

A SURVEY OF PAEDIATRIC RAPID SEQUENCE INDUCTION IN A DEPARTMENT OF ANAESTHESIA

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in the partial fulfilment of the requirements for the degree of
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Declaration

I, Lloyd Duncan, herewith declare that this research report is my own, unaided work. It is being submitted for the degree of Master of Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

LrDuncan _____

Signed

On this 25th day of July 2022

Dedication

This project is dedicated to my wife, Tamsin Faith Duncan, for her unwavering support and encouragement in my academic research.

Presentations and publications from this research project

1. A presentation at: none at present
2. A review article: none at present

Abstract

Background

Rapid sequence induction (RSI) is carried out by anaesthetists to secure the airway promptly in patients who are at risk of aspirating gastric content during induction of anaesthesia. RSI requires variation in the paediatric population. We conducted a survey to investigate current practice of paediatric RSI by anaesthetists.

Methods

A descriptive, contextual, cross-sectional research design was followed. The study population consisted of all anaesthetists working in the Department of Anaesthesia at the University of the Witwatersrand. Data was collected in the form of a self-administered questionnaire.

Results

Of 138 questionnaires that were distributed, 126 were completed. Clinical indication for RSI was predominantly for appendicitis with peritonitis (115/124; 92.7%). Preoxygenation was performed by 95.1% of anaesthetists for children, 87% for infants and 89.4% for neonates. Cricoid pressure was used significantly more in children (56%) than in infants (20.8%) and neonates (10.3%) ($p < 0.001$). Rocuronium was the paralytic agent of choice in children (42.7%) and infants (38.2%) while cisatracurium was used most frequently in neonates (37.4%). Suxamethonium was used least in neonates. Cuffed ETTs were used most frequently for children (99.2%) and least for neonates (49.6%). Eighty-five percent of anaesthetists omitted cricoid pressure during RSI for pyloromyotomy, for which a controlled RSI was performed more by consultants and senior registrars ($p < 0.01$). A classic RSI was performed by 53.6% of anaesthetists for laparotomy for small bowel obstruction. Consultants and PMOs were more likely to intubate a child for forearm MUA who was starved for 6 hours who and received opioids ($p < 0.05$). Controlled RSI with cisatracurium was the technique of choice for Tenkhoff insertion in a child with renal failure.

Conclusion

RSI practice for paediatric patients varied widely among anaesthetists. This may be attributed to a combination of anaesthetic experience, training in paediatric anaesthesia, and patient specific factors, along with the individualised clinical scenario's aspiration risk. A controlled RSI technique appears to be implemented more frequently by anaesthetists with increased experience.

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LIST OF ABBREVIATIONS

RSI	Rapid sequence induction
MO	Medical Officer
PMO	Principal Medical Officer
IV	Intravenous
NG	Nasogastric
BMV	Bag mask ventilation
ETT	Endotracheal tube
LMA	Laryngeal mask airway
GUS	Gastric ultrasound

Draft Article

A survey of paediatric rapid sequence induction in a department of anaesthesia

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Introduction

Rapid sequence induction (RSI) was introduced into anaesthetic practice to prevent aspiration of gastric content into the lungs.¹ The steps of a classic RSI do not take into account the physiological, anatomical and psychological differences in neonates, infants and children.² Technique variation, described as controlled RSI, balances the risk of aspiration with the more prevalent risk of hypoxaemia during classic RSI.³ The conduct of RSI in paediatric patients is performed with marked variation and appears to differ in relation to the practitioner's experience in paediatric anaesthesia.⁴

Classic RSI is fundamental to aspiration risk mitigation. Its key features include pre-oxygenation, intravenous induction, application of cricoid pressure, administration of suxamethonium and a period of apnoea until paralysis allows endotracheal intubation.¹ The direct application of this to the paediatric patient, however, may be stressful and harmful.⁵ Pulmonary aspiration with subsequent poor patient outcome during tracheal intubation is a much feared complication of anaesthesia, but it is rare in the paediatric population (2.2 per 10 000) emergency cases with no mortality reported.⁶

A controlled RSI technique addresses aspiration risk while tailoring the induction to paediatric physiological requirements. Its key features include appropriate bag-mask ventilation to maintain oxygenation and adequate depth of anaesthesia and paralysis prior to intubation.³ Although the incidence of pulmonary aspiration is extremely low in patients receiving controlled and classic RSI, patients managed with classic RSI techniques have been found to have significantly higher episodes of desaturation, bradycardia and difficult intubation.⁷

A study conducted in England in 2007 surveyed the RSI practice of 369 anaesthetists with varying degrees of experience in paediatric anaesthesia.⁴ Results showed that technique varied according to patient age and level of experience of the anaesthetist. Significant findings included that cricoid pressure was used less often on infants than on school children, and that suxamethonium was widely used in both infants and older children but was less likely to be used by consultants than trainee anaesthetists.

Published data on current paediatric RSI practice in our academic department setting is lacking. The aims of the study were to investigate the conduct of RSI in paediatric patients by anaesthetists at the University of the Witwatersrand and whether practice varies in relation to paediatric training, level of experience, age group of the patient and the clinical scenario for which RSI is indicated.

Methods

A descriptive, contextual, cross-sectional study was conducted which employed a self-administered questionnaire to the entire accessible population of medical officers (MO), registrars, principal medical officers (PMO) and consultants. A convenience sampling method was used.

A minimum sample size of 124 anaesthetists was calculated in consultation with a biostatistician. This was determined using Raosoft® sample size calculator and is in keeping with the minimum response rate of 60% considered acceptable for a questionnaire.⁸

Ethics clearance was received from the Wits Human Research Ethics Committee (Medical), clearance certificate number M1911108.

Permission to use and adapt a previously published questionnaire by Stedeford and Stoddart⁴ was obtained. Further construction of the questionnaire was based on an unpublished survey done by one of the authors of this study. To achieve further content and face validity, three consultant anaesthetists with an interest in the field of study were consulted to peer-review the questionnaire.

The self-administered questionnaire consisted of three sections (appendix 6). The first section included questions that ascertained level of training and paediatric experience of the anaesthetist as well as two RSI knowledge-based questions. The second section contained 10 practice-based questions which focused on the anaesthetist's standard RSI technique in neonates, infants and children. The final section consisted of four different clinical scenarios in which the anaesthetists were asked to indicate their stepwise conduct of the RSI for each given scenario. The scenarios evaluated the provision of anaesthesia for:

1. A 3-week-old, otherwise healthy baby, for a pyloromyotomy that had been fully resuscitated with intravenous fluids but the cannula came out during transfer to theatre. The patient had a nasogastric tube in-situ that appeared to be draining well.
2. A 4-year-old, previously healthy child for exploratory laparotomy who had suspected small bowel obstruction. The patient had been unwell for 48 hours, with episodes of vomiting and a tender, distended abdomen. The patient had an intravenous (IV) line running and had been resuscitated, but there was no nasogastric (NG) tube in place.
3. A 6-year-old, otherwise healthy child who had a painful forearm fracture requiring manipulation under anaesthesia (MUA). The patient had eaten two hours prior to the injury but had been starved for six hours since the injury and had received opioids in the pre-operative period.
4. A 7-year-old with renal failure and ascites who had been booked for Tenckhoff catheter insertion for peritoneal dialysis. It was an elective procedure and the child has been starved.

For each scenario the anaesthetist was instructed to describe the technique they would most commonly use to establish anaesthesia by indicating on the table the components they would use and the order in which they would use them (Table 1). Techniques were also assessed for features consistent with classic or controlled RSI.

Table 1: Anaesthesia technique details for scenarios

Components	Use (Circle)	Sequence order (Circle)
Site intravenous access	Y / N	N/A 1 2 3 4 5 6 7 8
Insert/suction naos/orogastric tube	Y / N	N/A 1 2 3 4 5 6 7 8
Pre-oxygenation	Y / N	N/A 1 2 3 4 5 6 7 8
Induction	Intravenous/ Inhalational	N/A 1 2 3 4 5 6 7 8
Cricoid pressure	Y / N	N/A 1 2 3 4 5 6 7 8
Appropriate Bag-mask-ventilation	Y / N	N/A 1 2 3 4 5 6 7 8
Muscle relaxant	<u>Circle drug of choice</u>	
<ul style="list-style-type: none"> • Suxamethonium (Sux) • Rocuronium (Roc) • Cis-/Atracurium (Cis-Atr) • None (Ø) 	Sux / Roc / Cis-Atr/ Ø	N/A 1 2 3 4 5 6 7 8
Definitive airway control		
<ul style="list-style-type: none"> • Laryngeal mask airway (LMA) • Cuffed endotracheal tube (cETT) • Uncuffed endotracheal tube (uETT) 	LMA / cETT / uETT	N/A 1 2 3 4 5 6 7 8

Data were collected by distribution of the questionnaires at departmental academic meetings from February to August 2020. Those who agreed to participate were given an information letter and the questionnaire. One researcher remained at the meeting to be available to answer any questions and to prevent data contamination. The completed questionnaires were placed into a sealed box. Each questionnaire was assigned a number. Questionnaires that were returned blank were also assigned a number and included for response rate calculation but not for data interpretation.

Statistical analysis was done in consultation with a statistician. Frequencies and percentages were used to describe categorical variables. Pearson's Chi-squared tests and Fisher's exact tests (where data were sparse) were used to compare differences in responses by anaesthetist grade or patient age group. Bar graphs were used to describe RSI indication, controlled RSI components, pre-oxygenation, cricoid pressure, suxamethonium use, and choice of airway by anaesthetist's grade. Data capturing and bar graphs were done in Microsoft Excel® 2016 and statistical analysis was done in Stata version 15® (StataCorp, USA). A p-value of < 0.05 was considered statistically significant.

