding tube and placement, 5) pH, and 6) tube placement determination methods. Inclusion and exclusion standards included: 1) languages that were written in English except for one French article, 2) articles that were published within the last ten years, 3) academic journal source type, and 4) various major subject headings. Controlled vocabulary was excluded in the search criteria limits. The French article written by Seguin et al. (2005) had to be translated into English using Google Translator. The searches focused on identifying current research evidence and EBP guidelines for initial verification methods of NG and OG tube placement prior to the administration of tube feedings, medications, or H2O boluses. The search strategy table which includes the database searches and abstractions can be found in Appendix A. The inclusion and exclusion criteria table can be found in Appendix B.

Methods of Appraisal

There were fourteen total research studies that were included in the final appraisal of evidence and that underwent rapid critical appraisal. Rapid critical appraisals were performed through utilization of the rapid critical appraisal checklists provided by Melnyk and Fineout-Overholt (2015). Once the rapid critical appraisal was complete for each of the research studies, an evidence evaluation table was created to appraise each of the separate research studies. The evidence evaluation table template was obtained from Melnyk and Fineout-Overholt (2015). The evidence evaluation tables summarizing each study can be found in Appendix C.

Hierarchy of Evidence

While there are numerous hierarchies of evidence rating systems accessible to rank research studies, for purposes of this EBP project, the hierarchy of evidence scale that was utilized for appraising interventions and treatment inquiries was the Johns Hopkins Nursing Evidence-based Practice Rating Scale and included the following rating systems: 1) the level of evidence scale and 2) the quality of evidence scale.

Level of evidence scale. Level I, considered the strongest level of evidence, is comprised of evidence from either systematic reviews of randomized control trials, meta-analysis of randomized control trials, or experimental investigations (Dearholt & Dang, 2012). Level II involves evidence acquired from quasi-experimental investigations, or reviews that are systematic in nature and involve a grouping of both randomized control experiments and quasi-experimental designs or quasi-experimental designs alone (Dearholt & Dang, 2012). The third level of evidence, level III, is comprised of evidence that has been attained from investigations that were not experimental, investigations that

are qualitative in nature, reviews that are systematic in nature and involve a grouping of randomized control experiments, quasi-experimental designs, and investigations that are not experimental in nature (Dearholt & Dang, 2012). Dearholt and Dang (2012) describe evidence that is considered level IV as recommendations from highly esteemed establishments and professionals that are accepted worldwide founded on evidence that is logical and precise, including guidelines that are clinically based and agreement boards. The final level of evidence, level V, is comprised of evidence that is based on experience and is not founded on research, including evidence appraisals, quality enhancement, appraisals of economics or processes, accounts of specific case studies, and recommendations from professionals that are accepted worldwide that are based on experience (Dearholt & Dang, 2012).

Quality of evidence scale. The overall quality of a study is also assigned a grade of poor, moderate, or high as per the quality of evidence scale described by Dearholt and Dang (2012). A study that is of poor quality is suggestive of large errors in the study, weak study design and proposal, extremely small sample amounts, and improper or insubstantial study results and outcomes (Dearholt & Dang, 2012). A study that is of moderate quality is suggestive of a small number of errors within the study, but overall the study is satisfactory (Dearholt & Dang, 2012). A study that is of high quality is indicative of a study that has a sturdy and durable design, sound and convincing outcomes, and no apparent limitations or errors (Dearholt & Dang, 2012).

Studies that have been found applicable to this project are discussed, reviewed, and have been assigned a specific level of evidence and study quality in the narrative

section of the literature review. A summary and comparison of the evidence level and quality can be found in Appendix D.

Appraisal of the Evidence

Through previously stated appraisal methods and discussed critical analysis techniques of the evidence, fourteen studies were found to be pertinent in identifying current research evidence and EBP guidelines for initial verification methods of NG and OG tube placement prior to the administration of tube feedings, medications, and H2O boluses. These fourteen studies were published between 2005 and 2015. The subsequent section is a synthesis of each utilized article in narrative format.

Boeykens et al. (2014) carried out a prospective observational study in a general hospital setting (n = 314) to appraise the auscultatory method along with the pH measurement method with a pH cut-off point of 5.5 after initial NG or OG tube insertion for verification of placement and compared these two interventions with an abdominal x-ray. This study also looked at the practicality of the pH measurement method. Data analysis included the use of a descriptive statistics program (IBM SPSS Statistics version 21) with a Chi-squared test to compare discontinuous variables along with a Mann-Whitney U to compare continuous variables (Boeykens at al., 2014). A significance level of $p < 0.05$ was utilized (Boeykens et al., 2014). Results from this study found that pH of ≤ 5.5 from an NG or OG tube aspirate is satisfactory to confirm the location of the NG or OG tube in the stomach even with the use of antacids (Boeykens et al., 2014). Results also found that the auscultatory method is unreliable in confirming the placement of the NG or OG tube in the stomach (Boeykens et al., 2014). The authors of this study conclude that the bedside pH method decreases the requirement of expensive

radiographic imaging, reduces radiation contact, & presents advantages for outpatient NG or OG care (Boeykens et al., 2014). In addition, the authors determined that in specific instances where the chance of aspiration is above average, where no aspirate can be attained, or where pH aspirate that is tested reads ≥ 6, radiological confirmation should be implemented (Boeykens et al., 2014). This study discourages the utilization of the auscultation method as it is not dependable in detecting an NG or OG tube outside of the stomach (Boeykens et al., 2014). Strengths of this study included the large sample size (Boeykens et al., 2014). The limitations, as stated by the authors, involved the utilization of the same practitioner each time for NG or OG tube placement as this does not accurately represent current daily practice (Boeykens et al., 2014). The level of evidence given to this study is a level III since it is a large prospective observational study. The quality of the study is rated as moderate as there is only a small number of limitations with an overall satisfactory study appraisal.

A clinical evidence review of 12 descriptive and comparative study designs in acute care/intermediate care and intensive care unit settings was performed between 1988 and 2007 (*n* = ranged from 51-880) by Bourgault and Halm (2009) to blend current evidence on the correctness of techniques that confirm initial placement of blindly introduced NG and OG feeding tubes. The techniques that were examined in this study to confirm initial placement of blindly introduced NG and OG feeding tubes were the following: 1) pH of aspirate, 2) capnography/capnometry, 3) auscultation of air bolus, 4) bilirubin levels, 5) enzyme levels, and 6) visual inspection (Bourgault & Halm, 2009). Results from this study found that pH measurement of aspirate, enzyme levels, bilirubin levels, and capnography/capnometry are capable of discriminating respiratory from

stomach placement of NG and OG tubes; however, pH measurement of aspirate, bilirubin levels, and capnography/capnometry are unable to distinguish NG or OG position in the esophagus or the gastro-esophageal junction (Bourgault & Halm, 2009). In addition, Bourgault and Halm (2009) found that auscultation of air bolus, visualization of aspirate, and the water bubbling method usage should be ceased due to lack of efficacy and possible threat of harm. Bourgault and Halm (2009) also state that the auscultation of an air bolus over the epigastrium misleadingly guides providers to believe the NG or OG tube is in correct placement. The authors of this study conclude that until verification techniques reliably support pulmonary and esophageal positioning of NG or OG feeding tubes to be identified, radiographic imaging persists as the only consistent and trustworthy technique to validate initial placement of blindly inserted NG and OG tubes (Bourgault & Halm, 2009). Strengths of this study include a large sample size among the studies and the moderate quality rating of the studies (Bourgault & Halm, 2009). In addition, the evidence was supported by fair to good evidence (Bourgault & Halm, 2009). There were no limitations listed by the authors of this study (Bourgault & Halm, 2009). The level of evidence given to this study is a level V since it is a clinical evidence review of descriptive and comparative studies. The quality of the study is rated as moderate as there were no limitations within the studies compared with an overall satisfactory appraisal of the combined studies.

Ellett et al. (2014) implemented a single-blind, randomized control study on children (24 weeks gestation to 212 months of age) (n = 276) among five Midwestern hospitals. The purpose of this study was to compare the accuracy and predictive validity of pH in identifying gastric tube placement errors (Ellett et al., 2014). The techniques

that were examined to assess NG or OG tube placement were: 1) the pH measurement method and the utilization of antacids, 2) the ability to obtain tube aspirate, 3) bilirubin levels, and 4) CO2 measurement (Ellett et al., 2014). The results of this study found that the ability of pH to detect position of NG tube in the stomach ranges from 87%-92.2% specificity and the ability of pH to detect errors in position of NG tube ranges from 0%-33% for positive predictive value (Ellett et al., 2014). Also, this study discovered that pH, CO2, and bilirubin measurements are less helpful in detecting NG/OG tube placement (Ellett et al., 2014). Additionally, this study found a small relationship between antacid use and the pH measurement. It was found that the mean and standard deviation (SD) without antacids was 3.8 (1.4) while the mean (SD) with antacids was 3.9 (1.5) (Ellett et al., 2014). This resulted in a d= 0.0707 and a small overall effect. Furthermore, inability to obtain aspirate is the best predictor of NG or OG tube location errors with a sensitivity of 34.9% and a positive predictive value of 66.7% (Ellett et al., 2014). The authors of this study conclude that misplacement of NG or OG tube should be suspected when no aspirate able to be obtained and the utilization of the pH measurement method, CO2, and bilirubin measurements may not be sufficient in detecting the correct placement of the NG or OG tube (Ellett et al., 2014). Strengths of this study include a high level of evidence and a moderate quality of evidence rating (Ellett et al., 2014). Limitations of this study include a small sample size and a small effect size of mean pH without antacids and mean pH with antacids (Ellett et al., 2014). The level of evidence given to this study is a level I since it is a single-blind randomized control trial. The quality of the study is rated as moderate as there were minimal limitations within the study.

Gilbertson, Rogers, and Ukoumunne (2011) implemented a large prospective observational study on pediatric inpatients (> 4 weeks old) (n = 645) within a tertiary pediatric hospital. The purpose of this study was to establish a dependable and useful pH level to determine correct NG/OG position (Gilbertson et al., 2011). The techniques that were examined to assess NG or OG tube placement were: 1) pH measurement, 2) the presence of antacids, and 3) the absence of antacids (Gilbertson et al., 2011). The results of this study found a medium relationship between antacid use and the pH measurement (Gilbertson et al., 2011). It was discovered that the mean (SD) without antacids was 3.4 (1.4) while the mean (SD) with antacids was 4.2 (1.5) (Gilbertson et al., 2011). This resulted in a d= 0.5585 and a medium overall effect. This study concluded that a gastric aspirate of ≤ 5 is safe, reliable, and a useful cut-off for pediatric patients (Gilbertson et al., 2011). Furthermore, a gastric aspirate pH of ≥ 5 should have a radiographic confirmation for NG or OG tube placement (Gilbertson et al., 2011). Strengths of this study include a high level of evidence, a medium effect size between the mean of gastric pH samples without antacids and with antacids, and a moderate quality of evidence rating (Gilbertson et al., 2011). Limitations of this study include a small sample size of endotracheal aspirate samples that were collected (Gilbertson et al., 2011). The level of evidence given to this study is a level III since it is a large prospective observational study. The quality of the study is rated as moderate as there were minimal limitations within the study.

A prospective study implemented in an emergency room (ER) setting (n = 47) over a five-month time span by Kim, So, Jeong, Choi, and Park (2012) relates the efficacy of utilizing the auscultation of air bolus, pH measurement of gastric aspirate, and

ultrasonography to confirm initial NG and OG tube placement. These methods were then compared to a chest x-ray for verification of placement (Kim et al., 2012). Data analysis was performed through descriptive statistical analysis using SPSS for Windows (Kim et al., 2012). Variables that were constant were itemized by their mean and average variation whereas numeric variables were itemized by their occurrence and ratio (Kim et al., 2012). Diagnostic ability of the methods assessed was achieved through calculation of sensitivity, specificity, positive predictive value, and negative predictive value (Kim et al., 2012). Degree of concordance was estimated through utilization of Cohen's Kappa analysis (Kim et al., 2012). A significance level of $p < 0.05$ was employed (Kim et al., 2012). Kim et al. (2012) found that utilization of the auscultation air bolus method could indicate incorrect placement of NG or OG tubes because bronchic insertion can also cause a gurgling sound recognized over the epigastric region. In addition, this study found a lower accuracy rate for ultrasonography in comparison to other studies and observed that the pH method has its limitations in that the method can provide false negative results in some instances (Kim et al., 2012). Kim et al. (2012) states that radiographic chest x-rays must be obtained in instances where tube placement could not be confirmed utilizing ultrasonography. Kim et al. (2012) conclude the following: 1) NG tube verification in an ER setting can be first confirmed by auscultation, 2) using pH measurement of aspirate for secondary verification of tube placement is not suggested because sometimes pH aspirate is not available and the measurement is endanger to false negative results in individuals utilizing antacids, 3) utilizing ultrasonography to confirm NG tube placement has the ability to decrease complications, avoid wastes of time, and decrease avoidable radiation contact, and 4) instances in which ultrasonography is unable

to confirm NG tube placement, verification with a chest x-ray is required. Limitations to this study include: 1) the utilization of a small sample size, 2) direct examination by ultrasonography was problematic due to the small number of cases of improper insertions of the NG tube, and 3) the complete overall history of the individual's use of antacids was unknown (Kim et al., 2012). The level of evidence given to this study is a level III since it is a prospective study. The quality of the study is rated as poor as there were numerous limitations to the study.

A prospective descriptive study was employed by Meert, Caverly, Kelm, and Metheny (2015) on infants (n = 54) in a critical care unit. The purpose of this study was to compare the pH values of gastric aspirates with and without the utilization of gastric acid inhibitors and feedings (Meert et al., 2015). It was found that there exists a large relationship between antacid use and the pH measurement (Meert et al., 2015). It was established that the mean (SD) without antacids was 3.43 (0.83) while the mean (SD) with antacids was 4.89 (1.35) (Meert et al., 2015). This resulted in a d= 1.43 and a large overall effect. The authors of this study conclude that the pH of gastric aspirates is usually $\leq$ 5.5 despite the use of acid inhibitors or feedings (Meert et al., 2015). Furthermore, a pH of $\leq$ 5.5 would rule out respiratory placement since tracheal pH is usually $\geq$ 6.0 (Meert et al., 2015). Strengths of this study include a high level of evidence, a large effect size between the mean of gastric pH samples without antacids or feedings and with antacids, a moderate quality of evidence rating, and a sample that was restricted to infants (Meert et al., 2015). Limitations of this study include a small sample size and the utilization of colorimetric pH checks instead of a pH meter (Meert et al., 2015). The level of evidence given to this study is a level III since it is a prospective

descriptive study. The quality of the study is rated as moderate as there were minimal limitations within the study.

Peter and Gill (2009) employed a bedside information compilation and point-prevalence review in one children's hospital and seven other hospitals in the city of Perth (n = 104) located in Western Australia to introduce clinical practice guidelines to standardize NG tube placement. Auscultation of air bolus and pH of aspirate upon insertion of the NG tube were compared to the 'gold standard' radiographic x-ray (Peter & Gill, 2009). Conclusions from this study indicated the following: 1) pH testing is recommended over litmus paper, 2) the auscultation of an air bolus along with the use of litmus paper is no longer supported, and 3) pH testing and radiographic x-ray are believed to be more consistent and dependable methods for checking initial NG or OG tube placement (Peter & Gill, 2009). The strength of this study was the usage of numerous hospital settings (Peter & Gill, 2009). The level of evidence given to this study is a level V since the studies performed were quality improvement audits at the bedside. The overall quality of the study is rated moderate as there are no obvious flaws in the study and the overall study is satisfactory.

Preetha (2009) implemented a bedside data collection on adult subjects (n = 50) at a medical center in the Kanya-Kumari district in India. The purpose of this study was to evaluate the pH testing method in verifying NG and OG tube placement (Preetha, 2009). Additionally, this study wanted to compare the auscultation method with the pH testing method in verifying NG and OG tube placement (Preetha, 2009). The results of this study found that 90% of the time gastric aspirate could correctly verify gastric placement of the NG or OG tube by means of measuring the pH of the gastric aspirate (Preetha,

2009). Furthermore, this study established that pH testing has greater sensitivity and specificity when compared to auscultation and pH testing is more reliable and effective when compared to auscultation (Preetha, 2009). The authors concluded that the pH testing method can be utilized in hospitals to verify NG or OG tube placement regardless of the age of the individuals (Preetha, 2009). Strengths of this study include a moderately-high level of evidence and a moderate quality of evidence rating (Preetha, 2009). Limitations of this study include a small sample size and a possible skewing of the pH testing sensitivity and specificity results as they were documented as both 100% (Preetha, 2009). The level of evidence given to this study is a level V since it was a quality improvement bedside data collection. The quality of the study is rated as moderate as there were minimal limitations within the study.

Seguin et al. (2005) implemented a prospective observational, monocentric & non-randomized study in France in an intensive care unit setting (n = 419) over a period of 16 months with a primary purpose to evaluate the following methods to determine initial NG or OG tube placement: 1) visualization of gastric fluid, 2) pH measurement of gastric fluid, and 3) auscultation of an air bolus. All of the three methods were then compared to a radiographic x-ray that gave the final confirmation of the position of the NG or OG tube (Seguin et al., 2005). Data analysis was performed through utilization of statistical analysis using the EPI software (version 6.04) (Seguin et al., 2005). For each of the methods, sensitivity and specificity were calculated along with the determination of positive and negative predictive values (Seguin et al., 2005). Findings from this study showed that malposition of the NG tube was detected in 10% of the NG tubes placed, visualization of the gastric fluid and pH measurement were not sensitive or specific,

auscultation of the air bolus was sensitive, but not specific, the combination of the three methods had no positive effect on the sensitivity or the specificity, and there were two complications identified through utilization of radiographic chest x-ray (Seguin et al., 2005). The authors of this study concluded that none of the three methods evaluated alone were adequate enough to evade obtaining a chest x-ray (Seguin et al., 2005). To add to this conclusion, the authors re-iterate that the detection of two potential and serious complications was only detected by obtaining a chest x-ray (Seguin et al., 2005). Strengths to this study include a large sample size while limitations include that the results were limited to one intensive care unit setting (Seguin et al., 2005). The level of evidence given to this study is a level III since the study performed was prospective observational and was non-randomized in nature. The overall quality of the study is rated moderate as there is only one limitation and the overall study is satisfactory.

A systematic review of six studies with an evidence level of III to IV was performed by Stepter (2012) to provide a critical appraisal of the best evidence guiding nursing care to maintain placement of NG and OG tubes and to deliver best practice recommendations for ongoing nursing assessment and care for individuals with NG tubes. The methods considered in this review of evidence were the auscultation of air bolus or whoosh test, water bubbling, visual inspection of the gastric aspirate, pH measurement of the aspirate, and radiographic confirmation (Stepter, 2012). Findings from this study suggest that auscultation or whoosh test and water bubbling methods are futile and should no longer be employed by bedside nurses, visual inspection of gastric aspirate is unreliable, the ability of pH measurement to verify small bowel and gastric placement is uncertain, and the gold standard radiographic x-ray confirmation method for

initial placement of NG and OG tubes should be utilized for verification (Stepter, 2012). The author of this study concluded that to identify and decrease harm related to NG and OG tubes, literature should be assessed and appraised regularly and practice changes must be considered (Stepter, 2012). In addition, Stepter (2012) states that clinical practice guidelines or protocols should be carried out and appraised for efficacy in avoiding unfavorable patient outcomes. The author of this study suggests that controlled studies that speak to assessment, implementation, & evaluation of clinical practice guidelines are needed to enhance the body of knowledge and information regarding bedside methods to assure appropriate placement of NG and OG tubes (Stepter, 2012). Strengths to this study include the use of a large number of highly ranked research studies; however, limitations were not made clear by the author (Stepter, 2012). The level of evidence given to this study is a level III since the studies systematically reviewed were levels III to IV. The overall quality of the study is rated moderate as there are no limitations and the overall study is satisfactory.

A prospective, observational study was implemented by Stock, Gilbertson, and Babl (2008) among children (n = 404) within a tertiary pediatric emergency department. The purpose of this study was to determine how often gastric aspirate could be obtained from the NG or OG tube and to establish a pH cut-off level to confirm gastric placement of the NG or OG tube (Stock et al., 2008). Results of this study found that 97.3% of the time, gastric aspirate could be obtained from the NG or OG tube through aspiration (Stock et al., 2008). Additionally, 86.8% of pH measurements were < 4 and the pH measurement method confirmed tube position 84.5% of the time (Stock et al., 2008). The authors of this study concluded that pH testing is a reliable way of confirming NG tube

location when pH ≤ 4 and if a pH of > 4 is obtained, a radiograph may be required to confirm NG or OG tube placement (Stock et al., 2008). Strengths of this study include a high level of evidence and a large sample size (Stock et al., 2008). Limitations of this study include: 1) a poor-quality evidence rating, 2) only 72% of NG tubes were captured, 3) correct placement in stomach was assumed since there was no occurrence of aspiration, 4) NG insertions were performed by registered nurses with varying skills and experience, and 5) the number of insertion tries may have been underreported (Stock et al., 2008). The level of evidence given to this study is a level III since it was a prospective observational study. The quality of the study is rated as poor as there were numerous limitations within the study.

