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Alternative methods of verifying the positioning of the gastric tube in children

Métodos alternativos de verificación del posicionamiento de la sonda gástrica en niños

Métodos alternativos de verificação do posicionamento de sonda gástrica em crianças

ABSTRACT

Objective: To identify alternative methods for radiological examination to record the position of the gastric tube in children. **Method:** Integrative review of the literature performed in the LILACS, MEDLINE and Cochrane databases of articles published from 2005 to 2015. The Health Sciences Descriptors (DeCS) used were: child and gastrointestinal intubation crossed using the booleans operators AND and OR. **Results:** The final sample consisted of 5 international papers, published between 2005 and 2015, all with an observational design. The methods identified were: measurement of pH and bilirubin, use of litmus paper, capnography, auscultation, air bubbling, absence of gastric residue and characteristics of the aspirate. **Conclusion:** Non-radiological verification methods in children include gastric auscultation, immersion of the catheter in water, use of litmus paper, characteristics and inability to obtain the aspirate, capnography, pH measurement and bilirubin. However, some of them should be discouraged for use in clinical practice because of their limitations, the main one being to the inability to rule out respiratory placement.

DESCRIPTORS: Child; Intubation, gastrointestinal; Patient Safety

RESUMEN

Objetivo: Identificar los métodos alternativos al examen radiológico para verificar el posicionamiento de la sonda gástrica en niños. **Método:** Revisión integrativa realizada en las bases de datos LILACS, MEDLINE y Cochrane, de artículos publicados entre 2005 y 2015. Los Descriptores de Ciencias de la Salud (DeCS) utilizados fueron: intubación infantil y gastrointestinal cruzada usando los operadores booleanos AND e OR. **Resultados:** La muestra final fue compuesta por 5 artículos internacionales, publicados entre 2005 y 2015, todos con delineamiento observacional. Los métodos identificados fueron: medición de pH y bilirrubina, uso del papel tornasol, capnografía, auscultación, burbujeación de aire, ausencia de residuo gástrico y características del aspirado. **Conclusión:** Los métodos de verificación no radiológicos en niños incluyen la auscultación gástrica, sumersión de la sonda en agua, uso del papel tornasol, características e incapacidad de obtención del aspirado, capnografía, medición del pH y bilirrubina. Sin embargo, algunos de ellos deben ser desalentados para su uso en la práctica clínica debido a sus limitaciones, el principal es la imposibilidad de descartar la colocación respiratoria.

DESCRIPTORES: Niño; Intubación Gastrointestinal; Seguridad del Paciente

RESUMO

Objetivo: Identificar os métodos alternativos ao exame radiológico para verificação do posicionamento da sonda gástrica em crianças. **Método:** Revisão integrativa realizada nas bases de dados LILACS, MEDLINE e Cochrane, de artigos publicados de 2005 a 2015. Os Descritores em Ciências da Saúde (DeCS) utilizados foram: criança e intubação gastrointestinal cruzados por meio dos operadores booleanos AND e OR. **Resultados:** A amostra final foi composta por 5 artigos internacionais, publicados entre 2005 e 2015, todos com delineamento observacional. Os métodos identificados foram: mensuração de pH e bilirrubina, uso do papel tornassol, capnografia, auscultação, borbulhamento de ar, ausência de resíduo gástrico e a características do aspirado. **Conclusões:** Métodos de verificação não radiológicos em crianças incluem a auscultação gástrica, submersão da sonda em água, uso do papel tornassol, características e incapacidade de obtenção do aspirado, capnografia, mensuração do pH e bilirrubina. No entanto, alguns deles devem ser desencorajados para uso na prática clínica devido as suas limitações, sendo a principal a incapacidade de descartar colocação respiratória.

DESCRIPTORIOS: Criança; Intubação Gastrointestinal; Segurança do Paciente.

