Editorial Commentary

Can video laryngoscopy and supplemental oxygen redefine pediatric, infant and neonatal tracheal intubation standards?

Laila Pinto Coelho[1]^, Thomaz Bittencourt Couto[2,3]^

[1]Postgraduate Medical Education Department, University of São Paulo Faculty of Medicine, São Paulo, Brazil; [2]Pediatric Emergency Department, Instituto da Criança do Hospital das Clínicas, Children's Hospital, University of São Paulo Faculty of Medicine, São Paulo, Brazil; [3]Simulation Center, Hospital Israelita Albert Einstein, São Paulo, Brazil

Correspondence to: Laila Pinto Coelho, MD. Postgraduate Medical Education Department, University of São Paulo Faculty of Medicine, Av. Dr Arnaldo 455, Office 1301, First Floor of the Main Building, Cerqueira César, São Paulo 01246903, Brazil. Email: lailapintocoelho@yahoo.com.br.

Comment on: Riva T, Engelhardt T, Basciani R, *et al.* Direct versus video laryngoscopy with standard blades for neonatal and infant tracheal intubation with supplemental oxygen: a multicentre, non-inferiority, randomised controlled trial. Lancet Child Adolesc Health 2023;7:101-11.

Keywords: Pediatric; laryngoscopy; tracheal intubation (TI); neonatal

Submitted Oct 26, 2023. Accepted for publication Feb 05, 2024. Published online Mar 22, 2024.
doi: 10.21037/tp-23-530
View this article at: https://dx.doi.org/10.21037/tp-23-530

Children, especially neonates, are more vulnerable to respiratory distress than adults. Neonatal and young infants' specific developmental airway anatomy and respiratory physiology features, such as high airflow resistance, high airway collapsibility, high oxygen consumption with increased metabolism, and low reserve, contribute to a higher risk for respiratory failure (1,2). Anesthesia and tracheal intubation (TI), added to their higher vulnerability to airway obstruction and lower apnea tolerance, may lead to oxygen desaturation and critical outcomes (1,2). Every neonatal intubation should be considered a critical event (2). In pediatric and neonatal intensive care units (PICU and NICU, respectively) as well as pediatric emergency departments, clinical instability may add to the factors mentioned above, turning TI of critically ill patients into a high-risk procedure that can be associated with several adverse events (3,4). Tracheal intubation associated events (TIAEs) are common in those settings, with TIAE rates estimated at around 18% in PICUs, 20% in NICUs, and 15% in pediatric emergency departments (3-5).

In addition to clinical factors, previous studies demonstrated that increased TI attempts led to higher rates of TIAEs and severe desaturation (5-8). TI first attempt failure has been associated with a higher risk of severe adverse TIAEs such as cardiopulmonary arrest in critically ill patients with respiratory compromise (9). Ongoing efforts aim to improve the success rate of initial pediatric TI while minimizing TIAEs. These initiatives encompass the adoption of video laryngoscopy (VL) and the integration of apneic oxygenation (AO) methodologies.

VL enables indirect visualization of laryngeal structures through high-resolution cameras and video systems. It has been increasingly used in PICU and NICU and pediatric emergency departments with promising results. In a prospective observational cohort study conducted in an academic pediatric tertiary emergency department, Couto *et al.* found that, when compared to DL, VL was associated with a higher success rate of first-attempt TI and a lower rate of TIAEs. This same study showed an 80% improvement in success rate compared to previously published historical series (10). According to a retrospective review of prospective collected observational data from the NEAR4KIDS (National Emergency Airway Registry for Children) database, VL use was independently associated with a lower occurrence of TIAEs among PICUs and cardiac ICU patients (11). In neonatal settings, VL has

^ ORCID: Laila Pinto Coelho, 0000-0002-7381-9549; Thomaz Bittencourt Couto, 0000-0003-4744-981X.

also been proven to be clinically significant and has been associated with fewer TIAES when compared to DL use (6,12,13). In an extensive retrospective review of prospective collected observational data from the National Emergency Airway Registry for Neonates (NEAR4NEOS), Moussa *et al.* found that, although VL use was not independently associated with higher TI first attempt success, it was associated with lower TIAEs (13). A systematic review that included three randomized trials that compared VL with DL for neonatal TI by trainees showed that VL increased TI first attempt success rate (moderate evidence) (12). VL has also gained a potential role in less invasive surfactant administration for neonates with respiratory distress syndrome. While enabling indirect visualization of the upper airway, VL can help guide adequate catheter placement for further surfactant administration (14).

