

# Controversies in rapid sequence intubation in children

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## Purpose of review

Rapid sequence intubation is the method of choice for intubation of the emergency department patient. The purpose of the present review is to address several controversies pertaining to emergency department rapid sequence intubation of children.

## Recent findings

The topics covered in this review include the determination of the appropriate clinician to perform emergency department intubation, the use of atropine and lidocaine as premedications, the choice of sedative agents depending upon the clinical scenario, and the choice of neuromuscular blockade agent. Concerning these topics,

- The literature supports that emergency department physicians, with appropriate training, successfully perform intubation in most patients.
- Limited data exist to determine the appropriate use of atropine and lidocaine for rapid sequence intubation.
- Etomidate has clearly become a preferred sedative for rapid sequence intubation with a low risk of cardiovascular side effects. Thiopental and propofol may more readily provide adequate sedation as compared with etomidate but both have the potential to reduce blood pressure.
- Succinylcholine arguably remains the preferred neuromuscular blockade agent for rapid sequence intubation in most children. The side effects of succinylcholine occur in relatively predictable circumstances. Rocuronium is a commonly used nondepolarizing paralytic agent but its prolonged duration of action must be weighed against the risk of side effects associated with succinylcholine.

## Summary

Though more research is needed, the available data allow for the development of protocols that will result in a rational, scenario-based approach to rapid sequence intubation in children.

## Keywords

children, emergency treatment, paralysis, premedications, rapid sequence intubation, sedation, sedative agents

## Abbreviations

<b>ACEP</b>	American College of Emergency Physicians
<b>CQI</b>	continuous quality improvement
<b>ED</b>	emergency department
<b>ICP</b>	intracranial pressure
<b>NEAR</b>	National Emergency Airway Registry
<b>RSI</b>	rapid sequence intubation

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## Introduction

Emergency department intubation (EDI) is frequently the primary lifesaving intervention in the management of the critically ill child. Data from the National Emergency Airway Registry (NEAR), a consortium of academic emergency departments, suggest that approximately half of EDIs in children are performed for trauma related events and the other half for patients with nontrauma medical illnesses such as seizures, altered consciousness, and asthma [1]. Head injury is the single most common indication for EDI in children (~25% of cases) [2].

Rapid sequence intubation (RSI) has clearly become the method of choice in the United States for intubation of the ED patient who is presumed to have a full stomach and is, therefore, at risk of aspiration of gastric contents during intubation. RSI can be defined as 'the virtually simultaneous administration of a sedative (induction) agent and a neuromuscular blockade agent for the purpose of intubation'[1]. RSI both facilitates airway visualization through muscle relaxation, control of agitation and seizures, and the stunting of involuntary reflexes (e.g. gag reflex) associated with laryngoscopy. Also, RSI potentially minimizes complications of EDI such as aspiration. The use of a neuromuscular blockade agent differentiates RSI from EDI performed by other methods. Excluding those in full cardiac arrest for whom the RSI sequence is unnecessary, NEAR (phase I) clinicians used RSI for 94% and 74% of trauma and nontrauma related EDIs in children, respectively [1]. Clinicians appear to use a paralytic agent less frequently (~40% of cases) for children ≤1 year of age [2].

One practical goal in the RSI sequence is to produce excellent intubating conditions 60 s after the administration of the neuromuscular blocking agent. Excellent intubating conditions can be defined as complete jaw relaxation, open and immobile vocal cords, and no coughing, bucking or diaphragmatic movement in response to intubation [3,4].

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The purpose of this review is to address controversies pertaining to RSI and offer a scenario based protocol as a means to summarize and make recommendations. The RSI components within which we discuss these controversies are general preparation, premedication, choice of sedation agent, and choice of paralytic agent. Up front, we must recognize the relative lack of high quality data upon which to make definitive recommendations. Ethical considerations and practical barriers limit investigator ability to perform comparative clinical trials of airway management in the ED setting. Since the available ED data is scant and mainly observational, we often must extrapolate from the anesthesia literature [5].

