Diagnostic Accuracy of pH Testing to Confirm Nasogastric Tube Placement

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Dysphagia after stroke

• Affects up to 78% of patients immediately following stroke
• Persist in 11% to 50% of stroke patients
• Associated with complications, including dehydration, malnutrition and aspiration
• Associated with a 3 fold increased risk in pneumonia, which can result in death
• Associated with poorer rehabilitation outcomes, prolonged hospital stay, dependency at discharge and social isolation
Nasogastric tube feeding

- Approximately 3000 stroke patients will require to be fed by nasogastric tubes (NGT) per year in Scotland to avoid malnutrition, dehydration and to give essential medications
- Misplacement into the respiratory tract occurs in 3% to 4%
- Serious incidents, including death, has increased by 60% between 2014-17
- Death as a result of NGT misplacement should be a “never event”
Nasogastric Tube Position

[source: google images, credit: American Nurse Today]

Scottish Stroke Nurses Forum
Checking nasogastric tube position

Position of NGT must be verified before each use

First Line Test
pH of NGT aspirate (<=5.5)

Second Line Test
Chest X-ray

Old versus New Tests
How accurate do you think the standard pH $\leq 5.5$ to confirm correct NGT placement?

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https://www.mentimeter.com/s/fd72e5019a141a11559185a2a311198c/630446498802/edit
Problems with the first line test: pH $\leq 5.5$

- False negative test (pH $>5.5$) can occur in patients who secrete less gastric acid
  - Receiving anti-acid medications (>40% of stroke patients)
  - Achlorhydria
  - Buffering by NGT feeds

- NGT aspirates cannot be obtained in up to 46% of patients

- Tester’s ability to differentiate the small differences in pH
  - Colour vision, environmental factors & time
Problems with the second line test: X-ray

• Chest X-ray considered gold standard
• Repeated tests increase risk of excessive radiation
• Expensive
• Delays feeding (17-47 hours)
• Misinterpretation errors
  • More cases of serious harm/death (45% to 8%) compared to pH readings

[source: google images, credit: Patient Safety Advisory]
Modified pH/lipase stick

• A solution is to check non-acid gastric aspirates

• pH stick modified to detect human gastric lipase (HGL) (Ingenza, Roslin, Scotland)
  • Secreted from gastric fundus
  • Considered to be acid stable

• The pH stick is coated in tributyrin
  • HGL will breakdown triglycerides to release acid and alcohol
  • Therefore, the modified pH/lipase test would aim to detect both pH and HGL activity
Do you think the modified pH stick <=5.5 to confirm correct NGT placement is more accurate than the standard pH stick?

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Method

• Important to avoid additional X-rays to verify the different types of aspirate
• Large number of aspirates from the stomach, oesophagus, lung and salvia were obtained from patients undergoing scope procedures
• The reference standard was direct confirmation of the type of aspirates confirmed by the operator undertaking the gastroscopy or bronchoscopy
• At the end of the procedure the research nurse tested two fresh samples using the standard and the modified pH stick
• Blinded pH testing undertaken at laboratory on two samples that were previously frozen
Participants/Samples

Total Patients (n=203)
Gastroscopy (n=97); Bronchoscopy (n=106)
Samples tested: Standard pH (n=390); Modified pH (n=379)

pH <=5.5
- Gastric
  - Standard (n=65)
  - Modified (n=62)
- Non-Gastric
  - Standard (n=61)
  - Modified (n=55)

pH >5.5
- Gastric
  - Standard (n=31)
  - Modified (n=32)
- Non-Gastric
  - Standard (n=233)
  - Modified (n=230)
Distribution of pH by sample type

- **Gastric**: n=96, median pH = 2, IQR 2-6.5
- **Oesophageal**: n=90, median pH = 5, IQR 2-6.5
- **Saliva**: n=101, median pH = 7, IQR 6.5-7.0
- **Bronchial**: n=103, median pH = 7, IQR 6.5-7.0
Accuracy of the modified and non-modified pH sticks for all gastric samples compared to non-gastric samples at the pH ≤=5.5

<table>
<thead>
<tr>
<th>Diagnostic test</th>
<th>pH stick</th>
<th>All % (95% CI)</th>
<th>Confounding factors* % (95% CI)</th>
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<tr>
<td>Sensitivity</td>
<td>Standard Modified</td>
<td>68 (57 to 77) 66 (56 to 75)</td>
<td>73 (57 to 85) 68 (52 to 81)</td>
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<td>Specificity</td>
<td>Standard Modified</td>
<td>79 (74 to 84) 81 (76 to 85)</td>
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<td>Overall agreement</td>
<td>Standard Modified</td>
<td>76 (72 to 81) 77 (73 to 81)</td>
<td>77 (70 to 83) 78 (71 to 84)</td>
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*Sensitivity: measures the proportion of true positives (gastric aspirate) that are correctly identified

*Specificity: measures the proportion of true negatives (non-gastric) that are correctly identified

*Confounding factors included antacid medication, pernicious anaemia and/or gastric surgery; CI, confidence intervals
Differences between paired fresh and frozen gastric samples

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- There no significant differences between fresh and frozen gastric samples at pH ≤5.5 [85/92 (92%), McNemar’s test=0.14, p=0.7]
- When the individual paired fresh and frozen gastric samples were observed between the observers there were only complete agreement in 57/92 (62%) of the samples [kappa=0.496, 95% CI 0.364 to 0.627].
Results summary

• The standard and modified pH sticks had a similar sensitivity

• Sensitivity was low in terms of correctly identifying gastric aspirate, regardless of whether patients were on antacids or had other confounding factors

• Two-thirds of oesophageal aspirates had a pH <=5.5

• Both sticks were able to rule out bronchial samples (100% specificity) and most of the saliva samples (98% specificity)

• Supports previous findings that testers have difficulties in differentiating between small differences in pH colours, particularly across the pH range 5 to 7
Strengths and limitations

• Included a large number of bronchial and oesophageal aspirates that have previously been under-reported
• The source of aspiration was verifiable, which would not be possible if taken directly from the NGT
• The pH of the samples were also tested by a blinded assessor to determine expectation bias
• The population undergoing scope procedures may differ from those requiring nasogastric feeding
• The pH results may be confounded by the fasting conditions or disease
What are the implications for practice?

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Conclusion

• There were no significant differences between paired standard and modified pH tests for identifying gastric aspirates in the presence and absence of antacid medications/confounding factors

• Current guidelines and training strategies need to be updated to better support healthcare professionals to accurately check the position of the NGT

• Further refinement of the modified pH stick and/or development of bedside tests are required to accurately detect NGT placement in stroke patients and other patient populations
References
