

Background

Currently, there is no consensus to guide anesthesiologists in selecting the appropriate pediatric endotracheal tube (ETT) size. There are various formulas and methods that aid providers in pediatric ETT selection. However, these formulas and methods are often inaccurate and cannot be extrapolated to all pediatric populations. Due to complications that can result from incorrect ETT sizes in children, an investigation of more accurate methods is warranted. Ultrasound (US) has emerged as an alternative to traditional formulas to estimate pediatric ETT size. Subglottic US assessment provides indirect visualization and measurement of structures to approximate pediatric ETT size.

Clinical Question

In pediatric patients undergoing general anesthesia (GA) with an ETT, how does the utilization of US compare to the use of traditional formulas, in correctly predicting ETT size?

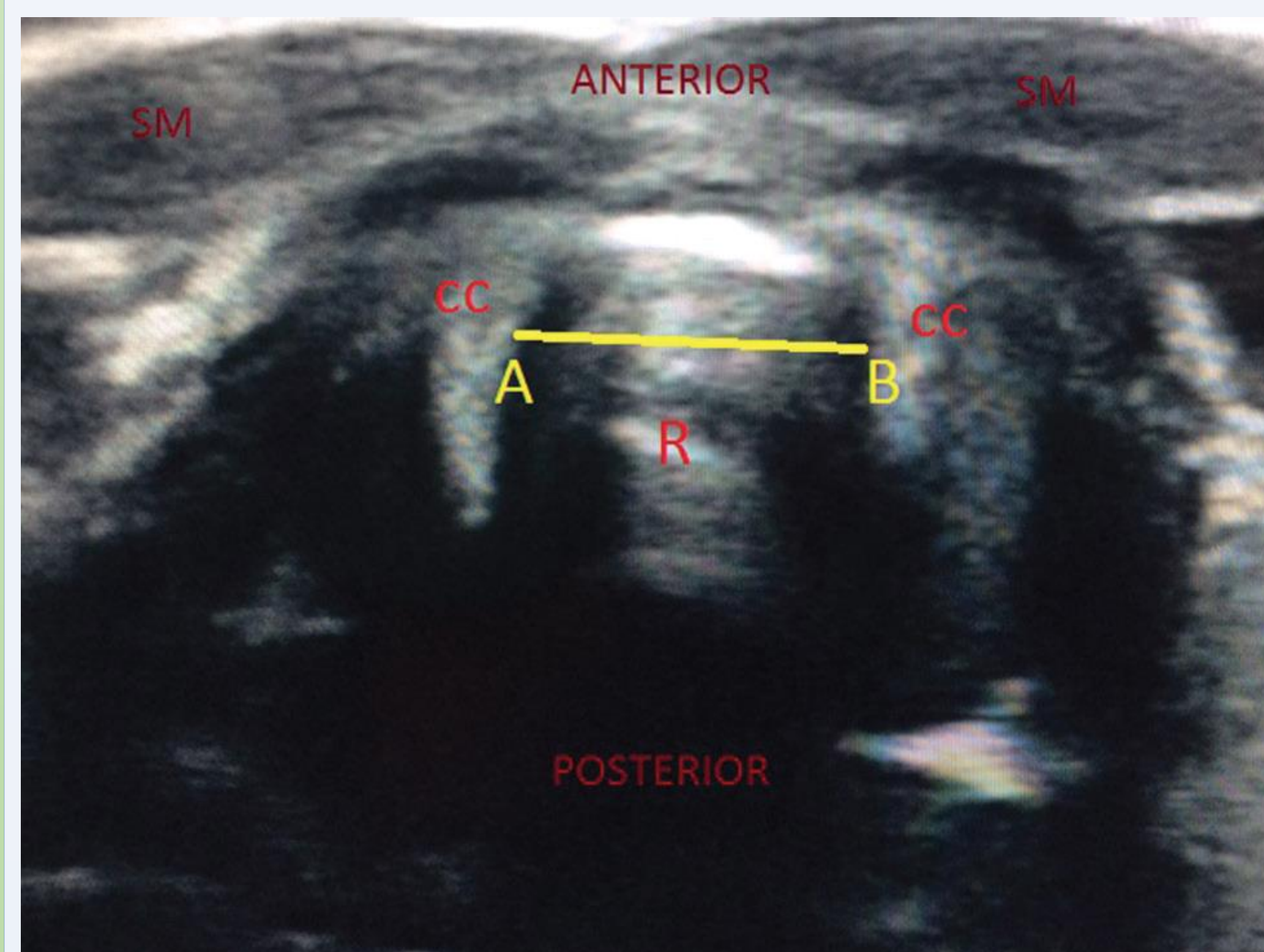


Figure 1. Ultrasound measurement of subglottic diameter. SM: Strap muscle, CC: cricoid cartilage, R: Reverberation, AB: subglottic diameter.

Gnanaprakasam PV, Selvaraj V. Ultrasound assessment of subglottic region for estimation of appropriate endotracheal tube size in pediatric anesthesia. *J Anaesthesiol Clin Pharmacol.* 2017;33:231-235. doi: 10.4103/joacp.JOACP_232_16

Case Report

- A 5 year-old, 22-kilogram female patient was scheduled for an elective dental rehabilitation.
- The anesthetic plan was GA utilizing a nasotracheal tube. Cole's age-based formula (ABF) $[(\text{age in years} + 16) / 4]$ was used to select the ETT. Since the patient was nearing age 6, the calculated ETT size was 5.5 mm internal diameter (ID).