### General preparation

Seamless, coordinated preparation is essential to the success of RSI, including assessing the difficulty of the airway, rapidly securing intravenous access (preferably two), applying cardiorespiratory monitoring, assembling necessary airway material (Table 1), drawing up appropriate medications, and gathering appropriate personnel. Personnel should have assigned roles, including a person designated to maintain cricoid pressure (Seldinger technique) from the moment the sedative takes effect to the point that intubation is confirmed. Patient characteristics suggestive of a potentially difficult airway include a history of obstructive sleep apnea or snoring; previous traumatic attempts at intubation; evidence of facial, cervical, or neck trauma; a short neck, micrognathia, dysmorphic facial features, low-set ears; limited mouth opening, small mouth, large tongue, or loose teeth; and Mallampati classification class III-IV [6]. The Mallampati classification has been widely used by anesthesiologists to assess airway difficulty, but is rarely described in emergency situations [7]. Physicians must be cautious administering a paralytic agent for patients suspected of having a difficult airway.

**Table 1. Airway material to be prepared prior to intubation**

Oxygen source	High-flow system, non-rebreather mask
Suction	Yankauer tip
Oral airway	Measure from angle of jaw to mouth
Bag valve mask	Infant, child and adult sizes
Endotracheal Tubes with stylets	Size: 4 + (age in years / 4). Obtain 1/2 size larger and smaller. Cuffed after 8 years of age.
Laryngoscope blades	Adult size 7.0–8.0 0–2 years: Miller 0–2; 2 years to adolescence: Macintosh 2–3; adolescence Macintosh 3–4
CO2 detector	Color or continuous capnometry/capnography
Laryngeal-mask airway	Size according to weight
Material for cricothyroidectomy	Pre-assembled and easily accessible

There has been much debate regarding who should perform EDI. Multiple reports in adults indicate very high success rates and low rates of complications when emergency medicine physicians perform EDI on adults [8,9]. Pediatric data from the NEAR noted that 77% and 50% of EDIs were successful on the first attempt when performed by pediatric emergency medicine fellows, emergency medicine residents, and pediatric residents, respectively, suggesting improvement with experience [1]. In a prospective, observational study, Bushra *et al.* noted that EDI was successful within two attempts and was successful overall for 94.6% and 96.6% of patients during a time period when EDI was supervised by a nurse anesthetist, anesthesia resident or anesthesia attending as compared with 95.2% and 98.1% when EDI supervision was changed to attending emergency medicine physicians [10]. Few data are available, however comparing the success and complication rates of pediatric EDI for different specialties, varied levels of training, or different age strata of children. Given the available data, we recommend that trainees gain substantial airway experience in a controlled environment (such as in the operating room) prior to attempting pediatric EDI. Even after such training, an attending or senior fellow experienced in pediatric airway management should be present for all EDIs with an anesthesiologist either present or immediately available. The clinicians most experienced with RSI should be in charge of the most critically ill (i.e. those with limited reserve).

As part of preparation, the spontaneously breathing patient should be pre-oxygenated to reduce the likelihood that positive pressure ventilation will be required after the administration of the sedative and neuromuscular blockade agents (i.e. while intubation is taking place), thereby reducing the risks associated with increased gastric pressure such as aspiration. Pre-oxygenation is achieved by providing 100% oxygen via a non-rebreather face mask for 3–5 min. With complete nitrogen washout, adults may remain well saturated after 5–6 min of apnea [11]. Because children have a higher basal oxygen use per kilogram, they tend to have a shorter time before desaturation, generally between 2 and 3 min [12].

