BACKGROUND: Inadvertent feeding tube placement into the lung results in patient discomfort, increased morbidity (and potential mortality), delayed enteral feeding (while clinicians wait for replacement and clearance to feed orders, etc.), increased length of stay, all of which results in increased healthcare costs. Methods to reduce the risk of blind placement are important to identify. Currently, at most institutions, clinicians place feeding tubes at the bedside followed by abdominal radiograph confirmation. In more difficult cases, fluoroscopy is used. Following the inadvertent placement of feeding tubes in two floor patients at our institution, a practice policy was written that required fluoroscopic validation of feeding tube placement in patients with decreased mental status. The cost of fluoroscopy is $850.00 per place. Our Medical Intensive Care Unit (MICU) had previously developed and tested a procedure using a capnograph to detect end-tidal CO₂ during gastric tube insertion. Subsequently, they extended the work by testing the efficacy of a colormetric CO₂ detector as an accurate substitute for the capnograph.

METHODS: A convenience sample of MICU patients was monitored with a capnograph while simultaneously monitoring for CO₂ with a colormetric device. The study consisted of monitoring 195 gastric tube insertions with the unit’s standard procedure using a capnograph while simultaneously monitoring the Pedi-Cap colormetric device for a color change indicating the presence of CO₂ during gastric tube insertion. The study monitored 195 gastric tube insertions. Subsequently, they extended the work by testing the efficacy of a colormetric CO₂ detector as an accurate substitute for the capnograph.

RESULTS: One hundred ninety-five insertions were monitored. Airway cannulation occurred in 27% of insertions. The colormetric indicator successfully detected the presence of CO₂ in 100% of the insertions where CO₂ was detected by capnograph. Airway cannulation was associated with nasal insertion (p = 0.03) and spontaneously breathing/non-intubated patient status (p = 0.01), but not with mental status or tube type.

CONCLUSIONS: The results of this study confirm the frequency of inadvertent airway cannulation during gastric tube insertion. In addition, the results demonstrate that factors assumed to place the patient at risk, such as decreased mental status or type of tube, are not accurate. The study findings will result in a practice change on the floors of our hospital. The technique is safe, effective, cost-effective and easy to perform.

BACKGROUND:

Inadvertent feeding tube placement into the lung results in patient discomfort, increased morbidity (and potential mortality), delayed enteral feeding (while clinicians wait for replacement and clearance to feed orders etc.), and increased length of stay and healthcare costs. Methods to reduce the risk of blind placement are important to identify. Currently most institutions place feeding tubes at the bedside and confirm placement with an abdominal radiograph. Fluoroscopy is used in more difficult cases. Following the inadvertent placement of two feeding tubes in floor patients at our institution, a practice policy was written that required fluoroscopic validation of tube placement in patients with decreased mental status. The cost of fluoroscopy is $850.00 per placement. Our Medical Intensive Care Unit (MICU) had previously developed and tested a procedure using a capnograph to detect end-tidal CO₂ during gastric tube insertion. Subsequently they extended the work by testing the efficacy of an inexpensive, disposable colormetric CO₂ detector as an accurate substitute for the capnograph.

PURPOSE:

The purpose of the study was to compare the MICU method using a capnograph to one using a colormetric CO₂ detector and to identify variables affecting accurate tube placement in our MICU patient population.

METHODS:

A convenience sample of 195 gastric tube insertions were studied in 130 adult MICU patients. The study equipment consisted of an existing unit-based portable capnograph (Novametrix, Wallingford CT) and disposable colormetric indicators (Pedi-Cap © Nellcor Puritan Bennett). Gastric tubes consisted of either a soft-bore (SB) feeding tube (Kendall Healthcare), size 12 French or a Salem Sump (SS) tube (Bard products) sizes 14-16 French.

The study consisted of monitoring 195 gastric tube insertions with the unit’s standard procedure using a capnograph while simultaneously monitoring the Pedi-Cap colormetric device for a color change indicating the presence of CO₂. Successful placement verification was accomplished according to existing MICU policy, SS tubes were confirmed by air (bolus) aspiration and nasal insertion were confirmed by x-ray. When CO₂ was sensed by the capnograph during insertion, the tubes were promptly removed and the attempt was called a failure. Each insertion was counted as a separate event.

RESULTS:

1. Insertion variables included tube type (Salem Sump: 60%, soft bore feeding tubes: 40%), insertion site (oral: 71%, nasal: 29%), mechanical ventilation (81%), and decreased mental status (72%).