Taylor and Clemente (2005) implemented an observational study over one day in adults (n = 52) on an ICU and on the medical floors. The purpose of this study was to establish the accuracy of pH testing in the presence of H2-blockers & proton-pump inhibitors (PPIs) (Taylor & Clemente, 2005). The results of this study found that when H2-blockers and PPIs are utilized, the accuracy of the pH measurement method could be decreased by 58% (Taylor & Clemente, 2005). The authors of this study concluded that radiographic imaging may be needed for repeated pH measurement method failures (Taylor & Clemente, 2005). Furthermore, the utilization of the pH measurement method or other methods, not including radiographic means, must be performed to correctly verify placement of NG or OG tubes (Taylor & Clemente, 2005). Strengths of this study include a high level of evidence and a moderate quality of evidence rating (Taylor & Clemente, 2005). Limitations of this study include a small sample size and the overall length of the study being one day (Taylor & Clemente, 2005). The level of evidence

given to this study is a level III since it was an observational study. The quality of the study is rated as moderate as there were minimal limitations within the study.

Tho, Mordiffi, Ang, and Chen (2011) carried out a systematic review of descriptive studies and employed a quality improvement project at an acute care tertiary hospital (n = 935) with an overall purpose to institute best practice of confirming NG tube placement. Methods for confirming NG tube placement that were reviewed in this study included auscultation of air bolus, bubbling at the end of the NG tube, testing of acidity or alkalinity of aspirate utilizing blue litmus paper, pH of aspirate utilizing pH indicator strips, and radiologic confirmation (Tho et al., 2011). Findings from this study indicated that testing of acidity or alkalinity of aspirate using litmus paper, auscultation of air bolus, and bubbling tests are imprecise to verify correct placement of NG or OG tubes (Tho et al., 2011). In addition, Tho et al. (2011) conditions that pH testing and radiographic confirmation are more reliable methods in confirming correct initial placement of NG and OG tubes. The authors of this study conclude that employing modifications to current practice for verification of NG and OG tube placement demands effective coordination and a multidisciplinary team approach (Tho et al., 2011). Strengths to this study include the large sample size utilized; however, limitations were not specified by the authors (Tho et al., 2011). The level of evidence given to this study is a level V since the studies systematically reviewed were descriptive studies. The overall quality of the study is rated moderate as there are no limitations and the overall study is satisfactory.

A methodological, case control study was implemented by Turgay and Khorshid (2010) in an intensive care unit setting of a large 2000-bed metropolitan university

teaching hospital in Turkey (n = 44) to determine the efficacy of the auscultatory and pH methods in predicting NG and OG tube location as compared to radiographic imaging. Data analysis was performed through utilization of the descriptive statistics software SPSS (version 11.0) for Windows operating system (Turgay & Khorshid, 2010). Cohen's Kappa analysis was employed to establish concurrence among radiological and auscultatory methods and among radiological and pH methods (Turgay & Khorshid, 2010). A significance level of p ‹ 0.05 was employed (Turgay & Khorshid, 2010). Findings from the study indicated that the overall efficacy of the pH measurement of aspirate method in verifying correct verification of NG tube placement was 88.6%, the efficacy for the auscultatory method in verifying correct placement of NG tube was 34.4%, and radiological confirmation remains the 'gold standard' in correctly verifying NG and OG tube placement (Turgay & Khorshid, 2010). The authors of this study conclude that the pH method is effective in determining the correct initial placement of the NG tube, the auscultatory method is ineffective in determining the correct initial placement of the NG tube, and radiological confirmation should continue to be obtained to verify correct NG tube placement as it remains the 'gold standard' (Turgay & Khorshid, 2010). Limitations to this study include the use of a small sample size and the utilization of pH paper due to its availability instead of a pH meter; thus, possibly posing a threat to external validity and influencing generalizability of the findings to other settings and samples (Turgay & Khorshid, 2010). The level of evidence given to this study is a level III since it is a methodological, case control study. The quality of the study is rated as poor as there are numerous limitations to the study including a small sample size along with a possible threat to external validity.

Synthesis of the Evidence

Numerous methods were utilized within the appraised articles to evaluate and assess initial NG and OG tube placement verification: 14 measured pH of aspirate, 9 studies evaluated auscultation of air bolus, 8 assessed radiographic imaging, 3 considered the visual inspection of gastric aspirate, 3 evaluated water bubbling, 2 assessed the use of litmus paper, 2 looked at the ability to obtain gastric aspirate, 1 considered ultrasonography, and 2 evaluated capnography/capnometry, bilirubin testing, and enzyme testing. All the studies compared and employed multiple verification methods. The appraised articles levels of evidence ranged from a level I to a level V. Comparison of NG and OG tube verification methods across the studies table can be found in Appendix D. Comparison of NG and OG tube verification outcomes table can be found in Appendix E.

pH measurement of Aspirate

Some of the research literature provides evidence that states the pH measurement of gastric aspirate is an effective and reliable method in determining correct position of the NG or OG tube on initial insertion (Gilbertson et al., 2011; Peter & Gill, 2009; Stock et al., 2008; Tho et al., 2011; Turgay & Khorshid, 2010). The pH measurement of ≤ 5.5 from an NG or OG tube aspirate is satisfactory to confirm the location of the NG or OG tube in the stomach even with the use of antacids (Boeykens et al., 2014; Meert et al., 2015). According to Gilbertson et al. (2011) and Taylor (2013) aspirate of gastric contents from an NG or OG tube that is ≤ 5.0 is safe, dependable, and correctly indicates gastric positioning. Stock et al. (2008) express that pH testing is a reliable way of confirming NG tube location when the pH ≤ 4. Utilizing the bedside pH method

decreases the requirement of expensive radiographic imaging, reduces radiation contact, & presents advantages for outpatient NG or OG care (Boeykens et al., 2014). In specific instances where the chance of aspiration is above average, where no aspirate can be attained, or where pH aspirate that is tested reads ≥ 6, radiological confirmation should be implemented (Boeykens et al., 2014). Kim et al. (2012) disagrees and states that sometimes pH aspirate is not available and the measurement is in danger of false negative results in individuals utilizing antacids. Additionally, individuals who receive acid reducing medications continue to pose a challenge and have the potential to decrease the accuracy of pH verification (Ellett et al., 2014; Taylor & Clemente, 2005). Misplacement of NG or OG tubes should be suspected when no aspirate can be obtained (Ellett et al., 2014). In addition, Seguin et al. (2005) positions that pH measurement of aspirate is not sensitive and not specific.

Auscultation of Air Bolus

The utilization of the auscultation of air bolus method in confirming NG or OG tube placement is unreliable (Boeykens et al., 2014; Bourgault & Halm, 2009; Kim et al., 2012; Peter & Gill, 2009; Seguin et al., 2005; Stepter, 2012; Tho et al., 2011; Turgay & Khorshid, 2010). The auscultatory method is variable in confirming the placement of the NG or OG tube in the stomach; therefore, the use of this method should be discouraged (Boeykens et al., 2014; Kim et al., 2012). Auscultation of the air bolus should be ceased as it lacks effectiveness and the risk of damage is great (Bourgault & Halm, 2009; Stepter, 2012; Tho et al., 2011). The easy to hear 'air pop' over the epigastric area incorrectly guides providers to believe there is appropriate placement of the NG or OG tube in the stomach (Bourgault & Halm, 2009; Kim et al., 2012). Turgay and Khorshid

(2010) state that the overall efficacy of the auscultatory method in correctly confirming NG or OG tube placement is 34.4%.

Radiographic Imaging

Most of the research literature supports the use of radiographic imaging and states that it should be utilized as it is a reliable technique in confirming correct placement of NG and OG tubes (Bourgault & Halm, 2009; Peter & Gill, 2009; Seguin et al., 2005; Stepter, 2012; Tho et al., 2011; Turgay & Khorshid, 2010). Radiographic confirmation remains the 'gold standard' in verifying correct initial placement of NG and OG tubes (Stepter, 2012; Turgay & Khorshid, 2010). Bourgault & Halm (2009) state that until verification techniques reliably support pulmonary and esophageal positioning of NG or OG feeding tubes to be identified, radiographic imaging persists as the only consistent and trustworthy technique to validate initial placement of blindly inserted NG and OG tubes. When visualization of gastric aspirate, pH measurement of gastric aspirate, and auscultation of air bolus are utilized independently, they are not adequate enough to verify correct placement of NG or OG tubes and a radiologic confirmation must still be obtained (Seguin et al., 2005). In addition, the act of obtaining a radiographic confirmation can detect potential and serious complications that are not identified when these three methods are utilized independently (Seguin et al., 2005). However, it should be noted that radiologists, or other experienced individuals, should interpret radiograph reports to ensure that misreading of the radiographic image does not occur (Boeykens et al., 2014). Additional limitations of radiographic imaging include the expense of performing this test, possible poor conditions of radiographic images, radiation contact to the patient (Boeykens et al., 2014).

Visual Inspection of the Gastric Aspirate

Visual inspection of the gastric aspirate to verify correct placement of NG or OG tubes should be discontinued due to an absence of effectiveness and risk of potential harm to the individual (Bourgault & Halm, 2009). Aspiration of gastric fluid with visual inspection is not sensitive or specific in determining the correct placement of NG or OG tubes (Seguin et al., 2005). Stepter (2012) states that visual examination of gastric aspirate is untrustworthy and yields variable results.

Water Bubbling

The utilization of the water bubbling method done by placing NG or OG tubes underwater to assess for water bubbling should be discontinued due to an absence of effectiveness and an overall risk of harm to the individual (Bourgault & Halm, 2009; Stepter, 2012). Bubbling tests are inaccurate to confirm the overall correct initial placement of NG and OG tubes (Bourgault & Halm, 2009; Stepter, 2012; Tho et al., 2011).

Litmus Paper

The use of litmus paper to verify correct position of the NG or OG tube is inaccurate and no longer advocated (Peter & Gill, 2009; Tho et al., 2011). Therefore, this practice should not be employed in the clinical setting to aide with identification of correct NG or OG tube placement within the gastric region (Peter & Gill, 2009; Tho et al., 2011). Utilizing pH testing over litmus paper is now an acceptable and recommended practice (Peter & Gill, 2009).

Ultrasonography

Verifying initial NG or OG tube placement with ultrasonography can decrease complications, avoid wastes of time, and decrease avoidable radiation contact (Kim et al., 2012). Instances in which ultrasonography is unable to confirm NG or OG tube placement, verification with a chest x-ray is required (Kim et al., 2012).

Capnography/Capnometry and Bilirubin/Enzyme Testing

The methods of capnography/capnometry, which is the process of carbon dioxide detection and indicates lung positioning of the NG or OG tube, bilirubin level testing, and enzyme level testing can discriminate respiratory tract placement from stomach placement of the NG and OG tubes (Bourgault & Halm, 2009). However, capnography/capnometry and bilirubin level testing, and enzyme level testing are unable to distinguish NG or OG tube position in the esophagus or the gastro-esophageal junction (Bourgault & Halm, 2009). Furthermore, Ellett et al. (2014) state that CO2 and bilirubin measurements are less than helpful in detecting NG or OG tube placement.

Review of Guidelines

The first selected practice guideline that was critically appraised with the AGREE II tool was the current NG and OG tube insertion practice guideline within the aforementioned northcentral Ohio community hospital. The practice guideline can be found on every nursing floor within this community hospital in the book titled, *Clinical Nursing Skills: Basic to Advanced Skills*, written by Smith et al. (2012). The practice guideline outlines the steps needed to confirm the placement of an NG or OG tube prior to the administration of tube feedings, medications, and H2O boluses (Smith et al., 2012). This document at this community hospital states that pH measurement of gastric aspirate should be checked prior to the initial administration of tube feedings, medications, and H2O boluses, but it does not state specifically how the pH should be checked (Smith et al., 2012).

The second selected practice guideline that was critically appraised with the AGREE II tool is the American Association of Critical Care Nurses (AACN) Practice Alert guideline regarding initial and ongoing verification of feeding tube placement in adults (Metheny, 2016). This Practice Alert guideline outlines the expected practice with rationale and supporting evidence that should be implemented by hospitals and nurses regarding the initial and ongoing verification methods of NG and OG tubes in adult populations (Metheny, 2016).

The third practice guideline that was critically appraised with the AGREE II tool was the revised NG/OG tube insertion practice guideline that was created within this document utilizing the best and most up-to-date evidence-based practices discussed within this document along with recommendations from the AACN Practice Alert

guideline and modifications to the original practice guideline at this community hospital. This revised practice guideline serves as a standard of care for verifying correct placement of the NG or OG tube on initial verification and during subsequent verifications.

An overview of the AGREE II tool is reviewed below. Following the AGREE II tool overview, the critical appraisals performed on both the current practice guideline at the above community hospital, the 2016 AACN Practice Alert guideline, and the revised practice guideline utilizing the AGREE II tool are reviewed. The critical appraisals of both guidelines were performed by three individual appraisers using the AGREE II tool.

Overview of AGREE II Tool

The overall purpose of the AGREE II tool is to offer a basis for evaluating the value and worth of guidelines (Brouwers et al., 2013). There are a total of six sections with individual subsections contained within the AGREE II tool that are applied to the evaluation of a guideline (Brouwers et al., 2013). Evaluators assess a guideline by applying these six sections to the guideline in question and score them using a 1-7 rating scale (Brouwers et al., 2013). A rating of 1 on the rating scale indicates the lowest possible quality and a rating of 7 indicates the highest possible quality. The final score of the guideline can be recommended for use without changes, with changes, or not at all (Brouwers et al., 2013). Below is a narrative of each section of the AGREE II tool.

The first section of the AGREE II tool contains the scope and purpose domain and includes the following considerations: 1) the purposes of the guideline are exactly defined, 2) the well-being inquires included in the guideline are exactly defined, and 3) the subjects that the guideline is to be concerned with are exactly defined (Brouwers et

al., 2013). The second section of the AGREE II tool contains the stakeholder involvement domain and includes the following considerations: 1) the creators of the guideline consist of persons within pertinent expert alliances, 2) the opinions and partialities of the subjects that the guideline is to be concerned with have been pursued, 3) the subjects that the guideline is to be concerned with are distinctly described, and 4) systematic approaches were utilized to obtain the literature (Brouwers et al., 2013). The third section of the AGREE II tool contains the rigor of development domain and includes the following considerations: 1) the standards of literature selection are exactly defined, 2) the strong points and weaknesses of the literature are exactly defined, 3) the approaches for articulating the proposals and suggestions are exactly defined, 4) the wellbeing advantages, adverse results, and hazards have been contemplated in articulating the proposals and suggestions, 5) there exists a clear relationship among the proposals and suggestions and the literature, 6) evaluation by external professionals of the guideline has been performed before the guideline was issued, and 7) a process for revising the guideline is offered (Brouwers et al., 2013). The fourth section of the AGREE II tool contains the clarity of presentation domain and includes the following considerations: 1) the proposals and suggestions are precise and clear-cut, 2) the diverse possibilities for control of the situation are exactly offered, and 3) crucial proposals and suggestions are clearly distinguishable (Brouwers et al., 2013). The fifth section of the AGREE II tool contains the applicability domain and includes the following considerations: 1) the guideline defines enablers and obstacles to the guidelines use, 2) the guideline offers guidance on the way in which the proposals and recommendations can be utilized, 3) the possible resources needed to utilize the proposals and

recommendations have been thought over, and 4) supervising and appraising measures have been offered by the guideline (Brouwers et al., 2013). The sixth and final section of the AGREE II tool contains the editorial independence domain and includes the following considerations: 1) the opinions of the supporting organization have had no impact on the subject matter contained within this guideline and 2) opposing gains of the creators of this guideline have been documented and spoken to (Brouwers et al., 2013).

Evaluation of Current Guidelines Using AGREE II Tool

Overall, the practice guideline being utilized at this community hospital has objectives that are specifically described; however, the health questions covered by this practice guideline are not discussed and the population to whom this practice guideline is meant to apply is vague and unclear. The practice guideline is only specific to individuals requiring an NG or OG tube and is not specific to gender, healthcare setting, or age. The guideline development group for the practice guideline at this community hospital includes the authors of the clinical skills book and does not include persons from pertinent professional organizations. The views and overall preferences of the individuals undergoing NG or OG tube insertion have not been pursued. The practice guideline indicates that the target users include nurses; however, the practice guideline does not clearly state the specificity of what type of nurses or the educational level of these nurses. The practice guideline states that information contained within this document is evidence-based; however, the practice guideline does not state what systematic methods were employed to search the evidence. The practice guideline does not discuss the criteria used to select the evidence nor does it examine the strengths and limitations of the evidence that was utilized to develop the practice guideline. The

method for creating the practice guideline is discussed and it is stated within the clinical skills book that the practice guideline is based on evidence-based research literature. The overall benefits, side effects, and risks of utilizing the practice guideline are listed throughout the document. The recommendations that are listed within the practice guideline are supported by rationale taken from the evidence-based literature. The practice guideline was reviewed by experts that included the authors of the book; however, this appraisal did not include a review by external experts. There is no procedure located within the practice guideline that can be employed to revise and update the current document. For the most part, the layout of the practice guideline is well written. The recommendations are not specific, but are laid out in a manner that is easily identifiable. However, there does continue to exist unclear and vague recommendations for practice that not expanded upon within this practice guideline. The different options for the management of the condition are offered, although these options could be expanded upon. The practice guideline that is implemented at this community hospital does describe facilitators and barriers to its application and provides advice and tools on the way in which the practice guideline should be put into clinical practice. The resources needed are discussed within the practice guideline. Specific details that need to be monitored and assessed by the user of the practice guideline are addressed by this document. The practice guideline being used within this community hospital is influenced by the authors of the clinical skills book and is therefore swayed by the funding body for the clinical skills book. The competing interests of the group members who developed the practice guideline are not logged or spoken to.

The overall quality of the current practice guideline being utilized at this community hospital is a 4. Based on the AGREE II tool evaluation findings from three individual appraisers along with the overall quality of the practice guideline, the current practice guideline at this community hospital for insertion of an NG or OG tube is recommended for utilization and implementation; however, with modifications.

Evaluation of 2016 AACN Practice Alert Using AGREE II Tool

The AACN Practice Alert guideline has objectives that are specifically described, the health questions covered by this practice guideline are discussed, and the population to whom this practice guideline is meant to apply to is evident. The guideline development group for the practice guideline does include persons from pertinent professional organizations. However, the views and overall preferences of the individuals undergoing NG or OG tube insertion have not been pursued. The practice guideline indicates that the target users include nurses and clearly states the specificity of what type of nurse. The practice guideline contains information that is evidence-based and contains systematic methods for the evidence obtained. The practice guideline does discuss the criteria used to select the evidence and does examine the strengths and limitations of the evidence that was utilized to develop the practice guideline. The method for creating the practice guideline is discussed and is based on evidence-based research literature. The overall benefits, side effects, and risks of utilizing the practice guideline are listed throughout the document. The recommendations that are listed within the practice guideline are supported by rationale taken from the evidence-based literature. The practice guideline was reviewed by experts that included a panel of external experts. For the most part, the layout of the practice guideline is well written.

The recommendations are specific and are laid out in a manner that is easily identifiable. The practice guideline does describe facilitators and barriers to its application and provides advice and tools on the way in which the practice guideline should be put into clinical practice. The resources needed are discussed within the practice guideline. Specific details that need to be monitored and assessed by the user of the practice guideline are addressed by this document.

The overall quality of the 2016 AACN Practice Alert guideline regarding initial and ongoing verification of feeding tube placement in adults is a 6. Based on the AGREE II tool evaluation findings from three individual appraisers along with the overall quality of the practice guideline, the 2016 AACN Practice Alert guideline for initial and ongoing verification of feeding tube placement in adults is recommended for utilization and implementation without modifications.

Evaluation of Revised Practice Guideline Using AGREE II Tool

The revised practice guideline has objectives that are precisely described, health questions that are covered by this practice guideline are discussed, and the population to whom this practice guideline is meant to apply is clear. The practice guideline is specific to individuals requiring an NG or OG tube, clearly states that it is to be utilized within a hospital facility, and the age that this guideline is to be utilized on is adults. The guideline development group for the practice guideline at this community hospital includes the authors of this document, key stakeholders within this community hospital, and recommendations from pertinent professional organizations. The views of the individuals undergoing NG or OG tube insertion have not been pursued; however, the preferences of these individuals were considered during the creation of this revised

practice guideline. The revised practice guideline indicates that the target users include nurses and other hospital staff who insert NG or OG tubes; however, the practice guideline does not clearly state the educational level of these nurses. The revised practice guideline states that information contained is evidence-based and does discuss the references utilized to create the revised practice guideline. The revised practice guideline does not discuss the criteria used to select the evidence, but it does consider the strengths and limitations of the evidence that was utilized to develop the practice guideline. The overall benefits, side effects, and risks of utilizing the revised practice guideline are listed throughout the document. The recommendations that are listed within the practice guideline are supported by rationale taken from the evidence-based literature. The practice guideline was reviewed by experts that included the author of this document and key stakeholders and experts within the implementation site at this community hospital. There is located within the revised practice guideline a process that can be employed to revise and update the current document. The layout of the revised practice guideline is well written, the recommendations are specific, and this guideline is laid out in a manner that is easily identifiable. The recommendations for practice are clear, well-defined, and have been expanded upon within this document. The different options for the management of the NG or OG tube are offered and have been expanded upon. The revised practice guideline does discuss barriers to its application and provides advice and tools on the way in which the revised practice guideline should be put into clinical practice. The resources needed are discussed within the practice guideline and specific details that need to be monitored and assessed by the user of the revised practice guideline are addressed by this document. The revised practice guideline has not been

influenced by the author and has therefore not been swayed by any funding bodies. The competing interests of the group members who developed the revised practice guideline are not logged or spoken to.

