

Michale Sofer

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### Case

A 5-year-old male presents to the emergency department (ED) with a right supracondylar fracture after falling from the monkey bars. He has no other injuries, no notable past medical history, and no past surgical history. He ate lunch about an hour prior to his fall and arrived to the ED approximately 30 min later. He has a 22-gauge IV in his left upper extremity and a splint to his right upper extremity. He is noticeably upset and tucked into his mother's arms. The pediatric orthopedic surgeon would like to take him urgently to the operating room (OR) for a closed reduction with percutaneous pinning (CRPP), and possible open reduction with internal fixation if needed. The surgeon anticipates 20–30 min operative time and minimal blood loss for the case.

Just as you are finishing preparing the room for the case, your friend, a pediatric anesthesiologist, peeks into the operating room to offer you a hand. You are not pediatric trained, but often take care of older children when on call. You welcome your friend, along with her professional input, into the room and ask her to peek at your setup and see if there is anything you forgot.

As she looks over your anesthesia machine and cart, she notices the medications you prepared for induction and asks, “Are you planning to do a rapid sequence induction?”

### Questions

Does Rapid Sequence Induction (RSI) have a role in pediatric anesthesia? Should we instead consider “modified-RSI?” If we do utilize RSI, which muscle relaxant is most appropriate: succinylcholine or rocuronium?

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M. Sofer (✉)

Department of Anesthesiology, Perioperative Care and Pain Medicine, New York University Langone Medical Center, 550 First Avenue, New York, NY 10016, USA  
e-mail: soferm@email.chop.edu

**PRO:** Of course! He's a trauma patient. He is a “full stomach.”

I was planning to do a classic RSI. I don't want to ventilate and insufflate his stomach. He ate lunch a measly 2 h ago! Thankfully, he already has an IV from the ED, so that's one less thing to worry about. I was going to place all my monitors and pre-oxygenate for at least 3 min. I've prepared propofol, fentanyl, and rocuronium for induction. With an intubating dose of rocuronium, he should have adequate intubating conditions in about a minute or so. I've done it this way before in older children, it works well.

**CON:** My main concern is that he won't tolerate apnea, even for that minute. In fact, the younger the child, the less likely they are to tolerate classic RSI. First, he simply may not cooperate. Wrestling a mask on his face for pre-oxygenation is likely to just leave you both out of breath! He is already in tears, and the mask may not do much more than add to his (and your) anxiety, without accomplishing adequate pre-oxygenation. Even if you accomplish pre-oxygenation, he is still much more likely to have hypoxemia between induction and intubation than to have an aspiration event. Aspiration events in children are not only infrequent, but appear low risk [1]. I'd be more concerned about the hypoxemia than aspiration.

**PRO:** It only takes about a minute for the rocuronium to take effect. That's not a long time for apnea! I can hold my breath longer than that! Why do you think he won't tolerate it?

**CON:** Compared to an adult, he has a decreased functional reserve capacity to minute ventilation ratio, increased oxygen consumption, and a greater closing capacity after induction of anesthesia and use of muscle relaxant. You may only have seconds until his oxygen saturation starts to drop, while older children do tend to tolerate apnea better.

For example, with adequate pre-oxygenation, a healthy adult can tolerate apnea for at least 8 min before desaturation to less than 90 % SaO<sub>2</sub>. On room air, this same adult will

start to start to desaturate within 45–60 s [2]. In a child who is pre-oxygenated, you may see desaturation in under a minute. Without pre-oxygenation, that time is even less, and the smaller the child, the less time you have [3].

Aspiration just isn't nearly as likely as desaturation in children. It shouldn't be more of a focus than hypoxemia.

**PRO:** We shouldn't just ignore the possibility of aspiration. It does happen, and it does increase morbidity and mortality. Our goal should still be to minimize its occurrence, utilizing all possible measures. Perhaps it happens so infrequently because we have been doing things right: minimizing ventilation, minimizing time between induction and intubation, and using rapid onset muscle relaxants.

In this case, cricoid pressure may do more harm than good. It will probably distort the airway and make intubation more difficult. Plus, a 5-year-old is unlikely to understand the benefit of pressure on his neck [3].

I would omit cricoid pressure, but I still feel that we should utilize all other measures to minimize his aspiration risk. I don't want him sitting in an intensive care unit because I chose to ignore the hotdog in his stomach.

**CON:** I agree, but aspiration in pediatric anesthetic practice appears to occur at a rate of 2 per 10,000 cases. It is potentially higher in emergency situations, but not significantly. Aspiration in young children is even rarer, and no pediatric deaths from aspiration have been appreciated in any recent reviews or studies [1]. There will always be risk factors that we can't control for, such as a difficult airway, gastrointestinal pathology, gastro-esophageal reflux, obesity, and esophageal disease. However, anxiety, increased abdominal pressure, and inadequate or light anesthesia were also found to be risk factors for aspiration and are in some realm of our control.

In his case, regurgitation and vomiting are most likely to result from direct laryngoscopy in the setting of light anesthesia or incomplete paralysis. This is classically what happens when a child starts to desaturate with classic RSI and the anesthesiologist rushes to intubate: the patient can buck and regurgitate, become a more difficult intubation, or experience hypoxemia or bradycardia [1, 4].

How about trying "controlled" RSI, with gentle mask ventilation? Mask ventilation pressures maintained below 10–12 cm H<sub>2</sub>O allow oxygenation, limit hypercarbia, and keep small airways open, with a very low likelihood of

resulting gastric inflation and regurgitation. Neuhuas et al. reported a retrospective cohort analysis of 1001 children who underwent controlled RSI with less than 4 h NPO after solids or 2 h after clears. This study reports significantly fewer episodes of hypoxemia, bradycardia, and difficult intubations compared to classic RSI, with no observed pulmonary aspiration events. This is in stark comparison to Gencorelli et al. retrospective study of 1070 children who underwent classic RSI, with high incidences of hypoxemia, especially in younger patients, and increased difficult intubations, but also no reported aspiration events [4].

It seems that either way, the risk of aspiration is low in the pediatric population and compromising ventilation to minimize the rare aspiration event may be overzealous. Controlled RSI allows time for adequate muscle relaxation and depth of anesthesia, while maintaining oxygenation. If you are worried about the time to intubation, you can also consider using succinylcholine as an alternative to high-dose rocuronium.

**PRO:** You would use succinylcholine? What about the side effects? What about the risks of hyperkalemic cardiac arrest, malignant hyperthermia, or rhabdomyolysis? We don't know that he's not susceptible! His lack of medical history doesn't exclude him from the possibilities of an undiagnosed muscular dystrophy or malignant hyperthermia. I'm not sure it's worth the risk. Besides, Mazruek et al. [5] study in 26 pediatric patients found comparable intubating conditions 30 s after RSI with administration of rocuronium 1.2 mg/kg as compared to succinylcholine 1.5 mg/kg. The only significant difference was the time until the return of the first twitch response. If the two drugs are comparable with respect to intubation, rocuronium seems safer to me.

**CON:** I would consider succinylcholine only because this is expected to be such a short case. Rocuronium isn't going to wear off in a timely fashion, and succinylcholine is another appropriate option, although less popular. The pediatric product labeling was revised and now states that succinylcholine is indicated for "emergency intubation or instances where immediate securing of the airway is necessary, [such as] laryngospasm, difficult airway, full stomach or intramuscular use when a suitable vein is inaccessible." Due to the potential side effects, I would generally agree with your use of rocuronium, but in this case, it may leave you with some waiting time at the end of the procedure.