### Premedication

With preparation ongoing, the clinician must appropriately administer RSI premedications. It is often stated that children and young infants have a more pronounced vagal response to intubation than adults, potentially resulting in bradycardia. The PALS guideline and the Pediatric Emergency Medicine Committee of the American College of Emergency Physicians (ACEP) recommend atropine for RSI in children younger than 1 year, older children (ages 1–5 years) receiving succinylcholine, and adolescents receiving a second dose of succinylcholine [13,14]. The recommended atropine dose is 0.01–0.02 mg/kg in children with minimum and maximum doses of 0.1 mg

and 1.0 mg, given at least 1 to 2 min prior to intubation. Despite the existence of these guidelines, little data exist to determine the most appropriate use of atropine. In a recent retrospective review, bradycardia occurred in 3 of 68 children (4.4%) and 3 of 75 children (4%) who did and did not receive atropine pretreatment prior to EDI. This included 2 of 49 (4%) and 1 of 32 (3%) patients who did and did not receive atropine and met the ACEP recommendations for pretreatment [15\*].

Although used in adults to prevent sympathetic responses due to EDI, the main consideration for intravenous lidocaine use in children is to potentially blunt the rise in intracranial pressure (ICP) associated with laryngoscopy and intubation. The exact mechanism of lidocaine action on ICP has not been elucidated, but is likely related to cough reflex suppression, brain stem depression, decreased cerebral metabolism, and cell membrane stabilization. Lidocaine has been shown to decrease the cough reflex in adult patients [16]. The current recommended pediatric dose is 1 to 2 mg/kg given intravenously 2 to 5 min prior to intubation [14]. While widely used, there are no studies that assess the efficacy of lidocaine to improve neurologic outcome for patients undergoing RSI in acute aftermath of a traumatic brain injury. In a systematic review of studies of adult patients, Robinson *et al.* detailed conflicting results on the ability of lidocaine to blunt the ICP response in patients who were being intubated or undergoing endotracheal suctioning [17]. Given the paucity of clinical evidence, clinicians must weigh the potential benefits of lidocaine administration with both its known adverse cardiovascular side effects and the disadvantage of adding a step to an already complex RSI process.

**Choice of sedative agent**

Adequate sedation in RSI rapidly renders a patient unconscious to eliminate patient awareness of being paralyzed and intubated as well as to facilitate the ease of intubation, additive to the effect of neuromuscular blockade [18]. In view of this, the sedative should be administered immediately prior to the paralytic agent. Unfortunately, no perfect sedative agent exists for RSI and controversy surrounds selection. Much of the data available pertaining to sedatives for intubation comes from the anesthesia literature. Practitioner choice of sedative agent depends primarily on the presence or absence of (a) shock, (b) substantial head trauma, and (c) bronchoconstriction (asthma).

**Scenario: absence of head trauma, shock, and bronchoconstriction**

Etomidate, thiopental, and propofol are three preferred sedative agents for ED RSI in children without hemodynamic instability, head injury or bronchoconstriction (Table 2).

Etomidate has seemingly become the most commonly used sedative for adult and pediatric ED RSI in the US,

**Table 2. Characteristics of preferred intravenous sedative agents for rapid sequence induction**

Drug	Class	Dose	Onset of action	Duration of action	Side effects	Selective contraindications
Etomidate	Imidazole, non barbiturate hypnotic	0.2–0.3 mg/kg	<1 min	4–10 min	Adrenal suppression, myoclonus, emesis	Focal seizure disorder, adrenal insufficiency
Thiopental	Barbiturate	Adults 3–5 mg/kg Children <12 years 5–6 mg/kg	0.5–1 min	10–30 min	Decreased cardiac output, hypotension, bronchospasm, laryngospasm	Hemodynamic instability, status asthmaticus
Propofol	Nonbarbiturate, non-opioid, sedative-hypnotic	Adults 1.5–2.5 mg/kg Children 2.5–3.5 mg/kg	<1 min	3–10 min	Hypotension, injection site pain	Hemodynamic instability
Ketamine	Nonbarbiturate dissociative agent	1–3 mg/kg	<2 min	10–30 min	Emergence phenomena, tachycardia, hypertension, hypersalivation, nystagmus, laryngospasm, increased ICP	Head trauma, hypertension, penetrating eye trauma

used in 42% of RSIs for children in the NEAR (phase I) [1]. Small prospective, observational studies of adult ED patients and studies of patients undergoing surgery suggest that etomidate in combination with a paralytic agent produces adequate intubating conditions in at least 75% of cases [4,19,20\*]. Data suggest, however, that etomidate may not be as effective a sedative for ED RSI when compared with thiopental or propofol but it has the major advantage of inducing only occasional hemodynamic changes (as discussed below) [4,18].

