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REVIEW ARTICLE

Rapid sequence intubation in pediatric emergencies: an integrative review

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Keywords:

Rapid sequence induction and intubation, Intubation, intratracheal, Pediatric emergency medicine.

Abstract

Objectives: To identify up-to-date information that contributes to increasing the progress of rapid sequence intubation (RSI) in pediatric emergencies. **Methods:** This is an integrative literature review that used the keywords “Rapid Sequence Induction and Intubation”, “Intubation, Intratracheal” and “Pediatric Emergency Medicine” in the Scielo, PubMed and Virtual Health Library databases, using, after applying the inclusion and exclusion criteria, the content analysis for discussion. **Results:** We found 9 articles that were later discussed. **Conclusions:** Many health professionals do not correctly indicate medications during and after RSI in pediatric emergencies, and educational interventions aimed at correcting this failure are beneficial. An accurate epidemiological profile of RSI in pediatric emergencies cannot yet be established. The best way to collect data in studies involving RSI is through video recording. Interventions aimed at reducing the time spent during orotracheal tube insertion may more effectively reduce the total apnea time during RSI. The use of apneic oxygenation and fractional expired oxygen (FeO₂) analysis may have some benefits in RSI.

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INTRODUCTION

Rapid sequence intubation (RSI) is an orotracheal intubation technique that promotes ultimate airway management in critically ill patients presenting to pediatric emergencies, and it is indicated to protect the airway and manage acute respiratory distress.¹

A study carried out at the Hospital das Clínicas of the State University of Campinas showed that 24.6% of all children treated in the pediatric emergency room, which is the place designed to care for patients who require immediate and intensive care, required orotracheal intubation.² Furthermore, the literature also indicates that around 80% of intubations performed in pediatric emergency rooms are performed as RSI.³⁻⁶

Even though it is a procedure highly recommended in pediatric emergencies, up to 15% of adverse events have been recorded, such as cardiorespiratory arrest and hypotension.⁴ Furthermore, more than one intubation attempt is a major factor associated with hypoxia during the peri-intubation period, which also can precipitate a cardiorespiratory arrest.⁷

Injury to the pediatric airway is another adverse event described in the literature as a risk associated with the procedure, especially when there is an incorrect selection of the tube size and its positioning, its displacement and the wrong intubation technique.⁸ Another fact to consider is that, in relation to adults, children have 1/3 the frequency of orotracheal intubations, showing that healthcare professionals have proportionally less experience with this procedure in the pediatric population.⁹

As a way to promote an adequate RSI performance, some centers have tried to implement educational measures, such as the use of a clinical algorithms and training programs, obtaining satisfactory results.^{1,10} Such measures must be based on updated references; however, the literature involving RSI in pediatric emergencies is small. Most of the current protocols on the subject are based on old studies or involving adult patients.

Therefore, an in-depth study on this topic is justified by enabling the provision of recent and reliable information for professionals working with pediatric emergencies. In this way, it contributes to carrying out and indicating RSI correctly and with fewer risks.

OBJECTIVES

Main objective

The overall objective was to identify updated information that contributes to increasing the success of rapid sequence intubation in pediatric emergencies.

Specific objectives

The specific objectives were:

- Investigate the main epidemiological data involving RSI in pediatric emergencies;
- Identify which measures are used to increase the success of RSI and reduce its risks;
- Check the main gaps in the literature involving this topic.

METHODOLOGY

The method used was the Integrative Literature Review. The databases used to select the papers were: PubMed, Scielo and the Virtual Health Library. The keywords used were “rapid sequence intubation”, “orotracheal intubation” and “pediatric emergency”, also using their respective translations in English and Spanish, the Boolean operator “and” and including the terms throughout the body of the article.

During the advanced search in each database, studies published in English, Portuguese or Spanish were included, during the years 2017 to 2022, of the following types: randomized clinical trials, descriptive studies, incidence and prevalence studies, cohort studies and case-control studies.

Afterwards, the following were excluded: review studies, meta-analyses, anecdotal reports and case reports; studies that did not include the pediatric population or that were an absolute minority (<50%) in the total sample; studies focused exclusively on children in the neonatal period; studies evaluating rapid sequence intubation in the surgical center or pre-hospital environment; studies that only evaluated the use of a supraglottic airway; studies that only addressed orotracheal intubation without the use of sedation or paralysis; studies that have already been selected in the previous database; studies whose sample size was too small for there to be statistically significant conclusions; studies whose conclusions did not fit the objectives of this paper.