The overall quality of the revised NG and OG tube verification practice guideline that was created within this document utilizing the best and most up-to-date evidence-based practices discussed within this document along with recommendations from the AACN Practice Alert guideline and modifications to the original practice guideline at this community hospital is a 6. Based on the AGREE II tool evaluation findings from three individual appraisers along with the overall quality of the practice guideline, the revised practice guideline for initial and subsequent verification of NG and OG tube placement in adults is recommended for utilization and implementation without modifications.

Methods

Project Setting and Population

The project setting for this EBP project was a 227-bed community hospital in northcentral Ohio. The population of interest was male and female patients greater than 18 years of age who had either an NG or OG tube placed within this community hospital over the three-month pre-implementation (December 2015, January 2016, & February 2016) or the three-month post-implementation (August 2016, September 2016, & October 2016) chart review time period. The project implementation began in the winter of 2015 and concluded in the winter of 2016.

Implementation Process

As stated previously, the Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) Model which consists of 18-steps divided into three phases was applied to organize and guide the implementation process of this EBP project. The three phases are defined as the Practice question, Evidence, and Translation (PET) (Dearholt, 2012). A flow chart has been created to serve as an overview and summarize the activities of the implementation process that were performed within each phase of the JHNEBP model (see Figure 1). Following the flow chart, a more detailed narration of the implementation process has been scripted.

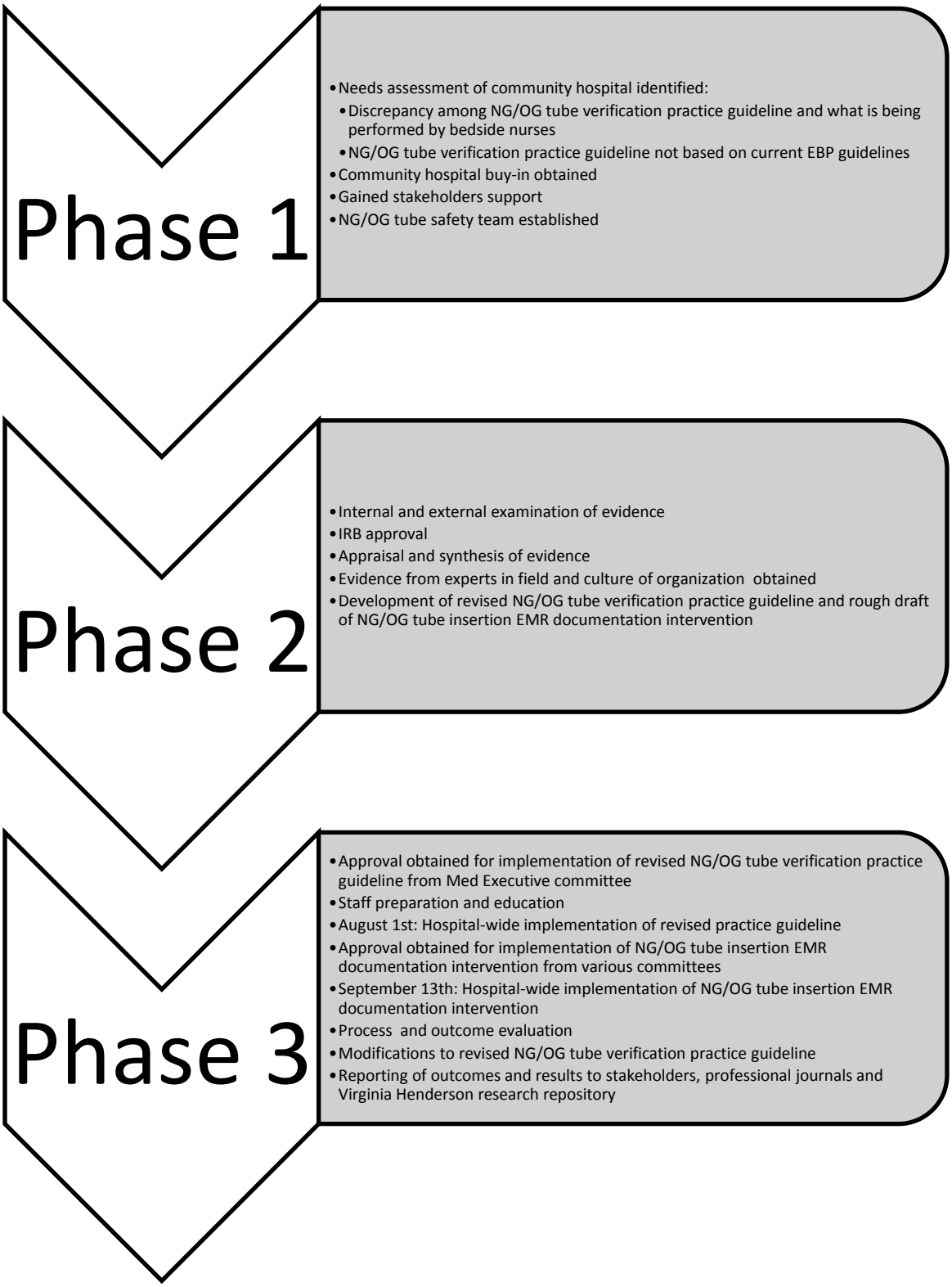


Figure 1. Summation of implementation process activities performed in phases of JHNEBP model.

Phase one. The first five steps of the JHNEBP found within the practice question phase are as follows: 1) draft an interprofessional team, 2) acquire, simplify, and enhance the EBP question, 3) describe the scope of the EBP question and distinguish stakeholders, 4) establish accountability for project leadership, and 5) arrange team meetings (Dearholt, 2012).

The NG/OG tube safety team members. The first step in implementing this EBP project was to draft an interprofessional team to generate and examine the specific practice concern within this EBP project. Prior to drafting an interprofessional team, hospital buy-in for the implementation of this EBP project was obtained from the Chief Nursing Officer (CNO) at this community hospital. The interprofessional team was established and is referred to as the NG/OG tube safety team. This team consisted of the PI and author of this paper, the CNO at this community hospital, the individual in charge of policy and procedure at this community hospital, the Quality Improvement (QI) Vice President, the Nurse Educator, and the information technology (IT) department. The second step of acquiring, simplifying, and enhancing the EBP question was completed with the help of the members from the NG/OG tube safety team. During a set of meetings with the PI, the CNO, the individual in charge of policy and procedure, and the QI Vice President, a needs assessment was executed for the specific practice concern in question. The needs assessment identified the following: 1) a discrepancy was occurring between what is stated in the practice guideline at this community hospital for the verification of NG and OG tubes and what was being performed by bedside nurses and 2) the practice guideline for verification practices of NG and OG tubes was not based on current EBP guidelines. Based on the completed needs assessment, an overall purpose

and objective for this EBP project was identified. The specific practice concern and overall purpose of this EBP project was to institute a systems-wide approach to update adherence guidelines for the most reliable and safest NG and OG tube verification practices in adults within a community hospital located in northcentral Ohio. Specifically, this study aims to improve nurse adherence to practice guidelines, increase the identification of misplaced NG and OG tubes, and decrease the adverse events caused by misplaced NG and OG tubes; ultimately, improving patient health outcomes.

The NG/OG tube safety team roles and responsibilities. The third step within this model involves defining the roles and responsibilities of each individual team member. The PI had the primary role in project leadership and responsibility with creation of the revised practice guideline, guiding and conducting staff education, implementing the revised practice guideline, and evaluating the implementation process of the revised practice guideline. The CNO, the individual in charge of policy and procedure, the QI Vice President, and the Nurse Educator all took part in reviewing and initially approving the composed revised practice guideline. The QI Vice President was in charge of scheduling meetings with the Medical Executive Committee to obtain final physician approval for the revised practice guideline. The Nurse Educator had the responsibility of scheduling and arranging the education sessions to the nursing staff and was also in charge of notifying the nursing staff of the educational sessions. The IT department had the distinct role, in collaboration with the PI, in creating the NG/OG tube insertion EMR documentation intervention within the Meditech operating system.

Stakeholders. Distinguishing the stakeholders is also contained within the third step of this EBP model. Stakeholders within this EBP project include members of the

NG/OG tube safety team as discussed above, along with the following individuals: 1) all staff nurses, 2) leadership team members including the executives and administrators, 3) physicians whom order NG and OG tubes, 4) patients in need of an NG or OG tube along with their family members, 5) residents and students whom practice in this community hospital, 6) the radiology department, and 7) the billing and financial staff. Step four consisted of accountability for project leadership and involved the PI of this paper. Step five consisted of arranging team meetings by the PI and these meetings were performed at a frequency set by the demands of this EBP project.

Phase Two. The next five steps of the JHNEBP found within the evidence phase are as follows: 6) perform internal and external examination for evidence, 7) appraise the level and quality of each piece of evidence, 8) review and condense the individual evidence, 9) synthesize overall strength and quality of evidence, and 10) develop recommendations for change based on evidence synthesis (Dearholt, 2012). An internal examination for evidence was performed through direct observation of bedside nursing staff, by not only the PI, but also by the CNO and the individual in charge of policy and procedure, utilizing incorrect NG and OG tube verification methods at the bedside. An additional task for the obtainment of internal evidence was performed by the PI within this step that included a three-month pre-implementation chart review for total nurse adherence to the current NG and OG tube practice guideline, the total NG and OG tube misplacement rate, and the total number of adverse events related to misplaced NG and OG tubes. Prior to any chart review being performed, permission by the Institutional Review Board (IRB) at the University of Toledo to complete this EBP project was received in May of 2016. The University of Toledo IRB approval letter can be found in

Appendix F. Official permission for the implementation of this EBP project was received by the aforementioned community hospital in May of 2016. The IRB committee at this community hospital deemed this EBP project to be a quality improvement project and stated that IRB was not needed at this community hospital. The approval letter obtained from the IRB at this community hospital can be found in Appendix G. External evidence was obtained through recommendations acquired from healthcare agencies, healthcare organizations, and through an evidence-based literature review for best practices for verification of NG and OG tube placement. Each piece of evidence has been appraised for its level and overall quality, the individual evidence has been reviewed, condensed, and synthesized, and recommendations for a revision to the practice guideline at this community hospital, based on evidence-based literature, for confirmation of NG and OG tube placement prior to the administration of tube feedings, medications, or H2O boluses was constructed.

The final step within this phase included the actual revision and modification of the current NG/OG tube verification practice guideline to include the evidence within this EBP project by the PI. The revisions and modifications that were the foundation for the revised NG/OG tube verification practice guideline at this community hospital were the implications for practice established by the evidence review of the literature within this EBP project. As stated previously, in addition to basing the revised practice guideline on the implications for practice established by the evidence review of the literature within this EBP project and the AACN practice guideline, it was imperative that the culture of this community hospital organization be respected and abided by. To ensure that the overall culture of this community hospital was respected, the PI gained input and

approval from a General Surgeon at this facility as to what he felt was the best practice recommendation for verification of NG and OG tubes, when comparing either pH measurement of gastric aspirate or radiographic confirmation since both were deemed adequate by the evidence. The General Surgeon was chosen for inquiry as he has the most dealings with the NG and OG tube patient population. He did not agree with measuring the pH of gastric aspirate due to the limitations and cumbersome nature of this verification procedure. Therefore, he deemed that obtaining a radiographic image prior to the administration of any substance via the NG or OG tube was the only safe and most accurate evidence-based practice recommendation as per the evidence. Subsequently, he then agreed to champion this practice change since he was one of the lead members on the Medical Executive committee. The Medical Executive committee is the physician committee that was needed for final approval of the revised practice guideline at this community hospital. The PI rewrote the current NG and OG tube verification practice guideline to reflect current best evidence-based practices as per recommendations within this document, the AACN practice guideline, and to also represent the culture of this community hospital. The implications for practice include the following: 1) a radiographic confirmation via a portable 1-view abdominal x-ray will be utilized to confirm the correct placement of the NG or OG tube prior to the initial administration of tube feedings, medications, and H2O boluses, 2) after initial placement has been verified via radiographic image, subsequent verifications of NG or OG tube placement will be done by assessing and documenting within the patient's EMR the number at the nare or the lip line of the NG or OG tube's exit site every four hours and as needed prior to the administration of any substance via these tubes, 3) the auscultatory method will not be

utilized to confirm gastric placement of the NG or OG tube since it is not reliable, and 4) the visual inspection of gastric aspirate to confirm gastric placement of the NG or OG tube will not be utilized alone. The revised practice guideline can be found within Appendix H.

During this step, the PI and the IT department worked together during a set of arranged meetings to create an NG/OG tube insertion documentation intervention within the electronic medical record (EMR) that bedside nurses could document the verification practices that are being performed when inserting NG and OG tubes at the bedside. After the NG/OG tube insertion EMR documentation intervention was constructed, approval was required for the intervention from members of three separate committees: 1) the documentation integration committee, 2) the documentation committee, and 3) the change advisory board committee. The NG/OG tube insertion EMR documentation intervention can be found in Appendix I.

Phase Three. The last eight steps of the JHNEBP found within the translation phase are as follows: 11) determine fit, feasibility, and appropriateness of recommendation for translation pathway, 12) produce an action plan, 13) secure support and resources to employ action plan, 14) employ the action plan, 15) assess outcomes, 16) report outcomes and findings to stakeholders, 17) recognize and distinguish next steps, and 18) distribute findings (Dearholt, 2012). Step eleven consisted of the NG and OG tube safety team reviewing the revised practice guideline and determining the overall fit, feasibility and appropriateness of the guideline for translation into practice. It was decided by the NG and OG tube safety team that because the revised practice guideline

considered the culture of the community hospital, the overall fit, feasibility, and appropriateness of the revised practice guideline was suitable for translation into practice.

Participant recruitment and training materials. An additional task needed to be performed to determine the overall fit and feasibility of implementation of this practice guideline within step eleven, participant, material, and monetary resources needed to employ the intervention were ascertained and secured. Participant recruitment consisted of female and male individuals, 18 years of age and older, hospitalized in this community hospital with an NG or OG tube during the specified three-month pre-implementation (December 2015, January 2016, and February 2016) and three-month post-implementation (August 2016, September 2016, and October 2016) chart review timeline of the revised practice guideline. Informed consent for patient chart review was not needed within this EBP project since this project fell within good clinical practice, is backed by external evidence and research, and is safeguarded by the participant's agreement to care in the clinical setting (Melnyk & Fineout-Overholt, 2015). Material resources that were needed to implement this EBP project included: 1) an abdominal x-ray, specifically the portable 1-view abdominal x-ray as requested per the radiologists and 2) the educational sessions to the nursing staff. A discussion with the hospital billing department and the PI occurred at this time and it was decided that the abdominal x-ray would be a standing order for the patient with an NG or OG tube who was to have any substance placed down the NG or OG tube. Therefore, it was determined that even though the abdominal x-ray would be considered a standing order, the bedside nurse must still write an order for the abdominal x-ray when it was deemed necessary so that the order could then be entered into the order entry system. Once the order was entered into

the order entry system by the nurse or the unit coordinator, the patient was then able to be charged for the abdominal x-ray procedure. The cost of a portable 1-view abdominal x-ray at this community hospital is approximately $160. The cost of the abdominal x-ray would increase if the patient had a large habitus that produced an insufficient image by the 1-view abdominal x-ray. This would lead to the individual needing to travel to the radiology department to undergo a non-portable abdominal x-ray to ensure all areas of the patient's habitus were captured. No additional training material, besides the creation of a PowerPoint by the PI, was needed to deliver the necessary education to the nursing staff. There was a cost to the community hospital to compensate nursing staff to attend the various educational seminars. The average nursing employee earns approximately $26.00 per hour. Since each educational seminar was approximately 30 minutes in length, the cost to this facility for each individual nursing employee to attend the NG/OG tube training was approximately $13.00. This cost fluctuated depending on the actual hourly base rate of the nursing employee. There was no additional cost for notifying the physicians and residents whom order NG and OG tubes in this community hospital since they were notified and educated of the revised practice guideline through weekly hospital email updates and at their scheduled physician meetings. A cost analysis summary table for this EBP project can be found in Appendix J. In addition, this step also speaks to the facilitators and barriers to implementation that were encountered during this EBP project.

Facilitators. It is well documented through the literature that implementing EBP into the healthcare setting can improve patient outcomes (Solomons & Spross, 2011). In addition to improvements in patient outcomes, EBP has been shown to bring clinical routines up-to-date and enhance the overall quality of care that is being provided by

healthcare providers to patients and families (Solomons & Spross, 2011). Sackett, Straus, Richardson, Rosenberg, and Haynes (2000) define EBP as the incorporation of the finest evidence literature alongside medical knowledge and a patient's distinctive beliefs and situations. It is therefore imperative that healthcare organizations share a mission and vision that supports and promotes EBP in their care environments. Misplaced NG and OG tubes that result from improper and unsafe initial verification practice guidelines can lead to devastating outcomes to patients and families. Through utilization of EBP, a safe and effective revised practice guideline has been created to replace improper and unsafe initial verification guidelines of NG and OG tubes. Implementing this revised practice guideline within a community hospital that supports EBP and encourages a culture of safety was a primary facilitator in this EBP project. A second facilitator within this EBP project was the community hospital buy-in and support. This second facilitator was primarily accomplished by educating staff and administrators responsible for clinical practice of the need for transforming and revising current NG and OG verification practice guidelines, and obtaining administration support for the revised practice guideline to be acknowledged as an organizational priority. A final facilitator that was of utmost importance to this EBP project was the celebration of success. Celebrating the success of this EBP project, no matter how small, occurred at frequent intervals within all phases of the project. The celebration of success occurred through acknowledgement of team members in educational seminars, staff meetings, and within the monthly "Did You Know?" community hospital newsletter. Positive outcomes were shared with all the stakeholders including bedside nursing staff. The facilitators table along with the methods that were utilized to assist with the facilitators can be found in Appendix K.

Barriers. Although there were numerous facilitators that occurred during the implementation of this EBP project, there still were barriers. However, once barriers were assessed during the beginning and assimilation phases of the EBP process, these barriers could then be recognized and overcome (Melnyk & Fineout-Overholt, 2015). Each barrier that occurred during the implementation of this EBP project is discussed in the following text along with the methods utilized to overcome these barriers. The first barrier that was encountered was a lack of peer or administrator support and an overall resistance to change. An essential method that was utilized to overcome this barrier was through education to administrators, peers, and staff. This education included the communication of improved patient outcomes that are possible with the implementation of the revised practice guideline along with highlighting the harms that can occur to the patient with continuation of current unsafe practice guidelines. An additional technique that was applied in addressing this first barrier was by ensuring that administrators within this community hospital along with the bedside nursing staff were aware of and understood the existing research evidence that supported the recommendations within the revised practice guideline that was being proposed for implementation. A second barrier that was met within this EBP project was the cost to the patient of implementing the revised practice guideline intervention since a portable 1-view abdominal x-ray would be required to be obtained for proper NG and OG tube placement identification. The cost to the patient included not only the monetary costs, but also the added radiation exposure. Additionally, there was a cost to the community hospital for educating staff on the specifics of the revised practice guideline. These cost barriers were overcome through emphasizing the long-term cost savings towards patients with NG or OG tubes to

administrators and key stakeholders of following a safe practice guideline and thus avoiding adverse outcomes to patients as opposed to following an unsafe practice guideline and having to pay for adverse outcomes to patients related to improper NG or OG tube placement. A third and probably the most significant barrier met during the implementation of this EBP project was communication, transmission, and dissemination of the revised practice guideline to all members of the community hospital team including administration, stakeholders, and bedside staff. In the beginning stages of implementation, it was very difficult to remain in constant communication with key individuals within administration due to the demanding workloads of these individuals. Through persistence of the PI in utilization of communication methods including email, telephone, and text messaging, this barrier was effectively able to be conquered. An additional communication barrier occurred one-week after the revised guideline had been implemented when the radiologists decided it would be a better fit for this organization to utilize an abdominal x-ray to identify placement of NG and OG tubes instead of a portable chest x-ray (PCXR) because the radiologists felt that more could be identified with this type of radiographic image. This barrier was conquered with effective communication and transmission of information of what the radiologists exactly wanted along with compromise and agreement in modifying the revised NG/OG tube practice guideline to reflect the requests of the radiologists. Additional methods in ensuring effective communication, transmission, and dissemination of the revised practice guideline was achieved included repeated exposure to staff of the revised practice guideline through: 1) numerous educational seminars, 2) monthly staff meetings, 3) email notifications, and 4) publication in the "Did You Know?" monthly community hospital

educational newsletter. A fourth barrier that occurred during the implementation of this EBP project was the overall adherence to the revised practice guideline. Methods employed to address this barriers included: 1) serving as a resource to trouble shoot processes, 2) making presence known on implementation floors through query to nursing staff via email on the progression of the revised practice guideline, 3) discussions with nursing staff via nurse floor directors of any challenges or barriers that were experienced in implementing the revised practice guideline, and 4) creating an NG/OG tube insertion documentation intervention in the patient EMR to assist with guiding nursing staff in proper revised guideline utilization. The most important approach to overcoming this barrier was the continuous education and reinforcement of the revised practice guideline. Revisions and modifications of practice deprived of education, training, and continual reinforcement of a revised guideline will not be successful in delivering quantifiable transformation in clinical outcomes (Melnyk & Fineout-Overholt, 2015). A fifth and final barrier that transpired during the implementation phase of this EBP project included the delay in release and publication of the NG/OG tube insertion EMR documentation intervention by the IT department. This delay was caused by wait times for approval from various required committees. Ultimately, this caused the revised practice guideline to be released and implemented prior to the NG/OG tube insertion EMR documentation intervention. However, this barrier was effectively overcome since nursing staff was still able to successfully implement the revised practice guideline and document the utilization of the revised practice guideline within either the nursing notes or the reassessment documentation interventions until the NG/OG tube insertion EMR

documentation intervention could go live. The barriers table along with the methods utilized to overcome the barriers can be found in Appendix L.

