PRACA ORYGINALNA

INDICATIONS FOR ENDOTRACHEAL INTUBATION IN NEONATES

WSKAZANIA INTUBACJI NOWORODKÓW PO PORODZIE

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ABSTRACT

Aim: Endotracheal intubation and mechanical ventilation in neonates remains an essential life-saving tool in many indications, especially in preterm births. The procedure is associated with a high risk of complications, however remains a necessity especially in various cases of respiratory insufficiency. The aim of this study was to analyze the causes of endotracheal intubation in neonates based on gestational age at birth. Material and methods: We analyzed 260 newborns requiring endotracheal intubation and mechanical ventilation based on gestational age at birth, with particular attention to the timing of intubation, its duration, and the distribution of key clinical indications. The main analyzed indications were infant respiratory distress syndrome (IRDS), general anaesthesia for surgery, congenital defects, infections, meconium aspiration syndrome (MAS), gastrointestinal disorders and perinatal asphyxia. Results: The longest average duration of intubation was observed in the group of neonates born before 32 weeks of gestational age. Among all the groups, the shortest mean intubation time (3.2 days) was recorded in neonates intubated for surgery anesthesia. The longest periods were noted in neonates with MAS and digestive system disorders, average 12.6 and 13.8 days, respectively. Comparable intubation durations were observed in neonates with congenital anomalies, infections, and birth asphyxia. In infants with IRDS, the mean duration of intubation was 9.5 days, with a median of 3 days. Conclusion: Endotracheal intubation remains a fundamental life-saving procedure in neonatal care. Some of the indications highlighted strong association between gestational age at birth and the need for ventilatory support. Multiple indications were evenly distributed across gestational age groups, suggesting the multifactorial etiologies and variable clinical courses, regardless of maturity. Most intubations occurred within the first 24 hours of life, indicating that this period is critical.

KEY WORDS: intubation, respiratory failure in neonates, Invasive ventilation, infant respiratory distress syndrome, preterm newborns

STRESZCZENIE

Cel pracy: Intubacja dotchawicza i wentylacja mechaniczna noworodków pozostają niezbędnymi narzędziami ratującymi życie w wielu wskazaniach, a szczególnie w przypadku porodów przedwczesnych. Procedura ta wiąże się z wysokim ryzykiem powikłań, jednak jest konieczna zwłaszcza w przypadku wystąpienia niewydolności oddechowej. Celem badania była analiza przyczyn intubacji dotchawiczej u noworodków w zależności od wieku ciążowego. Materiały i metody: Analizie poddano 260 noworodków wymagających intubacji dotchawiczej i wentylacji mechanicznej w zależności od wieku ciążowego ze szczególnym uwzględnieniem momentu intubacji, czasu jej trwania oraz rozkładu kluczowych wskazań klinicznych. Głównymi analizowanymi przyczynami były: zespół zaburzeń oddychania noworodka, znieczulenie ogólne, wady wrodzone, zakażenia, zespół aspiracji smółki, zaburzenia żołądkowo-jelitowe oraz niedotlenienie okołoporodowe.
Wyniki: Najdłuższy średni okres intubacji odnotowano w grupie noworodków urodzonych przed 32 tygodniem ciąży. Spośród wszystkich grup najkrótszy średni okres intubacji (3,2 dnia) odnotowano u noworodków intubowanych do znieczulenia ogólnego. Najdłuższe okresu intubacji obserwowano u noworodków z zespołem aspiracji smółki i zaburzeniami układu pokarmowego - średnio odpowiednio 12,6 i 13,8 dnia. Porównywalne okresy intubacji zaobserwowano u noworodków z wadami wrodzonymi, zakażeniami i zamartwica urodzeniowa. U noworodków z zespołem zaburzeń oddychania średni okres intubacji wyniósł 9,5 dnia z medianą 3 dni.
Wnioski: Intubacja dotchawicza pozostaje podstawową procedurą ratującą życie w opiece neonatologicznej. Wykazano korelację między wiekiem ciążowym a potrzebą wentylacji mechanicznej. Wiele wskazań było równomiernie rozłożonych w grupach o różnym wieku ciążowym, co sugeruje wieloczynnikową etiologię i zróżnicowany przebieg kliniczny niezależny od dojrzałości płodu. Większość intubacji miała miejsce w ciągu pierwszych 24 godzin życia, co potwierdza iż jest to okres krytyczny w tym zakresie.