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INTRODUCTION

The insertion of a gastric tube in many hospitalized children is usually indicated for nutritional support, medication administration and/or gastric decompression, being a private practice of the nurse professional. However, although common, there are risks.¹⁻²⁻³ A poorly positioned probe can lead to pulmonary complications, and in more severe cases, even death.⁴⁻⁵

The data on the prevalence of error in the placement of probes in children reported in the literature vary and risk factors associated with poor placement include decreased level of consciousness, abdominal distention, vomiting and orogastric tube, in addition to tracheal intubation.¹⁻⁴⁻⁶

The gold standard for checking the probe's location is abdominal radiography, but obtaining a radiographic image before each diet would be expensive and impractical.¹⁻⁵ Although the radiation dose for a single procedure may be low, repeated exposures can result in cumulative high doses of radiation, associating with various types of cancer, including childhood leukemia.⁷

Thus, non-radiological techniques contribute to the precision of the po-

sitioning of the probe and decrease the exposure to radiation in pediatric patients. This study aimed to review the literature to identify methods, alternative to radiological examination, for checking the positioning of the gastric tube in children.

METHOD

It is an integrative review of the literature, elaborated following Cooper's methodological proposal⁸, comprising five stages: formulation of the problem, data collection, data evaluation, analysis and interpretation of data and presentation of results. This research method makes it possible to gather and synthesize the knowledge already produced on a given topic.⁸

To guide this review, the following guiding question was formulated: "In children, what are the alternative methods to the radiological examination to check the positioning of the gastric tube?"

The search and selection of studies was carried out between the months of October and November 2018, in the databases: Cochrane Library, Latin American and Caribbean Literature in Health Sciences (LILACS) and Medical

Literature Analysis and Retrieval System On Line (MEDLINE) indexed in the Virtual Health Library (VHL). The Health Sciences Descriptors (DeCS) used were: child and gastrointestinal intubation, and their correspondents in English and Spanish: child and child, gastrointestinal intubation and gastrointestinal intubation, respectively.

The crossing between the versions of the descriptors in English and Spanish was performed using the Boolean operator "OR", and between them using the Boolean operator "AND" in the LILACS and MEDLINE databases. When searching the Cochrane Library, the Medical Subject Headings (MeSH) Child AND Intubation, Gastrointestinal were crossed.

The inclusion criteria for selecting the studies were: original articles, published between 2005 and 2015, available online in full, free of charge, in Portuguese, English and/or Spanish, which comprise non-radiological techniques to check gastric tube positioning in children. Monographs, dissertations, theses, texts from a letter to the editor, published in controlled access journals, duplicates, and those that did not answer the guiding question were excluded.

To delimit the sample, the articles were first selected by title and abstract following the established inclusion and exclusion criteria, after which the selected studies were read in full. Figure 1 shows a flowchart clarifying the study

selection process. For the collection and evaluation of data, an instrument was prepared by the author containing information related to: title, authors, language, country of origin, journal, year of publication, objective, methodo-

logical design and main findings.

Subsequently, the extracted data were organized and grouped in synoptic tables, facilitating the reader to access the information.

RESULTS

The final sample of this review consisted of 5 publications, whose unanimous language was English, 4 of which originated in the United States and 1 in England. The characterization of the sample is presented in Table 1, in ascending order of the year of publication.

