AUDIT ARTICLES

Clinical Audit: Optimal Positioning of Endotracheal Tubes in Neonates

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ABSTRACT

Background
The malposition of endotracheal tubes (ETTs) can be associated with endo-bronchial intubation or accidental extubation. A variety of methods have been reported for predicting insertional length (IL) including weight, nasal-tragus length (NTL) and sternal length (STL) measurements. In our unit no consistent predictor method was being used.

Aim
To audit the proportion of endotracheal tubes that required a significant position change after oral intubation. Our standard set was that the endotracheal tube should be in a satisfactory position in >80% of cases. If not met, practice would then be re-audited after a consistent predictor method had been implemented.

Methods
Data regarding changes in endotracheal tube position were collected. Significant position changes were defined as adjustments > 0.5 cm.

Results
Twenty two babies were included in the initial audit, and only 73% of endotracheal tubes had a satisfactory position. Thirty six babies were included in the re-audit and when the nasal-tragus length predictor was used, 94% of endotracheal tubes had a satisfactory position, meeting the standard.

Conclusion
The nasal-tragus length predictor improved the accuracy of endotracheal tube positioning after oral intubation. It is a simple, fast, reproducible method and can be used in everyday practice to help avoid significant endotracheal tube malposition.

Background

Optimal positioning of the endotracheal tube (ETT) plays a vital role in management of the neonate. Endo-bronchial intubation is associated with atelectasis, pneumothorax, asymmetrical surfactant distribution and poor ventilation. If an ETT is placed too high, accidental extubation may occur. Malposition of the ETT has been reported to occur in up to 50% of intubation episodes.[1,2,3] Historically, ETT position has been confirmed by chest radiograph. However, evidence of the benefit of prophylactic surfactant has led to many premature infants receiving surfactant immediately following intubation and prior to this confirmation of the ETT position.[4] Indeed some premature infants are rapidly extubated to nasal continuous positive airway pressure (NCPAP) after surfactant administration without ever having radiographic confirmation of ETT position.[5] These practice changes have increased the need for accurate clinical methods of determining optimal tube position.

A variety of clinical indicators have been used to determine correct ETT position. Our unit handbook indicated ETT diameter and insertional lengths for different birthweights.[6] However, birthweight is not available for babies who are intubated immediately following delivery. No other specific guidance is given and staff intubating babies in the delivery suite use clinical indicators such as using the black tip of the ETT to indicate maximum insertional distance and estimation of equal air entry on auscultation. A review highlighted that the black mark at the end of the ETT is a standard length regardless of ETT diameter and thus intended size of baby.[7] A study of the use of auscultation to determine equal breath sounds showed this clinical finding was present in up to 60% of mainstem bronchial intubations.[8]

Shukla et al[9] reported that nasal-tragus length (NTL) or sternal length (STL) measurements could predict insertional length (IL) for oral intubations using the formula: –

IL (position at the lips) = NTL or STL + 1 cm (Figures 1 and 2 overleaf)

Insertional length could be predicted accurately in approximately 10 seconds and was easier than using weight in the resuscitation setting. In their study, 38 out of 40 infants had satisfactory ETT positions using this method and 2 needed minor adjustments of 0.5 cm. It was suggested that using the NTL measurement was easier, as

Figure 1 Nasal-tragus length (NTL) is measured from the base of the nasal septum to the tragus of the ear. The insertional length of the endotracheal tube at the lips is predicted as NTL (cm) + 1 cm.

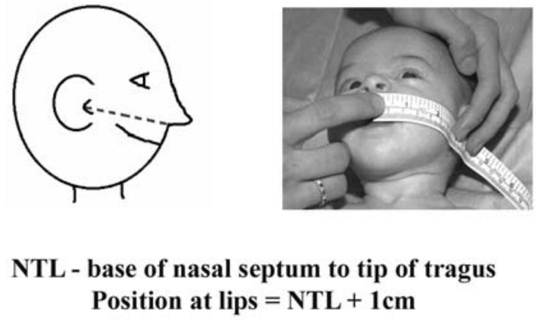
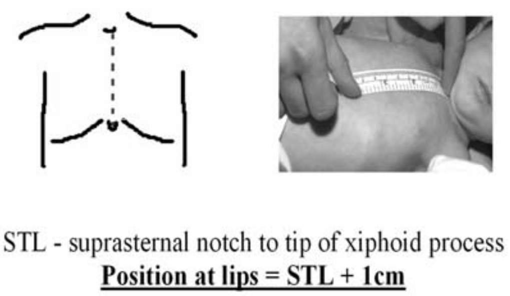


Figure 2 Sternal length (STL) is measured from the suprasternal notch to the tip of the xiphoid process. The insertional length of the endotracheal tube at the lips is predicted as STL (cm) + 1 cm.



it did not interfere with chest auscultation. STL could be used in cases of dysmorphism or craniofacial abnormality.[8]

Objectives

Our standard set was that the ETT should be in a satisfactory position (1-2 cm above the carina) in >80% of cases at the first chest radiograph. Significant changes were defined as adjustments > 0.5 cm. This was to identify ETTs that were at risk of endobronchial intubation or accidental extubation. If the standard was not met, a predictor method would then be introduced as a change in practice. However, it was felt that any proposed method would need to be validated before it was accepted. Therefore using the initial group of babies, retrospective comparison would be done between the known satisfactory position and that predicted using the weight table, NTL and STL method. The most accurate and practical method would then be implemented and practice re-audited.