Subsequently, a table was created with the items: Title; Authors; Objective/Methodology; Results; Discussion/Conclusions.

For the interpretation and discussion of the results, the analytical theory used was content analysis.

RESULTS

During the initial search for papers, considering the keywords and inclusion criteria, we found 2 studies in Scielo; 31 in PubMed and 28 in the Virtual Health Library. After applying the exclusion criteria, 2 papers were kept from the Scielo, 5 from PubMed and 3 from the Virtual Health Library. The two studies found in Scielo were by the same author, carried out in the same center, and obtained the same conclusions. However, one of them included, in its sample, patients intubated between May 2018 and January 2019, while the other included patients intubated between May 2018 and

May 2019, obtaining a more significant sample. This one was kept in the final analysis and that one was excluded. Finally, the studies were organized in the following table 1:

DISCUSSION AND CONCLUSIONS

RSI consists of an intubation technique that, in a coordinated and sequential manner, involves preparation, sedation and neuromuscular paralysis, ending quickly and effectively with laryngoscopy and tracheal intubation. By using pharmacological sedation and paralysis, it reduces the risk of complications in patients with varying levels of consciousness, exacerbated airway protective reflexes and without adequate fasting time¹¹.

Although the use of medications during and after RSI is well established in the literature, this review identified that many professionals who work in pediatric emergencies still do not correctly indicate medications. Lee et al¹² reported that, in younger patients or those with comorbidities, there is a greater probability of insufficient use of medications during the procedure. This is possibly due to an excessive fear of side effects, which is not justified in the literature. When comparing RSI with intubation without the use of neuromuscular blockade, the latter had a considerably lower success rate (55%) compared to the former (83%)³. Furthermore, when the doctors performing the intubation were pediatricians, they were more likely to use medications inappropriately compared to other professionals¹², which could perhaps be explained by a lack of studies and updates on the topic.

In addition to the medications used during RSI, the use of post-intubation medications was also evaluated in one of the studies. According to Berg et al¹³, the majority of patients do not receive post-intubation sedation at the appropriate time, especially when there is the use of long-acting neuromuscular blockers. A justification for this may be that, after RSI, the medications used must be prescribed, a chest x-ray requested to assess the position of the tube, among other pending issues that may delay the start of sedation. Furthermore, the use of long half-life blockers means that the patient has fewer signs of respiratory discomfort for a longer period of time, which may make early detection of the need for sedation difficult.

In this review, studies were found that focused on educational measures in order to reduce errors associated with the use of medications. Caruso et al¹⁴ showed that an intervention based on checklists can help professionals in the correct administration of medications during RSI. The use of this instrument helps to improve communication between healthcare professionals involved in the procedure and optimizes the time for starting medications. Regarding post-intubation sedation, Irwin et al¹⁵ also obtained satisfactory results using interventions based on checklists, optimizing the start time of sedation. Therefore, educational interventions on RSI should be encouraged in order to optimize the performance of the procedure.

Regarding the profile of patients who are intubated in pediatric emergencies, this is data that varies greatly depending on the center studied^{3-4,16-18,21-23}, and there are few recent studies with an adequate sample. In this review, the study carried out by Céspedes et al¹⁹ identified that the main indication for intubation was cardiopulmonary failure, with this and respiratory failure also being associated with greater difficulty in carrying out the procedure. Furthermore, more than half of the intubated patients were less than 1 year of age. Unfortunately, no recent studies with Brazilian data were found, even though the country has large pediatric emergency centers. This is a worrying fact, as an epidemiological study helps to define a target audience for interventions aimed at improving RSI.

Regarding the type of data collection, the study carried out by Rinderknecht et al²⁰ reported that video recording detected more information about RSI compared to a simple medical record review. After all, RSI is a procedure made up of many distinct steps that are often not recorded in detail in medical records, even more so in a dynamic environment such as a pediatric emergency. Therefore, video recording, when available, should always be prioritized as a data collection method.

An example of a study that used video data collection was the study carried out by Shah et al²¹. This showed that the longest apnea time recorded in the RSI was during the insertion of the tube into the airway, and not during laryngoscopy. No other similar studies were found in the pediatric age group, emphasizing the need for studies on the subject and interventions aimed at the moment of tube insertion. In this way, it is possible to reduce the total apnea time and, consequently, the risk of hypoxia.