Furthermore, VL has become an important teaching tool in TI training. Previous studies have shown superior success rates of TI in simulated patients after training with VL compared to DL among trainees (15,16). In association with simulation-based mastery learning, VL use for TI training may lead to increased intubation-related skills and greater safety in TI (17).

However, although several benefits have been reported with VL use in pediatrics TI compared to DL, consideration should be taken to the wide variety of video laryngoscope models, features, and sizes. These differences could lead to heterogeneity in the results of available studies. Each video laryngoscope model has advantages and disadvantages and will be more or less adequate for a specific scenario (18). C-MAC HD video laryngoscope, for example, comes with standard Miller and Macintosh blades, allowing DL and VL. This dual approach can be interesting for teaching and training purposes. Reusable designs are also available, for instance, in some GlideScope products. The anti-fogging mechanism and integrated oxygen jet to provide AO are other interesting features that can be found in some available models, such as some GlideScope products and Truview, respectively (18). Sizes and availability of pediatric standard blades will depend on the model and could be a significant limitation for VL use. C-MAC HD video laryngoscope models provide Miller blade numbers 0, 1, and 2 and Macintosh blade numbers 0, 2, 3, and 4, for example. The GlideScope system Cobalt AVL single use provides batons and Stats that should enable TI of infants with less than 1.5 kg, and the Truview model also comes with four pediatric blades that should enable intubation of neonates to obese children (18). Cost, availability, and need for specialized training can represent some drawbacks (18).

AO is also an initiative that can improve the TI procedure. Desaturation during intubation is a relevant clinical adverse event and may lead to hemodynamic TIAEs in critically ill pediatric patients (19). Employing supplemental oxygen during the apneic intubation period can reduce hypoxia and may extend safe apnea time during the intubation procedure. The use of AO has been associated with positive results in children and neonates (20-22). In a randomized controlled trial conducted by Hodgson *et al.* across two tertiary NICUs in Australia, the use of high-flow therapy in infants undergoing TI was shown to improve the chance of first-attempt TI success without physiological instability in the infant when compared to standard care (21). Additionally, in a prospective pre-post observational study conducted at a large single-center noncardiac pediatric intensive care in North America, Napolitano *et al.* found that AO use was associated with a significant reduction of moderate and severe desaturation among critically ill children (22). However, in a subsequent multicenter study in which AO was implemented across 14 PICUs as a quality improvement intervention, AO was not found to be independently associated with a decrease in TIAEs nor the occurrence of hypoxemia after an adjustment analysis was performed (23). When considering elective pediatric intubation, AO seems effective in prolonging apnea time. Humphreys *et al.* demonstrated that transnasal humidified rapid insufflation ventilatory exchange was associated with prolonged safe apnea time in healthy children undergoing TI for elective surgery or imaging under general anesthesia (20). The importance of supplemental oxygenation through TI to maintain safety during TI attempts in neonates is also highlighted by Garcia-Marcinkiewicz and Matava in their review article, along with the need for anesthetic/sedation depth maintenance and adequate choice of devices and equipment. These authors also emphasize the importance of situational awareness and close attention to human factors (2). These recommendations are resumed and reinforced in the European Society of Anesthesiology and Intensive Care and the British Journal of Anesthesia Guidelines on neonates' and infants' airway management (24).

In the February 2023 issue, Riva *et al.* compare direct laryngoscopy and VL with supplemental oxygen for elective TI in neonates and young infants across several pediatric tertiary hospitals (25). In this study, neonates and infants aged up to 52 weeks postmenstrual age, needing non-emergency surgery or nonsurgical procedure, were randomized at a 1:1 ratio to DL or VL either in the pediatric operating room or the PICU or NICU. All participants received supplemental oxygen. The primary outcome was the proportion of first-attempt TI success. Secondary outcomes included desaturation, number of attempts, intubation time, the first end-tidal CO2 after successful intubation, percentage of glottic opening, need for additional devices, Cormack-Lehane score, and the need to switch from one technique to another.

In this non-inferiority, international, multicenter, single blind, randomized controlled trial, seven Pediatric Tertiary Hospitals across Australia, Canada, Italy, Switzerland and USA were enrolled between October 2020 and March 2022. Two hundred and forty-four patients were included for the modified intention-to-treat (mITT) analysis and 233 for the per-protocol sensitivity analysis. The median age was 44 postmenstrual weeks in the direct laryngoscopy group and 46 postmenstrual weeks in the VL group. When supplemental oxygen was given, VL was associated with a higher first-pass success rate in the mITT analysis when compared to DL. The authors did not observe any differences between the two groups regarding the rate of complications associated with TI.