SŁOWA KLUCZOWE: intubacja dotchawicza, niewydolność oddechowa noworodków, wentylacja mechaniczna, zespół zaburzeń oddychania noworodków, wcześniactwo

INTRODUCTION

Endotracheal intubation and mechanical ventilation remain essential life-saving procedures in the management of respiratory failure in neonates [1]. Despite advancements in perinatal care, a significant number of newborns still require mechanical ventilation particularly among preterm infants and those with congenital malformations [2]. Due to the differences in the structure of the airways of newborns, endotracheal intubation is associated with a high risk of complications. Nethertheless, it remains the main method for ensuring airway patency in neonate anaesthesia and respiratory failure [3].

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It is estimated that up to 10–15% of preterm neonates require intubation due to pulmonary immaturity and infant respiratory distress syndrome (IRDS) [2]. IRDS is caused by a deficiency of surfactant and remains the leading cause of respiratory failure in infants born before 32 weeks of gestation. The introduction of surfactant therapy and non-invasive respiratory support such as continuous positive airway pressure (CPAP) has significantly reduced the need for intubation and invasive ventilation in this group but has not eliminated it entirely [4, 5].

Other indications for endotracheal intubation are general anaesthesia, congenital defects, respiratory tract infections, meconium aspiration syndrome (MAS), sepsis and perinatal asphyxia [3, 6].

AIM

The aim of this study was to analyse the indications for endotracheal intubation in neonates by gestational age (GA), the timing of intubation, its duration, and the distribution of key clinical indications.

MATERIAL AND METHODS

This retrospective study was conducted at the Department of Neonatology and Rare Diseases, Children's Clinical Hospital in Warsaw, and analyzed neonates requiring endotracheal intubation, hospitalized between 2020 and 2022.

353 newborns requiring endotracheal intubation and mechanical ventilation were initially included for the analysis. 93 patients were excluded due to being outborn (transferred from another hospital) or due to death before full diagnostic and therapeutic evaluation could be completed.

The final study group consisted of 260 neonates.

The neonates were divided into three groups based on GA (tab. 1).

Medical records were analyzed retrospectively. The study investigates indications for intubation, GA, postnatal age at the moment of intubation and the duration of mechanical ventilation. An additional factor included in the analysis was the birth weight.

Statistica software version 14.0.1 has been used for the statistical analysis of the data. Analysis of variance using ANOVA was conducted to calculate the significance of the differences in duration of intubation and age at the moment of intubation depending on the GA at birth. Post-hoc analysis to confirm the statistical significance of the results was conducted using the Tukey's range test. To calculate the correlation between each of the seven indications for endotracheal intubation and the length of intubation the Mann-Whitney U test with a continuity correction was performed. The obtained results were assessed with a p-value < 0.05 considered statistically significant.

RESULTS

Seven main indications for intubation were identified. Patients who have more than one indication were assigned to more than one category. The first group consisted of 151 cases of patients with congenital defects, including congenital diaphragmatic hernia (CDH) and congenital heart defects. The second group consisted of 43 cases of patients who presented with infections, including pneumonia and sepsis. The third group of patients (37 cases) were intubated due to gastrointestinal disorders such as obstruction, perforation, necrotizing enterocolitis (NEC). 34 patients presented with IRDS. 22 patients were intubated for surgery under general anesthesia. 11 patients were intubated due to MAS. 9 patients were intubated due to birth asphyxia.

The analysis of the data revealed significant variation in the causes of endotracheal intubation in newborns depending on the GA. Among the patients born before the 32 weeks GA (group 1), the predominant cause was IRDS, which was not observed in full-term infants.

The intubation due to MAS was observed only in 11 newborns, all of them being born after 32 weeks GA (group 2 and 3).

Among infants born after the 32 weeks GA, particularly in the full-term group, the main cause of intubation was congenital anomalies, including heart defects and CDH.

Indications for intubation related to infections, gastrointestinal disorders, and perinatal asphyxia had a similar distribution across all age groups.

The number of intubations due to general anaesthesia for surgery also increased with GA of the patients (fig. 1).

Comparing the continuance of mechanical ventilation among the groups of patients, the longest average period of time was observed in group 1 (14,59 days). The two other groups – group 2 and group 3 had significantly ($p = 0,007$) shorter average

Tab. 1. Characteristic of the groups.

Group	Number of patients	Gestational age (GA)	Median GA	Birthweight (BW)	Median BW	Gender (female/ male%)
1	59	< 32 Hbd (24 0/7–31 6/7)	29	480-2010 g	1130 g	78,79
2	73	32 0/7–36 6/7 Hbd	34 5/7	1100-3630 g	2455 g	65,91
3	128	≥ 37 Hbd (37 0/7–42 2/7)	39	2210–4500 g	3240 g	77,78

Fig. 1. Distribution of the main indications for intubation within the groups.