One of the attempts to prevent hypoxia in RSI is apneic oxygenation, consisting of providing oxygen to the patient in apnea during laryngoscopy and insertion of the orotracheal tube. In our review, the study found by Overmann et al¹² did not indicate benefits from this approach. However, a specific integrative review on the topic, published in 2019, indicated that there may be benefit to this procedure, although there is no strong evidence in the literature.²⁴ Therefore, as apneic oxygenation is a simple, quick and low-cost procedure, it can still be indicated while further studies on the topic have not yet been carried out.

Still regarding hypoxia in RSI, this review found the study carried out by Edmunds et al²⁴, which indicated a possible superiority of O₂ef in comparison to O₂ps in detecting risk for hypoxia, despite there being no strong evidence. However, in the current Brazilian reality, we do not have such a method in the vast majority of pediatric emergencies, and it may be a possibility in the future.

In conclusion, many healthcare professionals do not correctly recommend medication during and after RSI in pediatric emergencies¹⁴. Educational interventions aimed at correcting this flaw are beneficial and should be encouraged

Table 1. Distribution of the studies, according to title, authors, objective, methodology, results, discussions and conclusions.

Title/ Authors / Year of publication	Objective/Methodology	Results	Discussion/Conclusions
Evaluacion del manejo avanzado de la vía aérea en un departamento de emergencia pediátrico./ Céspedes et al. / 2019	Observational, descriptive and prospective study that described advanced airway management in pediatric patients in a pediatric emergency between May 2018 and May 2019.	93 patients were included, with a median age of 10 months. 20.4% were classified as having a difficult airway. 97.8% were intubated as RSI. 55/93 (59.1%) were intubated on the first attempt and 19/38 (50%) on the second. The average time spent in RSI was 3 minutes. The only complication was hyposaturation. Cardiopulmonary failure corresponded to 43% of indications for intubation.	The main indication for RSI was cardiopulmonary failure. Respiratory and cardiopulmonary failure were associated with greater difficulty in the procedure. The number of patients with a difficult airway was frequent, but there was no association with procedure failure. More than half of intubated patients were under 1 year of age.
Apneic oxygenation to prevent oxyhemoglobin desaturation during rapid sequence intubation in a pediatric emergency department. / Overmann et al. / 2018	Retrospective and observational study of patients undergoing RSI in a pediatric emergency department. The objective was to evaluate whether the use of nasal cannula oxygenation in apnea patients reduced the risk of hyposaturation.	The data were collected from 305 patients undergoing RSI over a period of 49 months. Hyposaturation occurred in 50 of 227 (22%) patients in the group that received oxygenation, contrasting with 11 of 78 (14%) in patients who did not receive oxygenation.	Maintaining patients on nasal cannula oxygenation during apnea was not associated with a lower risk of hyposaturation.
Factor associated with the underuse of sedatives and neuromuscular blocking agents for pediatric emergency endotracheal intubation in Korea/Lee et al. / 2022	Multicenter retrospective study that evaluated pediatric patients undergoing orotracheal intubation in the pediatric emergency department between 2016 and 2019. The objective was to evaluate factors associated with the inappropriate use of sedatives and muscle blockers during intubation.	The sample was 334 patients. 63.8% used sedatives and 32.9% used neuromuscular blockers. Patients in the group that did not use medication (n=121), with the group that used only sedatives (n=103) and with the group that used sedatives with blockers (n=110) were compared. The median age of the patients (1 year vs. 2.8 years vs. 11.3 years), the presence of comorbidities (77.7% vs. 56.3% vs. 36.4%) and pediatricians as doctors responsible for intubation (76.9% vs. 54.4% vs. 17.3%) were variables that showed a statistically significant difference.	Underuse of medications for orotracheal intubation is associated with younger patient age, underlying medical conditions, and when the intubating physicians were pediatricians.
The administration of postintubation sedation in the pediatric emergency department. / Berget al. / 2021	Retrospective cohort study with the objective of evaluating the percentage of patients who received post-intubation sedation at an appropriate time.	240 patients intubated between 2007 and 2016 were evaluated. Only 28% received timely sedation. The factors associated with the use of sedation at an inappropriate time were: use of long-acting neuromuscular blockers (eg.: rocuronium) and admission to a pediatric ICU. Children with elevated systolic blood pressure were more likely to receive timely sedation.	Most pediatric patients do not receive timely post-intubation sedation. The risk factors found were the use of long-acting neuromuscular blockers and subsequent admission to a pediatric ICU. Elevated systolic blood pressure was associated with adequate use of sedation.
Effectiveness of interventions to improve medication use during rapid-sequence intubation in a pediatric emergency department. / Caruso et al. / 2017	Retrospective study that evaluated whether an intervention based on checklists was able to improve medication selection and administration during RSI in a pediatric emergency.	253 patients underwent RSI during 3 periods: 136 before the intervention; 68 during the intervention with a checklist containing the step-by-step procedure; 49 during the intervention with the step-by-step checklist and another checklist containing the main medications indicated in the RSI. There was no change in the choice of medications, but the average time for medication administration fell from 28 seconds to 19 seconds.	A checklist-based intervention improved the medication administration technique but did not improve medication selection.