2. The colormetric indicator successfully detected the presence of CO₂ in 100% of the insertions where CO₂ was detected by capnograph. CO₂ was detected simultaneously with the capnograph in most cases (in two cases it was two seconds faster).

3. Inadvertent airway insertion occurred in 27% of the insertions and was associated with nasogastric insertion (p = 0.03) and spontaneously breathing/non-intubated status (p = 0.01) but not with mental status or tube type (Pearson’s chi-square).

4. All other placements that did not result in the detection of CO₂ were considered properly placed and placement was verified by x-ray or fluoroscopy.

DISCUSSION:

- Blind placement of gastric tubes is time and effort intensive and may be harmful to the patient. Furthermore, definitive methods to verify appropriate placement are expensive (i.e., fluoroscopy and x-ray).
- Traditional methods designed to assure accuracy in tube placement such as the use of a bolus, have not been demonstrated to be fail-safe.
- Although the capnograph is an effective indicator of pulmonary intubation, the device can be costly and may be misplaced or broken. In addition, if required in an isolation room, decontamination and other time-consuming preparations make it less "user-friendly" for busy bedside clinicians.
- Based on our study findings, the colormetric indicator appears to be an excellent substitute for the capnograph and will be used in our initiative on the floors.
- Though the procedure is a very easy one to teach to clinicians who may place gastric tubes, training is required. Also, it is essential to remember that the procedure is not a replacement for the gold standards used to verify tube position (i.e., jejunostomy, post-pylorus).
- The study did not test all sizes or tube types. Thus the application of these study findings cannot be assumed if smaller tubes are used.

CONCLUSION:

The results of this study confirm the frequency of inadvertent airway cannulation during gastric tube insertion. In addition, the results demonstrate that factors assumed to place the patient at risk such as decreased mental status, are not accurate. The study findings will result in a practice change on the floors of our hospital. The technique is safe, effective, cost-effective and easy to perform.

REFERENCES:


This study was sponsored by (Tyco Healthcare Group LP, Mansfield, MA USA).
IDENTIFYING INADVERTENT AIRWAY INTUBATION DURING GASTRIC TUBE INSERTION USING A DISPOSABLE COLORIMETRIC CO2 DETECTOR AND VARIABLES THAT AFFECT PLACEMENT

Suzanne M. Burns RN, MSN, RRT, ACNP, Richard Carpenter RN, BSN, Cheri Smith RN, BSN, Sharon Bragg RN, BSN, Mary Marshall RN, MSN, Liz Brown RN, Martha Hogan RN, Rebecca Bagby RN, BSN, Kris Blackstone RN, BSN, Jonathon D. Truwit MD, University of Virginia Health System, Charlottesville VA.

ABSTRACT

A procedure using a capnograph to detect end-tidal carbon dioxide (CO₂) during gastric tube insertion was previously developed, tested and published and was adopted as a standard of care in our Medical Intensive Care Unit (MICU). The purpose of this study was to compare our method using a capnograph to one using a colorimetric CO₂ detector and to identify variables affecting accurate tube placement. A convenience sample of gastric tube insertions were studied in MICU patients. The study consisted of monitoring gastric tube insertions with the unit’s standard procedure using a capnograph while simultaneously monitoring the colormetric device (Pedi-Cap®Nellcor Puritan Bennett) for a color change indicating the presence of CO₂. A total of 195 insertions were monitored. Insertion variables included tube type (Salem Sump: 60%, soft bore feeding tubes: 40%), insertion site (oral: 71%, nasal: 29%), mechanical ventilation (81%), and decreased mental status (72%). The colormetric indicator successfully detected (in seconds) the presence of CO₂ in 100% of the insertions where CO₂ was detected by capnograph. Inadvertent airway insertion occurred in 27% of the insertions and was associated with nasal insertions (p=0.03) and spontaneously breathing/non-intubated status (p=0.01) but not with mental status or tube type (Pearson’s chi-square). This study demonstrates that inadvertent airway intubation is relatively common during gastric tube placement and confirms the accuracy of a colorimetric CO₂ device in detecting airway intubation as compared to capnography. It also adds to our understanding of clinical variables affecting placement of the tubes and how gastric tube insertions might be more safely accomplished.

