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Paediatric RSI: Out with the Old, in with the New?

ABSTRACT

Background: Rapid sequence induction was first described in adult practice in 1970. Almost 50 years on there is still no international consensus for the direct translation to the paediatric population. In paediatric anaesthesia, RSI is a balance of theoretical risk vs. real world practicalities.

Aim: The primary aim of this study was to assess variation in practice in two longstanding paediatric departments. The secondary aim was to measure the safety profile of said technique used in each department.

Method: A one-page questionnaire was distributed throughout the Intensive care and anaesthesiology departments of the two paediatric hospitals in Dublin regarding two common scenarios. The first a 10-week-old with bronchiolitis needing intubation post feed and the second a two-year-old with a neurovascular injury to the forearm following trauma that requires emergency reduction.

Results: There was a significant difference in the use of standard RSI techniques between the two hospital sites (Table 1).

Conclusion: Practice can vary significantly between two paediatric hospitals despite proximity. But the "classical sequence" of RSI is still performed to this day in large tertiary paediatric centres. This may be because no international consensus exists for RSI in paediatric anaesthesia. Further data is required on modifications to paediatric RSI.

KEYWORDS: Paediatric; Rapid sequence; Airway; Airway technique; Anaesthesia; Induction

WHAT WE KNOW ALREADY?

The classic concept of rapid sequence induction (RSI) without ventilation prior to intubation was established in adult anaesthesia more than 50 years ago and was used thereafter also in paediatric anaesthesia. Even after many years of discussing whether intravenous/inhalational induction, cricoid pressure, depolarizing/non-depolarizing muscle relaxation or apnoea/intermittent facemask ventilation are appropriate in paediatric patients, there is still hardly any academic consensus on paediatric RSI. Unfortunately, this practice was associated with significant oxyhemoglobin desaturations resulting in unsafe situations for the children and high stress levels for the providers [1]. Proficiency in direct laryngoscopy and a good basic face mask technique remain the foundation of airway management in children [2]. Recent literature has confirmed conventional teaching of RSI in the paediatric population is

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often inappropriate and inadequate [3,4]. The Anatomical and physiological differences in the paediatric patient can mean that even short periods of apnoea can be deleterious [2].

WHAT NEW INFORMATION THIS STUDY ADDS?

This study neither supports nor refutes recent literature regarding the paediatric airway and RSI. It simply shows that the safe practise of paediatric RSI is not dependent on the drug used or the technique implied but more on the skill set and experience of the caregiver. It shows that the practise varies between very close departments and between different levels of training but that the risk of aspiration, often the reason for RSI, is low. It also shows that modifications are common practise and that more information regarding modifications to RSI in the paediatric airway may be of considerable value in future consensus planning. Interestingly and finally, it raises the question that despite the traditional RSI sequence having potentially deleterious effects and induce provider stress, why it is still used in tertiary paediatric centres? The reason may stem from the lack of hard evidence and lack of established international or academic guideline despite being 50 years on from its induction in anaesthesia. Old habits Die hard.

BACKGROUND

Perioperative airway problems frequently result in significant morbidity and mortality in children. Therefore, proficiency in airway management is a key element in the safe conduct of paediatric anaesthesia. Stept and Safar in 1970 amalgamated several techniques and first described Rapid Sequence Induction (RSI) in the adult population. Rapid sequence induction is an accepted method of inducing anaesthesia in patients who are at risk of aspiration of gastric contents into the lungs [5]. It involves a combination of techniques and drugs, traditionally thiopentone and succinylcholine/suxamethonium, which facilitate loss of consciousness at the same time as the application of cricoid pressure, followed by tracheal intubation without face mask ventilation. The aim is to intubate the trachea quickly and safely, minimising the risk of aspiration. However, even after many years of discussing this topic, there is still no international consensus on best practise in paediatric RSI and the practise still varies dramatically depending on whom you train with and where you train. Moreover, this traditional method has been modified in recent years with the introduction of newer induction agents and muscle relaxants. Due to the multitude of anatomical and physiological differences in children, a direct translation of RSI to the paediatric population may result in other potentially more deleterious effects [6]. Recent literature has suggested conventional teaching of RSI in the paediatric population is often inappropriate and inadequate [3,4]. In paediatric patient's RSI is a balance of theoretical risk versus real world practicalities, influenced by surgical urgency.