Results

Of 138 questionnaires that were distributed, 126 were completed (Table 2), giving a response rate of 91.3%.

Table 2: Responses according to grade of anaesthetist

Grade of anaesthetist	<i>N</i>	%
Medical Officer	23	18.3
Junior registrar (<2 years)	20	15.9
Senior registrar (>2 years)	41	32.5
Principal medical officer	5	3.9
Consultant	37	29.4
Total	126	100

The results of the knowledge and practice-based sections are presented below. Not all questions were answered by all anaesthetists, thus the number (*N*), or denominator indicated, reflects the completed responses for that particular question.

Figure 1 displays the indications for RSI (classic or controlled) by grade of anaesthetist (*N* = 124). MOs and senior registrars were significantly more likely to perform an RSI for 'lower GIT obstruction' than other grades of anaesthetist ($p < 0.01$).

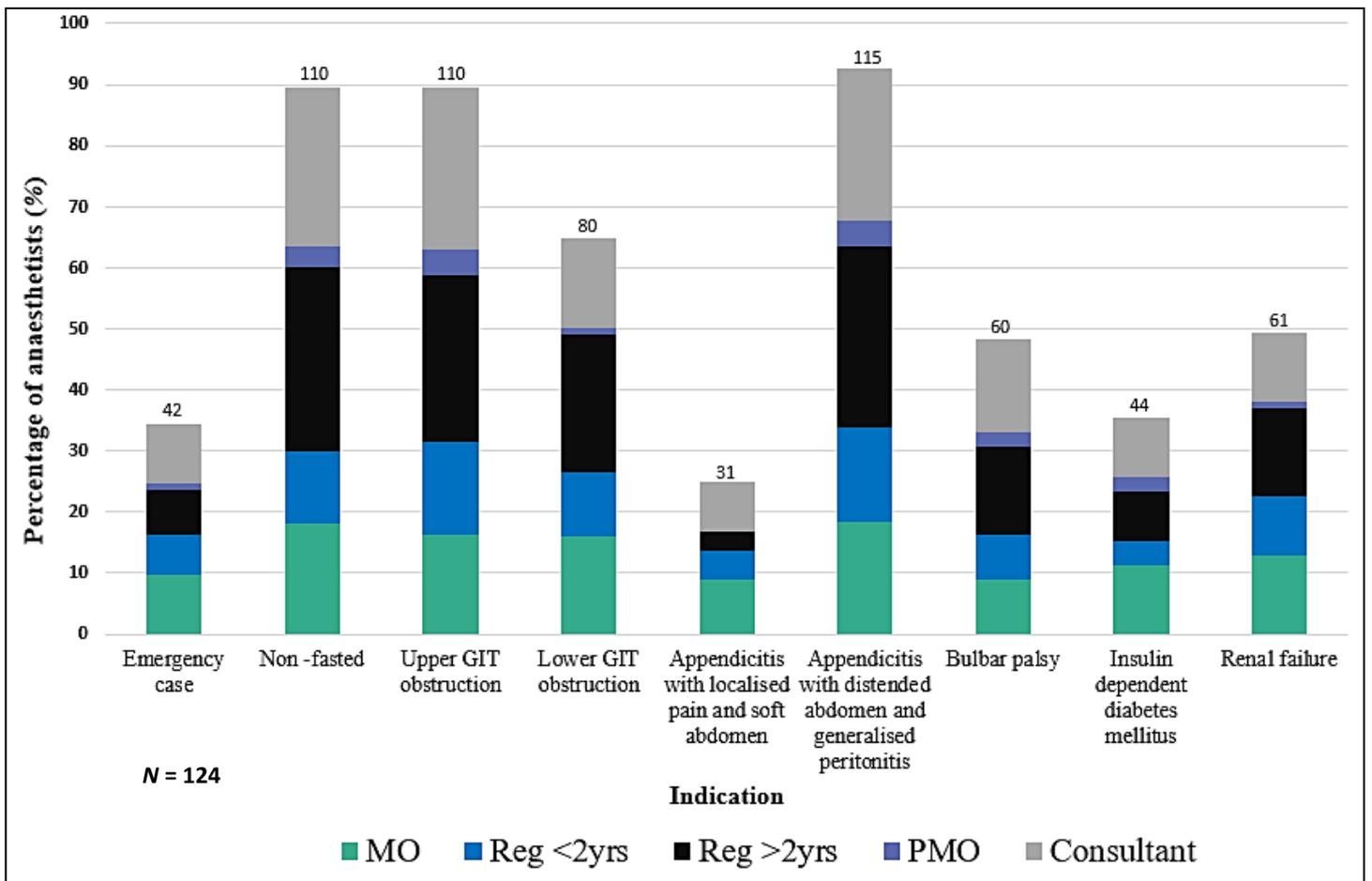


Figure 1: Indications for RSI technique by grade of anaesthetist

The results for anaesthetists' choice on their 2 most important components of a controlled RSI are presented in Figure 2. There was no significant difference in responses on the most important components by grade of anaesthetist ($p = 0.114$).

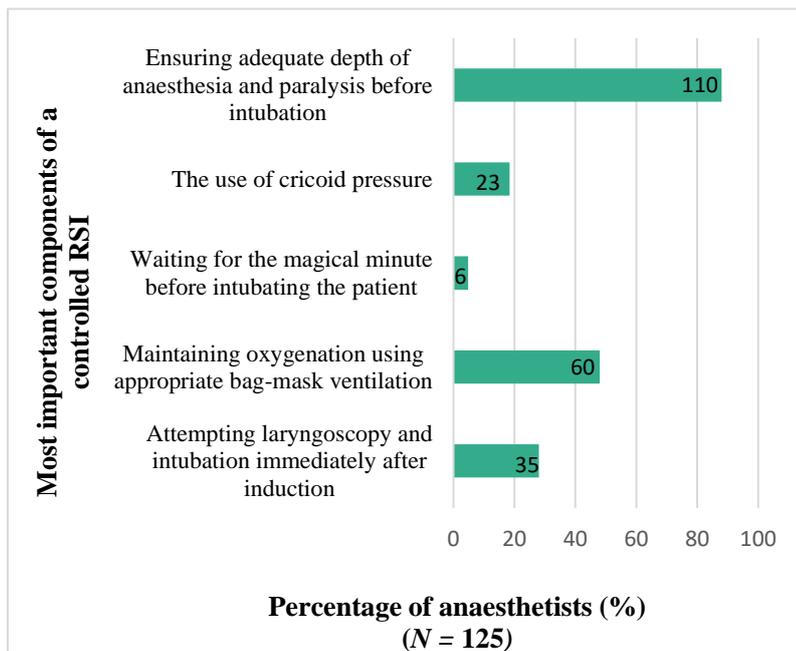


Figure 2: Choice on most important controlled RSI components

Results for standard RSI technique

Anaesthetists were asked to indicate their RSI technique in neonates, infants and children. Results for preoxygenation are shown in Figure 3. The tendency to preoxygenate did not differ significantly by age group ($p = 0.110$). Children were preoxygenated using normal tidal breaths by 76.9% ($n/N = 90/117$) of the anaesthetists of which 80% did this for a duration of 3 minutes or more and 20% for less than 3 minutes. Vital capacity breaths were used by 23.1% ($n/N = 27/117$) of which 76% used five to 10 breaths and 24% used less than five breaths. There was no significant difference in grade of anaesthetist and preoxygenation technique for any age group ($p = 0.221$).

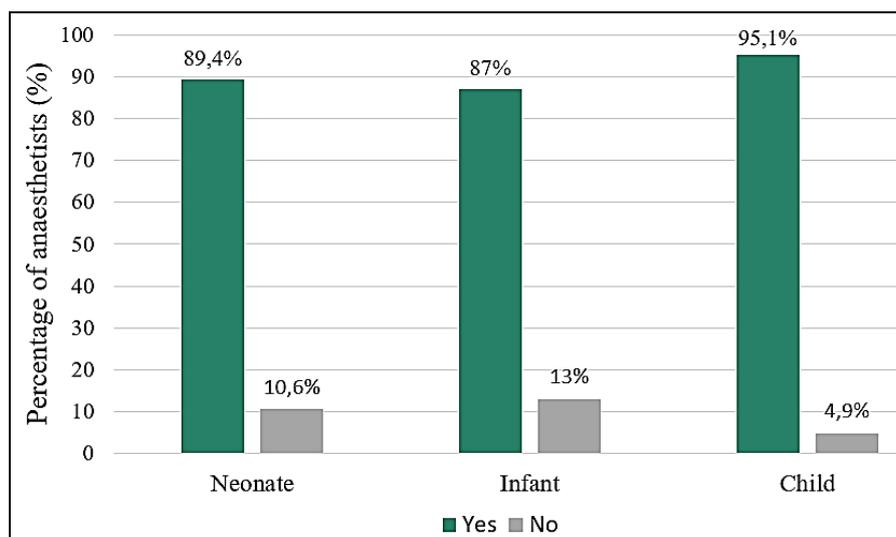


Figure 3: Preoxygenation during RSI

Propofol was the most frequently used induction agent across all age groups. For children, infants, and neonates it was used by 78% ($n/N = 96/123$), 67.2% ($n/N = 82/122$) and 62% ($n/N = 75/121$) of anaesthetists respectively. Sevoflurane was the next favoured induction agent and was used by 33.1% ($n/N = 40/121$) of anaesthetists in neonates, 30.3% ($n/N = 37/122$) in infants and 20.3% ($n/N = 25/123$) in children. Etomidate and ketamine were very seldomly used (less than 4% of anaesthetists in all age groups).