INTRODUCTION

The placement of gastric tubes is common in the care of critically ill patients. While bedside placement is often performed, the procedure is associated with significant risk. Inadvertent placements of the tube into the lungs with subsequent pneumothorax or infestation of tube feedings are dreaded and serious complications. Numerous methods for assuring proper placement of the tubes have been described and include air loss auscultation and pH testing; yet the gold standard continues to be a radiograph or fluoroscopy. In a previous study, three of the authors (SMB, RC, JT) developed and tested a procedure for assessing tube migration into the lungs during gastric placement. The procedure used a capnograph to detect end-tidal carbon dioxide, and thus inadvertent lung intubation. The method proved to be an effective, accurate, non-invasive and cost-effective method (1). Following the conclusion of the study, the method was adopted as a standard of care in the Medical Intensive Care Unit (MICU).

While the placement procedure using a capnograph is effective, the device is somewhat cumbersome to use, is frequently misplaced, and does break. The investigators believed that a disposable colorimetric CO₂ device might serve as an accurate substitute for the capnograph and have the advantage of ease of use, availability, and cost effective.

METHODS

The purpose of the study was to compare our method using a capnograph to one using a disposable CO₂ detector and to identify variables affecting accurate tube placement in our MICU patient population.

HYPOTHESES

- Colometric CO₂ detectors will accurately detect the presence of CO₂ and potential inadvertent airway intubation) during gastric tube insertion as compared to capnography.
- Variables that correlate with inadvertent airway intubation include mental status, tube route (nose or mouth), tube type (Salem sump or soft-bore feeding tube), artificial airway presence, and mechanical ventilation.

RESULTS

Part 1: To test the ability of the Pedi-Cap to detect flow through a SB gastric tube as compared to the capnograph. This was accomplished by placing a SB feeding tube 3 cm through the top of an endotracheal tube ventilator adapter in 5 consecutive patients with the Pedi-Cap device connected, with the appropriate desired result being a positive change in the colorimetric device, thus notching the presence of CO₂.

Part 2: To monitor 195 gastric tube insertions with the unit’s standard procedure using a capnograph while simultaneously monitoring the Pedi-Cap colormetric device for a color change indicating the presence of CO₂ (Figures 1 and 2). Successful placement verification was accomplished according to existing MICU policy. SB tubes were confirmed by air loss auscultation and/or aspiration of gastric contents and SB tubes were verified by x-ray. All tubes that did not register a change in CO₂ were bolused with air to assure patency and the two CO₂ devices were reattached to test once again for the presence of CO₂. When CO₂ was sensed by the capnograph during insertion, the tubes were promptly removed and the attempt was called a failure. Finally, insertions that could not be verified by either method (e.g. those that coiled in the back of the throat and those that could not be advanced) were categorized as non-failure/non-verified and immediately removed (they were not used in the final analysis). Each insertion was counted as a separate event.

DISCUSSION

- Blind placement of gastric tubes is time and effort intensive and may be harmful to the patient. Furthermore, definitive methods to verify appropriate placement are expensive (i.e. fluoroscopy and x-ray). Traditional methods designed to assure accuracy in tube placement such as the use of air bolus, have not been demonstrated to be fail-safe.
- This study extends our original study on the use of capnography to detect CO₂ during gastric tube placement to the use of a colormetric device. We believe that this is a significant improvement in the procedure since the colorimetric device is disposable, inexpensive, and lightweight. Given the frequency with which patients are placed on isolation and the potential for breakage and “down-time” associated with the capnograph, the use of a colorimetric indicator is an excellent substitute.
- Though the procedure is a very easy one to teach to clinicians who may place gastric tubes, training is required. Also, it is essential to remember that the procedure is not a replacement for the gold standards used to verify tube position.
- The number of inadvertent intubations recorded in this study may not be actual airway intubations but rather an escape of a breath (and CO₂) during placement. Regardless, no harm to the patient resulted since the required nursing action was to withdraw and replace the tube. If anything this potential sensitivity in sensing CO₂ erred on the conservative side, and thus increased patient protection.
- The study did not test all sized tubes or tube types. Thus the application of these study findings cannot be assumed if smaller tubes are used.

CONCLUSION

This study demonstrates that inadvertent airway intubation may be relatively common during gastric tube placement and confirms the accuracy of a colorimetric CO₂ device in detecting airway intubation as compared to capnography. It also adds to our understanding of clinical variables affecting placement of the tubes and how gastric tube insertions might be more safely accomplished.

REFERENCES

1. Burns, S.M., Carpenter, R., Truwit, J.D. Report on the development of a procedure to prevent placement of feeding tubes into the lungs using end-tidal CO₂ (ETCO₂) measurements. Critical Care Medicine, 2001; 29:936-939

This study was sponsored by (Tyco Healthcare Group LP, Mansfield, MA USA).