Step twelve consisted of developing a timeline for implementation and evaluation of this EBP project. A timeline for implementation and evaluation of this EBP project can be found in Appendix M.

Step thirteen included obtaining assistance and securing resources to employ the action plan and timeline. Once revision to the practice guideline was complete, all resources were in place, and the NG/OG tube insertion EMR documentation intervention was constructed, the PI received final approval for the practice guideline revision change from the CNO, the QI Vice President, the individual in charge of policy and procedure, the Nurse Educator, and physician members of the Medical Executive committee at this community hospital. As stated previously, the revised practice guideline was approved as a hospital-wide standing order and therefore denotes a standard of care for all adult individuals within this community hospital that have an NG or OG tube. Since this is the standard of care required for all patients with an NG or OG tube, there will be no physician order needed for bedside nurses to verify the placement of an NG or OG tube utilizing an abdominal x-ray. However, the bedside nurse does need to enter in a standing order within the patient's EMR so that this order will be entered into the order entry system and the patient will be charged for the procedure. All resources needed for implementation of this EBP project were double-checked at this time for their securement.

Action plan implementation. Step fourteen was the actual implementation of the action plan. After the practice guideline received final approval and all other necessary

items and resources were in place within step thirteen, the nursing staff within this community hospital was educated on the revised practice guideline. This education was primarily completed by the PI, except for the emergency room education which was provided by the lead charge nurse who was educated by the PI, and took place during various educational sessions. Educational sessions occurred at the following community hospital seminars and were done in such a way as to ensure education was provided to all nursing staff members: 1) Nursing Grand Rounds which consisted of 30-minute hospital education seminars that took place four times per day on two separate days, 2) mandatory Medical-Surgical Days that consisted of 30-minute hospital education seminars that occurred on three separate occasions, 3) critical care mandatory staff meetings that occurred on three separate occasions, and 4) emergency room mandatory staff meetings. Since most of the educational seminars were mandatory for all nursing staff to attend, the greatest number of nursing staff could receive in-person education on the revised practice guideline. Two additional education opportunities were implemented to ensure each and every nursing staff individual received education regarding this revised practice guideline. First, an email that contained the educational information required to successfully understand the revised practice guideline was sent out by the PI to all nursing directors and was then forwarded on to all nursing staff. Second, the revised practice guideline was published within the monthly "Did You Know?" community hospital educational newsletter. The "Did You Know?" community hospital educational newsletter can be found in Appendix N. In addition to these educational opportunities, a nursing accountability sheet highlighting the specifics of the revised practice guideline was distributed to all nursing units and had to be signed and acknowledged by all nursing

staff. The physicians and residents who order NG and OG tubes in this community hospital setting were notified and educated of the revised practice guideline through weekly hospital email updates and at their scheduled staff meetings.

After successful education to all nursing staff, the revised practice guideline was implemented hospital-wide on Monday, August 1st, 2016. The revised practice guideline was published and made available on this day for access by all hospital staff within the community hospital Intranet under the nursing policy and procedures link. Unfortunately, the NG/OG tube insertion EMR documentation intervention was not implemented on the same date as the revised practice guideline due to wait times for approval from the various required committees. However, nursing staff was still able to successfully implement the revised practice guideline and document the utilization of the revised practice guideline within either the nursing notes or the reassessment documentation interventions until the NG/OG tube insertion EMR documentation intervention went live on September, 13th, 2016.

Evaluation process. Step fifteen addressed the evaluation process which included both the evaluations of the implementation process along with the evaluation of the measures utilized in relation to the outcomes of this EBP project. Step fifteen also speaks to the results of this EBP project. The results section is discussed following the process and measure evaluation sections.

Process evaluation. The floor directors at this community hospital within each department observed the implementation process among bedside nurses to ensure that the revised practice guideline was being carried out by bedside nurses. The PI sent out an email or partook in communication every other week over a three-month time span to all

floor directors to inquire about any concerns, questions, or recommendations for improvement that surfaced regarding implementation of the revised practice guideline. One primary recommendation was encountered within one week of the revised practice guideline implementation. This recommendation was made by the radiologists and included the request to replace the PCXR with a 1-view abdominal x-ray. The radiologists decided it would be a better fit for this community hospital to utilize an abdominal x-ray to identify placement of NG and OG tubes instead of a PCXR because they felt that more could be identified with this type of radiographic image. The revised practice guideline was then reapproved by the physician members on the Medical Executive committee to include an abdominal x-ray instead of PCXR and the revised practice guideline was modified by the PI. The revised practice guideline was then updated within the nursing policy and procedure Intranet link, nursing staff was notified and educated via email by all nursing directors, and nursing staff had to sign a new accountability sheet that highlighted the change from PCXR to abdominal x-ray to the revised practice guideline. No further concerns, questions, or recommendations for changes to the revised practice guideline were encountered at this time. Additional evaluation of the NG/OG tube insertion EMR documentation intervention was performed by the PI during the post-implementation chart review. Since the NG/OG tube insertion EMR documentation intervention did not become live until the middle of September, the PI reviewed the charts of the patients with NG or OG tubes in the months of September and October 2016 to ensure that the nursing staff was correctly utilizing the NG/OG tube insertion EMR documentation intervention. Through the aforementioned chart reviews,

it was evident that the nursing staff was correctly and regularly utilizing the NG/OG tube insertion EMR documentation intervention.

Measure evaluation. The outcomes that were measured for this EBP project were evaluated via a post-implementation retrospective chart review for the months of August 2016, September 2016, and October 2016 after the revised practice guideline had been implemented for a total of three months. The three-month post-implementation retrospective chart review data was then compared to data from a three-month pre-implementation retrospective chart review that had been completed prior to the implementation of the revised practice guideline during the months of December 2015, January 2016, and February 2016. Patients that had an NG or OG tube during these specified months were identified via patient charges for an NG or OG tube. Therefore, if the patient was charged for an NG or OG tube, it was presumed that they had an NG or OG tube. These patient account numbers were obtained within an Excel program from the Co-Director of Business Analysis at this community hospital. Once the patients with NG or OG tubes were identified for the specified months, patient charts were reviewed for outcomes specific to this EBP project.

There were three primary outcomes that were collected, assessed, measured, and evaluated for this EBP project. The first outcome that was evaluated was the adherence rate of the bedside nurses in following the current or original practice guideline as compared to the revised practice guideline for the NG/OG tube verification procedure. The pre-adherence rate was collected via retrospective chart review of the patient's EMR over a three-month time period during the months of December 2015, January 2016, and February 2016 and the post-adherence rate was collected via retrospective chart review of

the patient's EMR over a three-month time period immediately following implementation of the revised practice guideline during the months of August 2016, September 2016, and October 2016. SPSS was utilized to perform a Chi Square statistical analysis to analyze proportions and compare the total adherence percentages pre-and post three-month chart reviews. A significance level of $p < 0.05$ was utilized. This outcome was evaluated through the documentation of the bedside nurse as to what verification method was utilized to confirm NG or OG tube placement. Bedside nurses at this hospital facility are required to document within the patient's EMR, in the nursing notes or the reassessment interventions, the verification method that was utilized to correctly confirm placement of the NG or OG tube. Since the pre-adherence rate assessed nurse's adherence to the current or original guideline, which stated the pH measurement of aspirate was to be utilized to confirm NG or OG tube placement, the nurse was considered adherent if a pH measurement of aspirate was performed. The post-adherence rate assessed the nurse's adherence to the revised practice guideline. Therefore, the nurse was considered adherent if an abdominal x-ray or other radiographic image was performed to correctly confirm NG or OG tube placement prior to the administration of any substance via the NG or OG tube. The nurse was also considered adherent if the position of the NG or OG tube was verified by absence of respiratory distress and the presence of gastric aspirate when no substance was introduced down the NG or OG tube.

The second outcome that was evaluated was the identified misplacement rate of NG and OG tubes. This outcome was evaluated through a retrospective chart review of the patient's EMR for the identified misplacement rate of NG and OG tubes three-months prior to the implementation of the revised NG/OG tube practice guideline during the

months of December 2015, January 2016, and February 2016 and three-months post implementation of the revised NG/OG tube practice guideline during the months of August 2016, September 2016, and October 2016. An NG or OG tube was considered misplaced if the NG or OG tube was in any other location besides the stomach as identified by a radiographic image. Additionally, if the side-port of the NG or OG tube is not beyond the gastro-esophageal junction and within the stomach on the radiographic image, the tube is considered misplaced. Primary locations for misplaced NG and OG tubes include the esophagus, the gastro-esophageal junction, and the lungs. Furthermore, misplacement was determined if the patient exhibited respiratory distress during NG/OG tube insertion or if the NG/OG tube was identified as misplaced by the nurse through visual assessment. The third and final outcome that was evaluated was the adverse events to patients caused by misplaced NG and OG tubes. This outcome was evaluated through a retrospective chart review of the patient's EMR for the occurrence of adverse events of NG and OG tubes three-months prior to the implementation of the revised NG/OG tube practice guideline during the months of December 2015, January 2016, and February 2016 and three-months post implementation of the revised NG/OG tube practice guideline during the months of August 2016, September 2016, and October 2016. An adverse event was determined to have occurred via review of the patient chart for documentation of either a decline in patient health status, a worsening of the patient's radiographic image, or a delay in patient treatment that could be directly related to the misplaced NG or OG tube. SPSS was utilized to perform a Chi Square statistical analysis on these last two outcomes to calculate the total identification rate of misplaced NG and OG tubes and the total adverse events caused by misplaced NG and OG tubes in the pre-

and post groups. A significance level of $p < 0.05$ was utilized. The outcome evaluation components table can be found in Appendix O.

Patient identification information was protected as it was only accessed at this community hospital setting and on their secured Intranet server. Patient identification information was de-identified during data collection and outcome information was recorded within an Excel spreadsheet. Some patients had multiple NG or OG tube insertions; therefore, each NG or OG tube data entry within the Excel spreadsheet represents an NG or OG tube insertion and does not signify a single patient. Within the Excel spreadsheet, each data entry or NG/OG tube insertion was investigated for the same outcome information. There were a total of three columns within the Excel data collection spreadsheet that were labeled adherence, misplacement, and adverse event, which each data entry was subject to. Each data entry or NG/OG tube insertion was queried with either a yes or no under the adherence, misplacement or adverse event columns. Demographic data was also collected for gender and age. During the chart reviews, it was found that some patients who were listed as being charged for an NG or OG tube, in fact did not have an NG or OG tube placed that could be found within the chart documentation. A total number of 37 patients had this occur and these patients had to be excluded from the data collection. Data that was collected within the Excel spreadsheet was then coded into the SPSS program.

Results. The results of this EBP project which includes the outcome measures of adherence, misplacement identification, and adverse events are discussed below following the demographic data results of the study population. The demographic data can be found in Table 1 after the demographic data results narrative section and the

outcome measure data can be found in Table 2 after the outcome measure data narrative section.

Demographics. The demographic results of this EBP project have been separated into gender and age categories; however, these two data categories have been compiled into one table (refer to Table 1). The gender demographic results will be discussed first followed by the age demographic results.

A total of 230 charts during the three-month pre-implementation phase and 236 charts during the three-month post-implementation phase of the revised practice guideline were reviewed, calculating 466 patient charts in total. Of these, 98 male (42.6%) and 132 female (57.4%) charts were reviewed during the three-month pre-implementation phase and 87 male (36.9%) and 149 (63.1%) female charts were reviewed during the three-month post-implementation phase of this EBP project. A chi-square statistical analysis was run on the gender samples of the pre- and post-implementation groups and resulted in a finding of .205. This test was performed to determine statistical significance between gender in the pre-implementation and the post-implementation groups. The finding of .205 indicates that there is no statistical significance between gender in the two pre- and post-groups. Therefore, the gender sample within the pre- and post-implementation group is similar and is not significantly different.

The mean age of the pre-implementation group was found to be 59.0696 with a minimum age of 19.00 and a maximum age of 99.00. The mean age of the post-implementation group was found to be 58.9280 with a minimum age of 18.00 and a maximum age of 95.00. The mean age of both groups combined was found to be 58.9979 with a minimum age of 18.00 and a maximum age of 99.00. An independent

sample t-test was run on the ages of the samples of the pre- and post-implementation groups and resulted in a finding of .933. This test was performed to determine statistical significance between the mean age in the pre-implementation and the post-implementation groups. The finding of .933 indicates that there is no statistical significance between the mean ages in the two pre-and post-groups. Therefore, the ages of the sample within the pre- and post-groups are similar and there exists no significant difference in age within the samples.

Table 1

Demographics of Study Population

Characteristics	**Pre-Implementation of Revised Practice Guideline**	**Post-Implementation of Revised Practice Guideline**	**P-value**
Gender			
Male (%)	98 (42.6%)	87 (36.9%)	.205
Female (%)	132 (57.4%)	149 (63.1%)	
Age			
Mean (SD)	59.0696 (17.88792)	58.9280 (18.19887)	.933

Adherence. During the pre-implementation phase of the revised practice guideline chart review, the adherence rate to the original practice guideline of the healthcare individuals within this community hospital when inserting NG and OG tubes was at 0 out of 266 (0.0%). After the implementation of the revised practice guideline, the adherence rate to the revised practice guideline of the healthcare individuals within this community hospital when inserting NG and OG tubes increased to 254 out of 274 (92.7%). A chi-square statistical analysis on the adherence rate of the pre-

implementation and the post-implementation groups resulted in .000. A result of .000 signifies that there is statistical significance between the adherence rate of the healthcare individuals when inserting NG and OG tubes pre- and post-implementation of the revised practice guideline. The increase in adherence rate can therefore be directly related to the implementation of the revised practice guideline.

Misplacement identification. During the pre-implementation phase of the revised practice guideline chart review, the total number of misplaced NG or OG tubes that were identified were 19 out of 266 (7.1%). After the implementation of the revised practice guideline, the total number of misplaced NG or OG tubes that were identified rose to 40 out of 274 (14.6%). A chi-square statistical analysis on the identified misplacement rate of the pre-implementation and the post-implementation groups resulted in .005. A result of .005 signifies that there is statistical significance between the total number of misplaced NG or OG tubes that were identified pre- and post-implementation of the revised practice guideline. The increase in misplaced NG and OG tubes that were identified can therefore be directly related to the implementation of the revised practice guideline.

Adverse events. During the pre-implementation phase of the revised practice guideline chart review, the total number of adverse events that were related to misplaced NG or OG tubes were 5 (1.9%) out of 261 (98.1%). After the implementation of the revised practice guideline, the total number of adverse events that were related to misplaced NG or OG tubes were 4 (1.5%) out of 270 (98.5%). A chi-square statistical analysis on the adverse events related to misplaced NG or OG tubes of the pre-implementation and the post-implementation groups resulted in .703. A result of .703

does not establish statistical significance and it can therefore be stated that there is no relationship between the total number of adverse events pre- and post-implementation of the revised practice guideline; however, there does exist clinical significance since the total number of adverse events did decrease pre- and post-implementation of the revised practice guideline.

Table 2

Outcome Measures

Measure	Pre-Implementation of Revised Practice Guideline		Post-Implementation of Revised Practice Guideline		P-value
	No (%)	Yes (%)	No (%)	Yes (%)	
Adherence	266 (100.0%)	0 (0.0%)	20 (7.3%)	254 (92.7%)	.000
Identified Misplacements	247 (92.9%)	19 (7.1%)	234 (85.4%)	40 (14.6%)	.005
Adverse Events	261 (98.1%)	5 (1.9%)	270 (98.5%)	4 (1.5%)	.703

Step sixteen included the reporting of the outcomes from step fifteen to the stakeholders previously mentioned. Communications including meetings and email exchanges with the CNO, the individual in charge of policy and procedure, the Nurse Educator, the QI VP, and the Nurse Directors of this organization were conducted and results of the study were discussed. These individuals afforded helpful feedback in regards to possible modification ideas to the revised practice guideline. A specific modification to the revised practice guideline that was discussed, involved additions to the revised practice guideline that included how frequent nursing staff should assess the

overall securement of the NG or OG tube. Although it is stated within the revised practice guideline that nurses should asses the NG or OG tube every four hours and as needed, the assessment of the securement of the NG or OG tube needs to be clarified. This need in guideline modification stemmed from concerns reported by some of the nursing staff of the Intensive Care Unit (ICU) that OG tubes were migrating frequently causing a discrepancy in the last documented number on the OG tube at the lip line leading to additional radiographic images needing to be performed. To conquer this difficulty, it was suggested that nurses must assess the securement of the NG or OG tube more frequently and re-secure these tubes if needed to mitigate the performance of repeat radiographic images. A second recommendation per the PI was in regards to possible need for investment into NG and OG tubes that are more radiopaque in nature and can be better visualized on the radiographic film. This request was specifically brought to the attention of the PI during the post-implementation period of this EBP project by bedside nurses who felt more radiographic images were occasionally being performed repeatedly due to radiology's inability to visualize the NG or OG tube on the image. The CNO within this facility stated that she would consider the cost summary of a more radiopaque NG/OG tube with the billing department and compare this cost to the current supply of NG/OG tubes.

Step seventeen included revision to the revised practice guideline to include the more frequent assessment of the securement of the NG or OG tube. The modification to the revised practice guideline to include this revision continues to be in the process of being revised.

The eighteenth and final step speaks to the sustainability of this EBP project and included the distribution of the modifications that have been made to the revised practice guideline for verifying the correct placement of NG and OG tubes prior to the administration of tube feedings, medications, and H2O boluses and the outcomes that have been established within this EBP project hospital wide at this community hospital. In addition, this step entails the distribution and dissemination of the findings of this EBP project to applicable professional journals and to the Virginia Henderson Global Nursing e-Repository. A poster presentation of this EBP project was presented at the Midwest Nursing Research Society (MNRS), at the University of Toledo's Nursing Research Day, and at the ProMedica Nursing Research Conference. Additionally, this EBP project will be presented at the *2017 Rising Stars of Research and Scholarship Poster Program* at Sigma Theta Tau International's (STTI) Creating Healthy Work Environments program in March of 2017.

Discussion

The goals of this EBP project included: 1) improved nurse adherence to practice guidelines, 2) increased identification of misplaced NG and OG tubes, and 3) decreased adverse events caused by misplaced NG and OG tubes.

Adherence

This project resulted in a 0.0% adherence rate of healthcare professionals for verification of NG and OG tubes pre-implementation of the revised practice guideline and a 92.7% adherence rate of healthcare professionals for verification of NG and OG tubes post-implementation of the revised practice guideline. This increase in NG/OG tube revised guideline adherence resulted in statistical significance of $p = .000$. The results of this EBP project are not consistent with the results of a previous study performed by Tho et al. in 2011 that found an 84.6% adherence to an implemented practice change involving key areas of feeding tube placement confirmation among nurses over an initial one month audit. This difference in adherence percentage results can be attributed to the fact that the adherence rate within this EBP project was collected over a three-month period of time in comparison to Tho et al.'s (2011) one month audit. However, results of this EBP project were supported in a previous study conducted by Bourgault et al. in 2014 that established a 94% ($n = 346$) rate of nursing professionals who suggested or promoted the performance of a radiographic image prior to the administration of any substance through an NG or OG tube.

Misplacement Identification

This project resulted in a 7.1% identified misplacement rate for NG and OG tubes pre-implementation of the revised practice guideline and a 14.6% identified

misplacement rate for NG and OG tubes post-implementation of the revised practice guideline. This increase in NG/OG tube misplacement identification resulted in statistical significance of p = .005. Both misplacement rates pre- and post-implementation of the revised practice guideline are not consistent with the results of a previous study performed by Sorokin and Gottlieb in 2006 that found within an assessment of more than 2,000 NG/OG tube insertions, approximately 50 (2.5%) feeding tubes were located within the pulmonary tract. Similarly, Sparks, Chase, Coughlin, and Perry (2011) reviewed five studies (*n* = 9931) on pulmonary misplacement of nasoenteric tubes and established a mean malposition rate of 1.9% within the tracheobronchial tree. Likewise, the AACN (2010) revealed that 1.3% to 3.2% of NG and OG tubes are inaccurately positioned in the lung. Furthermore, Marderstein, Simmons, and Ochos (2004) revealed 87 (2%) out of 4,190 feeding tubes that were misplaced within the lungs. The difference in the total number of identified misplaced NG/OG tubes established within this project as compared to the existing literature can be attributed to the fact that, unlike previous studies, this project incorporated all types of misplacements, including those exhibited by symptoms of respiratory distress, direct visualization of a misplaced NG/OG tube, or identification of a misplaced NG or OG tube on the radiographic image within the esophagus or the pulmonary tract. A previous study was found that incorporated various types of misplacements including esophageal and small bowel misplacement (Metheny, 2006). Metheny conducted this study in 2006 and had results consistent with the post-implementation phase of this EBP project that established 25 (12.4%) out of 201 NG/OG tubes inserted were in fact misplaced.