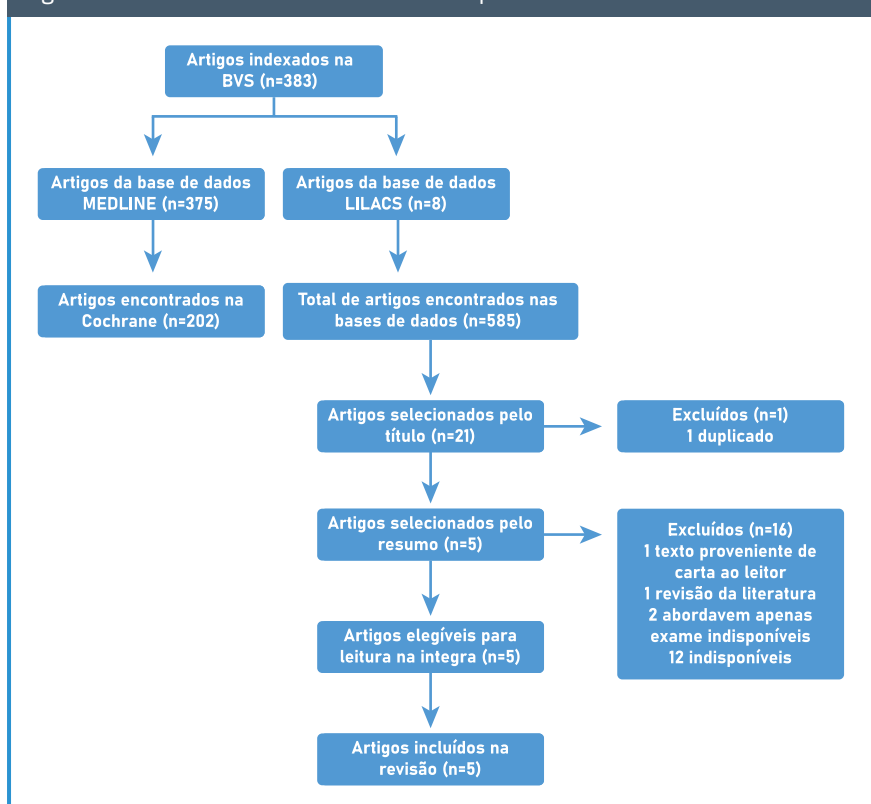
All studies were observational and contained children in their sample, most of them newborns. The methods identified to verify the positioning of the probe include measurement of pH and bilirubin, use of litmus paper, capnography, auscultation, air bubbling, absence of gastric residue and the characteristics of the aspirate.

In addition, studies 4 and 5 considered the feeding and use of gastric secretion inhibitors as factors that could affect stomach pH. The main findings of the articles are described in Chart 2.

DISCUSSION

The verification of the positioning of the gastric tube in children requires that

Figure 1 - Flowchart of the article selection process



Source: Prepared by the authors

Chart 1 - Summary of Articles Included in the Integrative Review

Nº	AUTORES, TÍTULO	ANO	PERIÓDICO	PAÍS
1	Ellet MLC, Croffie JMB, Cohen MD, Perkins, SM ⁹ Gastric tube placement in young children	2005	Clinical Nursing Research	Estados Unidos
2	Freer Y, Lyon A ¹⁰ Risk management, or just a different risk?	2006	Archives of Disease in Childhood: Fetal and Neonatal Edition	Inglaterra
3	Gilbertson HR, Rogers EJ, Ukoumunne OC ¹¹ Determination of a practical pH cutoff level for reliable confirmation of nasogastric tube placement	2011	Journal of Par-enteral and Ent-eral Nutrition	Estados Unidos
4	Ellet, MLC, Cohen MD, Croffie JMB, Lane KA, Austin JK, Perkins SM ¹² Comparing bedside methods of determining placement of gastric tubes in Children	2014	Journal for Specialists in Pediatric Nursing	Estados Unidos
5	Meert KL, Caverly M, Kelm LM, Metheny NA ¹³ The pH of feeding tube aspirates from critically ill infants	2015	American Journal of Critical Care	Estados Unidos

