A stylet use may be beneficial for elective and rescue intubation of prematurely born infants < 30 weeks

Klara Dunajova[1], Tereza Lamberska[1], Truong An Nguyen[1], Adam Kubica[1], Petr Kudrna[1,2], Richard Plavka[1]

Background. Recent studies have reported that using a stylet does not provide any advantages during intubation within a diverse infant population. Our research focuses on the issue, specifically in premature infants who undergo elective or rescue intubation (EI or RI) in the delivery room (DR).
Methods. We conducted a single-center retrospective observational study comparing the number of intubation attempts, the duration of intubation procedure until successful, and the rate of associated desaturations exceeding 20%. We derived outcomes from video recordings and performed statistical analyses.
Results. We have analyzed 104 intubation attempts in 70 infants with a mean gestational age and birth weight of 25±1.9 weeks and 736±221 grams, respectively; 39 of these attempts involved stylet use, and 65 did not. 75% of infants requiring intubation were less than 26 weeks of gestational age. The use of a stylet increased the rate of successful initial attempts [OR (95% CI) 4.3 (1.3–14.8), *P*=0.019], reduced the duration of the intubation procedure [median (IQR) seconds: 43 (30–72) vs 140 (62–296), *P*<0.001], and decreased the occurrences of desaturation exceeding 20% (13% vs 50%, *P*=0.003).
Conclusion. The benefits of using a stylet during rescue and elective intubations of premature infants in the delivery room outweigh the potential harms. Its use may be advantageous in settings where proactive approaches are implemented for periviable infants.

Key words: delivery room, extremely premature infant, intubation, stylet

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[1]Division of Neonatology, Department of Obstetrics and Gynecology, General Faculty Hospital and 1st Faculty of Medicine, Charles University in Prague, Prague, Czech Republic
[2]Department of Biomedical Technology, Faculty of Biomedical Engineering, Czech Technical University in Prague, Prague, Czech Republic
Corresponding author: Richard Plavka, e-mail: plavkar@gmail.com

INTRODUCTION

Although non-invasive ventilatory support is generally preferred for stabilizing extremely premature infants after delivery, a significant proportion of these infants require endotracheal intubation in the delivery room (DR) (ref.[1]). Repeated intubation attempts within the first four days after birth increase the risk of severe intraventricular hemorrhage in premature infants[2,3]. Performing endotracheal intubation in rescue mode can be more challenging and stressful for the practitioner, especially when dealing with small and fragile infants. Adhering to the strict "30-second rule" is particularly difficult during rescue intubation in extremely premature infants, where rapid and safe execution is crucial[4]. Factors that may influence the outcome include the appropriate size of the blade, the experience level of the medical professional, the elasticity of the endotracheal tube (ETT), and the technique used. One such variable is the stylet, a metal wire in a plastic sheath that is inserted into the endotracheal cannula to reduce its flexibility, allowing for easier navigation through the vocal cords. The standard use of the stylet is not generally recommended, as the data evaluating its benefit-to-harm ratio remains controversial. A recently published large multicenter study, which prospectively collected intubation data from both the DR and neonatal intensive care units, found no advantage to using a stylet[5]. Although the study population was sizable, significant heterogeneity existed among confounders, such as gestational age, birth weight, indication for intubation, postnatal age, and performer experience levels, which may have masked any limited positive effects of stylet use in specific infant groups or clinical situations.

In our observational study, we focused on the population of premature infants requiring intubation in the DR. We hypothesized that stylet use might have some benefits, as the small and narrow pharyngeal space can make the direct introduction of a soft, flexible cannula difficult, even for trained medical professionals. The objectives of this study are to compare the effectiveness and safety of using a stylet versus not using one during rescue intubation (RI) and elective intubation (EI) procedures performed by neonatologists or highly experienced physicians.