There are several developmental characteristics that distinguish the paediatric airway from the adult airway. Predictably, these differences are most pronounced at birth and lessen as the infant matures towards an adult airway by 8 years of age. The paediatric airway is smaller in diameter and shorter in length than the adults. The young child's tongue is relatively larger in the oropharynx. The larynx in infants and young children is located more anteriorly and the epiglottis is relatively long, floppy, and narrow. In children younger than eight years of age, the narrowest portion of the airway is below the glottis at the level of the cricoid cartilage. Consequently, the small calibre of the paediatric upper airway, the relatively larger tongue, and the "floppy" and relatively long epiglottis predispose young children to airway obstruction. In addition, the large occiput of the infant places the head and neck in the flexed position when the patient is placed recumbent further exacerbate the potential airway obstruction.

Abnormalities of the paediatric airway represent a significant challenge to paediatric anaesthesiologists. Many syndromes have a combination of airway anomalies and associated cardiac, neurological, metabolic, or endocrine abnormalities. Some become increasingly more difficult with age (e.g., Treacher Collins syndrome) and some improve as the child gets older (e.g., Pierre Robin sequence). Proficiency in direct laryngoscopy and a good basic face mask technique remain the foundation of airway management in children [2].

The relatively low functional residual capacity is an important physiological characteristic of the paediatric respiratory system. Combined with the higher oxygen demand, increased carbon dioxide production and increased closing capacity, there is a low tolerance of apnoea, which rapidly leads to significant hypoxaemia, respiratory acidosis and bradycardia [6,7]. Even optimal denitrogenating or preoxygenation does not result in a sufficiently long 'safety period' to prevent desaturation following even short periods of apnoea. The younger the child, the less time there is [2]. Our study sought to examine whether the traditional preparation and induction of anaesthesia for an anticipated full stomach is followed in infants and toddlers, or whether paediatric anaesthetists modify the RSI to mitigate the potential hazards of arterial desaturation.

There is no data on current practice and paediatric RSI in Ireland. Internationally many paediatric anaesthetists use airway management guidelines for children which have been

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expanded from adult practice. The Difficult Airway Society (DAS), together with the Association of Paediatric Anaesthetist (APA), specifically developed guidelines for the paediatric difficult airway in 3 scenarios: Difficult mask ventilation, unanticipated difficult intubation and the 'Can't Intubate, Can't Ventilate'(CICV) scenario. However there remains no published consensus for paediatric or neonatal rapid sequence induction.

AIMS

The primary aim of this survey was to assess how paediatric RSI is conducted in Ireland in the two tertiary paediatric hospitals, namely Hospital A and Hospital B. Hospital A is a paediatric centre that carries out approximately 14,000 general anaesthetics per annum and has sub-specialties that include Cardiology, Cardiothoracic surgery, Haematology, Oncology and Rheumatology. Hospital B is another tertiary paediatric site in Dublin city performs approximately 9,000 general anaesthetics per annum and has the subspecialties of Neurosurgery, Metabolic and solid organ renal transplantation. Both hospitals are staffed by consultants and non-consultant anaesthesiologists most of whom have trained with the same training body, the College of Anaesthesiologist of Ireland. With no current national data available we decided to investigate current practice by surveying both sites. It was intended to use this information to inform and educate paediatric anaesthetists in Ireland, specifically in advance of the amalgamation of the two tertiary paediatric units on one site over the next 3-5 years.

The secondary aim of this study was to compare the techniques used in each hospital and their safety profile, measured as admission to Paediatric intensive care unit following aspiration after RSI. Finally, as a side note the authors wanted to see how differently these departments performed RSI, which may pose a future challenge on the eve of their amalgamation to one centralised hospital.