The concerns raised regarding the use of a single dose of etomidate and the risk of adrenal suppression have not been completely answered. Two retrospective reviews in children (total of 205 patients) reported no clinically suspected cases of adrenal insufficiency after RSI with etomidate [21,22]. One prospective randomized controlled adult ED trial of 31 patients compared etomidate to midazolam specifically to assess adrenocortical function. While there was a significant decrease in adrenocortical function at 4 h in the etomidate group, there was no difference at 12 or 24 h, and measured absolute cortisol levels always remained within normal ranges [23].

Although etomidate may cause myoclonic jerking as a side effect, potentially more problematic is an apparent ability to lower the threshold for focal seizures in at-risk patients [19,22,24,25]. Of 105 children younger than 10 years who received etomidate for RSI, Guldner noted that 4 developed seizures after admission. All of these patients, however, had come to the ED for seizures or had a history of a seizure disorder [22].

Thiopental is the second most frequently administered sedative agent for pediatric ED RSI, used 22% of the time [1]. In the NEAR data, barbiturate use (mainly thiopental) was associated with a greater likelihood of successful intubation on the first attempt compared with other sedatives, including etomidate (OR = 2.58, 95% CI 1.48–4.50) [18]. At a dose of 4–5 mg/kg, thiopental produces good to excellent intubating conditions 73–100% of the time when used as an induction agent for children undergoing general anesthesia [26–29]. Thiopental, as well as other barbiturates, have the well-known disadvantage of decreasing systolic blood pressure [28–33].

Though used less frequently for ED RSI than either etomidate or thiopental, propofol appears to be an effective alternative sedative [1]. In studies of adults and children undergoing surgery, propofol in conjunction with a paralytic agent provided good to excellent intubating conditions in 79–97% of cases, frequently more often and more quickly than either etomidate or thiopental [4,29,34–37]. In one randomized trial, Skinner *et al.* simulated RSI conditions and noted that 94% and 75% of adult patients achieved clinically good to excellent intubating conditions 60 s after

the administration of either propofol (2.5 mg/kg) or etomidate (0.3 mg/kg), respectively, in combination with rocuronium (0.6 mg/kg) [4]. Similar to thiopental, one clear disadvantage of propofol is its ability to induce hypotension, potentially more so than thiopental [29,38]. One minor disadvantage of propofol is pain on injection, noted in up to 50% of cases [28,32].

Practitioners use benzodiazepines as the sole sedative in ~18% of RSIs, with midazolam accounting for 90% of these cases [1]. However, the variable effectiveness of this class of agents to induce unconsciousness and the availability of other more reliable agents generally makes them a suboptimal choice for RSI [26,39–41]. In one of the few ED RSI randomized trials, Sivliotti noted that 69% and 93% of adult patients given midazolam (0.1 mg/kg) or thiopental (5 mg/kg), respectively, were successfully intubated within 2 min of the administration of succinylcholine [26]. The lack of effectiveness of midazolam in children has mainly been noted in anesthesia studies. Salonen *et al.* noted that only 17% of 27 children undergoing general anesthesia induction for elective surgery were asleep at 3 min after given 0.15 mg/kg of midazolam and only 67% were asleep after doses ranging from 0.45–0.60 mg/kg [39]. Studies in adults corroborate that most patients are not asleep 1 minute after the administration of 0.15 mg/kg of midazolam [40,41]. Additionally, practitioners frequently administer benzodiazepine in doses less than recommended to induce unconsciousness. Sagarin *et al.* noted that 56% of children received less than the 0.1 mg/kg minimum dose of midazolam recommended to induce unconsciousness, seemingly not the result of physician concern over inducing hypotension or that the group of patients for whom low doses were used was more neurologically impaired [42].