METHODS

Study cohort

All premature infants born at less than 30 weeks gestation between 2016 and 2022 in the General Faculty Hospital in Prague were eligible for evaluation. This perinatal center has been practicing a pro-active approach from 22 weeks of gestation. Neopuff Infant Resuscitator (Fisher Paykel, Auckland, New Zealand) or Inspire rPAP (Inspiration HEALTHCARE, Crawley, United Kingdom) were used to provide positive pressure ventilation before and after intubation. Infants who were electively or rescue intubated and had clear and readable video recordings from the delivery room, were included in the data analysis. The cohort of premature infants were divided into two groups based on whether intubation was performed with or without a stylet. According to our standard DR protocol, EI is performed immediately after delivery for all premature infants born at less than 24 weeks gestation or at 24 weeks without antenatal steroid treatment. RI is strictly indicated when bradycardia (heart rate less than 100 bpm) persists for 180 s. It is also indicated when poor spontaneous breathing activity requires non-invasive positive pressure ventilation that does not improve time-related low heart rate or oxygen saturation within the first 5 min after delivery. Both EI and RI were primarily performed by neonatologists or skilled physicians trained in neonatal resuscitation. The decision to use a stylet was at the provider's discretion. The intubating stylet (Sheridan/Sher-I-Slip, HUDSON RCI) with an outer diameter (OD) of 1.7 mm was exclusively used for intubation cannulas with an internal diameter (ID) of 2.0 mm, and the stylet with an OD of 2.0 mm (Smith Medical, Portex) was used for endotracheal tubes with IDs ranging from 2.5 to 4.5 mm.

Data collection, definitions, and statistics

Technically clear records from two cameras fixed on the frame of the resuscitation bed were retrospectively analyzed according to a structured protocol by an unbiased physician. The two records allowed for simultaneous evaluation of the intubation procedure and time-related data displayed on a monitor screen, such as heart rate values from ECG electrodes and preductal oxygen saturations from the pulse oximeter. All ventilatory settings, including FiO2 levels, were recorded in real time.

An intubation course was defined as successful placement of the ETT, regardless of the number of attempts. The intubation course began when the laryngoscope blade was introduced into the mouth and ended when the blade was finally removed and followed by a gradual increase in heart rate or oxygen saturation. Each attempt to place the ETT was counted as a separate event from introduction of the blade until its removal from the mouth. To better understand the potential bias introduced by individual physician skill levels, we calculated both the average number of intubation attempts made with and without a stylet for each physician, as well as the variability in the ratio of intubations performed with and without a stylet across different physicians. This approach allows for a more nuanced analysis of how personal expertise may influence the use of intubation techniques.

Categorical data were analyzed using a Chi-square test and presented as n (%). Continuous variables were tested for normality and analyzed and presented using the Mann-Whitney test as median (IQR) or the two-tailed t-test as mean (± SD).

Ethics

The local institutional Research Ethics Committee of the General University Hospital in Prague approved the study protocol and issued a statement of no objection for performing this study. Approval number: 118/10.

Primary and secondary outcomes

The primary outcome was defined as a successful initial intubation attempt. The secondary outcomes included the duration of the first successful intubation attempt and the duration of intubation courses until successful placement of the ETT as well as the time taken to achieve SpO2 ≥80% and ≥90%.

Other outcomes

Additionally, we calculated the intubation courses without significant desaturation (a drop of more than 20% from baseline, just before the introduction of the blade) and the intubation courses that were successfully completed within 30 s ("the 30-second rule"). Any adverse events related to the introduction or extraction of the stylet from the ETT were documented and described.

RESULTS

A total of 547 infants born at less than 30 weeks gestation were evaluated. Most of them were stabilized non-invasively (433/547, 79%), while the remaining infants (114/547, 21%) required intubation in the DR. The proportion of infants who were stabilized non-invasively has a clear negative correlation with gestational age. The flow diagram depicting the development of the study groups can be found in Fig. 1.

