Diagnostic accuracy of the methods carried out to verify nasogastric tube position in mechanically ventilated adult patients: a systematic review protocol

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Review question/objective

The objective of this review is to evaluate the diagnostic accuracy of methods carried out to verify correct positioning of nasogastric (NG) tubes in mechanically ventilated adult patients.

More specifically, the objectives are to compare:

The diagnostic accuracy of all described methods versus chest X-ray as the gold standard to differentiate between respiratory and gastrointestinal (GI) placement of NG tubes in mechanically ventilated adult patients.

Background

Nasogastric tubes are widely used in hospital wards, including in intensive care units (ICU).¹ They are used for enteral feeding and medical administration, as well as for decompression of the GI tract. However, insertion of an NG tube can be problematic and malpositioning is frequently described. Published literature has described NG tubes being misplaced in the pleura, respiratory tract,² and upper esophagus, as well as a case-report describing an NG tube even being placed in the brain.³ The malpositioning may lead to complications such as pneumothorax,⁴ pleural effusion,⁵ abscess, empyema and death.⁶

A 2006 study evaluating the position of more than 2000 NG tubes (various categories of patients included in the analyses) was conducted using X-ray as the gold standard. Malpositioning was present in 1.3-2.4% of cases.⁷ Of these, 26% led to complications such as pneumonia and pneumothorax and two patients died due to the misplacement. Another study evaluating 1822 tubes, revealed that 3.2% of the tubes were misplaced in the respiratory tract (all NG tubes placed during the year 2005, at a 450-bed tertiary referral hospital were included in the study).⁸ The estimated risk of misplacement is thought to be as high as 13-
20% in high-risk patients.\textsuperscript{9,10} Identified risk factors for malpositioning of NG tubes include decreased level of consciousness, weak cough reflex and endotracheal intubation.\textsuperscript{9,11} Utilization of a cuffed tracheal tube does not prevent NG tubes being misplaced into the respiratory tract.\textsuperscript{12,13} Therefore, mechanically ventilated patients are at higher risk of getting an NG tube misplaced, since these patients are orally intubated or tracheotomized, have reduced cough reflex and often have a lower level of consciousness due to critical illness or medical sedation.\textsuperscript{1}

Verification of correct positioning of NG tubes is carried out at the bedside by the nurse on duty and a wide range of methods for this purpose are described in the literature. A common method for verifying tube placement involves auscultation.\textsuperscript{14} This method is performed by inflating 20ml of air into the NG tube while ausculting the epigastrium for gurgling sounds. However, evidence from several systematic reviews concluded this method is not advisable due to risk of false negative results and thereby non-identification of misplaced NG tubes.\textsuperscript{15,16} For example, a study from 1990 observed two out of three NG tubes (67\%) actually located in the respiratory tract to be misclassified as being located in the stomach. The misclassified NG tubes were located in the right lower lobe bronchus and the right pleural space, but loud gurgling sounds were still heard when auscultated at the epigastrium while inflating 20ml of air into the NG tube.\textsuperscript{2}

Another commonly used method is measuring pH from aspirate from the NG tube where low pH indicates presence of gastric acid and thereby correct positioning of the NG tube. However, this method is also associated with certain problematic issues. Acid-reducing treatment evidently influences the pH value measured.\textsuperscript{17} Another issue is that critically ill patients have a higher risk of aspiration of gastric content, which is suggested to reduce the pH of their tracheobronchial fluid.\textsuperscript{18} This could possibly lead to misinterpretation of the tube being correctly placed in the stomach.\textsuperscript{19} Furthermore, it is preferable that the patient has not had any food or medication by tube within one hour before measuring pH.\textsuperscript{17} This is not feasible for patients receiving continuous enteral nutrition, which is the case for many mechanically ventilated patients in the ICU.\textsuperscript{20} Consequently, a study was carried out to examine the reliability of verifying NG tube placement by testing pH in patients in an ICU. The study concluded that under the circumstances existing within the ICU, this method was not reliable.\textsuperscript{20}

This systematic review will be carried out to evaluate the diagnostic accuracy of methods performed to verify positioning of NG tubes to be intentionally placed in the GI tract and not in the respiratory tract in adult mechanically ventilated patients. The relevance of this review is strongly highlighted by the fact that malpositioning of an NG tube may have fatal consequences, the risk of which may be avoided or at least reduced by using evidence-based practice. The patient group is limited to include mechanically ventilated patients, since they are at a higher risk of getting an NG tube misplaced due to a low level of consciousness, weak cough reflex and intubation.

An initial literature search has revealed multiple systematic reviews describing the accuracy of methods to verify NG tube positioning that included various categories of patients;\textsuperscript{15,21} however, no review was identified that focused specifically on mechanically ventilated patients.
Keywords

Nasogastric tube; mechanical ventilation

Inclusion criteria

Types of participants

This review will consider studies that include adult mechanically ventilated patients with an NG tube, regardless of the purpose the NG tube serves. Studies concerning neonates and infants will be excluded.

Types of intervention(s)/phenomena of interest

This review will consider studies that evaluate any method (index test) performed to verify an NG tube was placed either in the GI tract or in the respiratory tract. Any method revealed by the literature search will be considered for inclusion. It could for example include auscultation, capnography or colorimetric capnography. Since chest X-ray is widely accepted as the gold standard for verifying NG tube placement, it will also be considered as the gold standard by this systematic review.

Types of outcomes

This review will consider studies that include the following outcomes: a test's ability to correctly verify an NG tube to be placed in the GI tract versus the respiratory tract (specificity) and its ability to correctly identify a misplaced tube (sensitivity).