Cricoid pressure was used significantly more in children (70/125; 56%) than in infants (26/125; 20.8%) and neonates (13/126; 10.3%) ($p < 0.001$) by all grades of anaesthetist, as shown in Figure 4.

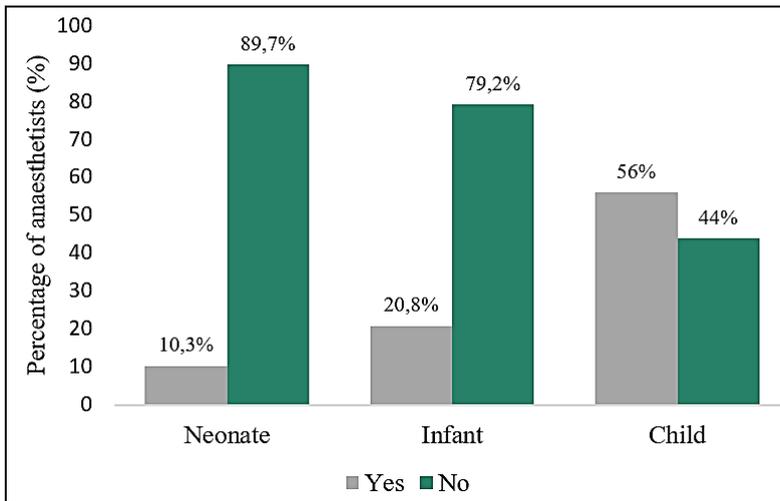


Figure 4: Use of cricoid pressure during RSI

Rocuronium was the anaesthetists’ muscle relaxant of choice for children and infants (53/124; 42.7% and 47/123; 38.2% respectively), while cisatracurium was the most frequently chosen agent for neonates (46/123; 37.4%). Consultants used cisatracurium more frequently in neonates than PMOs, registrars, and MOs (55.6% vs 0%, 40% and 9.1% respectively). Respondents preferentially indicated that they did not use muscle relaxants in neonates (39/123; 31.7% vs 26/123; 21.1% in infants and 13/124; 10.3% in children), however this technique was employed least by consultants than by any other grade of anaesthetist.

When suxamethonium was used, it was more frequently used in children (38/124; 30.6% vs 19/123; 15.4% in infants and 10/123; 8.1% in neonates). However, when suxamethonium was used in neonates, consultants were significantly more likely to use it than any other grade of anaesthetist ($p < 0.05$). The results for the use of suxamethonium are presented in Figure 5.

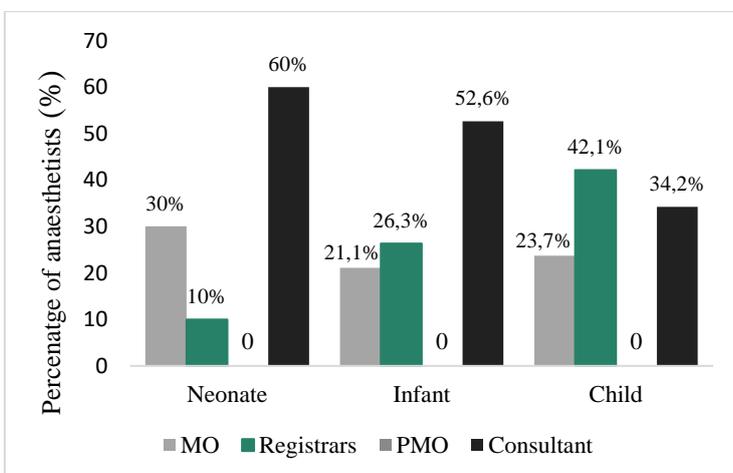


Figure 5: Use of suxamethonium during RSI by grade of anaesthetist

Bag-mask ventilation (BMV) was used by anaesthetists during RSI most frequently for neonates (77/126; 61.1%), followed by infants (59/126; 46.8%) and least in children (32/125; 26.6%). Consultants and registrars were significantly more likely to BMV neonates and infants than PMOs and MOs ($p < 0.05$). Of the anaesthetists that would BMV during RSI ($n = 100$), the majority (66%) would do so at an inspiratory pressure of less than 12 cmH₂O, followed by 33% at 12-16 cmH₂O and 1% at more than 16cmH₂O. Consultants and registrars performed BMV at an inspiratory pressure of less than 12 cmH₂O more frequently than PMOs and MOs (59.4% and 57.4% vs 20% and 34.8% respectively).

Nerve stimulator monitoring of adequate paralysis prior to intubation was used by 1.6% ($n/N = 2/124$) of anaesthetists. Ultrasound evaluation of gastric content was used by 0.8% ($n/N = 1/126$). The evaluation of volume status of the patient prior to RSI was performed by 78.6% ($n/N = 99/126$). Most anaesthetists (117/126; 92.9%) reported they would find it useful to have guidelines detailing the conduct of RSI in paediatric patients.

For RSI in neonates, uncuffed endotracheal tubes (ETT) were marginally favoured over cuffed ETTs (63/125; 50.4% vs 62/125; 49.6%). Respondents indicated that they were more likely to use a cuffed ETT in older children (112/126; 88.9% in infants and 125/126; 99.2% in children). Selection of cuffed vs uncuffed ETT varied little between grade of anaesthetist for any age group ($p = 0.1$).

Scenario 1: A 3-week-old neonate for pyloromyotomy

The 3 week old neonate for pyloromyotomy was intubated by all but one anaesthetist (120/121; 99.2%), who opted for the use of a laryngeal mask airway (LMA). An uncuffed ETT was chosen by 28.1% ($n/N = 34/121$). Suctioning on the NG tube prior to intubation was performed by 89.9% ($n/N = 107/119$) of anaesthetists. Preoxygenation was carried out by 91% ($n/N = 112/123$). Cricoid pressure was omitted by the majority (102/120; 85%) of anaesthetists and this was independent of grade. Volatile induction was opted for by 41.5% ($n/N = 49/118$) and the remainder chose an IV induction (69/118; 58.5%). Cisatracurium was the commonest muscle relaxant used (46/93; 49.5%). BMV during RSI was performed by 66.9% ($n/N = 79/118$) of anaesthetists. Less than a third of anaesthetists elected to intubate without paralysis (26/119; 28%), of which MOs formed the majority (11/26; 42.3%). A controlled RSI technique was used by 62.7% ($n/N = 74/118$) of anaesthetists and was carried out significantly more by consultants and senior registrars than other grades of anaesthetist ($p < 0.01$).

Scenario 2: A 4-year-old with suspected small bowel obstruction for laparotomy

A classic RSI technique was used by 53.6% ($n/N = 67/125$) of anaesthetists. NG tube insertion prior to induction was performed by 77% ($n/N = 97/126$) of anaesthetists. Cricoid pressure was applied by 56.4% ($n/N = 71/126$). The majority of respondents administered an IV induction agent (117/124; 94.4%) while the remaining induced with volatile (7/117; 5.6%). Paralysis with rocuronium was used most frequently (54/124; 43.6%), followed by suxamethonium (44/124; 35.5%). Most respondents (82/126; 65.1%) did not BMV during induction. Endotracheal intubation was performed by almost all anaesthetists (123/124; 99.2%). Results are shown in Table 3.

	Insert/suction NG tube		PreO2		Cricoid		Induction		Paralysis				BMV		Airway			RSI Technique		
	No	Yes	No	Yes	No	Yes	IV	Gas	Sux	Roc	Cis	None	Yes	No	LMA	cETT	uETT	Classic	Controlled	Other
MO	5 (21.7)	18 (78.3)	3 (13)	20 (87)	11 (47.8)	12 (52.2)	20 (87)	3 (13)	8 (34.8)	10 (43.5)	1 (4.3)	4 (17.4)	7 (30.4)	16 (69.6)	0	21 (91.3)	2 (8.7)	13 (56.5)	5 (21.7)	5 (21.7)
Reg <2yrs	7 (35)	13 (65)	0 (100)	20 (100)	9 (45)	11 (55)	17 (85)	3 (15)	3 (15)	9 (45)	6 (30)	2 (10)	5 (25)	15 (75)	1 (5)	19 (95)	0	11 (55)	5 (25)	3 (15)
Reg >2yrs	7 (17.1)	34 (82.9)	1 (2.4)	40 (97.6)	20 (48.8)	21 (51.2)	40 (97.6)	1 (2.4)	14 (34.2)	23 (56.1)	4 (9.7)	0	18 (43.9)	23 (56.1)	0	41 (100)	0	19 (46.3)	17 (41.5)	4 (9.8)
PMO	2 (40)	3 (60)	0 (100)	5 (100)	2 (40)	3 (60)	5 (100)	0	0	2 (40)	2 (40)	1 (20)	1 (20)	4 (80)	0	5 (100)	0	3 (60)	0	2 (40)
Cons	8 (21.6)	29 (78.4)	0 (100)	37 (100)	13 (35.1)	24 (64.9)	35 (95.6)	0	19 (54.3)	10 (28.6)	4 (11.4)	2 (5.7)	13 (35.1)	24 (64.9)	0	35 (95.6)	0	21 (58.3)	13 (36.1)	2 (5.6)
Total	29 (23) n (%)	97 (77) n (%)	4 (3.2) n (%)	122 (96.8) n (%)	55 (43.7) n (%)	71 (56.3) n (%)	117 (94.3) n (%)	7 (5.7) n (%)	44 (35.5) n (%)	54 (43.6) n (%)	17 (28.6) n (%)	9 (7.3) n (%)	44 (34.9) n (%)	82 (65.1) n (%)	1 (2.4) n (%)	121 (97.6) n (%)	2 (1.6) n (%)	67 (53.6) n (%)	40 (32.5) n (%)	16 (12.9) n (%)

Table 3: Anaesthesia technique for laparotomy for suspected small bowel obstruction

Scenario 3: A 6-year-old booked for forearm fracture MUA who was starved for six hours and received opioids

Regarding airway management, 61.3% ($n/N = 76/124$) of anaesthetists would use an LMA. Registrars and MOs used an LMA more frequently than a cuffed ETT, as opposed to PMOs and consultants, whose choice was more frequently a cuffed ETT than an LMA ($p < 0.05$) (Figure 6). Of those who used an ETT, 18.4% ($n/N = 9/49$) performed a classic RSI. The majority of anaesthetists preoxygenated (113/126; 89.7%), induced using volatile (106/126; 84.1%) and did not use cricoid pressure (106/126; 84.1%).