#### **Scenario: shock, no head trauma, no bronchoconstriction**

Etomidate has become a sedative of choice for ED RSI of adult and pediatric patients in shock (with or without hypotension) because of the relatively uncommon hemodynamic changes that occur with its use compared with barbiturates and propofol. Smith *et al.* noted no clinically significant hemodynamic changes with etomidate even in adult patients with cardiac disease or pre-existing hypotension [19]. In a study of 20 trauma patients intubated with etomidate, no clinically significant change in blood pressure was noted within 10 min of intubation [43]. In a retrospective review of 105 pediatric patients, Guldner reported no significant changes in systolic blood pressure with etomidate administration (mean change +4 mm Hg, 95% CI –3.3, +9.2). [22] In a separate retrospective review of 100 pediatric patients <10 years who underwent RSI with etomidate, the mean change in BP pre and post intubation was –1 mm Hg (95% CI –6, +7). Sokolove *et al.* did note, however, that 4.8% of patients experienced

a substantial reduction in BP with use of etomidate (not all necessarily due to etomidate), underscoring that no commonly used sedative is completely without hemodynamic side effects [21].

**Scenario: head injury, no shock, no bronchoconstriction**

Etomidate, thiopental, and propofol are preferred sedatives in cases of head injury as all three have beneficial effects on intracranial pressure (ICP) [44–46]. Etomidate has been shown to lower ICP in head injured patients with documented ICP > 20 [44]. In a multicenter randomized trial of 73 patients with severe head injury and elevated ICP, those treated with barbiturates were twice as likely to attain normal ICPs as those treated with other conventional therapies [45]. Because of their tendency to lower systemic blood pressure (as detailed above), thiopental and propofol should be used cautiously in patients at risk for hypotension so as to avoid lowering mean arterial pressure and, thereby, lowering cerebral perfusion pressure.

**Scenario: active asthma, no head injury, no shock**

Although etomidate is a reasonable sedative choice for RSI of a patient with active asthma, ketamine may be preferable as it both provides effective sedation and alleviates bronchospasm (likely through catecholamine release) [47]. Data from the anesthesia literature suggest that, at doses ranging from 1.5 mg/kg–2.0 mg/kg, ketamine in combination with a neuromuscular blocking agent produces acceptable intubation conditions in the vast majority of patients [48,49]. In a case series of five pediatric patients who received 1.5–2.0 mg/kg of ketamine as part of the EDI for status asthmaticus, all patients had a fall in pCO<sub>2</sub> after successful intubation [50].

**Choice of paralytic agent**

After a sedative has been administered, the next step in RSI is the induction of paralysis via a neuromuscular blockade. Prospective observational studies in both children and adults suggest that the use of paralytics improves the rate of successful intubation on the first attempt [1,51]. In a prospective study of adult ED patients, intubation was successful in 99% of patients for whom paralysis was induced as compared with only 82% without neuromuscular blockade [51]. Analysis of pediatric data from the NEAR noted a higher rate of successful intubation on initial attempt with the use of a paralytic agent (78%) compared with no medications (47%) or the use of a sedative alone (44%) [1]. ED practitioners who use paralytic agents, however, must be completely comfortable assessing the difficulty of a patient's airway, performing intubation, and managing the airway if the intubation fails.

There are two classes of paralytic agents used in RSI: depolarizing agents and nondepolarizing agents. While there are several available nondepolarizing agents, succi-

nylcholine is the only clinically available depolarizing agent. Succinylcholine has been in use since 1951 and arguably remains the preferred agent for induction of paralysis in RSI when performed by ED physicians because of its rapid onset of paralysis, within one minute of infusion, and short duration of action (approximately 5 min) [52]. In the setting of RSI, succinylcholine is given at a dose of 1–2 mg/kg IV or 2–4 mg/kg IM [53,54]. Recent data suggest that doses lower than 1 mg/kg may be equally effective at inducing paralysis but with shorter duration [55].

