International Journal of Nursing Studies 61 (2016) 248–257

Contents lists available at ScienceDirect

International Journal of Nursing Studies

journal homepage: www.elsevier.com/ijns

Confirming nasogastric tube placement: Is the colorimeter as sensitive and specific as X-ray? A diagnostic accuracy study

Siti Zubaidah Mordiffi [a,*], Mien Li Goh [a], Jason Phua [b], Yiong-Huak Chan [c]

[a] Evidence Based Nursing Unit, Nursing Department, National University Hospital, Singapore
[b] Division of Respiratory & Critical Care Medicine, University Medicine Cluster, National University Health System, Singapore
[c] Biostatistics Unit, Yong Loo Lin School of Medicine, National University Health System, Singapore

ARTICLE INFO

Article history:
Received 22 October 2015
Received in revised form 9 June 2016
Accepted 17 June 2016

Keywords:
Colorimeter
Enteral nutrition
General ward setting
Hospital
Inpatient
Nasogastric tube
Nursing
Sensitivity
Specificity
Radiographic imaging
X-ray

ABSTRACT

Background: The effect of delivering enteral nutrition or medications via a nasogastric tube that is inadvertently located in the tracheobronchial tract can cause respiratory complications. Although radiographic examination is accepted as the gold standard for confirming the position of patients' enteral tubes, it is costly, involves risks of radiation, and is not failsafe. Studies using carbon dioxide sensors to detect inadvertent nasogastric tube placements have been conducted in intensive care settings. However, none involved patients in general wards.

Objective: The objective of this study was to ascertain the diagnostic measure of colorimeter, with radiographic examination as the reference standard, to confirm the location of nasogastric tubes in patients.

Design: A prospective observational study of a diagnostic test.

Setting: This study was conducted in the general wards of an approximately 1100-bed acute care tertiary hospital of an Academic Medical Center in Singapore.

Participants: Adult patients with nasogastric tubes admitted to the general wards were recruited into the study.

Methods: The colorimeter was attached to the nasogastric tube to detect for the presence of carbon dioxide, suggestive of a tracheobronchial placement. The exact location of the nasogastric tube was subsequently confirmed by a radiographic examination.

Results: A total of 192 tests were undertaken. The colorimeter detected carbon dioxide in 29 tested nasogastric tubes, of which radiographic examination confirmed that four tubes were located in the tracheobronchial tract. The colorimeter failed to detect carbon dioxide in one nasogastric tube that was located in the tracheobronchial tract, thus, demonstrating a sensitivity of 0.80 [95% CI (0.376, 0.964)]. The colorimeter detected absence of carbon dioxide in 163 tested nasogastric tubes in which radiographic examination confirmed 160 gastrointestinal and one tracheobronchial placements, demonstrating a specificity of 0.865 [95% CI (0.808, 0.907)]. The colorimeter detected one tracheobronchial nasogastric tube placement that the radiographic examination was misinterpreted.

Conclusion: The study found that the use of the colorimeter in the general ward setting was not 100% sensitive or specific in ascertaining the location of a nasogastric tube as previously reported by many studies undertaken in intensive care settings. This is the first study on the use of a colorimeter to confirm the placement of a nasogastric tube in adult

* Corresponding author at: Evidence Based Nursing Unit, Nursing Department, National University Hospital, 5 Lower Kent Ridge Road, Main Building 1, Level 6, Singapore 119074, Singapore. Tel.: +65 6772 5137; fax: +65 6772 4032.
E-mail address: siti_zubaidah@nuhs.edu.sg (S.Z. Mordiffi).

http://dx.doi.org/10.1016/j.ijnurstu.2016.06.011

patients in the general ward setting. More research on the use of a colorimeter in the general ward setting and its potential use in certain processes for confirming the placement of a nasogastric tube is warranted.

What is already known about the topic?