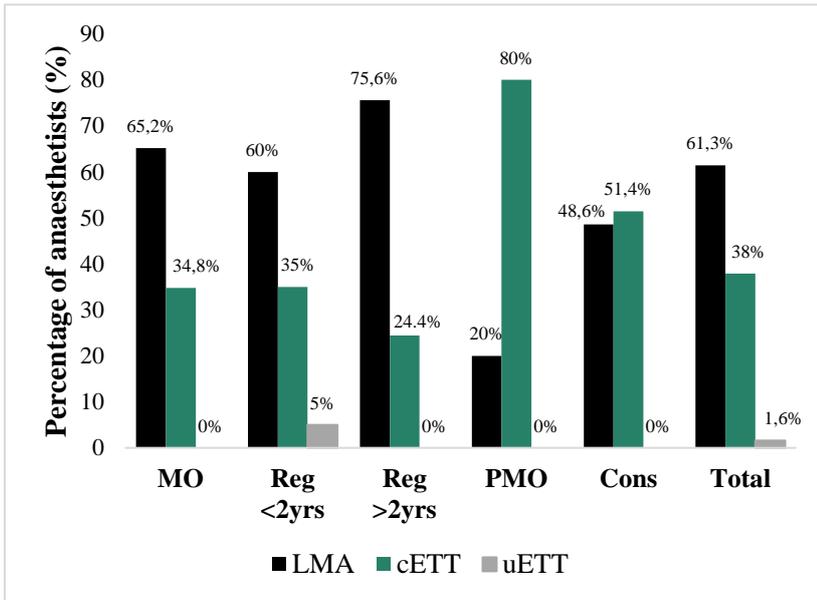


Figure 6: Choice of airway for forearm fracture MUA by grade of anaesthetist

Scenario 4: A 7-year-old with renal failure and ascites for elective Tenkhoff catheter insertion

Intubation was the definitive airway of choice by 96.8% ($n/N = 120/124$) of anaesthetists, of whom 65% ($n/N = 78/120$) employed a controlled RSI technique. Although the choice of induction method did not differ by much (52.4% IV agent vs 47.6% volatile), MOs and PMOs were more likely to perform an IV induction than registrars and consultants ($p < 0.01$). Most anaesthetists (119/126; 94%) pre-oxygenated the patient and 73% ($n/N = 92/126$) omitted cricoid pressure. Cisatracurium was used by 69.4% ($n/N = 86/124$) of anaesthetists and was the most popular paralyzing agent among all grades.

Discussion

Rapid sequence induction in paediatrics is a controversial issue, and there is a great variety in practice among practitioners.⁹ Consistency in terms of aspiration risk assessment was demonstrated in this study, with the most frequent selection of clinical indication for RSI being appendicitis with distended, peritonitic abdomen.

Anaesthetists showed a preference for RSI in cases of bowel obstruction or ileus with a high aspiration risk. This practice is in keeping with the recommendations made by Warner et al.¹⁰ in a study evaluating perioperative pulmonary aspiration, in which the majority of infants and children who aspirated indeed had bowel obstruction or ileus, especially those younger than 3 years of age.

Warner et al.¹⁰ also provided evidence that aspiration mainly occurs when there is coughing and straining due to insufficient anaesthesia at induction and tracheal intubation.

In order to prevent this, a controlled RSI has subsequently emerged as a safer technique. This technique aims to: 1) prevent hypoxemia by gentle ventilation; and 2) prevent aspiration by intubating only when ideal conditions are observed, which include demonstrated complete muscle paralysis and a deep level of anaesthesia.⁷ The results of this study were in-line with these recommendations as the majority of anaesthetists, independent of grade, indicated a preference for these two practices when asked what components of a controlled RSI were the most important.

In the controlled RSI guidelines for the Children's Hospital in Zurich, Switzerland, Neuhaus et al.³ recommend the use of preoxygenation by face mask with 100% oxygen for 2 to 3 minutes if possible. Time to allow adequate denitrogenation may not always be achievable in the non-compliant or combative child and may actually result in increased oxygen consumption.^{2,7} This was reflected in the survey done Stedeford and Stoddart⁴ in 2007 in England where anaesthetists were significantly less likely to preoxygenate infants than schoolchildren⁴. In this study, the tendency to preoxygenate was high for neonates, infants, and children. This may be explained by the fact that *if* optimal preoxygenation can be achieved for 2 minutes, then apnoeic time to desaturation can be extended from 25 to 60 seconds.¹¹ The recommendation is to use preoxygenation as well as soft ventilation after induction so that apnoea with potential hypoxaemia can be avoided altogether.³

The efficacy of cricoid pressure may be limited in paediatric patients. In children less than 8 years old the anatomy is such that the alignment of the upper esophagus differs between trachea and cervical vertebrae;¹² cricoid pressure may distort visualization of the airway, resulting in a more difficult intubation; and lastly, untimely application of cricoid pressure may result in bucking, straining, regurgitation and aspiration.¹³ Cricoid pressure was used by only 56% of anaesthetists in children in our survey, and significantly less in infants and neonates ($p < 0.001$). This differs from the survey conducted by Stedeford and Stoddart⁴ in which 96% of anaesthetists would apply cricoid pressure to children in an RSI, but may be ascribed to the categories in the study being only infant and 'schoolchild'. The guidelines developed by Neuhaus et al.³ emphasize no cricoid pressure unless in cases of achalasia, Zenker's diverticulum, or colon interposition for oesophageal replacement.

Rocuronium was the muscle relaxant of choice for RSI in children and infants in this study. This differs from the survey conducted by Stedeford and Stoddart⁴ in which suxamethonium was widely

used. This may be explained by an increased awareness for its potential adverse effects in paediatric patients,¹⁴ and the demonstration that, at an appropriate dose, rocuronium can create the same ideal intubating conditions as suxamethonium within one minute.¹⁵ When suxamethonium was used by respondents in this study, it was mostly used by consultants providing anaesthesia for neonates. However, suxamethonium remains the first choice drug for RSI in paediatrics, according to 2019 French guidelines, if no contra-indications exist.¹⁶

The use of gastric ultrasound (GUS) to accurately assess presence of gastric content before induction is well described in the literature,¹⁷ but was used infrequently in this study. GUS requires training and many supervised scans for the inexperienced practitioner to achieve 95% accuracy.¹⁸ Again, the lack of use of nerve stimulators in this study to establish adequate paralysis during RSI is likely to be explained by their lack of availability and, in turn, knowledge on their use.

Cuffed ETTs were chosen more frequently in our survey for the intubation of infants and children, while uncuffed ETTs were marginally more favoured for use in neonates. This may be attributed to the long term ideology that the airway of the neonate and infant was funnel-shaped (or conical) with its narrowest point at the cricoid. This has resulted in the use of uncuffed ETTs being common practice for this age group.¹⁹ However, more recent studies have shown that there is no significant change in the anterior-posterior to transverse ratio of the airway with age, and that the airway is in fact elliptical in shape and not circular.²⁰ This new understanding along with improved cuff technology has resulted in the increasing use of cuffed ETTs in neonates and infants.²¹ Uncuffed ETTs may still be the ETT of choice in premature neonates or those less than 3 kg as appropriately sized cuffed ETTs are currently not available.¹⁹

In this study, for the neonate coming for pyloromyotomy, 89.9% of anaesthetists chose to have suction applied to the NG tube to evacuate gastric content prior to induction. This is in keeping with the recommendation from a recent revalidation article which encourages aspirating the NG tube in the supine, left lateral decubitus, prone and right lateral decubitus positions.²² Although only chosen by 41.5% of anaesthetists in our survey, volatile induction has emerged as a safe induction technique for pyloromyotomy.²³ This may indicate a lack in awareness among anaesthetists that this is a safe alternative and continued medical education may help to increase this awareness.

Despite the merits of controlled over classic RSI having been discussed in this article, classic RSI seemed to be marginally favoured (53.6%) as the technique of choice for Scenario 2. It would seem

that for cases with undoubtedly high aspiration risk, classic RSI, in which ventilation with potential gastric insufflation and regurgitation is avoided, is used more readily by participants.