Ultimately, we analyzed 70 clearly recorded intubation courses in 70 infants, who required a total of 104 intubation attempts for successful placement of the ETT. The mean (±SD) gestational age and birth weight were 25+1(±1.9) weeks and 736 (±221) grams. Seventy-six percent of all intubated infants were born at less than 26 weeks of gestation (Fig. 2).

The stylet was primarily used in 30 infants (43%), who required 39 intubation attempts (37%), whereas 40 infants (57%) were intubated without a stylet and required 65 attempts (63%). The fundamental characteristics of the groups were similar (Table 1). Out of 70 intubation attempts by 17 doctors, only 2 were conducted by doctors with less than 5 years of neonatal experience. We found a significant association between the physician and the chosen intubation method, along with a notable variability in the intubation methods employed by different physicians (P<0.05).

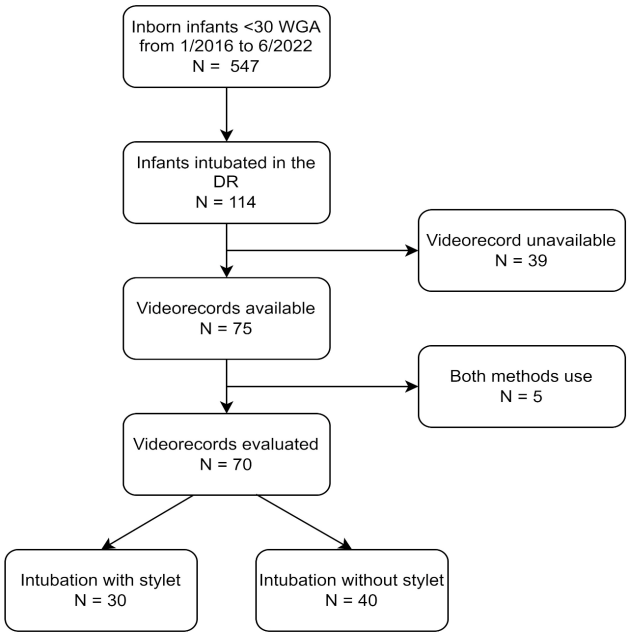

Fig. 1. Flow chart of the study groups. The flow chart shows the formation of the final groups of infants whose video records from the delivery room were available and clearly readable.

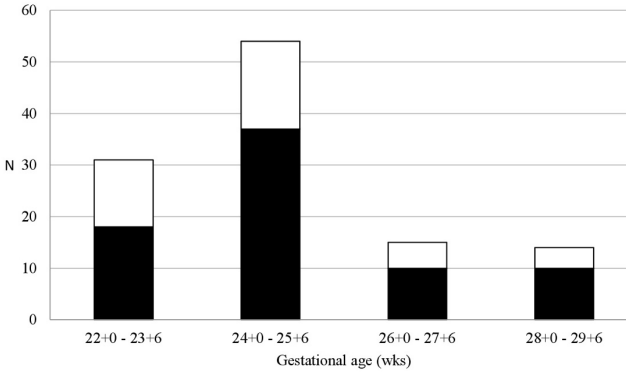

Fig. 2. The bars represent the count of all inborn infants who were intubated, grouped by gestational age subcategories. Each bar is segmented based on the assessment of video recordings; the BLACK sections of the bars denote infants with evaluated video records, while the WHITE sections indicate those without such records.

Table 1. Baseline characteristic, neonatal morbidities, and death in the groups with and without stylet.