METHODS AND MATERIALS

An eight-question survey was designed by the primary author and agreed with the co-authors before being distributed to both departments.

The questions included two common paediatric scenarios. The first, scenario 1 is a 10-week-old baby with bronchiolitis requiring intubation two hours after their last feed and the second scenario is regarding a 2-year-old child with an IV cannula in situ, requiring emergency surgery on a supra-condylar fracture with vascular compromise. Other questions included the level of qualification and speciality, ICU versus Anaesthesiology, or both. Answer options were in the format of both multiple choice and free text. The survey population included consultant and non-consultant anaesthesiologists/intensivists from both sites.

The results were anonymised and entereda Microsoft Excel® spreadsheet. Analysis of the data was carried out using GraphPad Prism version 5.01 for Windows (GraphPad Software, La Jolla California USA, www.graphpad.com). Differences in the practice of RSI between hospital site, and between consultants and doctors in training were assessed using Fisher's Exact test. All comparison tests were performed at a 5% significance level.

Data was also analysed from the ICU database in both sites. Both hospitals utilise the same computer system. A search was carried out over one academic year for admissions to intensive care following aspiration. Of note only one patient was admitted to ICU in hospital A and this was not following RSI.

RESULTS

There were 34 respondents out of a potential total of 73 anaesthesiologists giving a response rate of 47%. There was an early equal number of respondents from Hospital A (n=18) and Hospital B (n=16) (percentage 53% vs 47%). There was also an even distribution of respondents between anaesthesiologists in training (53%) and consultants (44%) (3% unknown). Not all questions were answered by all anaesthesiologists thus the denominators given reflect the number of completed responses for that question.

A statistically significant difference was found between Hospital A and B in the use of suxamethonium in both scenario 1 and scenario 2 (6% vs 75%, $p = <.0001$: 22% vs 75%, $p = 0.005$) as shown in Table 1.There was also a difference in the use of cricoid pressure (22% vs 81%, $p = 0.002$) and pre-oxygenation (56% vs 100%, $p = 0.003$) in Scenario 2. In both scenarios, an RSI technique was more likely to be used in Hospital B. Respondents were also asked about the likelihood that they would utilise various other techniques in these scenarios. In Hospital A, anaesthesiologists were found to be more likely to employ early muscle relaxant administration (50% vs 13%, $p = 0.03$) and inhalation induction (56% vs 13%, $p = 0.01$) in both scenarios. This was elaborated on in the free text boxes which the authors felt were important for heterogeneity. When comparing the practice of RSI between Consultants and non-consultants, there were no significant differences (Table 1,2).

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		Hospital A		Hospital B		
	RSI Technique	**N = 18**	**%**	**N = 16**	**%**	
10-Week-Old	Pre-Oxygenate	12	67%	14	88%	p = 0.23
	Suxamethonium	1	6%	12	75%	**p = < 0.0001**
	Cricoid	5	28%	8	50%	p = 0.29
	Atropine	0	0%	1	6%	p = 0.47
	NGT	13	72%	8	50%	p = 0.29
	Ventilate	10	56%	4	25%	p = 0.09
2-Year-Old	Pre-Oxygenate	10	56%	16	100%	**p = 0.003**
	Suxamethonium	4	22%	12	75%	**p = 0.005**
	Cricoid	4	22%	13	81%	**p = 0.002**
	Atropine	0	0%	0	0%	n/a
	NGT	1	6%	1	6%	p = 1
	Ventilate	8	44%	4	25%	p = 0.3
Other Modifications	Induce on Parent's Lap	4	22%	1	6%	p = 0.34
	Muscle Relaxant Early	9	50%	2	13%	**p = 0.03**
	Inhalation Induction	10	56%	2	13%	**p = 0.01**

Table 1: Conduct of RSI in Hospital A and Hospital B for two scenarios.