The authors acknowledge some limitations. First, the research team and the clinical investigators could not be masked to the randomization arm because of technical differences between VL and DL. Moreover, all patients received supplemental oxygen, which precluded a comparison between those two methods without it. Furthermore, all patients in this study had normal airways, limiting the findings to this specific population. Finally, this trial only included tertiary pediatric hospitals, and all intubations were electively performed by experienced teams, which could compromise the translation of these results to other settings with different healthcare providers' experience with neonatal intubation.

VL and AO can play important roles in pediatric and neonatal TI. VL use was associated with higher success of first-attempt intubations and fewer TIAEs than DL. However, some studies show it was not associated with reduced severe desaturation (6,10,13). Unfortunately, it is not always available, and its use can vary across sites (4,13). AO can be an interesting initiative to prolong the apneic phase of TI, decrease the chance of desaturation, and augment TI's first-attempt success rate.

In this study, Riva *et al.* utilize both strategies when comparing VL to VD while giving supplemental oxygen to all participants. VL was associated with a higher rate of TI first-attempt success compared to DL with supplemental oxygen in anesthetized neonates and young infants in the pediatric operating room or the PICU or NICU. Despite reporting that the complication rate was not significantly different between the two groups [adverse events were described in 4% of patients in the VL group and 7% of patients in the DL group with an adjusted risk difference −2.5% (95% confidence interval: −9.6% to 4.6%); P=0.49], the authors do outline that those rates were lower when compared to previous studies and suggest this might be related to supplemental periprocedural oxygenation (25). These results reinforce the advantages of VL over DL in young infants and neonatal TI and highlight the possible benefits of AO during TI. It also emphasizes the association of VL with AO as a possible new standard for young infants and neonatal TI with standard blades.

Pediatric TI can present many challenges. Attention should be paid to the unique characteristics of pediatric and neonatal airways and respiratory physiology to prepare for potential adverse events specific to this population (1,2,24). The number of TI attempts matters, and achieving TI within a limited number of attempts relies on several factors beyond professional expertise. This trial by Riva *et al.* shows that VL and AO can be valuable strategies when considering infant and neonate TI procedures (25).

The European Society of Anesthesiology and Intensive Care and the British Journal of Anesthesia Guidelines on neonates' and infants' airway management highlight these strategies, among other recommendations (24). These guidelines recommend VL with an age-adapted standard blade (Macintosh or Miller) as a first choice for TI in neonates and infants (strong recommendation, moderate evidence quality) as well as AO in neonates (strong recommendation, moderate evidence quality). According to these guidelines, the patient's risk of hypoxemia and the provider's experience should guide the use of AO in infants (clinical practice statement). VL use for neonatal and infant TI teaching and the need for VL training are also acknowledged and issued as clinical practice statements. Adequate levels of sedation or general anesthesia are endorsed (outside resuscitation). The impact of human factors (such as teamwork, communication, and situational awareness) in neonate and infant airway management outcomes is acknowledged, and optimizing communication, debriefing, and education is also recommended.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Translational Pediatrics*. The article has undergone external peer review.

Peer Review File: Available at https://tp.amegroups.com/article/view/10.21037/tp-23-530/prf

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-23-530/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