The controversy surrounding succinylcholine use results from infrequent side effects that often occur in relatively predictable circumstances. One side effect often discussed is hyperkalemia. As a depolarizing agent, succinylcholine initially stimulates muscle contraction, resulting in the release of potassium. Physiologically, this leads to a brief period of muscle fasciculation followed by an increase in serum potassium of 0.5–1 mEq/L after the administration of a 1.0 mg/kg dose [56]. When myocytes are damaged or diseased, such as occurs with burns, crush injuries and muscular dystrophy, post-synaptic receptor density increases [57]. In the presence of a higher receptor density, administration of succinylcholine results in an exaggerated response, with prolonged fasciculations, rhabdomyolysis, and hyperkalemia. Multiple case reports have described hyperkalemic cardiac arrests associated with succinylcholine use in both children and adults with underlying muscular dystrophies or who are immobilized for prolonged periods [58,59]. With burns and crush injuries, however, receptor proliferation does not occur until 48–72 h after the event. Therefore, the use of succinylcholine is not contraindicated in patients with acute burns or trauma, but is not recommended in patients for whom these injuries were sustained more than 24 h prior [60,61].

Relative contraindications to the use of succinylcholine include patients with increased intracranial or intraocular pressure. Concerns regarding increased intracranial pressure arise largely from animal studies and from studies on patients with brain tumors [62]. In small prospective randomized clinical trials performed in head trauma patients, no increase in ICP was noted with the use of succinylcholine [63,64]. In a systematic review, however, Clancy *et al.* noted that, while no studies revealed an increase in ICP with succinylcholine, existing studies were often small and inconclusive and did not address patients with immediate head trauma [65].

In both animal and clinical human studies, the administration of succinylcholine may result in increased intraocular pressure [66–68]. It is unclear, however, if this often small increase in intraocular pressure impacts clinical outcome. For example, no extrusion of vitreous content was noted in a series of 73 patients with penetrating eye trauma who were administered succinylcholine [69].

Lastly, succinylcholine triggers malignant hyperthermia in patients with a genetic predisposition. In such rare patients, administration of succinylcholine triggers a hypermetabolic state manifested by extreme hyperthermia, acidosis, tachycardia, hypoxemia, and rhabdomyolysis.

Although we contend that succinylcholine in general remains the preferred paralytic agent for ED RSI, the somewhat overstated risks of adverse events associated with succinylcholine have prompted the use of nondepolarizing agents. Nondepolarizing agents competitively interact with the postsynaptic receptor of the neuromuscular junction and prevent the binding of acetylcholine. There is no period of initial fasciculations or concomitant potassium release from myocytes. Unlike succinylcholine, nondepolarizing agents all have the disadvantages of a longer time to onset and a longer duration of action. While there are several newer nondepolarizing agents available, only vecuronium and rocuronium have been frequently used in children in the setting of RSI.

Rocuronium is preferred over vecuronium for RSI due to vecuronium's longer onset to paralysis and prolonged duration of action [70–72]. Rocuronium is a metabolic derivative of vecuronium; both are devoid of cardiovascular side effects. Recommended dosages of rocuronium for RSI range from 0.6–1.2 mg/kg i.v. with onset of action approximately 30 s at higher doses and 90 s at lower doses [73,74]. As with vecuronium, duration of action varies with age as well as with increasing dosage. At a dose of 0.6 mg/kg, rocuronium lasts approximately 45 min in infants and 27 min in children [57]. At higher doses that result in a more rapid onset of action, average duration of action of rocuronium is 53 min with a range from 23–88 min in adults [71].

It has been suggested that rocuronium is a suitable replacement for succinylcholine because it has a length to onset of action comparable to succinylcholine and fewer side effects. In a thorough meta-analysis of 26 randomized controlled trials of mainly adult patients, Perry *et al.* noted that succinylcholine established more reliably excellent intubation conditions relative to rocuronium (RR of 0.87) [75,76]. In a prospective RCT study of 120 children ages 1–10 years, however, rocuronium was shown to provide similar intubating conditions to succinylcholine, but at higher doses (1.2 mg/kg) [73]. The mean time to recovery for a 1.2 mg/kg dose of rocuronium was 45 min as compared with 5.8 min for succinylcholine [77].