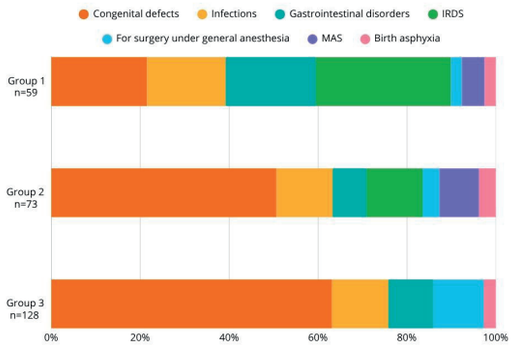


Fig. 2. Duration of mechanical ventilation within the groups.

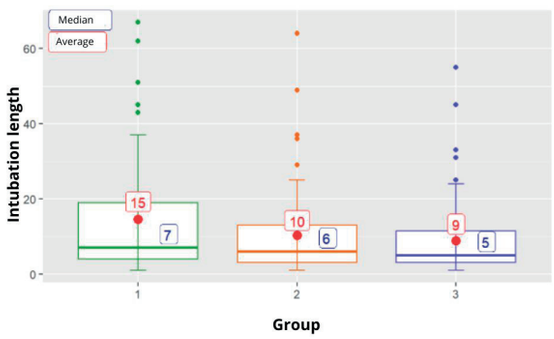


Fig. 3. Age at the moment of intubation within the groups.

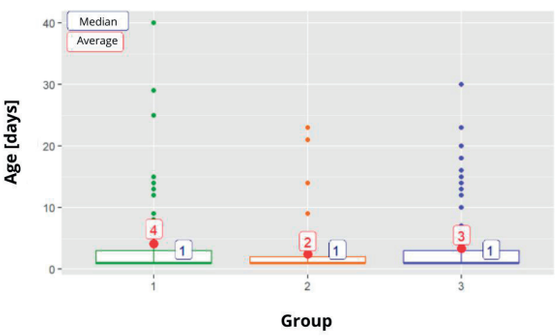


Fig. 4. Length of intubation depending on the indication for intubation.

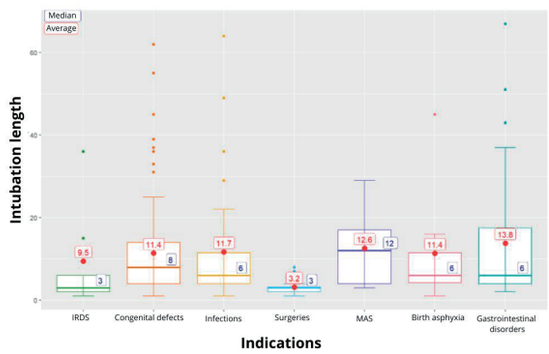
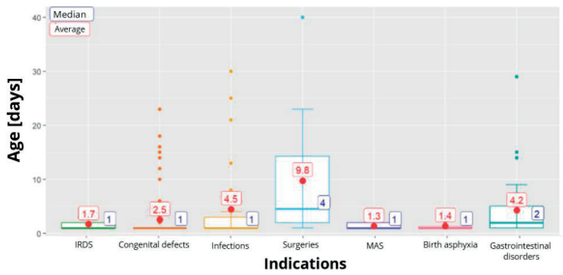


Fig. 5. Comparison of the postnatal age at the moment of intubation depending on the indication for intubation.



length of intubation (respectively: 10,25 and 8,81 days) (fig. 2).

The next analyzed point was the correlation between the GA and the postnatal age at the time of intubation. In all groups, the median age was 1 day, indicating that intubation typically occurred on the first day of life. The mean age at intubation ranged from the 2nd to the 4th day of life. No statistically significant differences were observed between the groups (p = 0,804) (fig. 3).

Across all GA groups and the seven main indications for intubation, the shortest length was observed in neonates intubated for surgery anesthesia, with a mean of 3.2 days which was statistically significantly (p = 0,0001). The longest intubation periods were observed in neonates with MAS and digestive system disorders, averaging 12.6 and 13.8 days, respectively. A comparable duration of intubation was observed in neonates with congenital anomalies, infections, and birth asphyxia. In cases of IRDS, the mean duration of intubation was 9.5 days, with a median of 3 days. This difference was statistically significant for congenital defects (p = 0,038), and two disorders from the gastrointestinal category: obstruction (p = 0,038) and perforation (p = 0,018). Others did not reach statistical significance, including IRDS (p = 0,615), and infections (p = 0,214) (fig. 4).