Methods

The audit included babies who were being intubated orally for the first time, or babies whose previous intubation details were no longer appropriate. After intubation, data were collected regarding gestation, weight, sternal and nasal-tragus length, surfactant administration and duration of ventilation prior to ETT position change. The position at the lips prior to chest x-ray and any position changes subsequently made were recorded.

In the re-audit, the NTL was used to predict insertional length either before or shortly after the first intubation. This was performed prior to final ETT fixation, surfactant administration and chest radiograph. ETT position would also have to be acceptable clinically with equal breath sounds, chest wall movement and adequate ventilation. If not inserted to the predicted length, reasons for this were recorded. Additional data were collected as in the initial audit.

The audit was discussed with the Local Research Ethics Committee chairman and in view of its design was felt not to require formal approval. The results were analysed using the statistics package MEDCAL Fisher's Exact Test was used and $p<0.05$ was considered to be statistically significant.

Results

Initial Audit

Twenty two babies were included ranging in age from 26 weeks to term. Using current practices, 73% (16) of ETTs had a satisfactory position and 27 % (6) required a significant position change. Four of the babies who required a change in ETT position had already received surfactant. The mean duration of ventilation prior to a position change was 2.5 hours (maximum 4.5 hours). The position change ranged from 1 – 1.5 cm. In one case the ETT had already been withdrawn just prior to chest radiograph because of poor ventilation and yet required to be pulled back a further 1 cm.

Retrospective Comparison

If the weight table predictor had been used the results suggested that it would have been less accurate than current practices with a satisfactory position in 68% (15) and significant position change required in 32% (7) of cases. If either the STL or NTL predictor had been used the results appeared more accurate with a satisfactory position in 91% (20) and significant position change required in 9% (2) of cases. The NTL predictor was felt to be both accurate and easy to use and was therefore implemented as a change in practice.

Re-Audit

Thirty six babies were included ranging in age from 26 weeks to term. Using the NTL predictor 94% (34) of ETTs had a satisfactory position and a further 6 % (2) required a significant position change. This now met the standard originally set and the number of satisfactory ETT positions in the re-audit group was significantly higher than in the initial audit group ($p<0.05$).

As can be seen in Table I, the patient demographics are similar in both the audit and re-audit groups. The median weight and gestation in the audit group was 1095g and 28 weeks respectively, which was similar to the re-audit group's medians of 1300g and 30 weeks. The improvement in outcome, using NTL as a predictor, is outlined in Table II.

Table I Patient Demographics

PATIENT DETAILS	AUDIT GROUP	RE-AUDIT GROUP
WEIGHT RANGE	570g-3640g	620g-2800g
GESTATION RANGE	26/40-Term	26/40-Term
STERNAL LENGTH RANGE	4.5cm-9cm	N/A
NASAL-TRAGUS LENGTH RANGE	5cm-9cm	5cm-8cm
AGE AT INTUBATION	30 seconds to day 13	3 mins to day 72
TIME TO CXR	20 mins- 4.5 hours	30 mins-4 hours
SURFACTANT	73% (16) cases	61% (22) cases

Table II Comparison of Satisfactory ETT Position using Current Practices and Nasal-Tragus Length (NTL) Predictor

	Satisfactory % (n)	Position Change % (n)
CURRENT PRACTICE	73% (16)	27% (6)
Retrospective Weight Predictor	68% (15)	32% (7)
Retrospective NTL predictor	91% (20)	9% (2)
Retrospective STL predictor	91% (20)	9% (2)
RE-AUDIT using NTL	93% (34)	7% (2)

Discussion

The NTL predictor is a valuable tool particularly for less experienced intubators, where the tendency is to insert the ETT too far. It would also have an important role in the emergency setting where the ETT can easily slip and an optimal ETT position is vital to provide effective ventilation. In neonatal transport, it could be a method employed to check ETT position when chest radiographs may be difficult to interpret or repeat. In all clinical settings, ventilation and surfactant administration will be optimised by correct placement.

An incidental but valuable outcome of the audit was that it heightened the awareness of maintaining intended ETT position during tube fixation. It also encouraged better documentation of ETT position, which is useful for re-intubations and where there are concerns about accidental position changes.

The main limitation of this audit was the small numbers studied. Head position can also affect the ETT position on the chest x-ray. Both this and the potential errors in documentation of ETT position need to be considered.

This audit highlighted the benefit of using the NTL as predictor of ETT position and the method was subsequently introduced into our unit protocol.

Conclusion

The nasal-tragus length predictor improved the accuracy of endotracheal tube positioning after oral intubation. It is a simple, fast and reproducible method and can be used in everyday practice to help avoid significant endotracheal tube malposition.

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