It was established within this EBP project that radiologists at this specific community hospital preferred 1-view abdominal x-rays over PCXRs to identify the placement of NG and OG tubes. Conversely, after review of the radiographic interpretations during the three-month post-implementation chart review, it became apparent that the radiologists could not always visualize the NG or OG tube on the abdominal film and a subsequent PCXR still needed to be performed. The existing literature states that a radiographic image is gold standard (Bourgault & Halm, 2009; Peter & Gill, 2009; Seguin et al., 2005; Stepter, 2012; Tho et al., 2011; Turgay & Khorshid, 2010); however, some of the literature is contradicting when determining whether an abdominal x-ray or a PCXR should be utilized. The National Patient Safety Agency (NPSA) (2011) affirms that the image must be positioned lower than where a normal chest x-ray would be taken and must also make evident the abdominal area under the diaphragm to ensure the lowest point on both hemi-diaphragms are visualized. Therefore, a chest x-ray would be sufficient to identify the placement of NG and OG tubes if the image was taken in such a manner as recommended by the NPSA. Additionally, it was suggested by the radiologists at this community hospital that more radiopaque NG/OG tubes need to be utilized to ensure the visualization of these tubes on radiographic images to avoid repeat and unnecessary x-ray images. This request from radiology is supported by recommendations from the NPSA's Patient Safety Report released in 2011 that states NG and OG tubes must be fully radiopaque through the entire tube. It is therefore imperative and has been made evident by results within this EBP project that recommendations from radiologists be taken into consideration when creating a practice guideline for NG/OG tube verification.

Adverse Events

This project resulted in a 1.9% adverse event rate for NG and OG tubes pre-implementation of the revised practice guideline and a 1.5% adverse event rate for NG and OG tubes post-implementation of the revised practice guideline. The results of this project are supported by the results established by Sparks et al. (2011) review of five studies (n = 9931) on pulmonary misplacement of nasoenteric tubes that identified 35 (1%) adverse event cases in which pneumothorace occurred. Of these 35 cases of pneumothoraces, 5 of these cases resulted in death (Sparks et al., 2011). This EBP project is further supported by the adverse event rate of NG and OG tubes established by a study implemented by Sorokin and Gottlieb in 2006 that found 50 (2.5%) out of 2,000 misplaced feeding tubes that caused a pulmonary adverse event. Similarly, Rassias, Ball, and Corwin (1998) observed a 2% tracheopulmonary adverse event rate among 740 NG/OG tubes placed. However, unlike this EBP project which looked at adverse events of all types, the studies conducted by Sparks et al. (2011), Sorokin and Gottlieb (2006), and Rassias, Ball, and Corwin (1998) limited their adverse event criteria to those that were only pulmonary in nature. This difference in inclusion criteria could be a reason for the adverse event rate of this EBP project to be although similar, slightly different than that of the existing literature. Statistically, p = .703 was established within this EBP project among the pre- and post-implementation adverse event rate of NG and OG tubes. While there were no statistically significant results established from the results of this EBP project concerning the adverse event rate of NG and OG tubes, there was clinical significance in that the total number of adverse events decreased from the pre- to the post-implementation time periods from 5 to 4. During chart reviews, it was difficult to

relate without a doubt the happening of adverse events to the misplaced NG or OG tube unless it was specifically documented. Implementing this EBP project over a longer period of time and requiring the specific and detailed documentation of adverse events related to misplaced NG or OG tubes may result in statistical significance for the adverse event rate of NG and OG tubes.

Through implementation of this EBP project, it has been proven that implementation of evidence into practice is difficult and is not without challenges. This fact has long been established within the existing literature that change is difficult (Abrahamson, 2000; Eveleigh et al., 2011; Ponti, 2011; Porter-O'Grady & Malloch, 2015). Furthermore, implementing evidence into practice that causes multiple practice changes can prove to be even more difficult. Implementation of this EBP project has proven that difficulties associated with change can be effectively overcome and conquered when evidence-based practices are correctly implemented using proper evidence-based frameworks. Utilization of proper evidence-based frameworks, such as the JHNEBP evidence-based framework utilized within this EBP project, enables evidence to be implemented into practice so that healthcare delivery can be safer and more effective. Additionally, it has been established through implementation of this EBP project, that communication and teamwork among a myriad of disciplines and specialties is needed for effective change to occur. Similarly, Tho et al. (2011) found that a multidisciplinary methodology must be utilized to successfully implement change within a practice setting. Therefore, it is essential that change be executed in healthcare organizations despite difficulties that are encountered with change.

Economic Benefit

The economic elements that were required for this EBP project to be completed included: 1) the time and effort of the PI along with the PI's EBP project committee members, 2) the time and effort of the individuals who assisted in the implementation of this EBP project, 3) the additional monetary and radiation cost to the patient for an abdominal x-ray, and 4) the cost of compensating the nursing staff during educational seminars. Although these economic considerations incurred additional cost to the community hospital and to the patient with an NG or OG tube, these costs have been proven to be justified when one considers the cost of adverse events caused by misplaced NG and OG tubes. It is almost impossible to defend in a court of law, when an adverse event occurs due to a misplaced NG or OG tube, and it is discovered that evidence-based standard of care verification practices for NG and OG tubes were not adhered to by bedside nurses or other healthcare professionals (AHC, 2015). The primary reason for this is because evidence in the literature exists that emphasize the proper NG and OG tube verification practices that should be utilized to avoid harmful consequences to patients (AHC, 2015). According to American Health Consultants (2015), each settlement for a misplaced NG or OG tube that is associated with an adverse event costs the healthcare facility an average of $1.07 million. Therefore, these misplaced NG and OG tubes have the potential to cost healthcare practitioners and facilities millions and millions of dollars in largely avoidable expenses (AHC, 2015). Through implementation of this revised practice guideline, there was an increase in identified misplaced NG and OG tubes within this community hospital that directly led to a decrease in the number of possible adverse events.

A cost savings analysis has been calculated utilizing the results of the misplacements discovered within the chart reviews performed. It was found during the three-month post-implementation of the revised NG/OG tube insertion practice guideline chart review, two specific incidences where an NG or OG tube was inserted into a patient's lung. In both incidences, the patients were cognitively alert and neither patient exhibited respiratory symptoms. It was found, only through performance of a radiographic image, that these two patients had in fact been intubated into the lung by the bedside nurse with an NG/OG tube. Since these misplaced tubes were identified immediately on radiographic image, neither patient suffered an adverse event. Had the revised NG/OG tube insertion practice guideline not been in place at this community hospital, the radiographic images most likely would never have occurred and the healthcare team would have been unaware that these tubes were in the patient's lungs. Several adverse events had the potential to occur due to these misplaced tubes had they not been immediately identified by radiographic image (AACN, 2010; Bourgault et al., 2014; Simons & Abdallah, 2012; Sorokin & Gottlieb, 2006). One common adverse event that occurs when NG or OG tubes are placed into the pulmonary tract is pneumonia (AACN, 2010; Bourgault et al., 2014; Simons & Abdallah, 2012; Sorokin & Gottlieb, 2006). According to the American Thoracic Society and the Infectious Diseases Society of America (2005), the average cost of one hospital-acquired pneumonia patient is $40,000. Since there were two pulmonary NG/OG tube misplacements identified over a three-month time period, a total of eight can be estimated to occur over a twelve-month time period. Therefore, implementation of this revised NG/OG tube insertion practice

guideline within this community hospital has a projected cost savings of $320,000 among hospital-acquired pneumonia patients alone in one single year.

Strengths

An identifiable strength of this EBP project includes the large sample size that was examined in the pre-and post-retrospective chart reviews. Examining a larger sample size enabled the possibility of establishing a valid statistical significance among the data obtained. An additional asset of this EBP project includes the fact that this EBP project was implemented hospital-wide and was therefore generalizable to the entire hospital population instead of being limited to one single population within a small setting.

Limitations

A limitation to this EBP project includes the fact that this EBP project was only implemented within one community hospital and not within multiple hospital facilities. An additional weakness to this EBP project involves the total number of adverse events caused by misplaced NG or OG tubes. During chart reviews, unless it was specifically documented within the patient's EMR, it was difficult to relate adverse events directly to misplaced NG or OG tubes. Therefore, there is a possibility that the total adverse event rate is misrepresented within this EBP project and more adverse events could have occurred that were not counted because they were not specifically related to misplaced NG or OG tubes in the patient's EMR documentation.

Application of Lewin's Change Management Model

The healthcare profession is in a constant state of change to best meet the needs of patients and their families. Treatment and procedural modalities delivered to patients in

the hospital setting must always be based upon the most up-to-date evidence-based standards. Through implementation of this EBP project, the revised guideline has been updated to reflect the best possible evidence-based practice standards for verification of NG and OG tubes. When implementing changes into the hospital setting, it is imperative that theoretical frameworks be employed to not only assist and effectively carry out the change process, but to ensure its sustainability over time.

The Lewin's Change Management Model (CMM) provided an easy to follow framework for this EBP project that could be applied by bedside nurses to assist with this crucial change in NG/OG tube practice guidelines. The first stage, the unfreezing stage, involved establishing the modifications that needed to occur to the current NG/OG tube practice guideline. During this same time, members within this community hospital needed to be informed of the reasons for the needed modification to the current NG/OG tube practice guideline so that they were better able to accept the needed modifications. Informing these individuals of the reason behind the needed change was crucial in enabling these individuals to adapt the principles within this revised practice guideline so that they saw merit in these modifications and did not continue to do what had always been done. The second stage, the change stage, involved implementation of the revised NG/OG tube practice guideline hospital-wide and the overall acceptance of this revised guideline by hospital staff. The final stage, the refreezing stage, involved the consistent adherence of hospital staff to the revised NG/OG tube practice guideline. Continual adherence by hospital staff to the revised practice guideline indicated that the individuals within this community hospital were ready to freeze this change into place. Re-freezing the change made within this community hospital utilizing the Lewin's CMM enabled the

change process to be effectively executed to guarantee the revised NG/OG tube practice guideline's sustainability over time.

Conclusion

There exist over 500,000 misplaced feeding tubes per year (AHC, 2015). Each of these misplacements has the potential to result in serious patient harm or even death and can incur millions of dollars in avoidable expenses to healthcare practitioners and facilities (AHC, 2015). Therefore, determining and identifying the correct placement of NG and OG tubes in the clinical setting by the bedside nurse prior to the administration of tube feedings, medications, and H2O boluses is imperative to avoid detrimental consequences to the patient receiving care. A needs assessment along with a critical appraisal of the current practice guidelines for this bedside procedure within a northcentral Ohio community hospital identified a need for an EBP change. Outcomes of this EBP project that were achieved after implementation of a revised practice guideline for NG/OG tube verification included increased total nurse adherence rates, increased identification of misplaced NG and OG tubes, and decreased number of adverse events caused by misplaced NG and OG tubes that ultimately, improved the overall health outcomes and safety of patients. This project offers a revised practice guideline for confirming initial and subsequent NG and OG tube placement that is not only feasible, but is also realistic in the clinical setting and is based upon the most up-to-date, evidence-based literature to achieve the best possible patient outcomes at this community hospital facility.

Future Recommendations

According to results of this EBP project, it is recommended that healthcare practitioners and facilities become aware of the consequences of inaccurately positioned NG and OG tubes caused by improper NG and OG tube verification practices.

Modifications to organizational NG/OG tube verification practice guidelines, as the ones evident within this EBP project, must be performed to mitigate unnecessary risks and costs to patients and healthcare facilities. Multi-disciplinary approaches to implement practice change within a healthcare setting is recommended and suggested. Furthermore, it is recommended that healthcare facilities take into consideration opinions from radiologists when creating NG and OG tube verification practice guidelines in regards to preferred type of radiographic image and preferred type of radiopaque feeding tube.

Doctoral Essentials Addressed by EBP Project

The Doctor of Nursing Practice (DNP) Essentials have been created by the American Association of Colleges of Nursing to speak to the foundational proficiencies that are essential to the training of each and every individual partaking in the advanced practice nursing degree (American Association of Colleges of Nursing, 2006). These DNP Essentials must be present in the curriculum of all universities and programs that offer the DNP credentials (American Association of Colleges of Nursing, 2006). There are a total of eight DNP Essentials (American Association of Colleges of Nursing, 2006). The individual pursuing their DNP degree needs to have the chance to incorporate all eight DNP Essentials into their clinical practice; though, it is not necessary to exhibit all eight DNP Essentials into their final EBP project (American Association of Colleges of Nursing, 2015). A total of six DNP Essentials have been demonstrated within this EBP project and are discussed in the following narrative sections.

Essential I

The first DNP Essential demonstrated within this EBP project is Essential I: Scientific Underpinnings for Practice. This DNP Essential focuses on the ability of the DNP graduate to utilize an extensive range of understanding and expertise from all the different sciences and employ these sciences into embarking on existing and future practice concerns and problems (American Association of Colleges of Nursing, 2006). A review of the literature has provided knowledge from many of the different sciences and a revised practice guideline for the verification of NG and OG tubes has been devised from this literature; thus, enabling the highest level of nursing practice to be achieved.

Essential II

The second DNP Essential exhibited within this EBP project is Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking. This DNP Essential speaks to the importance of improving patient safety outcomes through the DNP graduate occupying a role in organizational and systems leadership (American Association of Colleges of Nursing, 2006). This EBP project addressed a current gap in knowledge in the NG and OG tube placement verification policy within a community hospital in northcentral Ohio. Through creation and implementation of a revised NG and OG tube verification practice guideline based on evidence-based literature, the overall delivery of care to these patients has been enhanced and patient safety outcomes has been improved upon.

Essential III

The third DNP Essential made evident within this EBP project is Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice. DNP Essential number three expresses that the DNP graduate must be able to critique and appraise existing research and can implement this research into practice to ensure that current practices that are being carried out are based upon evidence-based traditions (American Association of Colleges of Nursing, 2006). Through a review and critique of existing research for verification practices of NG and OG tubes, a revised practice guideline based on EBP guidelines to improve patient healthcare outcomes has been established within this EBP Project.

Essential IV

The fourth DNP Essential apparent within this EBP project is Essential IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care. The DNP graduate must be able to utilize information systems and technology to assist and enhance the care that is delivered to patients (American Association of Colleges of Nursing, 2006). An NG and OG tube insertion EMR documentation intervention was created, in collaboration with the IT department, for this EBP project to enable improved healthcare delivery through the monitoring of care outcomes in patients with NG and OG tubes at a community hospital in northcentral Ohio.

Essential V

The next DNP Essential demonstrated within this EBP project is Essential V: Health Care Policy for Advocacy in Health Care. The DNP graduate must be able to lead policy changes at all levels of healthcare (American Association of Colleges of Nursing, 2006). This DNP project involved the development of a practice guideline modification along with a systems-wide implementation of a revised NG and OG tube verification practice guideline within a northcentral Ohio community hospital.

Essential VI

The sixth and final DNP Essential exhibited within this EBP project is Essential VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes. DNP graduates must be able to exhibit leadership within the role of interprofessional team development to examine multiplex practice and structural healthcare problems (American Association of Colleges of Nursing, 2006). Through

effective team leadership of the DNP student, an interprofessional NG/OG tube safety team was established within this EBP project that enabled the successful development, implementation, and evaluation of this revised NG and OG tube verification practice guideline to be accomplished.

References

Abrahamson, E. (2000). Change without pain. *Harvard Business Review*, 75-79.

American Association of Colleges of Nursing. (2006). *The essentials of doctoral education for advanced nursing practice.* Retrieved from http:// www.aacn.nche.edu/publications/ position/DNPEssentials.pdf

American Association of Colleges of Nursing. (2015). *The Doctor of Nursing Practice: Current issues and clarifying recommendations.* Retrieved from http:// www.aacn.nche.edu/aacn-publications/white-papers/DNP-Implementation-TF-Report-8-15.pdf

American Association of Critical-Care Nurses. (2010). *AACN practice alert: Verification of feeding tube placement*. Retrieved from http://www.aacn.org/wd/practice/docs/ practicealerts/verification-feeding-tube-placement.pdf?menu=aboutus

American Health Consultants. 2015. *Misplaced NG tubes a major patient safety risk.* Retrieved from https://www.ahcmedia.com/articles/135136-misplaced-ng-tubes-a-major-patient-safety-risk

American Thoracic Society and Infectious Diseases Society of America. (2005). Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. *American Journal of Respiratory and Critical Care Medicine*, 171, 388–416.

Boeykens, K., Steeman, E., & Duysburgh, I. (2014). Reliability of pH measurement and the auscultatory method to confirm the position of a nasogastric tube. *International Journal of Nursing Studies, 51*(11), 1427-1433. doi: 10.1016/j.ijnurstu.2014.03.004

Bourgault, A. M., & Halm, M. A. (2009). Feeding tube placement in adults: Safe verification method for blindly inserted tubes. *American Journal of Critical Care, 18*(1), 73-76. doi: 10.4037/ajcc2009911

Bourgault, A. M., Heath, J., Hooper, V., Sole, M. L., Waller, J. L., & NeSmith, E. G. (2014). Factors influencing critical care nurses' adoption of the AACN practice alert on verification of feeding tube placement. *American Journal of Critical Care*, 23(2), 134-143.

Brouwers, M, Kho, M. E., Browman, G. P., Cluzeau, F., Feder, G., Fervers, B., . . . Makarski, J. O. (2013). AGREE II: Advancing guideline development, reporting and evaluation in healthcare. *Canadian Medical Association Journal,* 182: E839-842. doi: 10.1503/cmaj.090449

Dearholt, S. L. (2012). The Johns Hopkins Nursing Evidence-Based Practice Model and process overview. In S. L. Dearholt & D. Dang (Eds.), *Johns Hopkins Nursing Evidence-Based practice: Model and guidelines* (pp. 33-53). Indianapolis, IN: Sigma Theta Tau International.

Dearholt, S. L., & Dang, D. (2012). *Johns Hopkins Nursing Evidence-Based Practice: Model and guidelines* (2nd ed.). Indianapolis, IN: Sigma Theta Tau International.

Ellett, M. C., Cohen, M. D., Croffie, J. B., Lane, K. A., Austin, J. K., & Perkins, S. M. (2014). Comparing bedside methods of determining placement of gastric tubes in children. *Journal for Specialists in Pediatric Nursing*, *19*(1), 68-79. doi:10.1111/jspn.12054

Eveleigh, M., Law, R., Pullyblank, A., & Bennett, J. (2011). Nasogastric feeding tube placement: Changing culture. *Nursing Times, 107*(41), 14-16.

Gawlinski, A., & Rutledge, D. (2008). Selecting a model for evidence-based practice changes: A practical approach. *American Association of Critical Care Nurses, 19*(3), 291-300.

Gilbertson, H., Rogers, E., & Ukoumunne, O. (2011). Determination of a practical pH cutoff level for reliable confirmation of nasogastric tube placement. *Journal of Parenteral & Enteral Nutrition, 35*(4), 540-544. doi:10.1177/0148607110383285

Haga, Y., Yamanouchi, T., Matsukura, S., Nagamatsu, Y., Yoshidomi, K., Fukano, K., . . . Tonai, T. (2008). Advice for prevention of inadvertent respiratory placement of nasogastric feeding tube. *International Journal of Risk & Safety in Medicine, 20*(4), 241-247.

Kim, H. M., So, B. H., Jeong, W. J., Choi, S. M., & Park, K. N. (2012). The effectiveness of ultrasonography in verifying the placement of a nasogastric tube in patients with low consciousness at an emergency center. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 20*, 38. doi: 10.1186/1757-7241-20-38

Lewin, K. (1947). Frontiers in group dynamics. In D. Catwright (Ed.), *Field theory in social science* (pp. 143-153). London: Social Science Paperbacks.

Marderstein, E., Simmons, R., & Ochos, J. (2004). Patient safety: Effect of institutional protocols on adverse events related to feeding tube placement in the critically ill. *Journal of the American College of Surgeons*, 199(1), 39-50.

Meert, K. L., Caverly, M., Kelm, L. M., & Metheny, N. A. (2015). The pH of feeding tube aspirates from critically ill infants. *American Journal of Critical Care*, *24*(5), e72-77. doi:10.4037/ajcc2015971

Melnyk, B. M., & Fineout-Overholt, E. (2015). *Evidence-based practice in nursing & healthcare: A guide to best practice* (3rd ed.). Philadelphia, PA: Wolters Kluwer Health.

Metheny, N. (2006). Preventing respiratory complications of tube feedings: Evidence-based practice. *American Journal of Critical Care*, 15(4), 360-369.

Metheny, N. (2016). Initial and ongoing verification of feeding tube placement in adults. *Critical Care Nurse*, *36*(2), 8-13. doi:10.4037/ccn2016141

Metheny, N., Meert, K., & Clouse, R. (2007). Complications related to feeding tube placement. *Current Opinion in Gastroenterology*, *23*(2), 178-182.

National Patient Safety Agency. (2005). *Patient safety alert NPSA/2011/PSA002: Reducing the harm caused by misplaced nasogastric feeding tubes in adults, children and infants.* Retrieved from http://www.nrls.npsa.nhs.uk/EasySiteWeb/getresource.axd?AssetID=129697&

O'Mathuna, D. P. (2015). Ethical considerations for evidence implementation and evidence generation. In B. M. Melnyk & E. Fineout-Overholt (Eds.), *Evidence-based practice in nursing & healthcare: A guide to best practice* (515-530). Philadelphia, PA: Wolters Kluwer Health.

Peter, S., & Gill, F. (2009). Development of a clinical practice guideline for testing nasogastric tube placement. *Journal for Specialists in Pediatric Nursing, 14*(1), 3-11. doi: 10.1111/j.1744-6155.2008.00161.x

Ponti, M. D. (2011). Why change fails. *Nurse Leader*, 9(4), 41-43.