Study limitations

As some responses to certain questions were omitted, and the study was contextual, the results may not be generalizable to all anaesthetists in the department, and other departments. Also, due to the study being a written survey, participants may have chosen the perceived right answer rather than what they may do in actual practice.

Conclusion

RSI practice for paediatric patients varied widely among anaesthetists. This may be attributed to a combination of anaesthetic experience, training in paediatric anaesthesia, and patient specific factors, along with the individualised clinical scenario's aspiration risk. A controlled RSI technique appears to be implemented more frequently by anaesthetists with increased experience. The development and implementation of specific departmental guidelines for paediatric RSI, with member education, may help to improve consistency of practice and ensure good patient outcomes.

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APPENDICES

Appendix 1: Proposal

A SURVEY OF RAPID SEQUENCE INDUCTION AND INTUBATION PRACTICE IN PAEDIATRIC PATIENTS AT THE UNIVERSITY OF THE WITWATERSRAND

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1. Introduction

Rapid sequence induction (RSI) was introduced into anaesthetic practice to prevent aspiration of gastric content into the lungs (1). The steps of a classic RSI, however, do not take into account the psychological, anatomical, and physiological differences in neonates, infants and children (2). A controlled RSI and intubation technique is now described in the literature and balances the risk of aspiration with the more prevalent risk of hypoxaemia during classic RSI (3). The conduct of RSI in paediatric patients is still performed with marked variation and appears to differ in relation to the practitioner's experience with paediatric anaesthesia (4, 5).

A number of findings historically led to the development of the classic RSI that is known today. In 1946, Mendelson (6) described the harmful effects of aspiration of gastric content under anaesthesia. Despite the invention of succinylcholine in 1951 and the newly found appreciation of fasting times, in 1958 Snow and Nunn (7) found that the most common causes of anaesthetic-related death was still aspiration. Sellick (8) then described cricoid pressure to prevent regurgitation of stomach contents in 1961. It was not until 1970 that Stept and Safar (9) combined these components to prevent aspiration by securing the airway as fast as possible after induction, establishing the technique still used today. The indications and components of a classic RSI will be examined more closely.

The performance of a classic RSI is indicated in patients considered at high risk for pulmonary aspiration of gastric contents on induction of anaesthesia. These risks factors for aspiration are:

- non-fasted patients
- abdominal pathology
- emergency surgery, trauma and pain
- use of opioids
- reflux disease
- altered level of consciousness
- pregnancy (1).

Classic RSI is comprised of a sequential order of events performed to secure the unprotected airway as soon as possible after loss of consciousness:

- Pre-oxygenation with 100% oxygen is administered for 3 to 5 minutes (or until expired oxygen fraction is >85%) to maximise the patient's functional reserve capacity of oxygen available during induction.
- A pre-calculated dose of a suitable induction agent is injected intravenously, followed immediately by a neuromuscular blocking agent, specifically succinylcholine.
- Just before loss of consciousness occurs, cricoid pressure is applied.
- As soon as the jaw has relaxed and succinylcholine-associated fasciculations have ceased, direct laryngoscopy is performed and the trachea is intubated.
- Confirmation of correct endotracheal tube (ETT) placement is ensured by ventilation, capnography and auscultation of the chest.
- Cricoid pressure is released once tube position and seal are confirmed.
- The ETT is secured and the patient is placed on mechanical ventilation(1).

Although these steps are suitable when conducting RSI in adults, there are a number of reasons why the classic RSI is not appropriate and even considered harmful in neonates, infants and children. These reasons will be discussed.

The fear of pulmonary aspiration has led to RSI being an often rushed and stressful procedure (10). This is despite no randomised controlled trials confirming decreased incidence of aspiration after RSI in adults or children (11). Studies have confirmed, however, that untimely manipulation of the airway in an inadequately anaesthetised and paralysed paediatric patient is associated with increased incidence of pulmonary aspiration of gastric contents (12). Furthermore, the incidence of aspiration in paediatric patients and its associated morbidity and mortality rates are lower than once perceived. In a study done by Walker in 2013 (13), the incidence of aspiration in paediatric patients during emergency procedures was 2.2 in 10 000 cases. Although 5 of the 24 patients who suffered aspiration required ventilatory support, no mortalities were reported.

Although pre-oxygenation is recommended for RSI in children, it may not be effective. Complete denitrogenation and pre-oxygenation requires time and an effective face-mask seal which may be unachievable in the non-compliant and combative child (2). Apnoea is poorly tolerated in neonates, infants and children, leading to rapid desaturation and hypoxaemia. A reduced functional reserve capacity, and an increased oxygen demand, compounded by anxiety and stress, contributes to rapid decompensation (14). Hardman and Wills (15) demonstrated that in the presence of apnoea and the absence of pre-oxygenation, time to hypoxaemia in a 1-year-old infant is 25 seconds. Two minutes

of optimal pre-oxygenation only increases that time to 60 seconds (16). This shows that the absence of ventilation while awaiting the onset of neuromuscular blockade (45 to 60 seconds), as advocated in classic RSI, would result in hypoxaemia in the infant (14). It is evident that pre-oxygenation alone may not be an effective tool in preventing hypoxaemia in neonates and infants.

Gentle ventilation is advocated while awaiting optimal intubating conditions. This prevents hypoxaemia during RSI without increasing the risk of pulmonary aspiration. This was shown in a study by Neuhaus et al, in which their guidelines recommend regular gentle facemask ventilation with a maximum inspiratory pressure of 10-12cmH₂O while administering sevoflurane at 2% (3). This gentle face mask ventilation does not cause inflation of the stomach (17). The concurrent administration of sevoflurane ensures maintenance of an adequate depth of anaesthesia.

There is no clear evidence that the use of cricoid pressure improves outcomes in the prevention of aspiration during RSI (18). A survey of 102 paediatric anaesthetists revealed 50-60% do not use cricoid pressure during RSI (19). The concerns with cricoid pressure include distortion of the airway anatomy leading to difficult intubation and an associated decrease in lower oesophageal sphincter tone (20). Children may react to its untimely application with bucking and straining, ultimately causing rather than preventing aspiration.-Alignment of the upper oesophagus between the trachea and cervical vertebrae differs in children younger than 8 years old (21), questioning the efficacy of cricoid pressure in younger children. It is for these reasons that the use of cricoid pressure is avoided (3).

Propofol and thiopental are the intravenous agents of choice for RSI in haemodynamically stable paediatric patients. These agents are used at larger doses when compared with adults. Thiopental has a more rapid onset of hypnosis, but propofol has the advantage of suppressing the laryngeal reflexes. Although propofol may cause pain on injection with subsequent movement and increased abdominal pressure, this can be ameliorated by the co-administration of lignocaine (2). Inhalational induction using sevoflurane is used successfully in neonates being anaesthetized for pyloromyotomy. In this setting, measures such as naso-gastric tube drainage and ultrasound assessment of gastric content are taken to ensure the stomach is empty prior to induction (22).

Because gentle bag mask ventilation with a volatile agent ensures adequate depth of anaesthesia and oxygenation, time to onset of sufficient paralysis from the chosen neuromuscular blocking agent is less important. For rapid onset effect, succinylcholine may be the ideal agent. It has, however, been

associated with adverse outcomes in some paediatric patients. Although rare, these complications include cardiac arrest, hyperkalaemia and malignant hyperthermia (23). A focus has therefore been made on the use of non-depolarising agents with less side-effects and the same ability to create ideal intubating conditions within one minute (24). The recommendation in a comprehensive paediatric RSI guideline (3), is the use of a non-depolarising agent with concomitant neuromuscular transmission (NMT) monitoring to indicate the ideal time at which to intubate. In the French 2019 guidelines (25), however, the consensus is the use of succinylcholine for RSI and rocuronium if there are succinylcholine contra-indications.

To accommodate for these differences, a *controlled* technique for RSI has been described. Its key features are: induction of deep anaesthesia; avoidance of cricoid pressure; gentle face mask ventilation to ensure adequate oxygenation and ventilation during induction; and confirmation of complete muscle paralysis prior to intubation utilising NMT monitoring (2). These guidelines on paediatric RSI are laid out in the publication by Neuhaus et al (3). To further emphasise the benefits of controlled RSI, both techniques have been compared and analysed in the literature.

A review by Engelhardt compared the outcome of a study where classic RSI was employed versus a study that used controlled RSI (14). Both studies were retrospective cohort analyses of more than 1000 paediatric patients each. The classic RSI study (26) revealed higher incidences of hypoxaemia, cardiovascular deterioration and difficult intubation when compared to the controlled RSI study (3). In both cohorts, no cases of pulmonary aspiration occurred. It was also shown that compared to controlled RSI, classic RSI resulted in higher stress levels of practitioners and unsafe patient events such as hypoxaemia, and unplanned or forced mask ventilation (10).

Surveys assessing the practice of RSI in children have been performed. One done in England in 2007 revealed variations in technique and drugs in relation to experience of the anaesthetist with paediatric patients (5). Since this survey there has been more published literature and revised guidelines on the topic, and so the proposed research may be of updated value. Another survey done at a Wits hospital, by a consultant in anaesthesia, showed marked practice variation between anaesthetists (4). This survey was done at one hospital with 59 participants and was used as the base work for guidelines to a non-academic field of practitioners. The survey results were not published, however, an article stemming from the survey was published on the controversies of paediatric RSI and proposed protocol (27). The proposed research aims to use a much larger study population for its survey,

across five Wits hospitals, and use the results to investigate variation within the academic setting. Adaptations of these surveys will be used as the data collection instrument in the proposed research.