	With stylet	Without stylet	*P*
n	30	40	
Gestational age, mean (± SD), wks	25+2 (±1+6)	25+1 (±1+5)	0.642
Birthweight, mean (± SD), g	735 (±231)	737 (±215)	0.966
Any antenatal steroids, n (%)	21 (70)	30 (75)	0.642
Caesarean section, n (%)	17 (57)	19 (48)	0.448
General anaesthesia, n (%)	13 (43)	13 (33)	0.353
Placental transfusion, n (%)	29 (97)	32 (80)	**0.039**
PROM, n (%)	10 (33)	12 (30)	0.766
Male gender, n (%)	15 (50)	23 (58)	0.533
Beginning of intubation attempt, median, IQR, min	3:09 (1:40–4:49)	4:23 (2:35–6:05)	0.114
End of intubation attempt, median, IQR, min	3:47 (2:27–6:32)	6:47 (4:33–10:14)	**0.001**
Prophylactic intubation, n (%)	9 (30)	9 (23)	0.477
Intubation for bradycardia, n (%)	16 (53)	18 (45)	0.490
Intubation for low SpO2, n (%)	5 (17)	13 (32)	0.134
Surfactant at the DR, n (%)	29 (97)	40 (100)	0.429
IVH grades III–IV, n (%)	4 (13)	5 (13)	0.918
BPD, moderate and severe, n (%)	13 (43)	13 (33)	0.353
ROP > II. stage, n (%)	1 (3)	4 (10)	0.284
Laparotomy, n (%)	4 (13)	8 (20)	0.536
Died before discharge, n (%)	5 (17)	10 (25)	0.400

BPD, Bronchopulmonary dysplasia; DR, delivery room IVH, Intraventricular haemorrhage; PROM, premature rupture of membranes; ROP, Retinopathy of prematurity.

Primary and secondary outcomes (Table 2)

Fifty intubation courses (71%) were successfully completed on the first attempt. The use of a stylet increased the likelihood of successful intubations on the first attempt [26/30 (87%) vs 24/40 (60%); odds ratio (OR) (95% confidence interval [CI]) 4.3 (1.3–14.8), *P*=0.019] and shortened the duration of successful intubation attempts [median (interquartile range [IQR]) seconds: 37 (26–59) vs 64 (33–91), *P*<0.003] as well as intubation courses [median (interquartile range [IQR]) seconds: 43 (30–72) vs 140 (62–296), *P*<0.001]. Although there were no significant differences in the time to reach

Table 2. Primary and secondary outcomes in the groups with and without stylet use.

	With stylet	Without stylet	
n	30	40	OR (95% CI)
Successful intubation on the first attempt, n (%)	26 (87)	24 (60)	**4.33 (1.26–14.80)**
			P
Length of successful intubation attempt, median, IQR, sec	37 (26–59)	64 (33–91)	**0.003**
Length of intubation course, median, IQR, sec	43 (30–72)	140 (62–296)	**< 0.001**
Time to achieve SpO2 80%, median, IQR, sec	382 (325–658)	507 (353–664)	0.276
Time to achieve SpO2 90%, median, IQR, sec	403 (358–679)	590 (458–823)	**0.040**

SpO2 80% between the groups [median (IQR) seconds: 382 (325–658) vs 507 (353–664), *P*=0.276], significantly less time was required to reach SpO2 90% with a stylet [median (IQR) seconds: 403 (358–679) vs 590 (458–823), *P*=0.040].

Other outcomes

The rate of intubation courses without desaturation greater than 20% was significantly higher when a stylet was used [26/30 (87%) vs 20/40 (50%), OR (95% CI) = 6.5 (1.9–22.1), *P*=0.003], and the 30-second intubation rule was achieved twice as often [8/30 (27%) vs 5/40 (13%), OR (95% CI) = 2.55 (0.74–8.78), *P*=0.139]. The rates of death and severe neonatal morbidity were similar in both groups (Table 1). No differences were found between blood-stained aspirates after NICU admission (8% vs 9%).

Adverse event regarding stylet extraction (Fig. 3)

One iatrogenic artificial displacement of the intratracheal ETT occurred due to excessive force during the extraction of the stylet (with an OD of 2.0 mm) from the tube lumen (ID of 2.5 mm). The overstretching of the plastic coating resulted in its rupture, and a portion of the plastic coating remained inside the tube. Fortunately, this was recognized immediately after the extraction of the entire stylet from the ETT, and the infant underwent a second successful intubation attempt.

