Orotracheal Tube Insertion in Extremely Low Birth Weight Infants

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Thirty-one consecutive infants <1000 g at birth were intubated according to Tochen’s rule; placement was verified/modified after auscultation and by radiology. Depth measurements were by caliper and radiology. Tochen’s rule alone would lead to inadequate tube placement in 47% of infants. Auscultation allows adequate placement in only three-fourths of patients. (J Pediatr 2009;154:764-5)

In sick neonates, endotracheal tube (ETT) placement may be essential for adequate ventilation and oxygenation. Immediate radiological verification of adequate placement is not always available or practical. Simple rules for determining tube depth are necessary. Too high a placement may cause accidental extubation,1 and too low a placement may cause lobar or whole lung atelectasis, single lung ventilation (and as a consequence, unilateral or unequal surfactant administration), and possible volutrauma.2,3

Based on the study by Tochen,4 the American Academy of Pediatrics and the American Heart Association used the “7-8-9-10” rule in the Neonatal Resuscitation Program (NRP): 1, 2, 3, or 4 kg babies are intubated to an endotracheal depth (“tip to lip” distance) of 7, 8, 9, or 10 cm, respectively.5

The NRP mentions that “babies weighing less than 750 g may require only 6 cm insertion.”5 However, ETT depth has not systematically been studied in extremely low birth weight (ELBW) infants (<1000 g). Indeed, Tochen studied 54 and Peterson studied 18 such infants.6 Peterson’s study was limited by imprecise measurements (whole centimeter markings on the ETT were used).6 The purpose of this study was to test whether the regression equation developed by Tochen was applicable to infants born at a birth weight below 1000 grams.

METHODS

In this retrospective study, we included all 31 consecutive preterm infants born below the birth weight of 1000 g admitted to the NICU at the Lis Maternity Hospital (Tel Aviv, Israel) between November 2005 and July 2007. The study was approved by our local Institutional Review Board. Because it is a retrospective study, the requirement for informed consent was waived. All patients were inborn. They were intubated according to a strict protocol either by a neonatologist, a fellow, or a “senior” resident (certified to independently intubate). Before intubation, the newborn infant was promptly weighed using a calibrated electronic scale (Model T-15-s, Shekel Scales; Tel Aviv, Israel). Infants were orally intubated according to clinical indications determined by the attending team. The initial ETT depth (upper lip to ETT tip) was calculated on the basis of Tochen’s rule, that is, weight of the infant (in kg) plus 6 cm.4 After insertion and taping, adequacy of placement was verified by auscultation (symmetrical air entry) and then adjusted (which may require second taping); routine digital AP chest radiograph was obtained (head midline as much as possible), and exact measurement of depth, to nearest mm, using a measuring Vernier caliper (Starret Inc; Athol, Massachusetts), was performed. According to this clinical protocol, tip to lip distance was the distance between the first centimeter marking on the ETT, visible above the securing tape minus the distance (measured using the caliper) between this same centimeter marking and the upper lip. Additionally, “ideal” tip-to-lip distance was determined on the digital radiograph by correcting the clinically measured tip-to-lip distance to an ideal (midtracheal) tip location, using computer software (Centricity Enterprise Web, General Electric Medical Systems; Wauwatosa, Wisconsin). Midtracheal area was the mid-distance between tra-

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<th>BW</th>
<th>Birth weight</th>
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<td>ETT</td>
<td>Endotracheal tube</td>
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chea at the level of the lower portion of the sternoclavicular joint to the tracheal bifurcation.

Data are reported as mean ± standard deviation (SD). Statistical analysis included linear regression to test relationship between various estimates of ETT placement, and Kruskal Wallis test to study differences between “correct” and “incorrect” ETT placement groups. Analyses were conducted using Minitab Version 14 software (Minitab Inc; State College, Pennsylvania). A P value of <.05 was considered significant.

RESULTS

Thirty-one consecutive infants were recruited. Mean ± 1 SD gestational age was 26.2 ± 2.0 weeks, with a range of 23 to 30 weeks. Mean ± 1 SD birth weight (BW) was 762 ± 151 grams, with a range of 407 to 980 grams.

By radiograph, the ETT position was adequate (mid-tracheal or close to mid-tracheal) position in 23 infants. Placement was inadequate in 8 infants, 7 of them weighing below 750 g, and in all cases of inadequate placement, the ETT was too high (Figure 1). There was no instance of too low placement.

Combined clinical and radiologic measurements of ETT depth permitted us to calculate actual ETT depth (“auscultated” Tochen’s) and ideal (exact mid tracheal) depth. There was poor correlation between BW and ideal depth (R² = 8.9%, P = .08), and between BW and “auscultated” Tochen’s (R² = 26.1%, P = .07). The use of the extrapolated Tochen’s rule, without correction after auscultation, would have led to inadequate ETT placement in 47% of infants. An excellent correlation was found between ETT actual depth (using Tochen plus auscultation) and ideal ETT depth (R² = 74.6%, P < .0001) (Figure 2).

DISCUSSION

We found that Tochen’s rule in infants below 1000 grams BW is largely inadequate when used without careful auscultation of the chest. Utilization of this rule alone will lead to inadequate ETT placement in nearly half of the patients.

In contrast, using the “auscultated” Tochen’s method, only 26% of ETT placements were inadequate. In all cases, ETT was too high, and in 7 of 8 cases, the infant weighed less than 750 grams and had a relatively long trachea. The finding that 6 of 15 babies weighing <750 grams would be ideally intubated to a depth of 7.5 to 8.75 cm is at odds with the NRP recommendation of 6 cm. We speculate that whenever auscultation shows asymmetrical breath sounds, the tendency of the operator is to pull the ETT out, and at times, excessively.

The poor correlation between BW and ETT length makes BW a poor predictor. Foot length was suggested as a predictor of ETT depth for nasotracheal intubation. We conclude that the NRP method which consists of using initial placement based on infant weight and Tochen’s rule followed by careful auscultation is sufficient to perform adequate intubations in 75% of such infants. We suggest that radiologic verification should be performed as soon as possible after EET insertion.

REFERENCES