References

1. Trachsel D, Erb TO, Hammer J, et al. Developmental respiratory physiology. Paediatr Anaesth 2022;32:108-17.
2. Garcia-Marcinkiewicz AG, Matava CT. Safe in the first attempt: teaching neonatal airway management. Curr Opin Anaesthesiol 2022;35:329-36.
3. Capone CA, Emerson B, Sweberg T, et al. Intubation practice and outcomes among pediatric emergency departments: A report from National Emergency Airway Registry for Children (NEAR4KIDS). Acad Emerg Med 2022;29:406-14.
4. Nett S, Emeriaud G, Jarvis JD, et al. Site-level variance for adverse tracheal intubation-associated events across 15 North American PICUs: a report from the national emergency airway registry for children*. Pediatr Crit Care Med 2014;15:306-13.
5. Foglia EE, Ades A, Sawyer T, et al. Neonatal Intubation Practice and Outcomes: An International Registry Study. Pediatrics 2019;143:e20180902.
6. Pouppirt NR, Nassar R, Napolitano N, et al. Association Between Video Laryngoscopy and Adverse Tracheal Intubation-Associated Events in the Neonatal Intensive Care Unit. J Pediatr 2018;201:281-284.e1.
7. Hatch LD, Grubb PH, Lea AS, et al. Endotracheal Intubation in Neonates: A Prospective Study of Adverse Safety Events in 162 Infants. J Pediatr 2016;168:62-66.e6.
8. Lee JH, Turner DA, Kamat P, et al. The number of tracheal intubation attempts matters! A prospective multi-institutional pediatric observational study. BMC Pediatr 2016;16:58.
9. Stinson HR, Srinivasan V, Topjian AA, et al. Failure of Invasive Airway Placement on the First Attempt Is Associated With Progression to Cardiac Arrest in Pediatric Acute Respiratory Compromise. Pediatr Crit Care Med 2018;19:9-16.
10. Couto TB, Reis AG, Farhat SCL, et al. Changing the view: Video versus direct laryngoscopy for intubation in the pediatric emergency department. Medicine (Baltimore) 2020;99:e22289.
11. Grunwell JR, Kamat PP, Miksa M, et al. Trend and Outcomes of Video Laryngoscope Use Across PICUs. Pediatr Crit Care Med 2017;18:741-9.
12. Lingappan K, Arnold JL, Fernandes CJ, et al. Videolaryngoscopy versus direct laryngoscopy for tracheal intubation in neonates. Cochrane Database Syst Rev 2018;6:CD009975.
13. Moussa A, Sawyer T, Puia-Dumitrescu M, et al. Does videolaryngoscopy improve tracheal intubation first attempt success in the NICUs? A report from the NEAR4NEOS. J Perinatol 2022;42:1210-5.
14. Kirolos S, Edwards G, O'Shea J. Videolaryngoscopy in neonatal clinical care. Semin Fetal Neonatal Med 2023;28:101486.
15. Moussa A, Luangxay Y, Tremblay S, et al. Videolaryngoscope for Teaching Neonatal Endotracheal Intubation: A Randomized Controlled Trial. Pediatrics 2016;137:e20152156.
16. Assaad MA, Lachance C, Moussa A. Learning Neonatal Intubation Using the Videolaryngoscope: A Randomized Trial on Mannequins. Simul Healthc 2016;11:190-3.
17. Couto TB, Reis AG, Farhat SCL, et al. Changing the view: impact of simulation-based mastery learning in pediatric tracheal intubation with videolaryngoscopy. J Pediatr (Rio J) 2021;97:30-6.
18. Gupta A, Sharma R, Gupta N. Evolution of

videolaryngoscopy in pediatric population. J Anaesthesiol Clin Pharmacol 2021;37:14-27.
19. Li S, Hsieh TC, Rehder KJ, et al. Frequency of Desaturation and Association With Hemodynamic Adverse Events During Tracheal Intubations in PICUs. Pediatr Crit Care Med 2018;19:e41-50.
20. Humphreys S, Lee-Archer P, Reyne G, et al. Transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) in children: a randomized controlled trial. Br J Anaesth 2017;118:232-8.
21. Hodgson KA, Owen LS, Kamlin COF, et al. Nasal High-Flow Therapy during Neonatal Endotracheal Intubation. N Engl J Med 2022;386:1627-37.
22. Napolitano N, Laverriere EK, Craig N, et al. Apneic Oxygenation As a Quality Improvement Intervention in an Academic PICU. Pediatr Crit Care Med 2019;20:e531-7.
23. Napolitano N, Polikoff L, Edwards L, et al. Effect of apneic oxygenation with intubation to reduce severe desaturation and adverse tracheal intubation-associated events in critically ill children. Crit Care 2023;27:26.
24. Disma N, Asai T, Cools E, et al. Airway management in neonates and infants: European Society of Anaesthesiology and Intensive Care and British Journal of Anaesthesia joint guidelines. Eur J Anaesthesiol 2024;41:3-23.
25. Riva T, Engelhardt T, Basciani R, et al. Direct versus video laryngoscopy with standard blades for neonatal and infant tracheal intubation with supplemental oxygen: a multicentre, non-inferiority, randomised controlled trial. Lancet Child Adolesc Health 2023;7:101-11.

Cite this article as: Coelho LP, Couto TB. Can video laryngoscopy and supplemental oxygen redefine pediatric, infant and neonatal tracheal intubation standards? Transl Pediatr 2024;13(3):508-512. doi: 10.21037/tp-23-530