The comparison of postnatal age at the time of intubation, based on the indication for the procedure, revealed that surgical intervention was the only indication associated with both a significantly broader range and the highest mean postnatal age at the time of intubation. Notably, this analysis included a patient who was intubated at 40 days of age; although exceeding the traditional neonatal period of 28 days, the infant was born at 26 weeks of gestation, thus still meeting the criteria for classification as a neonate due to corrected GA.

Infections and gastrointestinal disorders were also associated with a wider range of postnatal age at the time of intubation. In contrast, the remaining four indications: IRDS, congenital anomalies, MAS, and perinatal asphyxia typically necessitated endotracheal intubation within the first 24 hours of life (fig. 5).

DISCUSSION

Endotracheal intubation remains a fundamental procedure in airway management, used as a life-saving intervention in both emergency and elective clinical scenarios. It remains the main method for securing airway patency in neonate anaesthesia and respiratory failure [3]. Despite its utility, endotracheal intubation carries potential complications, including aspiration, esophageal intubation, and ventilatory-associated pneumonia. Therefore, the decision for intubation must balance the clinical necessity against potential risks. The availability of trained personnel and appropriate equipment is essential to mitigate associated risks.

The present study outlines the predominant indications for endotracheal intubation among neonates. Understanding these indications is essential for timely and appropriate airway management.. Infants born before 32 weeks of gestation were most frequently intubated due to IRDS, which was also observed in the 32–36 weeks GA group but entirely absent among term neonates. It reflects the strong association between IRDS and pulmonary immaturity in preterm infants. While many preterm infants initiate spontaneous breathing at birth, supportive interventions, such as tactile stimulation and delayed umbilical cord clamping along with non-invasive ventilation, may reduce the need for intubation and its associated complications [7].

Significant correlation was observed between GA and duration of mechanical ventilation. Neonates born before 32 weeks required longer ventilatory support compared to more mature newborns. This finding underscores the severity of respiratory failure in extremely preterm infants.

MAS is a cause of respiratory failure affecting term and post-term neonates. In our study it was not observed only in infants < 32 weeks of gestation. Out of 11 neonates included in the study 4 were born between 32 and 36 of GA and 7 were born at over 37 weeks of gestation. Recommendations for the management of infants born through meconium-stained amniotic fluid (MSAF) have evolved over time. Historically, it was recommended endotracheal intubation and suctioning in all infants born through MSAF for prevention of MAS [8]. Recent meta-analyses did not show a significant benefit of immediate endotracheal intubation with suctioning over noninvasive ventilation without suctioning. However, intubation and tracheal suctioning may be necessary if noninvasive ventilation does not result in adequate ventilation and an obstruction due to meconium is suspected [8, 9]. Currently, there is no consensus on the optimal ventilation strategies for MAS [8].

Intubation related to infections, gastrointestinal disorders, and perinatal asphyxia are evenly distributed across all GA groups, suggesting these conditions have multifactorial etiologies that are not dependent on gestational maturity.

The first 24 hours of life are critical for neonatal survival. During this period, blood flow is preferentially directed towards vital organs such as the brain, heart, and adrenal glands, while perfusion to the kidneys, intestines, skin, and other organs is significantly reduced [10]. This redistribution can lead to complications such as acute tubular necrosis [11], gastrointestinal hemorrhage, and NEC [12]. Therefore, early airway protection and prompt stabilization of the newborn are essential to minimize the risk of these life-threatening conditions. The analysis of the correlation between GA and postnatal age at the time of intubation suggests no significant association. The median postnatal age at intubation in all groups was 1 day, confirming that the primary cause for intubation are conditions requiring immediate intervention in the first few hours of life.

Infections and gastrointestinal disorders showed greater variability in postnatal age at intubation, likely due to their variable onset and progression.

Congenital anomalies represented a significant indication for endotracheal intubation across all GA groups. One of the most critical anomalies is CDH, a developmental defect of the diaphragm and lungs [13]. This malformation leads to herniation of abdominal organs into the thoracic cavity. Neonates with CDH are at high risk of gastric and intestinal insufflation and severe respiratory distress. Immediate postnatal intubation is typically recommended to minimize the risk [14]. However, in cases of mild CDH, immediate intubation may not be necessary. Avoiding overtreatment allows for a more physiologic perinatal transition and reduces the potential complications associated with intubation and sedation [15]. Critical congenital heart defects are the most frequent cause of acute heart failure in the neonatal period [16].