Fig. 3. The ruptured piece of plastic coat can be seen inside the snipped endotracheal tube (Portex I.D. 2.5 mm). This inside part of the plastic coat has its original width (left side) in comparison with two thinner parts of the overstretched plastic coat interrupted by the thinnest part (right side) that remains on the wire of the stylet (Sheridan/Sher-I-Slip, HUDSON RCI, O.D. 1.7 mm).

DISCUSSION

In this retrospective small study focusing on the intubation procedure in extremely premature infants, we found an association between stylet use and first-attempt intubation success, as well as a shortened intubation course when experienced physicians used the stylet for RI or EI. The success rate of the first attempt increased from 60% to 87%, and the median duration of all intubation courses were shortened by nearly one and a half minutes. Although our study is small and not randomized, the unique design encompasses a specific population, rescue and elective modes of intubation, and experienced practitioners. Seventy-six percent of intubated infants were under 26 weeks gestation, most of them (42%) required RI due to persistent bradycardia during the first few minutes of life. Sixty-seven percent of electively intubated infants were between 22 and 23 weeks of gestation. All operators were neonatologists or experienced pediatricians with extensive practice in neonatal intensive care.

Kamlin et al. (2013) found no benefit or harm when a stylet was used in premature infants weighing less than 1000 grams. The success rates of the first attempt for the stylet and no stylet groups were similar (53% and 54%) and lower than in our groups (87% vs 60%). In this Australian study, 75% of all intubations in the DR were performed by residents, inexperienced and less skilled physicians. These individuals often struggle with the correct and quick identification of the laryngeal inlet, which is a decisive factor in successful intubation[6]. The inability to quickly recognize laryngeal structures or poor visibility of the laryngeal space due to unskilled operation with a laryngoscope blade may compromise the potential benefits of a stiffened ETT (ref.[7]). A large retrospective analysis reported by NEAR4NEOS presents a generally low first-attempt success rate, and an even lower rate in the stylet group (47.7% vs 51%). After multivariate analysis, first-attempt success was most likely to occur in infants weighing >1.5 kg and in intubations performed by non-residents[5]. This is indirectly in line with our results, which show that neonatologists benefit from stylet use in the most premature infants. It can be speculated that

experienced practitioners may profit more from better passage of a less flexible ETT between partially open or even closed vocal cords.

Although our study "stylet" group achieved an 87% first successful attempt rate, the 30-second intubation rule was accomplished only in 19% of all intubation courses. Other studies report success rate of around 25%. This slightly better fulfillment is calculated from attempts rather than intubation courses, as in our study[3,5].

We consider the overstretching and rupture of the plastic coat to be a very rare event, which was likely caused more by excessive external pressure than the manufacturing design of the stylet. After analyzing the event mechanism and conducting repeated in vitro training extractions of the stylet with an OD of 1.7 mm from ETTs (Vygon ID 2.0 mm and Portex ID 2.5 mm), we found that the more the tube with the stylet inside is curved, the more difficult it becomes to extract the stylet from the tube. In this combination of ODs and IDs, the space between the plastic coat and the ETT wall is already narrow, and when the tube is curved, the frictional forces inside the tube significantly increase. That is why we recommend minimal curvature of the tube with the stylet inside (both ID 2.0 mm and ID 2.5 mm) before introduction into the mouth. After implementing this recommendation, no further problems during stylet extraction were reported or observed in video records.

The similarly low rates of blood-stained aspirates in both our groups and in other studies may be explained by the higher probability of harm caused by the blade rather than the increased rigidity of the ETT with the stylet. This speculation may be more valid for tiny infants, even when the smallest size of the blade is used (Miller blade 00).