Types of studies

This review will consider any quantitative study that examines the diagnostic accuracy of index tests to verify the position of NG tubes in the GI tract versus the respiratory tract.

Randomized studies in which participants are randomized to different index tests and all participants are verified by X-ray as the gold standard will be included.

Cohort studies or cross-sectional studies addressing the diagnostic accuracy of tests to verify NG tube placement where the participants are tested by one or more index tests and chest X-ray is the gold standard will be considered.

Case-control studies where participants have been selected by outcomes will also be considered.

Search strategy

The search strategy aims to find both published and unpublished studies. A three-step search strategy will be utilized in this review. An initial limited search of PubMed and CINAHL will be undertaken, followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe the article. A second search using identified keywords and index terms will then be undertaken across all included databases. Index terms will be selected to match the specific database, since index terms may vary between databases. Thirdly, the reference lists of reports and articles included for critical appraisal will be searched for additional studies. Studies published in English, Danish, Swedish and Norwegian will
be considered for inclusion in this review. This relates to the expertise of the review team. The search range will be from inception of the databases to September 2013.

The databases to be searched include:

PubMed
CINAHL
EMBASE
Scopus
SveMed+
TRIP database (turning research into practice) (http://www.tripdatabase.com/)

The search for unpublished studies will include:

Mednar
National Danish Clearinghouse for Nursing (http://www.kliniskkeretningslinjer.dk)
National Institutes of Health (NIH) Clinical Trials Databases (http://www.clinicaltrials.gov)
The Scottish Intercollegiate Guidelines Network (SIGN) (http://www.sign.ac.uk)
National Institute for Health and Care Excellence (http://www.nice.org.uk)

Additional searching for published literature will include:

Hand searching reference lists and bibliographies of included articles and any relevant systematic reviews identified in the Joanna Briggs Institute Database of Systematic Reviews and Implementation Reports and Cochrane Database of Systematic Reviews.

Initial keywords/search terms to be used will be:

Mechanically ventilated
Ventilator
Ventilation
Intubation
Tracheostom*
Feeding tube
Nasogastric tube
Nasoenteral tube
X-ray
Radiograph*
Roentgenogram
Radiolog*
Placement
Position*
Confirm*
Accuracy
Malposition*

Index terms specific for each database will be included in the search strategy.

**Assessment of methodological quality**

Papers selected for retrieval will be assessed by two independent reviewers for methodological validity prior to inclusion in the review using QUADAS (Appendix I), which is a standardized critical appraisal instrument applied to studies based on diagnostic accuracy tests. Any disagreements that arise between the reviewers will be resolved through discussion, or with a third reviewer. In situations where relevant information is missing in primary studies, the reviewers will contact the authors to seek additional information.

**Data collection**

Details from included studies will be extracted using a modified Joanna Briggs Institute (JBI) data extraction form (Appendix II). This modified data extraction tool was created by Mwita C et al., and published by JBI. The extraction tool is modified to fit the specific purpose of the present systematic review. Data will be extracted by two reviewers independently. Any discrepancies between the reviewers will be resolved by discussion.

**Data synthesis**

Sensitivity, specificity, positive predictive value and negative predictive value will be extracted from the studies and presented in forest plots. If these are not provided in the articles, where possible calculations will be done based on the data presented in the studies. Data will where possible, be pooled in statistical meta-analysis. Where statistical pooling is not possible, the findings will be presented in narrative form including in tables and figures to aid in data presentation where appropriate. Heterogeneity will be assessed statistically using the standard chi-square test.

Patients will be analyzed as a single group and subgroup-analyses based on specific patient categories will not be performed.
Conflicts of interest

None identified.

Acknowledgements

None
References


Appendix I: Critical appraisal tool – the QUADAS checklist\textsuperscript{23}

1. Was the spectrum of patients representative of the patients who will receive the test in practice?

2. Were selection criteria clearly described?

3. Is the reference standard likely to correctly classify the target condition?

4. Is the time period between reference standard and index test short enough to be reasonably sure that the target condition did not change between the two tests?

5. Did the whole sample or a random selection of the sample, receive verification using a reference standard of diagnosis?

6. Did patients receive the same reference standard regardless of the index test result?

7. Was the reference standard independent of the index test (i.e. the index test did not form part of the reference standard)?

8. Was the execution of the index test described in sufficient detail to permit replication of the test?

9. Was the execution of the reference standard described in sufficient detail to permit its replication?

10. Were the index test results interpreted without knowledge of the results of the reference standard?

11. Were the reference standard results interpreted without knowledge of the results of the index test?

12. Were the same clinical data available when test results were interpreted as would be available when the test is used in practice?

13. Were uninterpretable/ intermediate test results reported?

14. Were withdrawals from the study explained?
Appendix II: Data extraction form (Adapted from JBI MAStARI data extraction tool)\textsuperscript{24}

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<thead>
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<td>Number of participants</td>
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<tr>
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Index test 1/Sub-study 1:

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<td>(Airways)</td>
<td>(GI tract)</td>
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<th>n=</th>
<th>n=</th>
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<td></td>
</tr>
<tr>
<td>(True positive)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(False positive)</td>
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<td>(GI tract)</td>
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<tr>
<td>(False negative)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(True negative)</td>
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Sensitivity

Specificity
Index test 2/Sub-study 2:

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<th>Negative (GI tract)</th>
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<tbody>
<tr>
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<td>n= (True positive)</td>
<td>n= (False positive)</td>
</tr>
<tr>
<td>Negative</td>
<td>n= (False negative)</td>
<td>n= (True negative)</td>
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</tbody>
</table>

Sensitivity

Specificity