In order to perform RSI safely in paediatric patients, appropriate modifications to the classic technique are required. These modifications are used in a controlled RSI and have been shown to reduce adverse outcomes and improve overall patient safety and care. The proposed research will endeavor to establish and describe the current practice of RSI in paediatric patients among anaesthetists in the Wits Department of Anaesthesia. These findings will highlight if practice deviates from current international standard of care and will provide a platform for education and reinforced guidelines within the department if necessary.

2. Problem statement

Classic rapid sequence induction (RSI) has been the gold standard technique for preventing aspiration of gastric contents during induction of anaesthesia and intubation in at-risk patients. In paediatric patients, this time-critical procedure is now known to be associated with hypoxaemia and cardiovascular deterioration, as well as high stress levels for the anaesthetist. Premature laryngoscopy, cricoid pressure and attempted intubation before adequate depth of anaesthesia and paralysis is achieved causes bucking/straining and gagging, increasing the likelihood of gastric regurgitation and pulmonary aspiration. Suboptimal intubating conditions increases the risk of difficult, traumatic or failed intubation in addition to aspiration. The occurrence and complications of aspiration in paediatric patients are also not as common or as dangerous as once perceived.

International literature is now revealing that a controlled RSI technique has less complications and has become increasingly accepted by paediatric anaesthetists but is not necessarily practiced by all anaesthetists and trainees, especially those with limited paediatric exposure. The recommendations for RSI in children are being increasingly reinforced and balance the risk of pulmonary aspiration with the much more prevalent risks of performing the classic RSI. The current practice of RSI in paediatric patients by anaesthetists at the University of the Witwatersrand (Wits) is not known.

3. Aim

The aim of this study is to investigate the current conduct of RSI in paediatric patients by anaesthetists at various stages of training and differing levels of experience in the Department of Anaesthesia at Wits.

4. Objectives

The objectives of the study are to:

- describe, using a survey, the conduct and variation of technique in conducting RSI in paediatric patients;
- compare if RSI practice varies in relation to level of experience of the anaesthetist and age group of the patient;
- compare if having had the formal paediatric training block influences the conduct of RSI;
- describe if different clinical scenarios influence the employed RSI technique.

5. Research assumptions

The following definitions will be used in the study:

Classic rapid sequence induction (classic RSI): Intubation of the trachea after rapid onset hypnosis and neuromuscular blockade with the application of cricoid pressure and no artificial ventilation.

Controlled rapid sequence induction (controlled RSI): During induction, oxygenation and ventilation is maintained and the trachea is intubated when the patient is deeply anaesthetised and adequately paralysed.

Anaesthetist: is any qualified doctor working in the Department of Anaesthesiology on the Wits hospital circuit including medical officers, registrars and consultants.

Medical officer: is a qualified doctor practicing in the Department of Anaesthesiology under specialist supervision. Medical officers with more than 10 years of experience are principal medical officers and are regarded as consultants.

Registrar: is a qualified doctor who is registered with the Health Professional Council of South Africa as a trainee anaesthetist.

Consultant: is a specialist anaesthetist or principal medical officer.

Neonate: an infant less than 28 days old

Infant: a child that is 1 month to 1 year old

Child: is a person that is 1 to 12 years old

6. Demarcation of study field

The study will be conducted in the Department of Anaesthesiology, affiliated to the Faculty of Health Sciences of the University of the Witwatersrand. The staff complement of the department is 78 consultants, 112 registrars and 22 medical officers. The following hospitals constitute the core academic and training platform:

- Charlotte Maxeke Johannesburg Academic Hospital a 1200-bed central hospital.
- Chris Hani Baragwanath Hospital a 2888-bed central hospital.
- Helen Joseph Hospital a 500-bed regional hospital.
- Rahima Moosa Mother and Child Hospital a 338-bed regional hospital.
- Wits Donald Gordon Medical Centre a public-private hospital with 190 beds.

7. Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical) and the Graduate Studies Committee of the University of the Witwatersrand.

Permission to distribute the survey to anaesthetists during academic meetings has been granted from the Academic Head of the Department of Anaesthesia (Appendix 5).

An information letter will accompany a self-administered questionnaire (Appendix 6). The information letter will give participants information about why the survey is being conducted and invite them to participate. The return of their completed questionnaire will imply their consent.

In order to maintain anonymity and confidentiality, questionnaires will be numbered without identifying information. Returned questionnaires will be folded and placed in a sealed box. Only the researcher and supervisors will have access to the raw data.

If the study finds that practice is markedly varied and not in keeping with current recommendations, there will be education by way of posters and implementation of departmental guidelines will be considered.

Data will be stored securely for six years after completion of study. Questionnaires will remain in a locked cupboard and electronically captured raw data on a database that is password protected.

The study will be conducted according to the principles of the Declaration of Helsinki (28) and the South African Guidelines for Good Clinical Practice (29).

8. Data collection

8.1 Research design

A descriptive, contextual, cross-sectional research design will be used in this study.

In a descriptive study, information or data is collected without manipulation or alteration of the environment and the findings are then presented to show how, when and why certain phenomena occurred (30). This study will survey the practice of rapid sequence induction and intubation in paediatric patients using a self-administered questionnaire.

Contextual studies take place in a specific environment (30). This study is contextual as it describes practice within a prescribed context, that being by anaesthetists in the Department of Anaesthesiology at Wits.

This study is cross-sectional as the sample is drawn from a relevant population and is studied once (31). It aims to describe practice at a certain point in time i.e. currently.

8.2 Study population

The study population consists of anaesthetists working in the Department of Anaesthesiology at Wits. This population are the targeted participants for the survey.

8.3 Study sample

Sample method

In this study, a convenience sampling method will be used. It is convenience sampling as it makes use of the most readily accessible individuals (32). These will be the anaesthetists present at academic meetings.

Sample size

In consultation with a bio-statistician, a minimum sample size of 124 Wits anaesthetists was estimated for the study. This was determined using Raosoft© sample size calculator and is in keeping with the minimum response rate of 60% considered acceptable for a survey (33).

Inclusion and exclusion criteria

The inclusion criterion in this study are the anaesthetists in the department who are willing to participate and return completed surveys. Incomplete questionnaires will also be included, but a score of zero given to the unanswered question(s).

The exclusion criteria in this study are:

- Students and interns
- Returned blank questionnaires

8.4 Collection of data

Data collection process

The collection of data will be done by means of a self-administered questionnaire (Appendix 5). Permission from the chair of the academic meeting will be sought and the researcher will introduce the study and invite participants to take part in the survey. Information letters and questionnaires will be distributed, and participants will have 15 minutes to complete the questionnaire. After completion the questionnaires will be collected, folded, and put into a sealed box.

All questionnaire sheets will be numbered before distribution in order to keep track of the number of completed questionnaires. Numbering the questionnaires will help to prevent reproduction of results and will allow a response rate to be calculated.

Development of questionnaire

The questionnaire was developed based on a survey published in the literature (5) and a survey done at a Johannesburg academic hospital (4). Permission for the adaptations of these surveys was obtained from the relevant authors.

To ensure content validity, the questions for this survey were chosen and constructed following a comprehensive review of the literature. To further achieve face and content validity, three consultant anaesthetists with an interest in the field of study were consulted to peer-review the questionnaire. Consultation was also made with supervisors and minor corrections were made where necessary.

The questionnaire (appendix 6) consists of 3 questions that assess level of experience, 10 practice related questions and 4 different clinical scenarios that assess application of technique.

9. Data analysis

Data collected from the surveys will be captured onto a Microsoft Excel spreadsheet and a statistical program will be used to analyse the data. Practice and scenario related data will be described using frequencies and percentages. Categorical variables will be compared using the chi-

squared and Fisher's exact tests. Data will be graphically represented in tables and graphs. A 0.05 level of significance (p-value) will be used.

10. Significance of the study

Employing the correct technique when conducting a RSI in the paediatric population is important for patient safety. This population have considerable differences in anatomy and physiology that require adaptation of the classic RSI technique. The current practice of anaesthetists in the Department of Anaesthesiology across all hospitals at Wits is not known. The findings and results of the proposed research will highlight if practice deviates from current recommendations and will provide a platform for education and awareness, which may have a positive outcome on patient safety.

11. Validity and reliability of the study

The validity and reliability of this study will be maintained by:

- using a study design that is appropriate for the topic being researched
- using a standard questionnaire with face and content validity
- using a sample size established in consultation with a biostatistician and by analysing of data with a statistician
- the researcher and an assistant being present on completion of the questionnaires to answer any queries and prevent data contamination
- questionnaires being completed at non-consecutive academic meetings to prevent data contamination

12. Potential limitations of the study

Being a contextual study, the results will only be representative of the anaesthetists available at academic meetings with a potential limit to the range of experience of participants. Awareness of the survey may occur which could skew the authenticity of answers. There is also potential that the participant chooses a perceived right answer or practice rather than what the participant actually does in real practice.

13. Project outline

Activity	Sept 2019	Oct 2019	Nov 2019	Feb 2020	Mar 2020	Apr 2020	May 2020	Jun 2020	Jul 2020	Aug 2020
Proposal preparation										
Literature review										
Proposal submission										
Ethics approval										
Postgraduate approval										
Data collection										
Data analysis										
Draft article										
Submission										

14. Financial plan

Expected costs are laid out in table below and will be covered by the Wits Department of Anaesthesiology.

