

# Accuracy of 7-8-9 Rule for Endotracheal Tube Placement in Nepalese Neonates

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## Abstract

**Introduction:** Neonatal intubation is done for cardiopulmonary resuscitation, hypoxemia, and hypercapnia, for surfactant therapy or for airway protection. When correctly placed, endotracheal tube (ETT) tip should be at mid tracheal position which is half way between the clavicles and the carina to prevent complications of ventilation. **Objective:** To assess the accuracy of 7-8-9 Rule in neonates at Kanti Children's hospital. **Methodology:** Prospective observational study was conducted in neonates who required oral intubations from July 2009 to December 2009 at NICU of Kanti Children's Hospital. The initial ETT depth of insertion was determined using admission weight in the 7-8-9 Rule calculation. This depth was compared to the midtracheal depth to determine clinical accuracy of the 7-8-9 Rule. **Results:** Mean gestation age of the 69 infants was 36.01 weeks (26 to 42 weeks) and weight was 2411 g (900 g to 3800 g). 7 (10.1%) neonates weighed 1000 g or less, 19 (27.5%) weighed between 1001 to 2000 g, 31 (44.9%) weighed between 2001 to 3000 g, 12 (17.4%) weighed between 3001 to 4000 g. The accuracy of 7-8-9 rule in clinical setting with auscultation and Chest x-ray resulted in ETT depth 0.11 cm above midtracheal position. (-1.5 to 1.5 cm). Using this rule ET tube was placed 0.11 cm above the mid tracheal position. **Conclusions:** The 7-8-9 Rule appears to be an accurate clinical method for endotracheal tube placement in Nepalese neonates.

**Keywords:** Intubation, Neonate, Mid Tracheal Position

## Introduction

Endotracheal intubation means the insertion of endotracheal tube (ETT) into the trachea. Endotracheal Intubation was described more than 2000 years ago<sup>1</sup>. With the development of artificial respirations in 1960s and 1970s the endotracheal intubation became an established part of the neonatal intensive care<sup>2</sup>. Endotracheal intubation is either an emergency or an elective procedure for a number of indications like cardiopulmonary resuscitation, airway protection, respiratory failure and administration of surfactant<sup>3</sup>. The correct position of endotracheal tube (ETT) is mid tracheal region or half way between the clavicles and the carina<sup>2,3,4</sup>. The position of ETT should be precise to reduce the complications like atelectasis, hyperinflation of the right lung, pneumothorax, tracheal damage, unplanned extubation or post extubation stridor<sup>2,5,6</sup>.

Intubation is a practical skill which cannot be learnt from textbook best way to learn and maintain this skill is in a controlled environment<sup>2</sup>. Since intubation is a very essential life saving procedure every physician should be competent. Intubation can be done orally or nasally. The choice of route depends on the circumstances and the preference of the clinician. Oral intubation in the neonate is faster, more likely to be successful at the first attempt and less traumatic to perform so preferred in emergency intubation<sup>7</sup>. Apart from direct visualization of the tube as it passes through the glottis, there are a number of different methods for estimating the depth of ETT placement. The easiest to remember is rule of 7-8-9<sup>2,8</sup>.

The simple calculation for determining depth of ETT insertion was described by Tochen in 1979.<sup>9</sup> The predicted estimated insertion of ETT was 1.17 multiplied

by infants weight in Kilogram (KG) plus 5.58. According to this an infant weighing 1 kg being intubated to a depth of 7 cm, a 2 kg infant to a depth of 8 cm and a 3 kg infant a depth of 9 cm. The 7-8-9 rule is endorsed by The American Academy of Pediatrics and American Heart Association Textbook of Neonatal Resuscitation. To simplify this rule adds 6 to the weight (i.e. 1 kg + 6 = 7 cm) to estimate the depth of ETT insertion<sup>2, 8, and 10</sup>.

This rule is widely used but there is limited data on the accuracy of this test. There is no such study in Nepalese neonates. So this study was conducted at NICU settings at Kanti Children's Hospital.