		Consultant		Doctors in Training		
	RSI Technique	**N = 15**	**%**	**N = 18**	**%**	
10-Week-Old	Pre-Oxygenate	11	73%	14	78%	p = 1
	Suxamethonium	6	40%	6	33%	p = 0.73
	Cricoid	6	40%	6	33%	p = 0.73
	Atropine	0	0%	1	6%	p = 1
	NGT	9	60%	11	61%	p = 1
	Ventilate	8	53%	5	28%	p = 0.17
2-Year-Old	Pre-Oxygenate	9	60%	16	89%	p = 0.1
	Suxamethonium	5	33%	10	56%	p = 0.3
	Cricoid	8	53%	8	44%	p = 0.73
	Atropine	0	0%	0	0%	n/a
	NGT	0	0%	1	6%	p = 1
	Ventilate	7	47%	5	28%	p = 0.3
Other Modifications	Induce on Parent's Lap	1	7%	4	22%	p = 0.35
	Muscle Relaxant Early	7	47%	4	22%	p = 0.16
	Inhalation Induction	4	27%	8	44%	p = 0.47

Table 2: Conduct of RSI by Consultants and Doctors in Training for two scenarios.

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DISCUSSION

The authors feel the heterogeneity in practice and preferred techniques is worthy of discussion. Results of the survey show that a variety of techniques and modifications are being used in situations where RSI is being employed. It has been shown that practice varies between anaesthesiologists at different levels of training [8] and the results of this survey compliment these findings.

The authors acknowledge that the classical RSI approach for adults was adapted into paediatric practice without any evidence for benefit of same [4]. In fact there is evidence that even optimal pre-oxygenation carries little benefit and an alternative "controlled RSI" with deep anaesthesia, muscle relaxation, and intermittent face mask ventilation may be more appropriate [2,7,9]. However, it is clear from this survey that techniques approximating traditional RSI are being used preferentially in a site located close to one where traditional RSI techniques are no longer routine. Perhaps more questions arise from this survey than are currently answered in current data. The authors must also acknowledge the use of succinylcholine in the paediatric population carries risk of rhabdomyolysis, cardiac arrest, and malignant hyperthermia in undiagnosed muscular disease [10]. So why is it therefore still in use in paediatric anaesthesia when alternatives now exist? The other big question that arises is that despite some literature showing the potential detrimental effect of the "classical RSI Sequence" it is also still being used. Why is this? The authors feel that the lack of hard evidence and of international or academic consensus on paediatric RSI contributes to the continued use of the traditional RSI technique including suxamethonium. With the lack of larger trials and more evidence, old habits will continue to die hard.

Survey strengths include an acceptable response rate [11] and the presence of a free text box which allowed for respondents to include more information.This survey explored RSI conduct in two different scenarios, both an anaesthesia and intensive care scenario. While several comparison tests were performed, potentially undermining the power of the study, differences showed strong statistical significance with very low p-values in most cases. Weaknesses include the low total number of potential respondents which may have left the survey underpowered to find further differences between sites and between grades of anaesthesiologist.

CONCLUSION

Induction of anaesthesia in a child that is anxious, in pain or unwell is always challenging regardless of airway status. This study shows that RSI is still current practice in large tertiary paediatric centres including the use of suxamethonium but is now commonly modified. The results of this survey may help to improve standardised procedures prior to the amalgamation of the 2 largest paediatric sites in Ireland.

The authors' opinion is that the safe practice of paediatric RSI is not dependent on the drug used or the technique implied but more on the departmental skillset, experience and proficiency in the child undergoing intubation for whatever reason [3]. The combination of two distinguished hospitals with varying approaches to practicing RSI in the future not only shows safe anaesthesia for children but a sustained commitment to teaching and a practice to suit everyone's palate.

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DISCLOSURE

The Primary Author has the approval from all other authors to publish this manuscript. There are no competing interests to declare. This work is original and is not submitted or published elsewhere.

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