Source: Prepared by the authors

Chart 2 - Summary of the Main Findings of the Studies

Nº	DESENHO	AMOSTRA	TÉCNICAS INVESTIGADAS	PRINCIPAIS ACHADOS
1 ⁹	Observacional	72 crianças até 7 anos de idade	pH ≤ 5, bilirrubina ≥ 5mg/dl e capnografia comparado ao exame radiológico	Posicionamento correto em 79,2% (57/72) validados pelo exame radiológico. Utilizando o limite sugerido de pH foram identificadas 34/40 (VPN 85%) das crianças com sonda em posicionamento gástrico. Não houve diferença estatística entre pH e frequência alimentar ou uso de inibidores de secreção gástrica. O sugerido corte de bilirrubina ≥ 5 mg/dl não identificou nenhuma das duas sondas posicionadas incorretamente, ambas com valores abaixo, mas posicionadas no duodeno. Não foram detectadas sonda no trato respiratório, níveis de CO2 foram de 0-2 mmHg, abaixo do corte estabelecido em pacientes adultos <15 mmHg.
2 ¹⁰	Observacional	207 instituições (unidades de terapia intensiva neonatal)	Descrição da técnica utilizada para verificar o posicionamento da sonda, segundo respostas do enfermeiro da unidade a um questionário online	Dos 207 questionários enviados, houve 165 (80%) respostas. 55% das unidades usavam o papel tornassol e 45% a fita de pH. Entretanto, todas as unidades usaram testes complementares se os resultados fossem inconclusivos ou se ausência de resíduo gástrico. Dentre estes testes estavam a auscultação e as características do aspirado, além de uma unidade reportar o uso de "borbulhamento de ar" para identificar sonda posicionada em vias aéreas. Houve uma variação considerável no valor de pH seguro para alimentar.
3 ¹¹	Observacional	664 crianças até 5 anos de idade	Teste pH gástrico e endotraqueal	Um pH ≤ 4 como ponto de corte para assumir posicionamento gástrico é impraticável, um valor de pH ≤ 5 seria mais apropriado. O valor de pH do aspirado endotraqueal foi de 6. Uma sonda posicionada no esôfago foi identificada com pH de 5.5. Sugere-se realizar exame radiográfico se valor do pH > 5. A coloração do aspirado foi relatada como um método de confirmação da sonda quando pH > 4. As cores esbranquiçada, clara e verde podem indicar localização gástrica.
4 ¹²	Observacional	276 crianças até 17 anos de idade (173 recém-nascidas)	pH (limítrofe 5 para crianças em jejum e 6 para crianças alimentadas), bilirrubina e capnografia	Embora usar o pH para detectar posicionamento no estômago varia de 87% a 92,2% (especificidade), o método mais efetivo para detectar erro na localização é a ausência de resíduo gástrico (VPP 66,7%). As cores branca, verde e bronze podem indicar a localização gástrica da sonda. Entretanto, a consistência do aspirado não se mostrou útil para avaliação do posicionamento. Não foi possível avaliar bilirrubina e CO2, pois não apresentaram variabilidade.
5 ¹³	Observacional	54 recém-nascidas	Teste pH em situações com e sem uso inibidores da secreção gástrica, em crianças em jejum e alimentadas	Independente do uso de inibidores da secreção gástrica e se a criança estava ou não em jejum, o aspirado muitas vezes tem valor de pH ≤ 5.5 em 90% dos casos em que a sonda estava corretamente posicionada na avaliação radiológica.

Legend: VPN negative predictive value. VPP positive predictive value. Source: Elaborated by the authors

the nurse uses non-radiological techniques at the bedside that guarantee the safety of the patients, since the routine use of radiographic confirmation is not an adequate practice before each feeding or administration of medications.⁵

Gastric auscultation is the method that is traditionally used to assess the location of the tube in pediatric patients, however there is no evidence of its effectiveness in discarding respiratory placement.¹⁻⁵ One of the studies 10 reviewed showed that in the inability to obtain aspirate, nurses use this method as a confirmatory test for gastric positioning. However, inflating air in the airways produces a sound indistinguishable from the air inflated in the gastrointestinal tract.