- Aspirate of pH value of 5.5 or less suggests that the NGT is in the stomach. However, the gastric fluid aspirate might be affected by proton-pump inhibitors such as H2-blockers and antacids, which may increase the pH value of the aspirate to 6 or higher.
- Aspirate of pH value of 6 or more suggests tip of NGT may be in the stomach or tracheobronchial tract (incorrect location).
- Radiographic examination is the gold standard in confirming the position of the NGT in doubtful placements. However, there are still issues of incorrect interpretation of the radiographic imaging.
- In the mechanically ventilated patients that is admitted to the intensive care unit, the colorimeter is close to 100% sensitive and specific in confirming the placement of NGT when tested against the reference standard – X-ray.

What this paper adds

- Use of the colorimeter was not 100% sensitive and specific in determining the location of the nasogastric tube when tested against the X-ray in the adult general ward setting.
- Excessive respiratory secretions may cause blockage of a patient's nasogastric tube that is located in the tracheobronchial tract which may have resulted in the colorimeter test showing an absence of carbon dioxide (false negative finding).
- The colorimeter served as an additional test to ascertain placement of the nasogastric tube in the tracheobronchial tract in one instance where radiographic image was wrongly misinterpreted as being in the gastric region.

1. Introduction

Nutrition plays a crucial role in patients' health and well-being. Patients who require enteral nutrition are commonly quite ill or debilitated, may be experiencing malnutrition, or have the potential for malnutrition. The insertion of a nasogastric tube (NGT) for enteral nutrition may be ordered for patients in situations where their nutritional intake is inadequate or consuming food via the mouth is unsafe, such as in those with dysphagia (National Institute for Health and Clinical Excellence, 2006). Given that an NGT is mainly inserted as a blind procedure, it may be inadvertently inserted or dislodged into the respiratory system. Administered feeds via a misplaced NGT has a potential risk of causing serious complications (Metheny et al., 2007) such as aspiration pneumonia or death (Phillips and Nay, 2008). In the UK, the National Health Service (England) reported 21 deaths and 79 cases of harm associated with malpositioned NGT feeding between September 2005 and March 2010 (National Patient Safety Agency, 2011). A systematic review (Sparks et al., 2011) of complication arising from the blind placement of nasoenteric feeding tubes found that 1.9% ($n = 187$) of the nasoenteric tubes were malpositioned in the tracheoonchial tract of patients. Pneumothorax and death were complications cited in the review (Sparks et al., 2011).

Complications arising from misplaced NGTs are preventable (Metheny et al., 2007). Thus, the National Health Service (2015) designated misplaced NGTs as a 'Never Event'. Thus, confirming the position of an NGT prior to commencing enteral nutrition is imperative to ascertain that an NGT is not in the respiratory system after the initial insertion, as well as prior to administering medication or feeds via the NGT (National Health Service, 2013). The National Patient Safety Agency (2011) recommends performing a pH test of the NGT aspirate as a first-line test to confirm the internal position of the NGT. A pH value of 5.5 or less suggests that the NGT is in the stomach; a pH value of 6 or more may indicate intestinal or respiratory placements of the NGT (Taylor, 2013). The use of pH indicators in some instances was limited in diagnosing the correct placement of the NGT as it relied on the operator's interpretation of color change and testing technique (Boeykens et al., 2014). Furthermore, the pH of the gastric fluid aspirate may be increased to 6 or higher by antacids and acid inhibitors (Boeykens et al., 2014; National Patient Safety Agency, 2011). In a cross-sectional study, Taylor (2013) found that 22% of the NGT positions could not be confirmed using a pH test due to the interaction of patients' aspirate with acid inhibitor medications, which altered the pH of the gastric aspirate to alkaline.

Another reason for not being able to check the location of the NGT using a pH test is when no aspirate can be obtained from the NGT. When this occurs, or when a patient is receiving medications such as H2-blockers, the National Patient Safety Agency (2011) recommends radiographic imaging (X-ray) as the second-line test for confirming the placement of the NGT. Furthermore, an X-ray is considered the gold standard (Metheny et al., 2007) and the only acceptable method besides a pH test (National Health Service, 2013) for confirming the position of an NGT.

In fact, some institutions recommend in their policy that a chest X-ray should be taken immediately after the insertion of an NGT to confirm its correct placement and prior to commencing enteral nutrition (Rauen et al., 2008). However, the use of an X-ray for confirming the location of