To gain the advantages of succinylcholine and minimize its side effects, it has been suggested that a defasciculating dose of a nondepolarizing agent be given prior to the administration of succinylcholine. In a small randomized controlled study, 45 children, 3–15 years old, were pretreated with either saline or a nondepolarizing paralytic agent, and then treated with succinylcholine. While there was no dif-

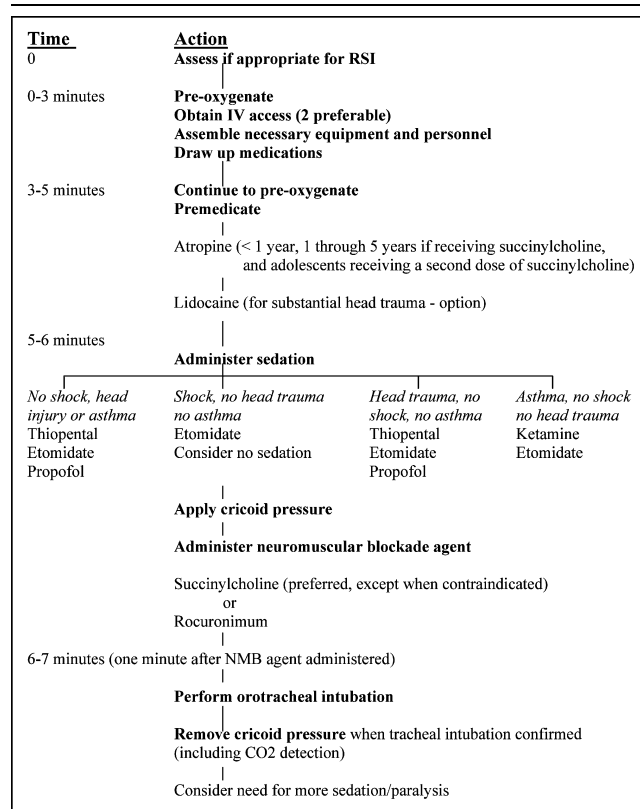
ference in the amount of fasciculations, the rise in serum potassium levels was significantly less when pretreated with a nondepolarizing agent (0.45 mmol/L for saline group vs. 0.0 for nondepolarizing agent group) [78]. Unfortunately, the pre-fasciculating dose must be given 2 min prior to succinylcholine which may not be tenable in an emergent situation.

In summary, a comparison of available nondepolarizing agents to succinylcholine reveals that succinylcholine remains a preferred agent for RSI in children due to the rapidity of onset of action and its short duration of action. Rocuronium appears to provide a safe alternative, especially for children with crush injury or burns more than 24 h prior or a history of neuromuscular disease or renal insufficiency. Clinicians must weigh the rare, potential side effects of succinylcholine with the prolonged duration of action of rocuronium.

### Conclusion: rapid sequence intubation protocols

Studies have described the development and implementation of RSI protocols [79]. As part of a continuous quality improvement (CQI) initiative, a committee composed of anesthesiologists and emergency medicine physicians at the Medical Center of New Orleans developed an RSI protocol for children that included the sequence

Figure 1. A potential scenario based protocol for rapid sequence intubation in children



and timing of events and appropriate interventions (including drug choice) [79]. The committee also developed RSI protocols for specific circumstances in adults including one for increased intracranial pressure and one for asthma [80]. The staff collected useful CQI data on standardized forms including the reason for intubation, success rates, number of attempts, training level of the intubator, protocol deviations (e.g. alternative medication use), mode of endotracheal tube placement verification, and complications [80]. We recommend the development of such protocols to promote institutional consensus, provide a framework for staff and trainee education and assessment, and provide a template for CQI. A potential scenario based protocol for RSI in children is detailed in Figure 1 and serves to summarize existing data.

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- of outstanding interest

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