Porter-O'Grady, T., & Malloch, K. (2015). *Quantum leadership: Building better partnerships for sustainable health* (4th ed.). Burlington, MA: Jones & Bartlett Learning, LLC.

Preetha, K. (2009). Effectiveness of auscultation and testing pH for assessing the placement of feeding tube. *Nursing Journal of India*, *100*(5), 112-114.

Rassias, A. J., Ball, P. A., & Corwin, H. L. (1998). A prospective study of tracheo pulmonary complications associated with the placement of narrow-bore enteral feeding tubes. *Critical Care*, 2, 25-28.

Sackett, D. L., Straus, S. E., Richardson, W. S., Rosenberg, W., & Haynes, R. B. (2000). *Evidence based medicine: How to practice and teach EBM* (2nd ed.). London, England: Churchill Livingstone Elsevier.

Schaffer, M. A., Sandau, K. E., & Diedrick, L. (2013). Evidence-based practice models for organizational change: Overview and practical applications. *Journal of Advanced Nursing, 69*(5), 1197-1209. doi: 10.1111/j.1365-2648.2012.06122.x

Seguin, P., Le Bouquin, V., Aguillon, D., Maurice, A., Laviolle, B., & Malledant, Y. (2005). Testing nasogastric tube placement: Evaluation of three different methods in intensive care unit. *French Annals of Anesthesia and Intensive Care 24*(6), 594-599. doi: 10.1016/j.annfar.2005.03.041

Simons, S. R., & Abdallah, L. M. (2012). Bedside assessment of enteral tube placement: Aligning practice with evidence. *American Journal of Nursing, 112*(2), 40-48.

Smith, S., Duell, D., & Martin, B. (2012). *Clinical nursing skills: Basic to advanced skills* (8th ed.). Upper Saddle River, NJ: Prentice Hall, Inc.

Solomons, N., & Spross, J. (2011). Evidence-based practice barriers and facilitators from a continuous quality improvement perspective: An integrative review. *Journal of Nursing Management,* 19(1), 109-120. doi:10.1111/j.1365-2834.2010.01144.x

Sorokin, R., & Gottlieb, J. (2006). Enhancing patient safety during feeding-tube insertion: A review of more than 2,000 insertions. *Journal of Parenteral & Enteral Nutrition, 30*(5), 440-445.

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.

Stepter, C. R. (2012). Maintaining Placement of Temporary Enteral Feeding Tubes in Adults: A critical appraisal of the evidence. *Medsurg Nursing, 21*(2), 61-102.

Stock, A., Gilbertson, H., & Babl, F. (2008). Confirming nasogastric tube position in the emergency department: pH testing is reliable. *Pediatric Emergency Care, 24*(12), 805-809.

Taylor, S. J. (2013). Confirming nasogastric feeding tube position versus the need to feed. *Intensive and Critical Care Nursing, 29*(2), 59-69. doi: 10.1016/j.iccn.2012.07.002

Taylor, S., & Clemente, R. (2005). Confirmation of nasogastric tube position by pH testing. *Journal of Human Nutrition & Dietetics, 18*(5), 371-375.

Tho, P. C., Mordiffi, S., Ang, E., & Chen, H. (2011). Implementation of the evidence review on best practice for confirming the correct placement of nasogastric tube in patients in an acute care hospital. *International Journal of Evidence Based Healthcare, 9*(1), 51-60. doi: 10.1111/j.1744-1609.2010.00200.x

Turgay, A. S., & Khorshid, L. (2010). Effectiveness of the auscultatory and pH methods in predicting feeding tube placement. *Journal of Clinical Nursing, 19*(11-12), 1553-1559. doi: 10.1111/j.1365-2702.2010.03191.x

Appendix A

Search Strategy: Database Searches and Data Abstraction

Date of Search	Keyword Used/Boolean Phrase	Limits	Database/ Source Used	# of Hits		
				Listed	Reviewed	Used
2/9/15	"Nasogastric tube" + "Placement"	Published date: Last 10 years Source Type: Academic Journals Major Subject Heading: Tube placement determination	CINAHL	131	6	5
2/9/15	"Nasogastric feeding tube" + "Placement"	Published date: Last 10 years Source Type: Academic Journals	CINAHL	10	8	2
2/9/15	"Nasogastric feeding tube"	Published date: Last 10 years Major Subject Heading: Nasoenteral Tubes	CINAHL	28	5	1
2/9/15	"Feeding tube" + "Placement"	Published date: Last 10 years Source Type: Academic Journals Major Subject Heading: Intubation, gastrointestinal & Tube placement determination	CINAHL	267	9	3
2/9/15	"Tube placement determination methods"	Published date: Last 10 years Source Type: Academic Journals Age: All adult	CINAHL	149	22	7
2/9/15	"Nasogastric tube" + "Placement"	Published date: Last 10 years Language: English Age: All adult 19+ Search Criteria: Within title	PubMed	392	20	11
2/9/15	"Nasogastric feeding tube" + "Placement"	Published date: Last 10 years Language: English	PubMed	27	13	1

10/19/15	“Nasogastric tube” + “Position”	Published date: Last 10 years Source Type: Academic Journals	CINAHL	34	8	3
10/19/15	“Nasogastric tube” + “Verification”	Published date: Last 10 years Source Type: Academic Journals	CINAHL	10	7	1
10/19/15	“Nasogastric tube” + “pH”	Published date: Last 10 years Source Type: Academic Journals	CINAHL	27	6	0
10/19/15	“Feeding tube” + “Verification”	Published date: Last 10 years Source Type: Academic Journals	CINAHL	13	6	1
10/19/15	“Feeding tube” + “Position”	Published date: Last 10 years Source Type: Academic Journals	CINAHL	57	10	1
10/19/15	“Feeding tube” + “pH”	Published date: Last 10 years Source Type: Academic Journals	CINAHL	32	12	1
10/19/15	“Feeding tube”	Published date: Last 10 years Language: English	CINAHL	954	20	1
10/19/15	“Nasogastric tube” + “pH”	Published date: Last 10 years Language: English	PubMed	51	5	1
10/19/15	“Feeding tube” + “pH”	Published date: Last 10 years Language: English	PubMed	18	3	0
12/11/15	"Nasogastric tube" + "Placement"	Published date: Last 10 years Language: English	Cochrane	3	1	0
12/11/15	"Nasogastric feeding tube" + "Placement"	Published date: Last 10 years Language: English	Cochrane	2	0	0

Appendix B

Inclusion and Exclusion Criteria

Title	Author (Year)	Included & Rationale or Excluded & Rationale
Techniques, materials, devices. Noninvasive verification of nasogastric tube placement using a magnet-tracking system: A pilot study in healthy subjects	Bercik, P., Schlageter, V., Mauro, M., Rawlinson, J., Kucera, P., & Armstrong, D. (2005).	Excluded – NG magnet tracking system does not offer value to answering question
Reliability of pH measurement and the auscultatory method to confirm the position of a nasogastric tube	Boeykens, K., Steeman, E, & Duysburgh, I. (2014).	**Included** – Compares measurement of pH gastric contents & auscultatory method to confirm NG placement
Feeding tube placement in adults: Safe verification method for blindly inserted tubes	Bourgault, A. M., & Halm, M. A. (2009)	**Included** – Clinical evidence review of feeding tube placement verification methods
Factors influencing critical care nurses' adoption of the AACN practice alert on verification of feeding tube placement	Bourgault, A. M., Heath, J., Hooper, V., Sole, M. L., Waller, J. L., & NeSmith, E. G. (2014).	Excluded – Discusses AACN practice alert of NG tube verification; however, looks at reasons why the information is not adopted in comparison to the verification methods themselves
A new procedure for gastrostomy tube replacement verification: A case report	Burke, D. T., Hoberman, C. J., Morse, L. R., & Pina, B. D. (2005).	Excluded – Discusses PEG tube & not NG tubes; does not offer value to answering question
A malfunctioning nasogastric feeding tube	Cereda, E., Costa, A., Caccialanza, R., & Pedrolli, C. (2013).	Excluded – Case study does not offer value to answering question
Nasogastric feeding practices: A survey using clinical scenarios	Chan, E., Ng, I. H., Tan, S. L., Jabin, K., Lee, L., & Ang, C. (2012).	Excluded– compares various methods and case scenarios for bolus tube feedings & NOT initial verification methods of NG tube placement
Use of end-tidal carbon dioxide detection to determine correct placement of nasogastric tube: A meta-analysis	Chau, J. C., Lo, S. S., Thompson, D. R., Fernandez, R., & Griffiths, R. (2011).	Excluded – intervention of end-tidal carbon dioxide detection does not fit question
A randomized, clinical trial of frozen versus standard nasogastric tube placement	Chun, D. H., Kim, N. Y., Shin, Y. S., & Kim, S. H. (2009).	Excluded – Discusses NG insertion technique instead of confirmation method to answer question

Comparing bedside methods of determining placement of gastric tubes in children	Ellett, M. C., Cohen, M. D., Croffie, J. B., Lane, K. A., Austin, J. K., & Perkins, S. M. (2014).	**Included**- Compared bedside methods for determining NG placement
Nasogastric feeding tube placement: Changing culture	Eveleigh, M., Law, R., Pullyblank, A., & Bennett, J. (2011).	Excluded – Not a research article
Nasogastric tube placement verification in pediatric and neonatal patients	Farrington, M., Lang, S., Cullen, L., & Stewart, S. (2009).	Excluded – verification methods did not represent question
Safe passage: Feeding tube insertion teams in the ICU	Federwisch, A. (2005).	Excluded – Not a research study
Accuracy of biochemical markers for predicting nasogastric tube placement in adults: A systematic review of diagnostic studies	Fernandez, R. S., Chau, J. P., Thompson, D. R., Griffiths, R., & Lo, H. S. (2010).	Excluded – Results of the study were weak; Due to the heterogeneity of the studies and small sample sizes, conclusions about the diagnostic performance of the different tests cannot be drawn
Increasing the safety of blind gastric tube placement in pediatric patients: The design and testing of a procedure using a carbon dioxide detection device	Gilbert, R. T., & Burns, S. M. (2012).	Excluded – Wrong intervention for question
Determination of a practical pH cutoff level for reliable confirmation of nasogastric tube placement	Gilbertson, H. R., Rogers, E. J., & Ukoumunne, O. C. (2011).	**Included**– Compared pH measurement method cut-off levels
Ultrasound-guided nasogastric feeding tube placement in critical care patients	Gok, F., Kilicaslan, A., & Yosunkaya, A. (2015).	Excluded – Intervention did not match my question intervention
Advice for prevention of inadvertent respiratory placement of nasogastric feeding tube	Haga, Y., Yamanouchi, T., Matsukura, S., Nagamatsu, Y., Yoshidomi, K., Fukano, K., Kawano, M., Abematsu, Y., Matoba, K., Koga, T., & Tonai, T. (2008).	Excluded – Literature search with low level of evidence
Should simple and common procedures be taken lightly?: Nasobronchial feeding: A case report	Hussain, A. (2006).	Excluded – Not a research study; Case study which would not aide in answering question
Nasogastric tube placement and verification in children: Review of the current literature	Irving, S. Y., Lyman, B., Northington, L., Bartlett, J. A., & Kemper, C. (2014).	Excluded – Verification methods did not represent question

A case report of esophageal perforation: Complication of nasogastric tube placement	Isik, A., Firat, D., Peker, K., Sayar, I., Idiz, O., & Soyturk, M. (2014).	Excluded – Discusses complication of NG tube r/t esophagus perforation; does not help in answering question
A call to action: The development of enteral access safety teams	Kemper, C., Northington, L., Wilder, K., & Visscher, D. (2014).	Excluded – Did not accurately depict question
The effectiveness of ultrasonography in verifying the placement of a nasogastric tube in patients with low consciousness at an emergency center	Kim, H. M., So, B. H., Jeong, W. J., Choi, S. M., & Park, K. N. (2012).	**Included** – Compares various methods for confirming NG placement; pH vs auscultatory vs CXR vs Ultrasound
Validation of the RightSpot device for determination of gastric pH during nasogastric tube placement	Lambert, C. R., Varlotta, D., Posey, M., Heberlein, J. L., & Shirley, J. M. (2013).	Excluded – Looks at specific brand of indicator for measuring pH of gastric contents when aspirated & does not compare interventions
Best evidence: Nasogastric tube placement verification	Longo, M. A. (2011).	Excluded – Does not fit question
A coiled nasogastric tube in a newborn	Manikoth, P., Nair, A. K., Zachariah, N., & Sajwani, M. J. (2005).	Excluded – Case study; does not discuss verification methods of NG tube
The pH of feeding tube aspirates from critically ill infants Fine-tuning your feeding-tube insertion skills: What every nurse should know to make feeding-tube insertion safer	Meert, K. L., Caverly, M., Kelm, L. M., & Metheny, N. A. (2015). Merrel, P., & Fisher, C. (2007).	**Included**- Compared pH measurement method Excluded – Level 7 of evidence r/t Expert/Peer-Reviewed study
Indicators of tube site during feedings	Metheny, N. A., Schnelker, R., McGinnis, J., Zimmerman, G., Duke, C., Merritt, B., Banotai, M., & Oliver, D. A. (2005).	Excluded – Intervention looked at NG tube and small bowel feeding tubes; Does not fit with answering my question
Safe and adequate placement of nasogastric tubes in the presence of a cuffed tracheostomy tube Development of a clinical practice guideline for testing nasogastric tube placement	Parmar, A., Macleod, I., McDonald, S., & Tierney, P. (2011). Peter, S., & Gill, F. (2009).	Excluded – Looks at specific patient population (cuffed tracheostomy tube) **Included** – Discusses pH as new guideline and dismisses auscultatory method for NG placement verification
Elimination of radiographic confirmation for small-bowel feeding tubes in critical care	Powers, J., Fischer, M. H., Ziemba-Davis, M., Brown, J., & Phillips, D. M. (2013).	Excluded – Looks at small bowel feeding tubes and not NG tubes
Effectiveness of auscultation and testing pH for assessing the placement of feeding tube	Preetha, K. (2009).	**Included**- Compares auscultation and pH measurement methods

Testing nasogastric tube placement: Evaluation of three different methods in intensive care unit	Seguin, P., Le Bouquin, V., Aguillon, D., Maurice, A., Laviolle, B., & Malledant, Y. (2005).	**Included** – Intervention compares pH, aspiration of gastric contents, and air insufflation versus CXR
Maintaining placement of temporary enteral feeding tubes in adults: A critical appraisal of the evidence	Stepter, C. R. (2012).	**Included** – Systematic review of evidence of current methods in maintaining placement of NG tubes
Confirming nasogastric tube position in the emergency department: pH testing is reliable	Stock, A., Gilbertson, H., & Babl, F. (2008).	**Included-** Evaluates pH measurement method
Confirming nasogastric tube position with electromagnetic tracking versus pH or X-ray and tube radio-opacity	Taylor, S., Allan, K., McWilliam, H., Manara, A., Brown, J., Toher, D., & Rayner, W. (2014).	Excluded – Intervention compared does not accurately answer question
Confirming nasogastric feeding tube position versus the need to feed	Taylor, S. J. (2013).	Excluded – Does not compare various methods in verifying NG tube placement to accurately answer question
Confirmation of nasogastric tube position by pH testing	Taylor, S., & Clemente, R. (2005).	**Included**- Evaluates pH measurement method
Implementation of the evidence review on best practice for confirming the correct placement of nasogastric tube in patients in an acute care hospital	Tho, P. C., Mordiffi, S., Ang, E., & Chen, H. (2011).	**Included** – Study looked at pH versus auscultatory method versus CXR in confirming CXR results
Effectiveness of the auscultatory and pH methods in predicting feeding tube placement	Turgay, A. S., & Khorshid, L. (2010).	**Included** – Study intervention compares pH to auscultatory method

Appendix C

Evidence Evaluation

Author (Year)	Purpose	Sample/ Setting	Design/ Measurement	Findings	Appraisal	
					Strengths/Limitations	Conclusions
Boeykens, Steeman, & Duysburgh (2014)	Assess the air bolus method and pH measurement method with a pH cut-off level of 5.5 post NG/OG tube placement and to contrast with abdominal X-ray (gold standard) Assess practicality of pH measurement method	*n* = 314 Setting: general hospital	Prospective observational study M1: pH of gastric aspirate M2: auscultatory method M3: abdominal X-ray	98.9% of aspirate samples with pH ≤ 5.5, tube was positioned in stomach pH ≥ 6 probability of NG located outside stomach 19.7% When aspirate was attained, pH measurements revealed sensitivity of 78.4% & specificity of 84.6% Aspirate able to be obtained 77% of pH ≤ 5.5 Without antacids 85.4% was ≤ 5.5 as opposed to 72.9% with antacids (P=0.062) Without antacids, average pH: 3.5 (SD: 1.8) & With antacids average pH: 4.6 (SD: 1.7) ($p<$ 0.05) d= 0.6283	<u>Strengths:</u> Level III evidence Moderate quality Large sample size Medium effect size <u>Limitations:</u> Intubation by, or in the presence of, the same practitioner does not completely reflect current daily practice	pH of ≤ 5.5 from NG/OG tube gastric aspirate is acceptable even in the presence of antacids In cases where risk of aspiration is high or where pH tested ≥ 6, radiological verification should be performed Auscultation method should be discouraged pH method reduces need for costly X-ray, decreases radiation exposure, & offers advantages for o/p care Limitations of radiographic imaging: expense poor conditions of radiographic images, radiation contact

Author (Year)	Purpose	Sample/ Setting	Design/ Measurement	Findings	Appraisal	
					Strengths/Limitations	**Conclusions**
Bourgault & Halm (2009)	Synthesize current evidence on the accuracy of methods to verify initial placement of blindly inserted feeding tubes	*n* = 51-880 12 studies 1988-2007 Setting: Acute care/ intermediate care & ICU settings	Clinical evidence review of descriptive & comparative study designs M1: pH of gastric aspirate M2: capnography/ capnometry M3: auscultation M4: bilirubin levels M5: enzyme levels M6: visual inspection	pH, enzyme, bilirubin, & carbon dioxide testing can distinguish respiratory from GI placement of NG tubes pH, enzyme, bilirubin, & carbon dioxide cannot detect NG placement in esophagus or gastro-esophageal junction Auscultation of air bolus, gastric aspirate inspection, & immersing NG/OG tubes in water to appraise "bubbling" should not be continued b/c of lack of efficacy & potential risk for harm Audible "air pop" over epigastrium falsely leads clinicians to assume correct gastric placement of NG tube	<u>Strengths:</u> 4, 729 NG tube placements from 1988-2007 in 12 hospitals Moderate quality of studies Quality of studies are moderate since evidence grading ranged from indeterminate (treatment of promise) to IIb (interventions acceptable & useful-supported by fair to good evidence) <u>Limitations:</u> Level V evidence	Until verification methods consistently enable pulmonary & esophageal placement of feeding tubes to be detected, radiography remains only reliable method to verify initial placement of blindly inserted NG tubes

Author (Year)	Purpose	Sample/ Setting	Design/ Measurement	Findings	Appraisal	
					Strengths/Limitations	**Conclusions**
Ellet et al. (2014)	Compare accuracy and predictive validity of pH	*n* = 276 children Setting:	Single-blind, randomized control trial	Ability of pH to detect position of NG tube in stomach ranges from 87%-92.2% specificity	<u>Strengths:</u> Level I evidence Moderate quality of evidence	Misplacement of NG/OG tube should be suspected when no aspirate able to be obtained

	in identifying gastric tube placement errors	Five Midwestern hospitals	M1: pH measurement method M2: ability to obtain tube aspirate M3: bilirubin M4: CO2 measurement	Inability to obtain aspirate best predictor of NG/OG tube location errors with sensitivity of 34.9% and positive predictive value of 66.7% pH, CO2, and bilirubin measurements are less helpful in detecting NG/OG tube placement	Limitations: Small effect size of mean pH without antacids and mean pH with antacids Small sample size	pH, CO2, and bilirubin measurements are less helpful in detecting NG/OG tube placement

Author (Year)	Purpose	Sample/ Setting	Design/ Measurement	Findings	Appraisal	
					Strengths/Limitations	**Conclusions**
Gilbertson, Rogers, & Ukoumunne (2011)	Establish a dependable and useful pH level to determine correct NG/OG position	*n* = 645 Pediatric Setting: Tertiary pediatric hospital	Prospective observational study M1: pH measurement M2: presence of antacids M3: absence of antacids	pH > 4 in 30.9% of aspirate samples; 244 were radiographed & identified 10 misplaced tubes (1 with pH 5.5)	Strengths: Level III evidence Medium effect size Moderate quality of evidence Limitations: Small sample size of endotracheal aspirate samples collected	Gastric aspirate ≤ 5 is safe, reliable, and useful cut-off for pediatric patients pH of gastric aspirates ≥ 5, radiographic confirmation should be performed