- An inhalation induction was performed with sevoflurane, IV access was obtained, and IV propofol was administered. The cuffed ETT easily advanced through the nasal passages and the vocal cords were visible under direct laryngoscopy. However, resistance was met when attempting to advance the ETT through the vocal cords with Magill forceps; the ETT was oversized.
- The ETT was easily exchanged for a 5.0 mm ID cuffed nasotracheal tube. The case was completed, and the patient was discharged without complications.

Evidence Based Discussion

- Oversized pediatric ETTs can cause damage to the airway, post-extubation stridor, subglottic stenosis, and laryngeal edema.
- Undersized pediatric ETTs can result in increased resistance to gas flow, increased risk of aspiration, impaired ventilation, inaccurate monitoring of end-tidal gases, and leakage of anesthetic gases.
- Cole's, modified Cole's, Khine's, and Penlington's formulas are examples of commonly used ABFs. Natural variations among children impact the success of ABFs.
- Age-based formulas were primarily developed in the western world and accuracy may not extrapolate to other ethnicities, regions, and populations.
- Age-based formulas often overestimate ETT size.
- Height-based formulas can help select an ETT size in emergencies, but the results are inconsistent.
- Measurement of the diameter of the little finger for ETT size has a poor correlation.
- The auscultated leak test should always be performed to confirm the appropriate pediatric ETT size.

