



ORIGINAL ARTICLE

# Usefulness of bedside ultrasound compared to capnography and X-ray for tracheal intubation<sup>☆</sup>



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## KEYWORDS

Bedside ultrasound;  
Tracheal intubation;  
Newborn;  
Children;  
Capnography;  
X-ray

## Abstract

**Objectives:** The aim of this study was to assess the usefulness of bedside ultrasound compared to capnography and X-ray for endotracheal intubation in children and newborns.

**Materials and methods:** Hemodynamically stable children intubated in pediatric and neonatal intensive care unit were included. Endotracheal tube insertion was checked after every intubation attempt by tracheal ultrasound and capnography simultaneously. The endotracheal tube insertion depth was then checked by assessment of lung sliding by thoracic ultrasound. Thereafter, Chest X-ray was performed and interpreted as usual. Time to perform each technique was recorded.

**Results:** The study included 31 intubations in 26 patients (15 in PICU and 16 in NICU). There were no statistically significant differences between tracheal ultrasound and capnography or between thoracic ultrasound and X-ray in identifying the correct endotracheal intubation and assessment of endotracheal tube insertion depth, respectively. Sensibility and specificity of ultrasound compared to capnography were 92% and 100%, and 100% and 75% compared to X-ray. Ultrasound was significantly slower compared to capnography [12 (4–16) vs 6 (3–12) s;  $P < .001$ ] and significantly quicker compared to X-ray [0.22 (0.17–0.40) vs. 20 (17–25) min,  $P < .001$ ].

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**PALABRAS CLAVE**

Ecografía;  
Intubación traqueal;  
Neonatos;  
Niños;  
Capnografía;  
Radiografía

*Conclusions:* Ultrasound appears to be as effective as capnography, although slower, for identifying endotracheal intubation. Ultrasound may be useful in clinical situations, such as cardiopulmonary resuscitation where capnography is less reliable. Ultrasound is as effective as, and quicker than X-ray for assessment of endotracheal tube insertion depth, and it may contribute to decrease the routine use of X-ray after tracheal intubation.

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## Utilidad de la ecografía comparada con la capnografía y la radiografía en la intubación traqueal

### Resumen

*Objetivos:* Evaluar la utilidad de la ecografía frente a la capnografía y la radiografía en la intubación traqueal (IT) en niños y neonatos.

*Material y métodos:* Se incluyó a pacientes hemodinámicamente estables intubados en la UCIP y UCIN. Se verificó la posición del tubo endotraqueal (TET) tras cada intubación mediante ecografía traqueal y capnografía. Posteriormente, se comprobó la profundidad del TET por ecografía mediante la visualización de la punta del mismo y el deslizamiento pleural y, posteriormente, con radiografía de tórax. Se cronometraron los tiempos de realización de las técnicas.

*Resultados:* Se incluyó a 31 intubaciones en 26 pacientes (15 en UCIP y 16 en UCIN). No hubo diferencias significativas entre la ecografía y la capnografía ni entre la ecografía y la radiografía en la detección de la IT ni en la comprobación de la profundidad del TET. La sensibilidad y la especificidad de la ecografía comparada con la capnografía y la radiografía fueron del 92 y el 100%, y del 100 y el 75%, respectivamente. La ecografía fue significativamente más lenta que la capnografía (12 [4–16] vs. 6 [3–12] s;  $p < 0,001$ ) y más rápida que la radiografía (0,22 [0,17–0,40] vs. 20 [17–25] min;  $p < 0,001$ ).

*Conclusiones:* La ecografía parece tan efectiva como la capnografía, aunque más lenta en la comprobación de la IT. Podría ser de utilidad en situaciones donde la capnografía no sea fiable. La ecografía es tan efectiva y más rápida que la radiografía en la evaluación de la profundidad del TET, por lo que podría disminuir la utilización rutinaria de la radiografía.

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## Introduction

Endotracheal intubation (EI) is an essential technique in airway management. However, it can be associated to potentially serious complications, such as unrecognised oesophageal intubation (OI) or one-lung intubation. Consequently, it is important to verify the correct placement and depth of insertion of the endotracheal tube (ETT) after each intubation.<sup>1–3</sup> Direct laryngoscopy allows the direct verification of the EI, but it requires proficiency by the operator and the interruption of resuscitation manoeuvres in patients with cardiac arrest.<sup>4,5</sup> There are alternative methods such as auscultation, capnography, observation of chest movements, observation of condensation in the ETT, and raising the heart rate in neonates.<sup>6</sup> Although none of the existing methods have been proven to be fully reliable, capnography is the most widely used and recommended.<sup>7</sup> Chest radiography is routinely performed in most units to check the correct placement of the tip of the ETT after intubation. There is still little experience in the use of ultrasound in paediatric intubation. Studies in adults seem to suggest that ultrasonography is as reliable and fast as

conventional methods and could be advantageous in specific situations, such as cardiopulmonary arrest.<sup>3,8–10</sup>

The purpose of our study was to assess the feasibility and efficacy of ultrasonography in EI compared with the most widely used methods, such as capnography or chest radiography.

## Materials and methods

### Study design

We conducted a diagnostic validation study between January 2011 and June 2013. The study included patients admitted to the paediatric and neonatal intensive care units who required intubation at a time when the researcher in charge of performing the ultrasound tests was available. None of the patients were undergoing cardiac arrest and all were haemodynamically stable. The protocol of the study was approved by the clinical research ethics committee of the hospital, and we obtained signed informed consent from the parents or legal guardians.

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