Item	Price per page	Number of pages	Copies	Total
Proposal	1	15	10	R 150
Ethics	1	10	25	R 250
Survey	1	5	150	R 750
Post graduate form	1	2	6	R 12
Complete report	1	100	4	R 400
Grand total				R 1562

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Appendix 2: Human research ethics committee clearance certificate



R14/49 Dr Lloyd Duncan

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M1911108

NAME: Dr Lloyd Duncan
(Principal Investigator)
DEPARTMENT: Anaesthesiology
Hospitals of the University of the Witwatersrand: CHBAH,
CMJAH, RMMCH, HJH and Donald Gordon Hospital

PROJECT TITLE: A survey of rapid sequence induction and intubation practice in
paediatric patients at the University of the Witwatersrand

DATE CONSIDERED: 29/11/2019

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Dr Palesa Mogane and Dr Michelle Correia

APPROVED BY: 
Dr Nitien Naran, Co-Chair, HREC (Medical)

DATE OF APPROVAL: 07/01/2020

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized

to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **November** and will therefore be due in the month of **November** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____

Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 3: Plagiarism/ turn-it-in report cover page

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ORIGINALITY REPORT

13 %	7 %	10 %	1 %
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

Appendix 4: Journal guidelines to authors

SAJAA

Original articles

Original articles on research relevant to anaesthesia and analgesia should not exceed 3 200 words, no more than 30 references, with up to 6 tables or figures. A structured abstract under the following headings, Background, Methods, Results, and Conclusions is a requirement and should not exceed 300 words.

Manuscript Preparation

Refer to articles in recent issues for the presentation of headings and subheadings. If in doubt, refer to 'uniform requirements' - www.icmje.org. Manuscripts must be provided in UK English.

Qualification, affiliation and contact details

This information must be provided for ALL authors and must be submitted as a supplementary file.

Email addresses of all author must be provided.

ORCID number of ALL authors must be provided - if authors do not have ORCID, please register at <https://orcid.org/>

Abbreviations

All abbreviations should be spelt out when first used and thereafter used consistently, e.g. 'intravenous (IV)' or 'Department of Health (DoH)'.

Scientific measurements

Scientific measurements must be expressed in SI units except blood pressure (mmHg) and haemoglobin (g/dl). Litres is denoted with a lowercase 'l' e.g. 'ml' for millilitres). Units should be preceded by a space (except for %), e.g. '40 kg' and '20 cm' but '50%'. Greater/smaller than signs (> and <) should also be preceded by a space e.g. > 20 years. No spaces should precede ± and °, i.e. '35±6' and '19°C'.

Numbers should be written as grouped per thousand-units, i.e. 4 000, 22 160...

Quotes should be placed in single quotation marks: i.e. The respondent stated: '...'

Round brackets (parentheses) should be used, as opposed to square brackets, which are reserved for denoting concentrations or insertions in direct quotes.

General formatting

The manuscript must be in Microsoft Word or RTF document format. Text must be 1,5-spaced, in 12-point Times New Roman font, and contain no unnecessary formatting (such as text in boxes, except for Tables). *The manuscript must be free of track changes.*

Disclaimers should follow the Conclusion and it should be in the following order:

Acknowledgements, Declaration conflict of interest, Funding source, Ethics declaration and ORCID.

Illustrations and tables

If tables or illustrations submitted have been published elsewhere, the author(s) should provide consent to republication obtained from the copyright holder.

Tables may be embedded in the manuscript file and provided as 'supplementary files'. They must be numbered in Arabic numerals (1,2,3...) and referred to consecutively in the text (e.g. 'Table 1').

Tables should be constructed carefully and simply for intelligible data representation. Unnecessarily complicated tables are strongly discouraged. Tables must be cell-based (i.e. not constructed with text boxes, tabs or enters) and accompanied by a concise title and column headings. Footnotes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || then ** †† ‡‡ etc.

Figures must be numbered in Arabic numerals and referred to in the text e.g. '(Figure 1)'. Figure legends: Figure 1: 'Title...'. All illustrations/figures/graphs must be of high resolution/quality: 300 dpi or more is preferable, but images must not be resized to increase resolution. Unformatted and uncompressed images must be attached as 'supplementary files' upon submission (not embedded in the accompanying manuscript). TIFF and PNG formats are preferable; JPEG and PDF formats are accepted, but authors must be wary of image compression. Illustrations and graphs prepared in Microsoft PowerPoint or Excel must be accompanied by the original workbook.

References

Authors must verify references from the original sources. *Only complete, correctly formatted reference lists will be accepted.* Reference lists may be generated with the use of reference manager software, but the final document must be delinked from the reference database or otherwise generated manually. Citations should be inserted in the text as superscript, e.g. These regulations are endorsed by the World Health Organization,² and others.^{3,4-6} The superscript reference number should come after the punctuation mark and should not be in brackets.

All references should be listed at the end of the article in numerical order of appearance in the Vancouver style (not alphabetical order). Approved abbreviations of journal titles must be used; see the List of Journals in Index Medicus. Names and initials of all authors should be given; if there are more than six authors, the first four names should be given followed by et al. First and last page, volume and issue numbers should be given. Wherever possible, references must be accompanied by a digital object identifier (DOI) link and PubMed ID (PMID)/PubMed Central ID (PMCID). Authors are encouraged to use the DOI lookup service offered by CrossRef. Crossref DOIs should always be displayed as a full URL link in the form <https://doi.org/10.xxxx/xxxxx>

Journal references:

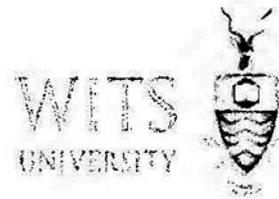
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Other references (e.g. reports): should follow the same format: Author(s). Title. Publisher place: publisher name, year; pages. Cited manuscripts that have been accepted but not yet published can be included as references followed by '(in press)'. Unpublished observations and personal communications in the text must not appear in the reference list. The full name of the source person must be provided for personal communications e.g. '...(Prof. Michael Jones, personal communication)'.

Appendix 5: Permission letter by the Anaesthesiology Head of Department



Department of Anaesthesia – University of the Witwatersrand

7 York Road, Parktown, 2193 South Africa • Telegrams "Witsmed" • Telephone (011) 488-4344 • Fax (011) 488-4343

Department of Anaesthesia
Area 361
Charlotte Maxeke Johannesburg Academic Hospital

Tel: 011 488-4344

16th September 2019

Subject: Permission to conduct survey from Department of Anaesthesiology

To whom it may concern,

This letter stands to affirm that I, Dr PMV Motshabi, grant permission to Dr Lloyd R. Duncan HPCSA number MP 0744654, to conduct survey in Department of Anaesthesiology at University of Witwatersrand for his study "Current practice survey on the conduct of RSI in paediatric patients by anaesthetists in the Wits Department of Anaesthesia".

The approximate period will be, but not limited to, the months of January 2020 to June 2020, until his sample size is obtained. The information obtained from the data will be used for Dr Duncan research study for his Masters in Medicine only, and will include information and data relevant to his study.

Yours sincerely,

	<p>Dr Palesa Motshabi Academic Head, Department of Anaesthesia Head of Clinical Unit, Cardiac Anaesthesia</p> <p>Tel: +27 (0)11 488 4344 Cell: 083 432 1894 Email: palesa.motshabi@wits.ac.za Website: www.wits.ac.za</p>		
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Appendix 6: Data collection sheet

A survey of rapid sequence induction (RSI) and intubation practice in paediatric patients
(Tick the appropriate block)

1. What grade of anaesthetist are you?

Medical officer	
Junior registrar (<2yrs)	
Senior registrar (>2yrs)	
Principal medical officer	
Consultant < 5 years	
Consultant 5 – 10 years	
Consultant >10 years	

2. For registrars only – How long ago did you complete your paediatric training block?

Have not yet done the block	
Currently doing the block	
0 - 12 months ago	
1 – 2 years ago	
> 2 years ago	

3. For consultants only – How often do you anaesthetise children?

At least one list per week	
At least one list per month	
Less than one list per month	
Never	

4. For which of the following cases would you use a RSI technique?
(You can choose more than one option)

Any emergency case	
A non-fasted patient	
An upper GIT obstruction	
A lower GIT obstruction	
Appendicitis with localized pain and soft abdomen	
Appendicitis with distended abdomen and generalized peritonitis	
A patient with bulbar palsy	
Insulin dependent diabetes mellitus	
Renal failure	

5. In your opinion, what are the **2** most important components of a *controlled* RSI?
(Choose 2)

Attempting laryngoscopy and intubation immediately after induction	
Maintaining oxygenation using appropriate bag-mask ventilation	
Waiting for the ‘magical minute’ before intubating the patient	
The use of cricoid pressure	
Ensuring adequate depth of anaesthesia and paralysis before intubation	

During a RSI for paediatric patients:

Key:

Neonate	< 28 days old
Infant	1 month-1 year
Child	1-12 years

1. Which is your preferred method of pre-oxygenation for

(A) a neonate:

Normal tidal breathing If so, for how long?		Do not attempt pre-oxygenation	
--	--	--------------------------------	--

(B) an infant:

Normal tidal breathing If so, for how long?		Do not attempt pre-oxygenation	
--	--	--------------------------------	--

(C) a child

Normal tidal breathing If so, for how long?		Vital capacity breaths. If so, how many?.....		Do not attempt pre-oxygenation	
--	--	--	--	-----------------------------------	--