The observation of air bubbling, also reported in this study 10, is an unreliable method, as the stomach may contain air and falsely indicate respiratory placement.¹⁻⁴ In addition, the submersion method may increase the risk of aspiration with the patient's inspiration.⁴

In studies that observed accuracy tests for incorrect probe positioning⁹⁻¹², the absence of aspirate had the highest indicator of positive predictive value (VPP 66.7%), this value assertively represents the incorrect positioning. However, the literature shows that the inability to obtain aspirate does not necessarily indicate that the tube is poorly positioned, as there may be presence of marginal stomach contents, or that the tip of the tube is not in contact with gastric fluids.¹⁴

Bilirubin evaluation was not a reliable indicator, as it did not identify the probes positioned in the intestine.⁹ The concentration of this substance can vary depending on the location of the probe, waste with bilirubin level of ≥ 5 mg / dl has been associated with intestinal positioning in adult patients, however there are divergences in the literature about this concentration in children.⁵

The most reliable method to confirm the placement of the gastric tube is to measure the pH of the aspirated

Bilirubin evaluation was not a reliable indicator, as it did not identify the probes positioned in the intestine. The concentration of this substance can vary depending on the location of the probe, waste with bilirubin level of ≥ 5 mg / dl has been associated with intestinal positioning in adult patients, however there are divergences in the literature about this concentration in children.

residue.¹ The study that investigated the accuracy for a correctly positioned probe demonstrated that the use of pH has a negative predictive value (NPV) of 85%, this value assertively represents the correct positioning of the probe.⁹

The use of a gastric secretion inhibitor, as well as the food frequency, raises questions about the safety of this test, since they would have the potential to raise gastric pH.¹⁻⁴ However, studies comparing stomach pH, found no significant differences between children who received and did not receive these drugs, as well as between those who were fed continuously, intermittently or who were fasting.¹²⁻¹³

Although there is no consensus established in the literature, studies have shown that the pH value ≤ 5 is a good predictor for gastric location.⁹⁻¹¹⁻¹² Bronchial and esophageal secretions commonly have pH > 6 , although esophageal pH can be acidic in the presence of gastric reflux.¹

A pH higher than 5 does not reliably predict the correct insertion of the probe, which may indicate respiratory or esophageal insertion¹⁵, a case of pH 5.5 in an esophageal position was reported in one of the studies included in this review.¹¹

One of the studies pointed out the use of litmus paper as a probe verification method.¹⁰ It is argued that this acidity/alkalinity method should be replaced, as it has a low sensitivity in distinguishing between gastric and bronchial secretions, especially blue litmus paper.¹⁻¹⁶

Blue litmus paper will turn pink in the presence of an acidic medium, regardless of the acidity level, that is, a pH value below 7, so it is not sensitive enough to distinguish between the pH of the fluids. It is possible that a poorly positioned probe is not detected, an incident has been reported where this contributed to the patient's death.¹⁶

Some researchers report that associating the measurement of pH and the color of the aspirate improves the success in predicting the correct placement of the probe, since the aspirate has a spe-

cific color for the intended placement site.^{4,5} The white, green and bronze color was indicative of gastric placement in the studies reviewed¹¹, although consistency was not helpful.¹²

The use of capnography is promising to identify pulmonary loss, since the absence of signs of respiratory distress can be ineffective in detecting a poorly positioned probe, especially in unconscious and intubated patients¹, although it is not useful to discern differences in esophageal, gastric or intestinal positioning.^{4,5} In children, according to a revised study, no tubes were in the respiratory tract, although not all were in the stomach.⁹ Capnography values were 0-2 mmHg, well below the limit established for adult patients, ≤ 15 mmHg.⁹

There is evidence of several non-radiological methods used to verify the positioning of the gastric tube in children. However, for use in clinical practice, the limitations of the methods must be considered, ensuring patient safety.

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CONCLUSION

In view of the possible catastrophic results that can occur with a poorly positioned probe, it is imperative to continuously check the probe's position in children. Non-radiological verification methods in children include gastric auscultation, immersion of the probe in water, use of litmus paper, characteristics and inability to obtain aspirate, capnography, pH measurement and bilirubin.

Auscultation, submersion of the probe and the use of litmus paper, especially blue, should be discouraged for use in clinical practice. The most accurate method to assess the location of the probe is the pH test, a level of 5 or less suggests gastric positioning. The results of this review were limited by the scarcity of research focusing on children, and the predominance of observational studies suggests the need for further studies that raise the level of evidence on nursing practices. ■

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