

CORRESPONDENCE

Difficult airway management in children with trisomy 18: a retrospective single-centre study of incidence, outcomes, and complications

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Editor—Trisomy 18, or Edwards syndrome, presents with multiple anomalies, including congenital heart disease, craniofacial malformations, gastrointestinal and genitourinary defects, and severe neurocognitive disability.¹ Survival has improved, and many of these children receive life-sustaining surgical procedures, including cardiac, gastroenterological, and otolaryngologic procedures.^{2–4} Airway management is thought to be challenging because of micrognathia/retrognathia and restricted mouth opening, which can lead to difficulties with mask ventilation and tracheal intubation, as reported in a single case series.⁵ Larger studies comprehensively examining airway management in children with trisomy 18, including incidence and risk factors of difficult airway, specific techniques used, and related complications, have not been published.

This study was designated as exempt by the University of Michigan Institutional Review Board (HUM00201335; Ann Arbor, MI, USA) and a requirement for informed consent waived. We measured the incidence of difficult mask ventilation and tracheal intubation, risk factors, airway management techniques used, and related adverse events in children (<18 yr old) with trisomy 18 undergoing general anaesthesia using a retrospective single-centre review from January 1, 2010 to June 1, 2021. Patients were identified using International Classification of Diseases 9 and 10 codes and confirmed by chart review. Patient characteristics, use of face mask, laryngeal mask airway, and tracheal intubation, and the difficulty of each intervention, were collected. Mask ventilation was designated as easy (no adjuvants or oral or nasal airway only) or difficult (inadequate or impossible mask ventilation despite airway

adjuvants and additional personnel) based on prior definitions.⁶ For each tracheal intubation, we collected the following: (i) number of attempts, (ii) laryngeal exposure by direct laryngoscopy, and (iii) device used for successful intubation (direct or videolaryngoscopy, flexible fiberoptic scope, rigid bronchoscope, and combined techniques). Difficult intubation criteria included⁷ (i) Cormack and Lehane classification ≥ 3 using direct laryngoscopy, (ii) three or more intubation attempts, and (iii) intubation achieved after escalating to an advanced device because of an expected difficult intubation or failure to intubate after direct laryngoscopy. Complications included mild and severe hypoxaemia, defined as a ≥ 1 min 10–20% or $\geq 20\%$ decrease in oxygen saturation by pulse oximetry from pre-induction, respectively, cardiac arrest, cardiopulmonary resuscitation, administration of vasoactive medications, pulmonary aspiration, airway or lung injury, laryngospasm, bronchospasm, or malposition of the tracheal tube. Univariable statistics (e.g. mean and proportion) were used to assess measure distribution. Characteristics of patients having easy vs difficult intubation were compared using standardised differences.

The final dataset included 165 anaesthetics amongst 48 children (Supplementary Fig 1). Micrognathia or retrognathia was identified in 48% of subjects and restricted mouth opening in 10%. Approximately 60% of subjects experienced at least one difficult intubation (Supplementary Table 1). Amongst 165 anaesthetics with an airway intervention (Supplementary Table 2), 40% were performed in children <1 yr old and 60% weighed ≤ 10 kg. Otolaryngologic procedures constituted 33% of anaesthetics.

Table 1 Characteristics of easy and difficult tracheal intubation (n=145). *Definition of difficult tracheal intubation included laryngeal exposure ≥ 3 Cormack and Lehane view with direct laryngoscopy (DL); three or more intubation attempts; and intubation was achieved by escalating to an advanced device, such as videolaryngoscope (VL), fiberoptic scope (FOS), rigid bronchoscope, or combined techniques attributable to expected difficult intubation or failure to intubate after DL attempt(s). †Standardised differences. ‡Otolaryngology airway devices included rigid bronchoscope and Dedo and Hollinger laryngoscopes (Both Dedo and Hollinger laryngoscope are the common direct laryngoscopes used by paediatric otolaryngologists).