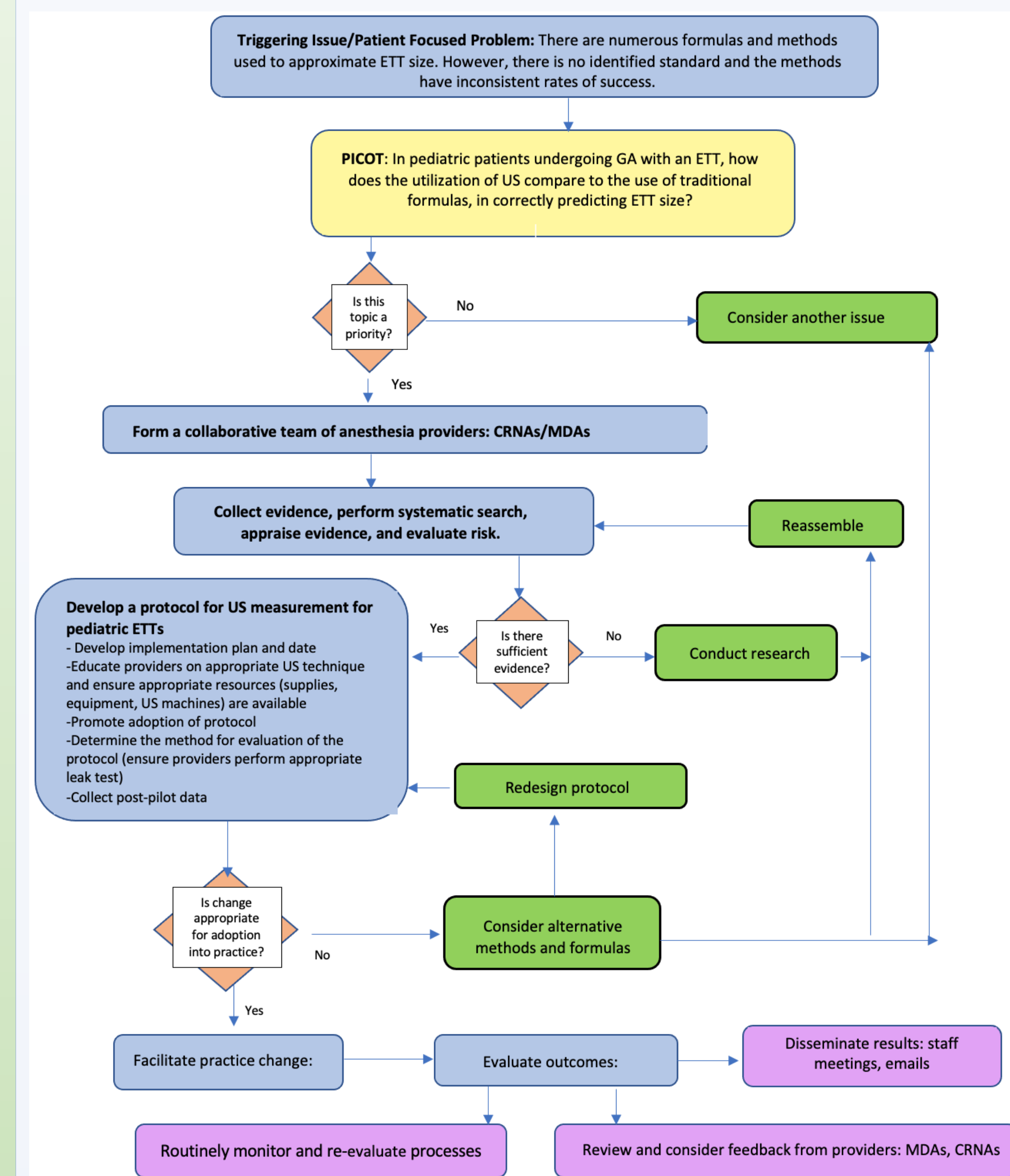
Translation to Practice

- Ultrasound measurement is safe and likely more accurate than traditional methods to approximate pediatric ETT size.
- Summarization of the accuracy of methods:
 - US measurement > ABFs > Height based formulas > diameter of little finger
- To implement US measurement for pediatric ETT sizing, a protocol should be developed for the facility. A collaborative team of anesthesia providers will determine a start date, educate providers on appropriate techniques, and ensure the availability of resources. Post-pilot data will be collected such as appropriate ETT placement as verified by the auscultated leak test. Outcomes, processes, and provider feedback will be routinely evaluated.
- Recommendations for future research include the development of systematic reviews and meta-analyses. Future research is needed on the use of US in difficult airways, patients with known subglottic stenosis, and high acuity pediatric populations.

Evidence Based Discussion (cont.)

- Ultrasound measurement of the subglottic area is used to select the ETT based on the outer diameter (OD), instead of the ID as with traditional methods. This is advantageous because the OD of ETTs can vary by manufacturer and specialty tubes.
- Ultrasound measurement can be completed immediately after induction or before induction.
- The child must be cooperative and not crying. Sedation may be necessary.
- Using US to measure the subglottic diameter is provider skill dependent; however, this skill has a short learning curve and plateaus by 15-20 examinations.
- Most studies reveal greater accuracy of US measurement, compared to ABFs and height-based formulas.
- Ultrasound measurement of the subglottic area is a useful and accurate tool for pediatric ETT sizing.

Implementation



EBP Framework Algorithm and References

Scan this QR code for the algorithm and a complete reference list.



Questions?

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