### Material and methods

The study was prospective observational where 69 consecutive neonates admitted to NICU of Kanti Children's hospital who were intubated for various indications during the period of July to December 2009 were the subjects. Neonates already intubated outside NICU and those with congenital anomalies were excluded. After verbal consent intubation was performed by the on duty medical officer or pediatric resident in accordance with the protocol. Initial depth of insertion of ET tube was determined using the 7-8-9 rule where the weight taken during admission to NICU was taken as reference. This is important in our setting as exact birth weight is not known in babies delivered at home.

Portable chest x-ray was obtained with neutral head position after intubation and the tip of ET tube was documented. The ideal placement for ET tube placement is defined at mid trachea. This is the point

halfway between the inferior portion of clavicle and carina as shown in figure 1. The distance of ET tube tip from the ideal mid tracheal position was calculated from the each x-ray in centimeters. Help of radiologist was taken while calculating the measurements.

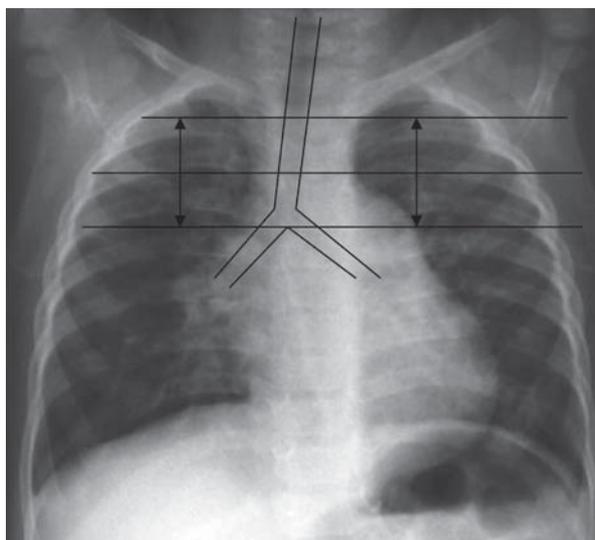
Infants were classified into weight groups of <1000, 1001 to 2000, 2001 to 3000, 3001 to 4000. These weight classes were chosen based on weight categories for appropriate selection of ET Tube<sup>1</sup>. Accuracy was determined using the mean paired differences with 95% confidence intervals between the initial or predicted ETT depth and the ideal ETT depth. Linear regression was used to adjust for confounding variables and p value <0.05 was considered statistically significant. Statistical calculations were performed using SPSS version 16.

### Results

69 neonates admitted at NICU for various reasons and who were intubated for artificial ventilation during the study period were enrolled in the study. Among them 49 (71%) were males and 20 (29%) were females. Most of the neonates (78.3%) were > 72 hours of age on admission at NICU.

**Table 1:** Age of the neonates in the study

Age in hours	No. of neonates	Percentage
<24 hours	5	7.2%
24- 48 hours	4	5.79%
48- 72 hours	6	8.69%
>72 hours	54	78.26%



Line A: Inferior surface of clavicle

Line B : Mid tracheal position

Line C: Carina

The mid tracheal position is calculated from the mid point between the inferior surface of clavicle and the carina. The distance of ETT tip from this mid tracheal position is measured. A positive distance means the tip is below the mid tracheal position and negative value means the tip is above the mid tracheal position.<sup>8</sup>

**Fig 1:** Calculation of mid tracheal position<sup>8</sup>

**Table 2:** Distance of ETT tip (as predicted by 7-8-9 rule) from midtracheal position by weight group.

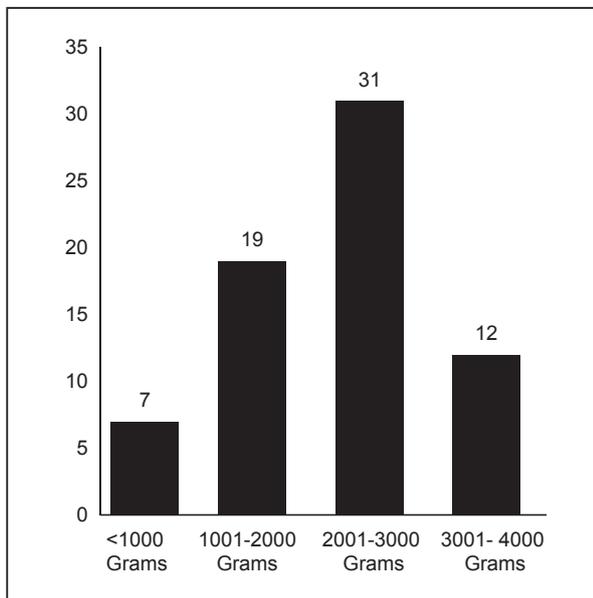
Weight (g)	No of infants	Distance (cm) from mid trachea(cm)*	P value
<1000	7	0.25 (-0.30 - 0.7)	0.571
1000 - 2000	19	0.28 (-1.3 - 1.5)	0.474
2000 - 3000	31	0.16 (-1.5 - 1.5)	0.831
3000 - 4000	12	-0.40 (-1.5 -0.75)	0.338