Measures	Full sample (n=145)		Easy intubation (n=85)		Difficult intubation* (n=60)		SD [†]
	N	Percentage (%)	N	Percentage (%)	N	Percentage (%)	
Age group							
Newborn to <1 yr	65	44.8	32	37.6	33	55.0	0.67
Toddler (1–3 yr)	38	26.2	21	24.7	17	28.3	
Preschool (4–5 yr)	9	6.2	4	4.7	5	8.3	
School age (6–12 yr)	29	20.0	24	28.2	5	8.3	
Teens (13–18 yr)	4	2.8	4	4.7	0	0.0	
Weight							
≤10 kg	87	60.0	40	47.1	47	78.3	0.77
>10 kg	53	36.6	43	50.6	10	16.7	
Missing	5	3.4	2	2.4	3	5.0	
Preoperative comorbidities							
Prematurity	15	10.3	8	9.4	7	11.7	0.07
Congenital heart disease	113	77.9	67	78.8	46	76.7	0.05
Sleep apnoea	76	52.4	43	50.6	33	55.0	0.09
Gastroenterology tube feeding	56	38.6	34	40.0	22	36.7	0.07
Procedure type							
Craniofacial	5	3.4	2	2.4	3	5.0	0.85
Paediatric general and urology	24	16.6	17	20.0	7	11.7	
Otolaryngology	50	34.5	23	27.1	27	45.0	
Cardiac	25	17.2	10	11.8	15	25.0	
Radiology	11	7.6	11	12.9	0	0.0	
Orthopaedic	16	11.0	13	15.3	3	5.0	
Others	14	9.7	9	10.6	5	8.3	
Orofacial features related to difficult intubation							
None	73	50.3	53	62.4	20	33.3	0.61
At least one feature	72	49.7	32	37.6	40	66.7	0.61
Micrognathia	56	38.6	24	28.2	32	53.3	0.53
Retrognathia	45	31.0	25	29.4	20	33.3	0.09
Restricted mouth opening	16	11.0	6	7.1	10	16.7	0.30
Multiple features	45	31.0	23	27.1	22	36.7	0.21
Eventual device used to intubate							
DL	87	60.0	76	89.4	11	18.3	2.22
VL	32	22.1	3	3.5	29	48.3	
FOS	7	4.8	0	0.0	7	11.7	
Otolaryngology airway devices [‡]	17	11.7	4	4.7	13	21.7	
Combined (FOS+LMA and FOS+VL)	2	1.4	0	0.0	2	3.3	0.26
Intubation attempts (number of attempts)							
1	110	75.9	77	90.6	33	55.0	0.99
2	18	12.4	8	9.4	10	16.7	
≥3	17	11.7	0	0.0	17	28.3	
Neuromuscular blocking agent							
None	80	55.2	48	56.5	32	53.3	0.06
Yes	65	44.8	37	43.5	28	46.7	
Intubation performed by							
Anaesthesiologist	128	88.3	81	95.3	47	78.3	0.52
Otolaryngologist	17	11.7	4	4.7	13	21.7	

There were four episodes of difficult mask ventilation amongst four separate patients out of 140 anaesthetics with documented mask ventilation (incidence: 2.9%; 95% confidence interval [CI]: 0.9–7.6%). All four subjects had micrognathia or retrognathia and had difficult tracheal intubation as well.

Table 1 illustrates patient and procedural variables associated with difficult intubation. Sixty intubations were designated difficult (60/145 incidence: 41.4%; 95% CI: 33.4–49.9%). More than half occurred in children <1 yr old. Videolaryngoscopy was used to secure the airway in half of the difficult intubations; direct laryngoscopy was used in <20%.

Finally, 13/60 of difficult intubations were performed by a paediatric otolaryngologist with rigid bronchoscopy (6/13) or non-conventional laryngoscopes (Dedo or Hollinger, 4/13), including three emergent for non-otolaryngologic procedures after attempts by a paediatric anaesthesiologist. No failed or emergent surgical airways occurred. Risk factors included age <1 yr (55% vs 45%; standardised difference 0.67), weight ≤10 kg (78% vs 17%; standardised difference 0.77), otolaryngology procedures (45%; standardised difference 0.38), and orofacial features associated with difficult intubation (67% vs 33%; standardised difference 0.61).

Hypoxaemia occurred in 75 (45.5%) anaesthetics, including 32 (19.4%) classified as severe. Critical cardiopulmonary events requiring treatment with vasoactive medication (epinephrine, atropine, phenylephrine, or ephedrine) occurred in 11 anaesthetics, including eight cases of hypoxaemia and bradycardia, and three cases of hypotension. Other complications included one mainstem intubation and three laryngospasm or bronchospasm events.

Overall, the incidence of difficult mask ventilation in children with trisomy 18 was found nearly 30-fold higher than in children in general (0.1%) from our institutional report. The incidence of difficult intubation was comparable with children with orofacial abnormalities, like Pierre Robin sequence.⁸ Risk factors were consistent with previous studies^{7,9} and included patient age <1 yr, weight ≤10 kg, and orofacial anomalies, such as micrognathia or retrognathia and small mouth opening.

Several safety messages can be derived from these data. First, we confirmed that when encountering difficult tracheal intubation, alternative airway devices, such as videolaryngoscopy and flexible fibreoptic intubation, were more frequently successful compared with direct laryngoscopy.^{10,11} Second, several intubations required emergent rescue by paediatric otolaryngologists, strongly suggesting that elective intubation should not be attempted in this population in settings where advanced airway devices and paediatric otolaryngologists are not available, particularly in patients with concerning orofacial anatomies.¹² Finally, critical cardiopulmonary events during induction requiring cardiopulmonary resuscitation or vasoactive medications were not rare, reinforcing the importance of preparedness and medication availability during induction.⁷

Our study has several limitations. First, our incidence of difficult airway may be partially impacted by a high volume of otolaryngologic procedures related to local expertise. Second, genotypes, such as mosaicism, were not identifiable in the medical record; such patients may have different phenotypes and outcomes. Similarly, diagnosis miscoding might have led to omission of some patients. Finally, inaccurate intraoperative documentation could have led to under-detection or misclassification of adverse airway events; however, the variable definitions we used and our primary outcomes have been validated in multiple studies.^{13,14}

In conclusion, difficult airway management and significant adverse events were common in children with trisomy 18. These patients are at high risk for difficult airway and associated complications and should be cared for by providers with expertise in difficult airway management in infants (i.e. paediatrics trained anaesthesiologists and otolaryngologists). Formal recommendations for airway management in these children are provided in [Supplementary Table 3](#).

Declaration of interest

All authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.bja.2023.02.022>.

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