Author (Year)	Purpose	Sample/ Setting	Design/ Measurement	Findings	Appraisal	
					Strengths/Limitations	**Conclusions**
Kim et al. (2012)	Compare the effectiveness of using auscultation, pH	*n* = 47 Setting: ER setting	Prospective study M1: auscultation	Auscultation of an air bolus has potential to denote inaccurate placement of NG/OG tubes b/c pulmonary introduction can cause gurgling that is identified	Strengths: Level III evidence Limitations: Small sample size	NGT placement in ER setting can be first verified by auscultation Because the measurement of

	measurements of gastric aspirates, and ultrasonography to verify NG tube placement	over 5-month time span	M2: pH testing of gastric aspirate on litmus paper M3: ultrasonography M4: CXR results	to be located within the epigastric region Decreased precision of ultrasonography when compared to other research findings pH analysis provided false negative results in several cases—pH method alone has limitations Chest x-ray should be performed when NG/OG tube verification can't be confirmed by ultrasonography	Poor quality of evidence Trouble with exact evaluation of precision of ultrasonography b/c of a small quantity of incidences of improper NG tube introductions Complete hx of the patient's use of H2 blockers not known	gastric pH is not achievable in a handful of individuals & the measurement of gastric pH is at times in danger of false negative outcomes, utilizing the measurement of gastric pH for a back-up confirmation of NGT location is not advised Confirming NGT position with ultrasonography can decrease difficulties, avoid wastes in time, and diminish avoidable radiation contact In instances that ultrasound is unable to confirm NGT position, verification with CXR is needed

Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Meert, Caverly, Kelm, & Metheny (2015)	Compare pH values of gastric aspirates with and without use of gastric acid inhibitors and feedings	*n* = 54 infants Setting: Critical care unit	Prospective descriptive study M1: pH measurement with gastric inhibitors M2: pH measurement without gastric inhibitors	<u>pH ≤ 5.5:</u> 97% of gastric aspirates with no recent feedings or acid inhibitors (mean 3.43 & SD 0.83) 77% of gastric aspirates receiving acid inhibitors (mean 4.89 & SD 1.35)	<u>Strengths:</u> Large effect size Level III evidence Moderate quality of evidence Sample restricted to infants <u>Limitations:</u> Small sample size Use of colorimetric pH	pH of gastric aspirates usually ≤ 5.5 in spite of use of acid inhibitors or feedings pH of ≤ 5.5 would rule out respiratory placement since tracheal pH is usually ≥ 6.0

				checks instead of pH meter		
Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Peter & Gill (2009)	Metropolitan hospital facility group of individuals initiated clinical practice recommendations to systematize the verification methods utilized to determine nasogastric tube position	*n* = 104 Setting: Western Australia; 1 pediatric hospital, 7 hospitals in Perth metropolitan area	Bedside data collection & point-prevalence audit M1: auscultation M2: pH of gastric aspirate (not on litmus paper) M3: X-ray	Aspirate able to be attained for 97% of all pH tests 84% of gastric aspirate pH was ≤ 5.5 Several pH testings fails with continuous feeds and/or those receiving acid inhibiting medications	<u>Strengths:</u> Multiple hospital settings Level V evidence Moderate quality of evidence <u>Limitations:</u> None specified	pH testing is recommended over litmus paper Use of the whoosh test & litmus paper are not recommended pH measurement of gastric aspirate and radiographic imaging have a higher dependability Instances where pH measurement cannot confirm NG placement or aspirate is unable to be obtained will always occur X-ray is not always appropriate due to cost, radiation exposure, availability Continuous feeding and/or acid reducing medications continue to pose a challenge
Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Preetha (2009)	Evaluate pH testing as a	*n* = 50 adults	Bedside data collection	pH testing showed that 90% of NG tubes were placed in	<u>Strengths:</u> Level V evidence	pH testing has greater sensitivity and specificity

	method in verifying NG/OG tube placement Compare auscultation & pH testing in verifying NG/OG tube placement	Setting: PS Medical Centre in Kanya-kumari district	M1: auscultation M2: pH measurement method	stomach and 10% were placed in intestines pH testing sensitivity is 100% and specificity is 100% (skewed results?)	Moderate quality of evidence <u>Limitations:</u> Small sample size Statement that pH testing sensitivity/specificity are both 100% (possible invalid results)	when compared to auscultation pH testing is more reliable and effective compared to auscultation pH testing can be utilized in hospitals regardless of age of individuals
Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Seguin et al. (2005)	Evaluation of three methods (aspiration of gastric fluid, pH measurement of gastric fluid, and insufflation of air) to determine the right position of NGT	*n* = 419 adults Setting: ICU over a period of 16 months	Prospective observational, monocentric & non-randomized study M1: aspiration of gastric fluid M2: pH measurement of gastric fluid M3: insufflation of air	Malposition of NGT was observed in 10% Aspiration of gastric fluid and pH measurement were not sensitive and not specific Insufflation of air was sensitive and not specific The combination of the three methods did not improve the sensitivity or the specificity Two complications were detected by CXR	<u>Strengths:</u> Large sample size Level III evidence Moderate quality <u>Limitations:</u> Results limited to one ICU setting	None of the methods evaluated alone were sufficient enough to avoid a CXR Moreover, the detection of two potential and serious complications were only detected by the CXR
Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Stepter	Offers a	*n* = 6	Systematic	Auscultation, “whoosh”, or	<u>Strengths:</u>	Auscultation, “whoosh”,

(2012)	critical appraisal of the evidence guiding nursing care to maintain placement of NGT Best practice recommendations for ongoing nursing assessment & care for pts w/ NGT provided	studies Setting: Not stated	Review of Level III-IV studies M1: auscultation (whoosh test) M2: water bubbling M3: examination of gastric aspirate through observation M4: pH measurement of gastric aspirate M5: radiographic confirmation	water bubbling methods are ineffective & should no longer be used Visual inspection of gastric aspirate is unreliable Ability of pH measurement to determine between small bowel & gastric location is unclear Gold standard radiographic confirmation method for initial placement of NGT for verification	Level III evidence Moderate quality <u>Limitations:</u> None specified	visual inspection of gastric aspirate, and water bubbling methods are ineffective & should no longer be used Gold standard radiographic confirmation method for initial placement of NGT for verification

Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Stock, Gilbertson, & Babl (2008)	Establish pH cut-off level to confirm gastric placement	*n* = 404 children Setting: Tertiary pediatric ED	Prospective observational study M1: pH measurement method M2: ability to	97.3% NG aspirates could be attained 86.8% pH measurement < 4 pH measurement confirmed tube position in 84.5%	<u>Strengths:</u> Level III evidence Large sample size <u>Limitations:</u> Poor quality of evidence Only 72% of NG tubes were	pH testing is a reliable way of confirming NG tube location when pH ≤ 4 pH > 4, radiograph may be required

			obtain aspirate		captured Correct placement in stomach assumed r/t no occurrence of aspiration NG insertions performed by varying RN skill and experience Number of insertion tries may have been underreported	
Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Taylor & Clemente (2005)	Establish accuracy of pH testing in presence of H2-blockers & PPIs	*n* = 52 Setting: ICU and Medical floors	Observational study over 1 day M1: pH measurement method M2: H2-blockers M3: PPIs	Utilization of H2-blockers & PPIs could decrease accuracy of pH verification to 58%	<u>Strengths:</u> Level III evidence Moderate quality of evidence <u>Limitations:</u> Small sample size Only occurred over 1 day	Radiographic imaging may be needed for repeated pH measurement failures Utilization of pH measurement method or other methods not including radiographic means must be performed to verify placement of NG/OG tubes
Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Tho et al. (2011)	Implement the best procedure to verify NGT position in	*n* = 935 Setting: acute care	Systematic review of descriptive studies and QI project	Litmus paper, auscultation, and bubbling tests are inaccurate to verify accurate NGT position pH test & radiographic	<u>Strengths:</u> Large sample size Moderate quality	Employing a modification in clinical practice for NGT position verification necessitates sound organization &

	acute care locations	tertiary hospital	implementation M1: auscultation M2: bubbling at end of feeding tube M3: analysis of acidity or alkalinity of gastric aspirate utilizing blue litmus paper M4: pH of aspirate using pH indicator strips M5: radiologic confirmation	confirmation are more reliable tests	<u>Limitations:</u> Level V evidence	interprofessional methodology

Author (Year)	**Purpose**	**Sample/ Setting**	**Design/ Measurement**	**Findings**	**Appraisal**	
					Strengths/Limitations	**Conclusions**
Turgay & Khorshid (2010)	Establish the efficacy of the auscultation of air bolus method and pH of gastric aspirate method in verifying NGT position	*n* = 32 Setting: ICU in a 2000 bed hospital in Turkey	Methodological study (Case control study) M1: pH measurement with test strip M2: auscultatory	pH method effectiveness in confirming correct verification of NGT was 88.6% Auscultatory method effectiveness in confirming correct verification of NGT was 34.4% Mean pH measurement of	<u>Strengths:</u> Level III evidence <u>Limitations:</u> Poor quality Small sample size pH paper utilized due to availability instead of pH	pH measurement of gastric aspirate is successful in verifying the location of the NGT Auscultatory method is not valuable in verifying the location of the NGT Radiographic confirmation

	method	gastric aspirate 4.23 (SD 1.20) When pH was < 5, gastric placement of feeding tube was effectively identified 90.4% of the time using pH method	meter – possible threat to external validity & affecting generalizability of the findings to other settings/samples	remains the gold standard to verify NGT placement

Note. Adapted from *Evidence-based practice in nursing & healthcare: A guide to best practice* (3rd ed.), p. 552, by B. M. Melnyk & E. Fineout-Overholt, 2015, Philadelphia, PA: Wolters Kluwer Health.

Appendix D

Comparison of NG/OG Tube Verification Methods of Studies

Intervention	Articles													
	Boeykens, Steeman, & Duysburgh (2014)	Bourgault & Halm (2009)	Ellet et al. (2014)	Gilberts on, Rogers, & Ukoumunne (2011)	Kim et al. (2012)	Meert, Caverly, Kelm, & Methen y (2015)	Peter & Gill (2009)	Preetha (2009)	Seguin et al. (2005)	Stepter (2012)	Stock, Gilbertson, & Babl (2008)	Taylor & Clemente (2005)	Tho et al. (2011)	Turgay & Khorshid (2010)
Intervention Level & Quality	III M	V M	I M	III M	III P	III M	V M	V M	III M	III M	III P	III M	V M	III P
pH	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Auscultation	X	X			X		X	X	X	X			X	X
Radiographic Imaging	X	X			X		X		X	X			X	X
Capnography/ Capnometry		X	X											
Bilirubin		X	X											
Enzyme		X												
Visualization		X							X	X				
Ultrasonography					X									
Litmus paper							X						X	
H2O bubbling		X								X			X	
Able to obtain aspirate			X								X			

NOTE: I~V- Level of Evidence; M- Moderate Quality of Evidence; P- Poor Quality of Evidence

Appendix E

Comparison of NG/OG Tube Verification Outcomes

Outcomes	Articles													
	Boeykens, Steeman, & Duysburgh (2014)	Bourgault & Halm (2009)	Ellet et al. (2014)	Gilbertson, Rogers, & Ukoumunne (2011)	Kim et al. (2012)	Meert, Caverly, Kelm, & Methen y (2015)	Peter & Gill (2009)	Preetha (2009)	Seguin et al. (2005)	Stepter (2012)	Stock, Gilbertson, & Babl (2008)	Taylor & Clemente (2005)	Tho et al. (2011)	Turgay & Khorshid (2010)
pH ≤ 5.5 of aspirate is reliable (even in presence of antacids)	X					X								
Gastric aspirate ≤ 5 is safe, reliable, and useful cut-off for pediatric patients				X										
pH testing is a reliable when pH ≤ 4											X			
pH measurement of gastric aspirate is an effective and reliable							X	X				X	X	X

Auscultatory method is unreliable	X	X		X	X	X	X				X		X
Perform radiologic confirmation if risk of aspiration is high, no aspirate, or pH tested ≥ 6	X												
Perform radiographic confirmation pH ≥ 5			X										
Radiograph required for pH > 4									X				
Radiologic confirmation is reliable		X			X		X	X			X	X	X
pH, enzyme, bilirubin, & carbon dioxide testing distinguishes respiratory from GI		X											
pH, enzyme, bilirubin, & carbon dioxide cannot detect NG placement in esophagus or GE		X											

junction								
Discontinue aspirate visual inspection	X				X	X		
Discontinue using bubbling method	X					X	X	
pH analysis unclear			X		X			
Obtain radiographic image when ultrasonography fails			X					
pH testing recommended over litmus paper				X			X	
Suspect misplacement with no gastric aspirate		X						
pH, CO2, and bilirubin less useful		X						

Appendix F

University of Toledo IRB Approval Letter

University of Toledo
Department for Human Research Protections
Institutional Review Boards
CCE Building, Room 0106
3000 Arlington Avenue
Toledo, OH 43614-2570
Ph: 419-383-6796
Fax: 419-383-3248

MEMORANDUM

TO: Susan Sochacki, Ph.D., UT College of Nursing
Jennifer Kaple, BSN, RN, Doctoral Candidate

Signature Redacted

FROM: Carolyn Pinkston, MPH, RN, CIP
Director, Department for Human Research Protections

CC: Roland T. Skeel, M.D., Chair, Biomedical IRB

DATE: April 12, 2016

RE: KC Application #201394: Verification Methods of Nasogastric and Orogastric Tubes: Improved Patient Outcomes through Nurse Adherence to Practice Guidelines

We have reviewed your inquiry regarding your Doctoral Project at Firelands Regional Medical Center, along with the site letter of permission, proposed data collection tool (chart-review log) and your follow up response to our questions. According the submitted materials, the purpose of the project is to process improvement and staff development, not to test a hypothesis. Best practices for the placement of nasogastric and orogastric tubes, rather than interaction or intervention with human subjects, is the focus of the project.

Based on this information, it is our determination that this project does not constitute "human subject[1] research[2]" under federal human research regulations (45 CFR 46) and University policy. Projects that are not considered human subject research do not require review and approval by the University of Toledo IRB. However, there may be other departments with policies and procedures relating to this type of activity.

IRB approval is not required for publication since this is not human subject research.

Thank you for your inquiry. You may proceed with this project without further review from the IRB or Department for Human Research Protections unless changes are made to the project that might bring the project within the scope of human subject research.

Please contact me at Personal Info Redacted if you have additional questions or would like further clarification.

---

[1] *Human subject* means a living individual *about whom* an investigator (whether professional or student) conducting research obtains (1) data through intervention or interaction with the individual, or (2) identifiable private information.

[2] *Research* means a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge.

Appendix G

Community Hospital IRB Approval Letter

FIRELANDS
Regional Medical Center

Quality & Patient Satisfaction
1111 Hayes Avenue
Sandusky, OH 44870
Phone: 419-557-6817
Fax: 419-557-6824
martinp@firelands.com

May 16, 2016

Jennifer Kaple, BSN, RN
Personal Info Redacted

Dear Mrs. Kaple:

Thank you for providing information pertaining to your Nurse Practitioner Doctoral Project for Institutional Review Board consideration. Leaders from the Quality and Legal Departments understand your project to include a review of the literature associated with best practices in confirming placement of nasogastric tubes for patients, a retrospective chart review to measure current practices in confirming placement, an evaluation of the data collected to identify any practices that are inconsistent with the evidence base, formulation of recommendations for policy changes to facilitate process improvement as indicated and associated recommendations for staff education and monitoring to verify the outcomes of the planned change. It is our evaluation that this project does not present a risk to human subjects nor does it require participation by subjects who would be required to provide informed consent. Accordingly, the project is viewed as planned change for process improvement and staff development and does not require institutional review board evaluation or approval to be initiated at Firelands Regional Medical Center.

You have been authorized to complete a chart review to collect the data necessary for evaluation and action planning. We have agreed that all information will be de-identified prior to submission for review by faculty within your academic program. Additionally, it is expected that the any data collected and held prior to de-identification will be maintained on paper or electronically in a secure manner until such point as de-identification may be achieved. At that point, original identifiable data will be destroyed. Should you need additional secure space within the Quality Department or the Quality databases, we will make that available to you. Please feel free to contact me at 419-557-6817 if I can provide any additional information in this regard.

Sincerely,

Signature Redacted

Patty Martin, MOD, BSN, RN, FACHE
Vice President, Quality & Patient Satisfaction

Appendix H

Revised NG/OG Tube Practice Guideline

Insertion of a Nasogastric (NG) or Orogastric (OG) Tube Policy

I. Purpose:

This policy is designed to guide all Healthcare Professionals within this healthcare institution in the safe insertion of NG and OG tubes in adults.

II. Equipment

- Tapered plug for tube (if indicated for single-lumen tube)
- Single-lumen Levin tube or double-lumen Salem sump tube with anti-reflux valve (30-36 in.)
- Water-soluble lubricant
- Tape (2.5 cm or 1 in.) or commercial tube holder
- Towel
- Emesis basin
- Tissues
- Safety pin and rubber band
- Tongue blade
- Small cup with water and straw (unless contraindicated)
- 50-mL piston syringe with catheter tip
- Clean gloves
- Permanent marker for marking tube or tape
- Spindle adapter
- Suction tubing and suction canister
- Suction wall unit

III. Preparation

1. Check physician's order and client care plan for inserting an NG or OG tube.
2. Check client's name band and have client state name and date of birth.
3. Discuss and educate client of procedure.
4. Provide privacy.
5. Gather equipment.

IV. Procedure

1. Perform hand hygiene. Don clean gloves.
2. Position client at 45^0 angle or higher with head of bed elevated.
3. If inserting an NG tube, examine nostrils and select the most patent nostril by having client breathe through each one.
4. Place a towel over client's chest, an emesis basin and tissues within reach; establish a cueing signal for client to use to stop you momentarily.

5. If inserting an NG or OG tube, measure from tip of client's nose to earlobe to xiphoid (NEX) process of sternum to determine appropriate length for tube insertion.
6. Mark determined distance on tube with tape or pen if tube does not have markings.
7. Coil end of tube over fingers.
8. Lubricate first 4 in. of tube with water-soluble lubricant.
9. With client's head slightly extended, carefully insert tube through nostril or mouth to back of throat. Aim the tube toward the ear on that side and downward toward the nasopharynx.
10. If client is conscious, instruct client to flex head forward.
11. If client is conscious and able, suggest client sip water (if patient is not NPO) or dry swallow while advancing tube until predetermined mark is reached.
12. Use the following bedside methods to predict NG or OG tube location during the insertion procedure:
    a. Observe for signs of respiratory distress. If these signs occur, immediately remove the NG or OG tube and re-insert the NG or OG tube.
        i. RATIONALE: Signs of respiratory distress include coughing, choking, and dyspnea have the potential to arise when NG or OG tubes are unintentionally placed into the lungs. If these signs should arise during NG or OG tube insertion, the NG or OG tube should be taken out immediately and a new insertion of the NG or OG tube should occur. It is essential to note that respiratory distress signs do not always arise when NG or OG tubes are unintentionally placed into the lungs, specifically in those individuals who have a compromised level of consciousness.
    b. If able, observe for visual characteristics of the aspirate from the NG or OG tube.
        i. RATIONALE: Visual characteristics of aspirate have the potential to be helpful in deciding when an NG or OG tube has migrated from the stomach region to the small bowel. Aspirates from the stomach are usually clear in color or grassy green; while aspirates from the small bowel are usually bile stained.
13. For NG tubes, tape tube securely to nose or use an attachment device.
    a. Cut tape about 3 in. long.
    b. Split half of tape lengthwise.
    c. Place un-split end of tape over bridge of nose, with bifurcated ends hanging free.
    d. Wrap each end of tape around the tube where it exits from the nose.
14. For OG tubes, tape tube securely to endotracheal tube or other securement device.
15. Visualize the number on NG or OG tube's exit site at the client's nare or lip and document the number immediately.

a. RATIONALE: Documenting the NG or OG tube's site of exit from the client's nare or lip at the time of insertion will be beneficial in the successive monitoring of the NG or OG tube's positioning throughout its utilization.

16. Secure tube with tape or rubber band pinned to client's gown, leaving slack for head movement.
17. Confirm NG or OG tube placement
    a. If the NG or OG tube is going to have any substance administered via the NG or OG tube, obtain an abdominal 1-view x-ray to confirm NG or OG tube placement prior to the use of the NG or OG tube.
        1. RATIONALE: An accurately acquired and read radiographic image is the only proven method to verify correct NG or OG tube placement prior to administration of any substance.
        ii. Put an order into the order entry system for a stat abdominal 1-view x-ray with stat read. It is imperative that the reason for the x-ray, to obtain confirmation of NG/OG tube placement, be indicated and communicated to radiology either within order entry or via direct verbal communication.
    b. If NG or OG tube is not going to have any substance administered via the NG or OG tube (NG or OG tube is going to be placed to suction or will be clamped), then confirm placement by ensuring no respiratory distress signs are present and observing the visual characteristics of the aspirate from the NG or OG tube.
    c. In either circumstance, use caution when confirming NG or OG tube placement via the auscultation of the air bolus method.
        i. RATIONALE: The auscultatory method may not differentiate between pulmonary and gastric placement of the NG or OG tube. Additionally, it may not differentiate between esophagus, gastric, and small bowel placement of the NG or OG tube. Therefore, this method should be utilized with caution when confirming the placement of the NG or OG tube.
18. Depending on physician's orders, plug end of NG or OG tube, connect tube to suction tubing using tapered adapter, or connect tube to enteral feeding tube.
19. Implement procedure below when using double-lumen (Salem sump) tube.
    a. Stabilize blue pigtail above level of stomach.
    b. Insert anti-reflux valve (blue tip) into blue pigtail of Salem sump tube.
20. Provide oral and nasal hygiene.
21. Remove gloves and perform hand hygiene.
22. Position client for comfort.
23. Document procedure within the NG/OG Tube Documentation Intervention.

On-going Maintenance for NG (Nasogastric) and OG (Orogastric) Tube AFTER Initial Correct Placement has been Confirmed

I. Purpose:

This policy is designed to guide all Healthcare Professionals within this healthcare institution in maintaining the safe placement of NG and OG tubes in adults.