This study has several weaknesses. It is a retrospective observational design, and the cohort is small. The generalizability and applicability of our results are strictly limited to rescue and elective modes of intubation, which should be performed by more experienced physicians in extremely premature infants. Most attempts, 68, were performed by highly skilled doctors with at least 5 years of experience in neonatology. Notably, 21 of these intubations were carried out by doctors with over 10 years of experience, with 11 using a stylet and 10 without. Allowing practitioners to decide whether to use a stylet introduces potential biases in several ways. First, the predetermination itself may improve the success of intubations[6]. Second, a slight majority of physicians favoured intubation without a stylet, possibly influenced by a large retrospective study that found no clear advantages to using a stylet[5]. Third, the varied ratio of intubations performed with versus without a stylet by individual physicians could also compromise the results' reliability. Most of our infants were intubated when the baseline oxygen saturation was low, which makes the outcome regarding desaturation of >20% imprecise because generally measured oxygen saturations <60% are not reliably valid. Despite these biases the data supports a stylet use, if the extremely premature infants require intubation during their initial stabilization. This difficult and stressful procedure can be shortened, and the first successful attempt may be more certainly achieved.

CONCLUSION

Our data suggest that the use of a stylet may improve the success rate of rescue and elective intubations in extremely premature infants, especially when performed by experienced physicians. In this limited clinical situation, the benefits of using a stylet may outweigh the potential harms.

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REFERENCES

1. Govindaswami B, Nudelman M, Narasimhan SR, Huang A, Misra S, Urquidez G, Kifle A, Stemmle M, Angell C, Patel R, Anderson C, Song D, DeSandre G, Byrne J, Jegatheesan P. Eliminating Risk of Intubation in Very Preterm Infants with Noninvasive Cardiorespiratory Support in the Delivery Room and Neonatal Intensive Care Unit. Biomed Res Int 2019;2019:5984305.
2. Sauer CW, Kong JY, Vaucher YE, Finer N, Proudfoot JA, Boutin MA, Leone TA. Intubation Attempts Increase the Risk for Severe Intraventricular Hemorrhage in Preterm Infants-A Retrospective Cohort Study. J Pediatr 2016;177:108-3.
3. Singh N, Sawyer T, Johnston LC, Herrick HM, Moussa A, Zenge J, Jung P, DeMeo S, Glass K, Howlett A, Shults J, Barry J, Brei BK, Kim JH, Quek BH, Tingay D, Mehrem AA, Napolitano N, Nishisaki A, Foglia EE. National Emergency Airway Registry for Neonates (NEAR4NEOS). Impact of multiple intubation attempts on adverse tracheal intubation associated events in neonates: a report from the NEAR4NEOS. J Perinatol 2022;42(9):1221-7.
4. Wozniak M, Arnell K, Brown M, Gonzales S, Lazarus D, Rich W, Katheria A. The 30-second rule: the effects of prolonged intubation attempts on oxygen saturation and heart rate in preterm infants in the delivery room. Minerva Pediatr 2018;70(2):127-2.
5. Gray MM, Rumpel JA, Brei BK, Krick JA, Sawyer T, Glass K, DeMeo S, Barry J, Ades A, Napolitano N, Johnston L, Moussa A, Jung P, Quek BH, Mehrem AA, Zenge J, Shults J, Nadkarni V, Kim J, Singh N, Tisnic A, Foglia E, Nishisaki A. National Emergency Airway Registry for Neonates: NEAR4NEOS Investigators. Associations of Stylet Use during Neonatal Intubation with Intubation Success, Adverse Events, and Severe Desaturation: A Report from NEAR4NEOS. Neonatology 2021;118(4):470-8.
6. Kamlin CO, O'Connell LA, Morley CJ, Dawson JA, Donath SM, O'Donnell CP, Davis PG. A randomized trial of stylets for intubating newborn infants. Pediatrics 2013;131(1):198-5.
7. O'Shea JE, Loganathan P, Thio M, Kamlin COF, Davis PG. Analysis of unsuccessful intubations in neonates using videolaryngoscopy recordings. Arch Dis Child Fetal Neonatal Ed 2018;103:F408-2.