Studying the safety and performance of rapid Sequence intubation: data collection method matters. / Rinderknecht et al. / 2017	Retrospective cohort study that compared the effectiveness of medical record review and video recording in detecting relevant data during RSI in pediatric emergency.	Video review detected 67% of adverse events in RSI, while chart review only 46%. Video review identified 221 laryngoscopy attempts, while chart review detected 187. Duration of preoxygenation was more reliably assessed by video review.	Regarding data collection, medical record review can significantly underestimate RSI adverse events when compared to video recording.
Fraction of expired oxygen as a measure of preoxygenation prior to rapid sequence intubation in the pediatric emergency department. / Edmunds et al. / 2022	Prospective and observational study that aimed to evaluate the use of expired fraction of oxygen (O ₂ ef) in pre-oxygenation as a predictor of post-RSI hypoxia and compare it with the measurement of peripheral hemoglobin saturation (O ₂ ps).	85 patients were included. O ₂ ef at the beginning and end of pre-oxygenation averaged 90%, while O ₂ ps averaged 100%. 11 patients developed desaturation, where the mean O ₂ ps before intubation was 89.5% and O ₂ ps was 100%.	The use of O ₂ ef may be more accurate than O ₂ ps to perform adequate pre-oxygenation, but there is a need for studies with a larger sample.
Don't hold your breath – a Video-based study of procedural intervals during pediatric rapid sequence intubation / Shah et al. / 2022	Retrospective and observational study, collected via video, with the objective of evaluating the breath-hold time spent during laryngoscopy and insertion of the orotracheal tube during RSI.	There were 69 patients and 89 RSI attempts. The average apnea time was longer during unsuccessful attempts (57 seconds) than during successful ones (44 seconds). The duration of laryngoscopy was similar in all attempts, but the time spent inserting the tube was longer during unsuccessful attempts, with an average difference of 15.5 seconds.	The time spent during tube insertion in the RI is the longest breath-hold period of the procedure.
Initiative to improve postintubation sedation in a pediatric emergency department / Irwin et al. / 2022	Intervention study that evaluated the effectiveness of educational measures aimed at improving post-intubation medication administration time. The appropriate sedation administration time was defined when it was shorter than the action time of the medications used in RSI.	Properly timed post-intubation sedation increased from 27.9% to 55.6% after the intervention. The number of patients who received some sedation increased from 74% to 94%. The mean time from RSI to sedation reduced, on average, from 13 to 9 seconds.	Educational measures, such as the use of intubation checklists, are effective in improving post-intubation management.

in our environment. Among them, the use of checklists stands out.²⁰

A precise epidemiological profile of RSI in pediatric emergencies cannot yet be established, especially within the Brazilian reality.

The best way to collect data in studies involving RSI is through video recording²², which is superior to medical recordings.

Interventions aimed at reducing the time spent during insertion of the orotracheal tube can help more effectively reduce the total apnea time of the procedure.

Despite the different results found in this review²⁴, the use of apneic oxygenation can still be used as it is a simple and low-risk procedure. However, more specific studies on the topic must be carried out.

The use of O₂ef may be superior to the use of O₂ps in detecting the risk of hypoxia during the procedure; however, in our current environment, its use is technically unfeasible.

Finally, in this review, we expected to find more papers related to the topic, especially with Brazilian data. Although RSI is an important procedure in pediatric emergencies, literature remains scarce. This reflects the urgent need to carry out more

studies on the topic, which will increasingly contribute to the construction of more complete reviews and, consequently, to the realization of a safer and better indicated RSI in pediatric emergencies.

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