II. Maintenance
   a. The placement of all NG or OG tubes must be assessed, verified, and documented every 4 hours within the NG/OG Tube Documentation Intervention.
   b. Additionally, placement of the NG or OG tube must be assessed, verified, and documented prior to the administration of any substance via the NG or OG tube.
   c. On-going verification of NG or OG tube placement must be done by:
      i. Documenting tube length via the number of the NG or OG tube at the insertion site (ie. the nare or the lip)
      ii. If at any time the number obtained is different from the previous shift or is not identical to the number obtained when the NG or OG tube was initially verified, the NG or OG tube is suspected to be displaced, or there exists unexplained respiratory symptoms, an abdominal 1-view x-ray must be re-obtained to verify NG or OG tube placement. If respiratory symptoms warrant, remove the NG or OG tube and re-insert prior to obtaining a new abdominal 1-view x-ray.

References

Metheny, N. (2016). Initial and ongoing verification of feeding tube placement in adults. *Critical Care Nurse, 36*(2), 8-13. doi:10.4037/ccn2016141

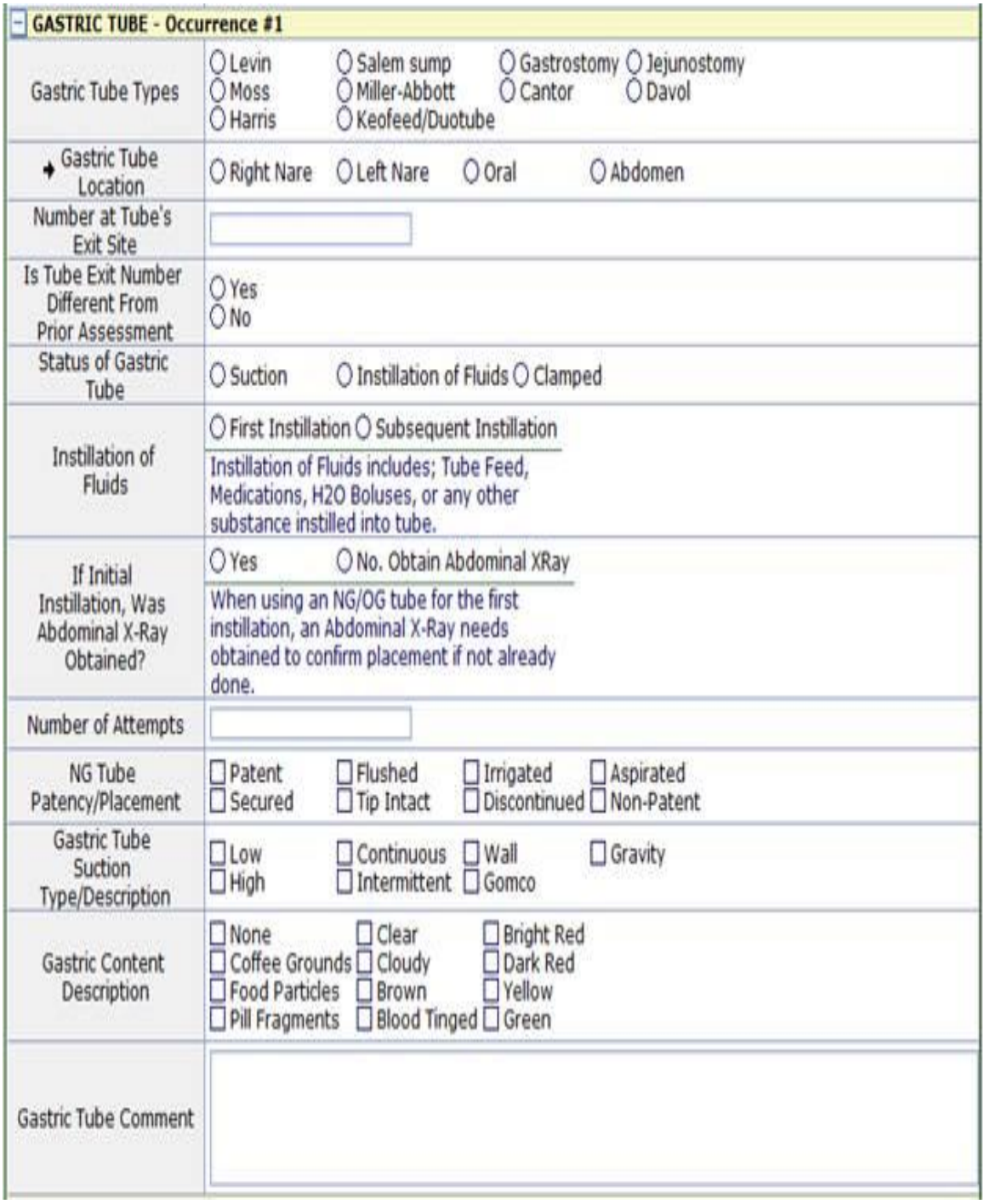
National Patient Safety Agency. (2005). *Reducing the harm caused by misplaced nasogastric feeding tubes: How to confirm the correct position of nasogastric feeding tubes in infants, children and adults.* Retrieved from http://www.nrls.npsa.nhs.uk/EasySiteWeb/getresource.axd?AssetID=60000&type=full&servicetype=Attachment

National Patient Safety Agency. (2011). *Patient Safety Alert NPSA/2011/PSA002: Reducing the harm caused by misplaced nasogastric feeding tubes in adults, children and infants*. Retrieved from http://www.nrls.npsa.nhs.uk/EasySiteWeb/getresource.axd?AssetID=129697&

Smith, S., Duell, D., & Martin, B. (2012). *Clinical nursing skills: Basic to advanced skills* (8th ed.). Upper Saddle River, NJ: Prentice Hall, Inc.

Appendix I

NG/OG Tube Insertion EMR Documentation Intervention



GASTRIC TUBE - Occurrence #1	
Gastric Tube Types	○ Levin ○ Salem sump ○ Gastrostomy ○ Jejunostomy ○ Moss ○ Miller-Abbott ○ Cantor ○ Davol ○ Harris ○ Keofeed/Duotube
Gastric Tube Location	○ Right Nare ○ Left Nare ○ Oral ○ Abdomen
Number at Tube's Exit Site	
Is Tube Exit Number Different From Prior Assessment	○ Yes ○ No
Status of Gastric Tube	○ Suction ○ Instillation of Fluids ○ Clamped
Instillation of Fluids	○ First Instillation ○ Subsequent Instillation Instillation of Fluids includes; Tube Feed, Medications, H2O Boluses, or any other substance instilled into tube.
If Initial Instillation, Was Abdominal X-Ray Obtained?	○ Yes ○ No. Obtain Abdominal XRay When using an NG/OG tube for the first instillation, an Abdominal X-Ray needs obtained to confirm placement if not already done.
Number of Attempts	
NG Tube Patency/Placement	☐ Patent ☐ Flushed ☐ Irrigated ☐ Aspirated ☐ Secured ☐ Tip Intact ☐ Discontinued ☐ Non-Patent
Gastric Tube Suction Type/Description	☐ Low ☐ Continuous ☐ Wall ☐ Gravity ☐ High ☐ Intermittent ☐ Gomco
Gastric Content Description	☐ None ☐ Clear ☐ Bright Red ☐ Coffee Grounds ☐ Cloudy ☐ Dark Red ☐ Food Particles ☐ Brown ☐ Yellow ☐ Pill Fragments ☐ Blood Tinged ☐ Green
Gastric Tube Comment	

Appendix J

Cost Analysis Summary

Item	Estimated Cost	Unpredicted Cost	Cost Savings
Portable 1-view Abdominal X-ray	$160	Cost is based on portable 1-view abdominal x-ray; cost would increase if patient had a large habitus and needed to travel to the radiology department for non-portable abdominal x-ray	The overall cost savings will be an increased adherence to practice guidelines causing the rate of correctly placed NG/OG tubes to increase due to increased identification of misplaced NG/OG tubes and an overall decrease in adverse events caused by misplaced NG/OG tubes.
Education Expenses: Pay staff nurses to attend 30-minute education seminars on new NG/OG tube practice guideline	$13.00 (Based on average pay per hour for RN is $26.00)	Difference in the actual pay of nurses + or -	

Appendix K

Facilitators

Facilitators	Methods Utilized to Assist Facilitators
Agency desire to support culture of safety	Implementation of the revised practice guideline within a healthcare organization that possesses a mission and vision that supports and promotes EBP in their care environments
Agency buy-in and support	Education to staff and administrators responsible for clinical practice of the need for transforming and revising current NG and OG verification practice guidelines Obtainment of administration support for the revised practice guideline to be acknowledged as an organizational priority
Celebrate Success	Celebrating the success of this EBP project occurred at frequent intervals within all phases of the project Celebration of success occurred through acknowledgement of team members in educational seminars and staff meetings and within the monthly "Did You Know?" hospital newsletter Positive outcomes were shared with all the stakeholders including bedside nursing staff

Appendix L

Barriers

Barriers	Methods Utilized to Overcome Barriers
Lack of peer or administrator support/Resistance to change	Education to peers and staff of improved patient outcomes that are possible with revised practice guideline & harms of continuing with current unsafe practice Ensure that administrators within this hospital facility along with the bedside nursing staff were aware of and understood the existing research evidence that supported the recommendations within the revised practice guideline that was being proposed for implementation
Cost of implementing revised practice guideline intervention	Emphasize the long-term cost savings towards patients with NG or OG tubes to administrators and key stakeholders of following a safe practice guideline and thus avoiding adverse outcomes to patients as opposed to following an unsafe practice guideline and having to pay for adverse outcomes to patients related to improper NG or OG tube placement
Communication, transmission, and dissemination of revised practice guideline	Persistence in utilization of communication methods including email, telephone, and text messaging Effective communication and transmission of information of what the radiologists exactly wanted along with compromise and agreement in modifying the revised NG/OG tube practice guideline to reflect the requests of the radiologists Repeatedly expose staff to the revised guideline through: Numerous educational seminars Monthly staff meetings Email notifications Publication in the “Did You Know?” monthly hospital newsletter

Adherence to the revised practice guideline	Serve as a resource to trouble shoot processes Make presence known on implementation floors through query to nursing staff via email on the progression of the revised practice guideline Discussions with nursing staff via nurse floor directors of any challenges or barriers that were experienced in implementing the revised practice guideline Creation of nursing documentation intervention in the patient EMR to assist with guiding nursing staff in proper revised guideline utilization Education and reinforcement of revised practice guideline
Delay in release and publication of NG/OG documentation intervention by IT	Nursing staff was still able to successfully implement the revised practice guideline and document the utilization of the revised practice guideline within either the nursing notes or the reassessment documentation interventions until the NG/OG tube insertion documentation intervention went live

Appendix M

Timeline for Guideline Implementation and Evaluation

Johns Hopkins Nursing Evidence-Based Practice (JHNEBP) Model (Steps 1-18) Project Objectives	Activities Completed	Person(s) Accountable	Timeline
Phase One	**Step 1:** Obtain hospital buy-in	PI & CNO	Fall 2015
	Establish NG/OG tube safety team <u>Members of the NG/OG tube safety team:</u> PI, the CNO, the individual in charge of policy and procedure, the QI Vice President, the Nurse Educator, and the IT department	PI, the CNO, the individual in charge of policy and procedure	Fall 2015
	Step 2: Complete needs assessment for specified facility	PI, the CNO, the individual in charge of policy and procedure, and QI VP	Fall 2015
	Based on the completed needs assessment, identify overall purpose and objective for this EBP project <u>Overall purpose of EBP project:</u> Institute a systems-wide approach to update adherence guidelines for the most reliable and safest NG and OG tube verification practices in adults within a community hospital located in northcentral Ohio to improve nurse	PI, the CNO, the individual in charge of policy and procedure, and QI VP	Fall 2015

	adherence to practice guidelines, decrease the misplacement rate of NG and OG tubes, and decrease the adverse events caused by misplaced NG and OG tubes; ultimately, improving patient health outcomes.		
	Step 3:		
	Define the NG/OG tube safety team member's roles and responsibilities	PI, the CNO, the individual in charge of policy and procedure, QI VP, and Nurse Educator	Fall 2015
	Define the stakeholders for this EBP project	PI, the CNO, the individual in charge of policy and procedure, QI VP, and Nurse Educator	Fall 2015
	Step 4:		
	Establish accountability for project leadership	PI	Fall 2015
	Step 5:		
	Arrange team meetings	PI, the CNO, the individual in charge of policy and procedure, QI VP, and Nurse Educator	Spring/Summer/Fall 2016
Phase Two	**Step 6:**		
	Perform internal examination of evidence: Needs assessment completed in phase 1	PI, the CNO, the individual in charge of policy and procedure, and the QI Vice President	Fall 2015
	IRB application and approval	PI and Co-Chair of Project	Spring 2016
	Perform 3-month pre-implementation chart review for total NG/OG adherence, misplacement rate, and total adverse events r/t misplaced NG/OG tubes	PI	Summer 2016

	Perform external examination of evidence	PI	On-going process since Winter 2015
	Step 7: Appraise the level and quality of each piece of evidence	PI	On-going process since Winter 2015
	Step 8: Review and condense the individual evidence	PI	On-going process since Winter 2015
	Step 9: Synthesize overall strength and quality of evidence	PI	On-going process since Winter 2015
	Step 10: Develop recommendations for NG/OG tube verification practice change based on evidence synthesis	PI	On-going process since Winter 2015
	Revise current NG/OG tube guideline based on the evidence	PI, the CNO, individual in charge of policy and procedure, QI VP, and General Surgeon	Summer 2016
	Create NG/OG tube insertion EMR documentation intervention	PI and IT	Summer/Fall 2016
Phase Three	**Step 11:** Determine fit, feasibility, and appropriateness of revised NG/OG tube practice guideline for translation pathway	NG/OG tube safety team	Summer 2016
	Discussion with the hospital billing department it was decided that the abdominal x-ray would be a standing	PI	Summer 2016

	order for the patient with an NG or OG tube who was to have any substance placed down the NG or OG tube		
	Identify facilitators and barriers	PI	Fall 2015 (Anticipated) and Fall/Winter 2016 (Actual)
	Step 12: Produce an implementation and evaluation timeline	PI	Rough draft began in Fall 2015 and edits made through Winter 2016
	Step 13: Secure resources	PI	Summer 2016
	Obtain approval of revised guideline from hospital facility and physicians on Medical Executive Committee	PI, CNO, and QI VP	Summer 2016
	Step 14: Employ the action plan:		
	Educate the nursing staff and hospital physician staff	PI	Summer/Fall 2016
	Implement the revised NG/OG tube practice guideline	PI, CNO, and QI VP	August 1st, 2016
	Implement the NG/OG tube insertion EMR documentation intervention	PI and IT	September 13th, 2016
	Step 15: Assess process and outcomes:	PI	Fall/Winter 2016
	Email communications to nurse directors every other week for a total of 3 months	PI	Fall/Winter 2016

Process problem identified: edits to revised NG/OG tube practice guideline to reflect radiologist's requests, re-approval of edits to NG/OG tube practice guideline to reflect radiologist's requests, email notification and practice guideline modification to document on Intranet	PI, CNO, QI VP, Nurse Directors	August 2016
Perform 3-month post-implementation chart review of adherence to revised practice guideline, total NG/OG misplacement rate, and total adverse events r/t misplaced NG/OG tubes	PI	Fall/Winter 2016
Code pre-and post revised guideline implementation retrospective chart review data into the SPSS program	PI	Fall/Winter 2016
Examine, compare, and run statistical analysis on pre-and post revised guideline implementation retrospective chart review data in the SPSS program	PI	Fall/Winter 2016
Step 16: Report outcomes and findings to stakeholders	PI	Winter 2016
Step 17: Perform modifications to revised practice guideline	PI	Winter 2016
Step 18: Notify hospital staff of modifications	PI	Winter 2016

	to revised practice guideline		
		PI	Winter 2016
	Distribute and disseminate findings to professional journals and Virginia Henderson research repository		

Appendix N

"Did You Know" Newsletter

DID YOU KNOW?

Clinical Information from the Nursing Performance Improvement Committee August 2016

During July and August 2016, training sessions and a revised procedure with accountability sheets were offered pertaining to the new patient safety initiative for Verification of Nasogastric (NG) and Orogastric (OG) Tubes. Please note that a portable 1-view abdominal x-ray is to now be obtained instead of a PCXR to confirm NG or OG tube placement. The important guidance related to this effort is as follows:

Starting August 1st, 2016

- Implementation of a revised standard of care procedure for confirming placement of NG and OG tubes at Firelands

Reason for Procedural Change

- Evidence from countless research studies have found that the air bolus method is unreliable and cannot correctly determine gastric placement of NG or OG tube
- Radiographic imaging remains the only verification method that is 100% reliable in determining correct placement of NG or OG tube

Practice Recommendations

- AACN and National Patient Safety Agency recommend that radiographic imaging be utilized to confirm placement of NG or OG tube prior to administration of any substance
- Current bedside practice at Firelands:
  - Primarily, auscultation of air bolus method
  - Infrequent utilization of radiographic imaging

Key Elements of Revised Standard of Care Procedure

- An initial portable 1-view abdominal x-ray needs to be obtained to confirm NG or OG tube placement prior to administration of any substance via the NG or OG tube
  - Nursing needs to put order into Order Entry system as a standing order per the ordering physician for a STAT portable 1-view abdominal x-ray with STAT read to confirm NG or OG tube placement
- If no substance is going to be introduced into NG or OG tube (suction or clamped) verify placement via absence of respiratory symptoms and aspiration of gastric contents
- Subsequent verifications of tube placement must be done every 4 hours via bedside nursing assessment and documentation of NG or OG tube number at nare or lip line within gastric tube assessment documentation intervention

        - Again, nurses will document placement of the NG or OG tube every 4 hours and PRN prior to the administration of any substance within this intervention
    - A repeat abdominal x-ray to re-confirm placement only needs done if:
        - There is a discrepancy in the number at nare or lip line
        - There is doubt as to placement of NG or OG tube
    - Keep in mind, NG and OG tubes that were originally placed to suction or clamped and placement was not confirmed via abdominal x-ray, an abdominal x-ray needs done to ensure gastric placement of NG or OG tube prior to administration of any substances (H2O boluses, meds, feedings)

If you have any questions regarding the new processes, please contact your Nurse Director.

The Nursing Department extends it thanks to Jenny Kaple, RN, BSN, from nursing who led this change project as a component of her requirement in her Doctor of Nursing Practice program.

Appendix O

Outcome Evaluation Components

Evaluation Component	Measurement Approach	Analysis Method
Adherence rate of the bedside nurses in following the current or original practice guideline as compared to the revised practice guideline for the NG/OG tube verification procedure	Pre-adherence rate was collected via retrospective chart review of the patient's EMR over a three-month time period during the months of December 2015, January 2016, and February 2016 Post-adherence rate was collected via retrospective chart review of the patient's EMR over a three-month time period immediately after implementation of the revised practice guideline during the months of August 2016, September 2016, and October 2016 Evaluated through the documentation of the bedside nurse as to what verification method was utilized to confirm NG or OG tube placement Bedside nurses at this hospital facility are required to document within the patient's EMR in the nursing notes or the reassessment interventions, the verification method that was utilized to correctly confirm placement of the NG or OG tube Pre-adherence rate assessed nurse's adherence to the current or original guideline, which stated the pH measurement of aspirate was to be utilized to confirm NG or OG tube placement. Considered adherent if a pH measurement of aspirate was performed Post-adherence rate assessed the nurse's adherence to the revised practice guideline. Considered adherent if an abdominal x-ray was performed to correctly confirm	SPSS utilized to perform a Chi Square statistical analysis to analyze proportions and compare the total adherence percentages pre- and post 3-month chart review

	NG or OG tube placement prior to the administration of any substance via the NG or OG tube and if the position of the NG or OG tube was verified by absence of respiratory distress and the presence of gastric aspirate in the instance when no substance was introduced down the NG or OG tube	
Misplacement rate of NG/OG tubes	Evaluated through a retrospective chart review of the patient's EMR for the identified misplacement rate of NG and OG tubes three-months prior to the implementation of the revised NG/OG tube practice guideline during the months of December 2015, January 2016, and February 2016 and three-months post implementation of the revised NG/OG tube practice guideline during the months of August 2016, September 2016, and October 2016 Tube considered misplaced if tube was in any other location besides the stomach as identified by a radiographic image, if the side-port of tube not beyond the gastro-esophageal junction and within the stomach on the radiographic image, and if patient exhibited respiratory distress during tube insertion or if the tube was identified as misplaced by the nurse through visual assessment	SPSS utilized to perform a Chi Square statistical analysis to calculate the total rate of misplaced NG and OG tubes in the pre-and post groups
Adverse events to patients caused by misplaced NG/OG tubes	Evaluated through a retrospective chart review of the patient's EMR for the occurrence of adverse events of NG and OG tubes three-months prior to the implementation of the revised NG/OG tube practice guideline during the months of December 2015, January 2016, and February 2016 and three-months post implementation of the revised NG/OG tube practice guideline during the months of August 2016, September 2016, and October 2016 Adverse event was determined to have occurred via	SPSS utilized to perform a Chi Square statistical analysis to calculate the total adverse events caused by misplaced NG and OG tubes in the pre-and post groups

	review of the patient chart for documentation of either a decline in patient health status, a worsening of the patient's radiographic image, or a delay in patient treatment that could be directly related to the misplaced NG or OG tube	