\*A positive value is below and a negative value is above the midtracheal position.

Neonate's weight on admission ranged from 900 gram to 3800 gram and mean weight was 2411 g (900 g to 3800 g). Seven (10.1%) infants weighed 1000 g or less, Nineteen (27.5%) weighed between 1001 to 2000 g, Thirty one ( 44.9%) weighed between 2001 to 3000 g, Twelve (17.4%) weighed between 3001 to 4000. The admission weight was counted for the study purpose as there were 13(18.8%) babies delivered at home.

There were neonates of 26 to 42 weeks age calculated from last menstrual period and the mean gestational age was 36.1 weeks.

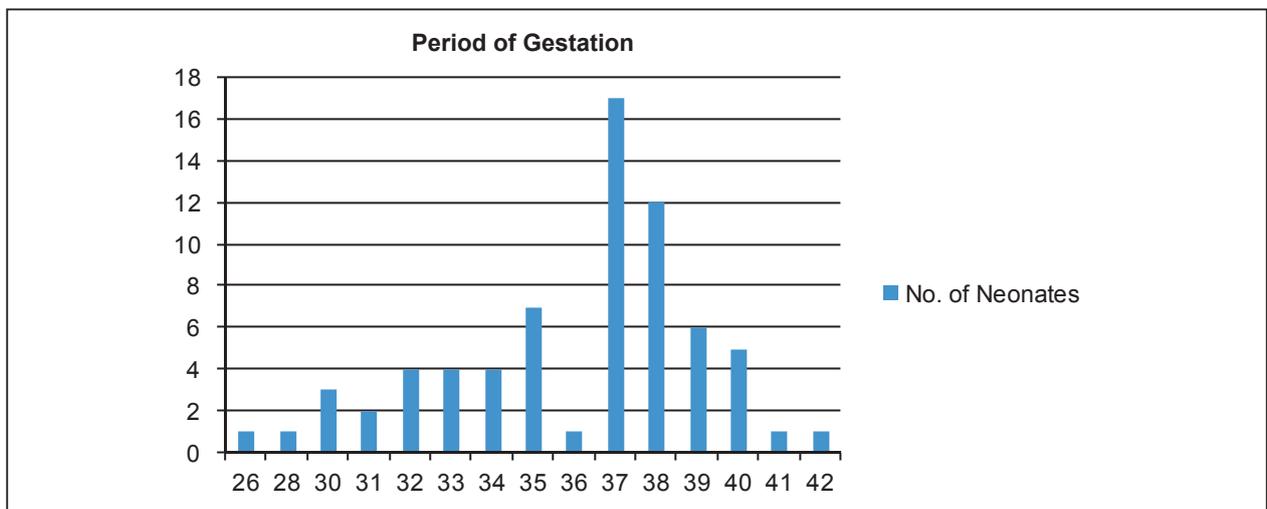
Out of the 69 babies enrolled in the study ET tube needed adjustment after auscultation and chest x-ray in 6 neonates.ETT size internal diameter ranging from 2.5 to 4 were used and ETT was fixed at 7 to 9 centimeters in length.