Among all indications for intubation, gastrointestinal failure was associated with the longest average duration of mechanical ventilation (13.8 days). NEC, one of the primary conditions in this category, is classified into three stages based on severity - ranging from mild (Bell's Stage I) to severe (Bell's Stage III) [17]. Treatment strategies vary accordingly but generally include broad-spectrum intravenous antibiotics, bowel rest, abdominal decompression, and parenteral nutrition. Severe NEC is characterized by complications such as bowel perforation, peritonitis, pneumoperitoneum, hypotension, and profound metabolic acidosis. In these cases, surgical intervention and endotracheal intubation are typically required [18].

This was a single-center, retrospective study, which may limit the generality of the findings. Moreover, the classification of indications was based on clinical records, which can be subject to interpretation. The lack of a non-intubated control group also hampers complex evaluation.

CONCLUSIONS

Endotracheal intubation remains a fundamental life-saving procedure in neonatal care. Despite its benefits,

endotracheal intubation carries a risk of complications that must be carefully considered.

Most intubations occurred within the first 24 hours of life, highlighting the critical nature of this early neonatal period.

IRDS was the leading indication for intubation in neonates born before 32 weeks of gestation, reflecting association between immaturity and the need for ventilatory support in preterm infants. Duration of mechanical ventilation was correlated with GA. More premature infants required longer respiratory support.

Infections, gastrointestinal disorders, and perinatal asphyxia were evenly distributed across GA groups, suggesting that these conditions have multifactorial etiologies and variable clinical courses, independent of gestational maturity.

Gastrointestinal failure was associated with the longest ventilation duration, indicating its severe course and frequent need for surgical intervention.

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We declare no conflict of interest.

REFERENCES

1. Sawyer T, Foglia E, Hatch LD i wsp. Improving neonatal intubation safety: a journey of a thousand miles. J Neonatal Perinatal Med 2017;10(2):125–131.
2. Sweet DG, Carnielli VP, Greisen G i wsp. European consensus guidelines on the management of respiratory distress syndrome: 2022 update. Neonatology 2023;120(1):3–23.
3. Rawicz M. Wskazania do intubacji dotchawiczej. Med Wieku Rozwoj 2008;12(4 cz. 1):851–856.
4. Foglia EE, Ades A, Sawyer T i wsp. Neonatal intubation practice and outcomes: an international registry study. Pediatrics 2019;143(1):e20180902.
5. Polin RA, Carlo WA. Surfactant replacement therapy for preterm and term neonates with respiratory distress. Pediatrics 2014;133(1):156–163.
6. Gnanaratnem J, Finer NN. Neonatal acute respiratory failure. Curr Opin Pediatr 2000;12(3):227–232.
7. Roberts CT, O'Shea JE. Alternatives to neonatal intubation. Semin Fetal Neonatal Med 2023;28(5):101488.
8. Olicker AL, Raffay TM, Ryan RM. Neonatal respiratory distress secondary to meconium aspiration syndrome. Children (Basel) 2021;8(3):246.
9. Dikou M, Xanthos T, Dimitropoulos I i wsp. Routine tracheal intubation and meconium suctioning in non-vigorous neonates with meconium-stained amniotic fluid: a systematic review and meta-analysis. Diagnostics (Basel) 2022;12(4):881.
10. Moshiro R, Mdoe P, Perlman JM. A global view of neonatal asphyxia and resuscitation. Front Pediatr 2019;7:489.
11. Sweetman DU, Molloy EJ. Biomarkers of acute kidney injury in neonatal encephalopathy. Eur J Pediatr 2013;172(3):305–316.
12. Thornton KM, Dai H, Septer S i wsp. Effects of whole body therapeutic hypothermia on gastrointestinal morbidity and feeding tolerance in infants with hypoxic ischemic encephalopathy. Int J Pediatr 2014;2014:643689.
13. Kotecha S, Barbato A, Bush A i wsp. Congenital diaphragmatic hernia. Eur Respir J 2012;39(4):820–829.
14. Chatterjee D, Ing RJ, Gien J. Update on congenital diaphragmatic hernia. Anesth Analg 2020;131(3):808–821.
15. Cochius-den Otter SCM, Horn-Oudshoorn EJJ, Allegaert K i wsp. Routine intubation in newborns with congenital diaphragmatic hernia. Pediatrics 2020;146(4):e20201258.
16. Khalil M, Jux C, Rueblinger L i wsp. Acute therapy of newborns with critical congenital heart disease. Transl Pediatr 2019;8(2):114–126.
17. Bell MJ, Ternberg JL, Feigin RD i wsp. Neonatal necrotizing enterocolitis: therapeutic decisions based upon clinical staging. Ann Surg 1978;187(1):1–7.
18. Neu J, Walker WA. Necrotizing enterocolitis. N Engl J Med 2011;364(3):255–264.

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