2. Which induction agent do you use in a haemodynamically stable patient for

(A) a neonate

Propofol		Ketamine		Etomidate		Sevoflurane		Other (specify)	
----------	--	----------	--	-----------	--	-------------	--	-----------------	--

(B) an infant

Propofol		Ketamine		Etomidate		Sevoflurane		Other (specify)	
----------	--	----------	--	-----------	--	-------------	--	-----------------	--

(C) a child

Propofol		Ketamine		Etomidate		Sevoflurane		Other (specify)	
----------	--	----------	--	-----------	--	-------------	--	-----------------	--

3. Which paralysing agent do you use during induction for

(A) a neonate

Suxamethonium		Rocuronium		Cis-/atracurium		None		Other (specify)	
---------------	--	------------	--	-----------------	--	------	--	-----------------	--

(B) an infant

Suxamethonium		Rocuronium		Cis-/atracurium		None		Other (specify)	
---------------	--	------------	--	-----------------	--	------	--	-----------------	--

(C) a child

Suxamethonium		Rocuronium		Cis-/atracurium		None		Other (specify)	
---------------	--	------------	--	-----------------	--	------	--	-----------------	--

4. Do you use cricoid pressure in

(A) a neonate

YES		NO	
-----	--	----	--

(B) an infant

YES		NO	
-----	--	----	--

(C) a child

YES		NO	
-----	--	----	--

5. Do you use bag-mask-ventilation during a RSI in

(A) a neonate

YES		NO	
-----	--	----	--

(B) an infant

YES		NO	
-----	--	----	--

(C) a child

YES		NO	
-----	--	----	--

If so, what is your maximum inspiratory pressure used while bag-mask-ventilating the patient?

<12 cmH ₂ O	
12 – 16 cmH ₂ O	
>16 cmH ₂ O	

6. Do you use a nerve stimulator to monitor adequate paralysis prior to intubation?

YES		NO	
-----	--	----	--

7. Do you use ultrasound to assess the presence of gastric content prior to a RSI?

YES		NO	
-----	--	----	--

8. Do you routinely assess clinical parameters of volume-status prior to performing a RSI on a paediatric patient?

YES		NO	
-----	--	----	--

9. Do you use a cuffed or uncuffed endotracheal tube for a paediatric patient at risk of pulmonary aspiration in:

(A) a neonate

cuffed		uncuffed	
--------	--	----------	--

(B) an infant

cuffed		uncuffed	
--------	--	----------	--

(C) a child

cuffed		uncuffed	
--------	--	----------	--

10. Would you find it useful to have guidelines which direct you on the conduct of RSI in paediatric patients?

YES		NO	
-----	--	----	--

Clinical Scenarios:

You are asked to anaesthetise the patient in the following scenarios:

Please describe the technique you would most commonly use to establish anaesthesia by indicating on the table the components you would use and the order you would use them:

(1= first action, 2= second action, and so forth. You do not have to use all components)

1. **A 3-week-old, otherwise healthy baby, for a pyloromyotomy. He has been fully resuscitated with IV fluids but the cannula came out during transfer to OT. He has a nasogastric tube in-situ that appears to be draining well.**

Components	Use (Circle)	Sequence order (Circle)
Site intravenous access	Y / N	N/A 1 2 3 4 5 6 7 8
Insert/suction naos/orogastric tube	Y / N	N/A 1 2 3 4 5 6 7 8
Pre-oxygenation	Y / N	N/A 1 2 3 4 5 6 7 8
Induction	Intravenous/ Inhalational	N/A 1 2 3 4 5 6 7 8
Cricoid pressure	Y / N	N/A 1 2 3 4 5 6 7 8
Appropriate Bag-mask-ventilation	Y / N	N/A 1 2 3 4 5 6 7 8
Muscle relaxant	<u>Circle drug of choice</u>	
<ul style="list-style-type: none"> • Suxamethonium (Sux) • Rocuronium (Roc) • Cis/-Atracurium (Cis-Atr) • None (Ø) 	Sux / Roc / Cis-Atr/ Ø	N/A 1 2 3 4 5 6 7 8
Definitive airway control		N/A 1 2 3 4 5 6 7 8
<ul style="list-style-type: none"> • Laryngeal mask airway (LMA) • Cuffed endotracheal tube (cETT) • Uncuffed endotracheal tube (uETT) 	LMA / cETT / uETT	

2. A 4-year-old, previously healthy child who has suspected small bowel obstruction. He has been unwell for 48 h, with episodes of vomiting and a tender, distended abdomen. He has an IV line running and has been resuscitated. There is no naso/orogastric tube in place.

Components	Use (Circle)	Sequence order (Circle)
Site intravenous access	Y / N	N/A 1 2 3 4 5 6 7 8
Insert/suction naso/orogastric tube	Y / N	N/A 1 2 3 4 5 6 7 8
Pre-oxygenation	Y / N	N/A 1 2 3 4 5 6 7 8
Induction	Intravenous/ Inhalational	N/A 1 2 3 4 5 6 7 8
Cricoid pressure	Y / N	N/A 1 2 3 4 5 6 7 8
Appropriate Bag-mask-ventilation	Y / N	N/A 1 2 3 4 5 6 7 8
Muscle relaxant	<u>Circle drug of choice</u>	
<ul style="list-style-type: none"> • Suxamethonium (Sux) • Rocuronium (Roc) • Cis-/Atracurium (Cis-Atr) • None (Ø) 	Sux / Roc / Cis-Atr/ Ø	N/A 1 2 3 4 5 6 7 8
Definitive airway control		N/A 1 2 3 4 5 6 7 8
<ul style="list-style-type: none"> • Laryngeal mask airway (LMA) • Cuffed endotracheal tube (cETT) • Uncuffed endotracheal tube (uETT) 	LMA / cETT / uETT	

3. A 6-year-old, otherwise healthy child who has a painful forearm fracture requiring manipulation. He ate 2hrs prior to the injury and has now been starved for 6hrs since the injury. He has received opioids in the pre-operative period.

Components	Use (Circle)	Sequence order (Circle)
Site intravenous access	Y / N	N/A 1 2 3 4 5 6 7 8
Insert/suction naso/orogastric tube	Y / N	N/A 1 2 3 4 5 6 7 8
Pre-oxygenation	Y / N	N/A 1 2 3 4 5 6 7 8
Induction	Intravenous/ Inhalational	N/A 1 2 3 4 5 6 7 8
Cricoid pressure	Y / N	N/A 1 2 3 4 5 6 7 8
Appropriate Bag-mask-ventilation	Y / N	N/A 1 2 3 4 5 6 7 8
Muscle relaxant	<u>Circle drug of choice</u>	
<ul style="list-style-type: none"> • Suxamethonium (Sux) • Rocuronium (Roc) • Cis-/Atracurium (Cis-Atr) • None (Ø) 	Sux / Roc / Cis-Atr/ Ø	N/A 1 2 3 4 5 6 7 8
Definitive airway control		N/A 1 2 3 4 5 6 7 8
<ul style="list-style-type: none"> • Laryngeal mask airway (LMA) • Cuffed endotracheal tube (cETT) • Uncuffed endotracheal tube (uETT) 	LMA / cETT / uETT	

4. A 7-year-old with renal failure and ascites who has been booked for Tenckhoff catheter insertion, in order to commence dialysis. It is an elective procedure and the child has been starved:

Components	Use (Circle)	Sequence order (Circle)
Site intravenous access	Y / N	N/A 1 2 3 4 5 6 7 8
Insert/suction naso/orogastric tube	Y / N	N/A 1 2 3 4 5 6 7 8
Pre-oxygenation	Y / N	N/A 1 2 3 4 5 6 7 8
Induction	Intravenous/ Inhalational	N/A 1 2 3 4 5 6 7 8
Cricoid pressure	Y / N	N/A 1 2 3 4 5 6 7 8
Appropriate Bag-mask-ventilation	Y / N	N/A 1 2 3 4 5 6 7 8
Muscle relaxant	<u>Circle drug of choice</u>	
<ul style="list-style-type: none"> • Suxamethonium (Sux) • Rocuronium (Roc) • Cis-/Atracurium (Cis-Atr) • None (Ø) 	Sux / Roc / Cis-Atr/ Ø	N/A 1 2 3 4 5 6 7 8
Definitive airway control		N/A 1 2 3 4 5 6 7 8
<ul style="list-style-type: none"> • Laryngeal mask airway (LMA) • Cuffed endotracheal tube (cETT) • Uncuffed endotracheal tube (uETT) 	LMA / cETT / uETT	

Appendix 7: Checklist STROBE

Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract ✓
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found ✓
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported ✓
Objectives	3	State specific objectives, including any prespecified hypotheses ✓
Methods		
Study design	4	Present key elements of study design early in the paper ✓
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection ✓
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants ✓
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable ✓
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group ✓
Bias	9	Describe any efforts to address potential sources of bias ✓
Study size	10	Explain how the study size was arrived at ✓
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why ✓
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding ✓
		(b) Describe any methods used to examine subgroups and interactions ✓
		(c) Explain how missing data were addressed ✓
		(d) If applicable, describe analytical methods taking account of sampling strategy ✓
		(e) Describe any sensitivity analyses
Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed ✓
		(b) Give reasons for non-participation at each stage ✓
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders ✓
		(b) Indicate number of participants with missing data for each variable of interest ✓

Outcome data	15*	Report numbers of outcome events or summary measures ✓
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives ✓
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias ✓
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence ✓
Generalisability	21	Discuss the generalisability (external validity) of the study results ✓
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based