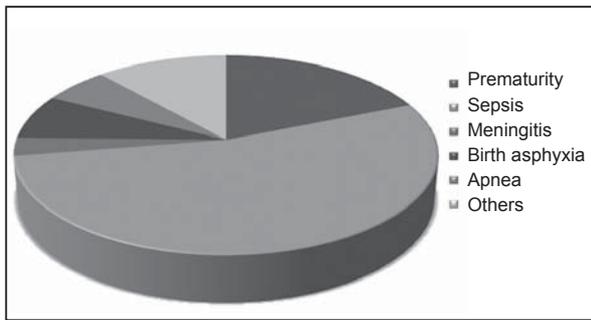
**Fig 2:** Weight of neonates in the study

The main indication for admission at NICU was sepsis (53.6%), prematurity (18.8%), birth asphyxia (7.2%), apnea (5.8%) and meningitis (2.9%). The indication for intubation was for mechanical ventilation in neonates. Out of the 69 babies enrolled in the study ETT needed adjustment after auscultation and chest x-ray in 6 neonates. ETTs internal diameters ranging from 2.5 to 4 were used and ETT was fixed at 7 to 9 centimeters in length.

The overall accuracy of 7-8-9 rule in clinical setting with auscultation and ETT adjustment gave an initial ETT depth 0.11 cm above midtracheal position. (-1.5 cm to 1.5 cm). Using this rule ET tube was placed 0.11 cm above the mid tracheal position.



**Fig 3:** Period of Gestation in weeks of neonates at birth (by date)



**Fig 4:** Pie chart showing indications for admissions at NICU of neonates

## Discussion

The techniques of ETT insertion are proposed in various studies. Lee et al<sup>11</sup> found flexible fiberoptic bronchoscopy correlated with the chest radiograph and required less time to confirm ETT position in neonates and pediatric age groups. Jain et al<sup>12</sup> reported digital palpation of ETT tip at suprasternal notch was safe inexpensive and teachable method of confirmation of ETT in neonates.

The neonatal resuscitation program<sup>3</sup> uses the 7-8-9 rule to determine ETT depth of insertion. This rule is easy to use, safe, inexpensive and effective. This study provides additional evidence that the 7-8-9 rule is an accurate method for neonatal intubation in Nepalese neonates too. The accuracy improves following clinical auscultation and adjustment when necessary.

In a study done by J Peterson et al<sup>8</sup> in 2004 found that 7-8-9 rule appears to inaccurately position ETT between 0.30 and 0.93 cm too deep in infants weighing <750 g and recommended placing ETT at least 0.5 cm higher than predicted. A revision of the 7-8-9 Rule for the extremely low birth weight neonate may be justified<sup>2,3,8</sup>. This technique of adjustment is also supported in the Neonatal Resuscitation Textbook which states: 'Babies weighing <750 g may require only 6 cm insertion'<sup>3,8</sup>. A prospective study examining the accuracy of this revised equation for ETT insertion depth in infants weighing <750 g is recommended. We in this study were unable to assess this in such neonates as our lowest weight was only 900 g. The adjustments of <1 cm is challenging with tubes have only whole centimeter markings so tubes with smaller markings are needed in lower weight categories. The inaccurate position is concerning as it may increase the neonates risk of pneumothorax and subsequent intraventricular hemorrhage<sup>13,14</sup>. In a study by Kempley ST and colleagues in 2008<sup>15</sup> and Mainie P et al in 2006<sup>16</sup> observed that ETT length was related to gestation in a linear manner and relation with weight

was non linear so caution in use of 7-8-9 rule was urged especially those with very low birth weights. Blayney MP and colleague in 1994<sup>17</sup> suggested confirmation of ETT using a radiograph and alignment of tip of ETT with the first thoracic vertebra is probably the best marker of midtracheal position. However the position of the patient will cause the ETT to move, so if chest radiographs are used to prove correct placement babies' heads should be in a standard position as flexion of the neck decreases and extension increases oro - carina distances<sup>15,18</sup>.

This was a first of such study done at Nepal and the distance of ETT tip was calculated from mid tracheal point rather than a range for simplicity using a fixed point rather than a range of distances to define midtracheal position allowed us to obtain a more accurate estimate of placement. Tochen<sup>9</sup> defined midtracheal depth at the level of the first or second thoracic vertebral body. This study examined the use of the 7-8-9 Rule as it is most often applied in clinical practice in Nepal too.

## Conclusions

The 7-8-9 Rule is an accurate clinical method for endotracheal tube placement in Nepalese neonates. When the 7-8-9 Rule is applied to infants weighing <750 g, caution is warranted. The ETT tip should be confirmed by auscultation and Chest X-ray after intubation.

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**Conflicting Interests:** None

**Permission from IRB:** Yes

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