Neuromuscolar blocking agents are potentially dangerous drugs when not safely managed.

The reversal of neuromuscolar activity can occur spontaneously (after a certain lack of time) or with the use of reversal agents.

Neuromuscolar activity must be completely reversed before proceeding with extubation.
Are NMBA really necessary???
SURGICAL GOOD VISION
Laryngeal Morbidity and Quality of Tracheal Intubation

A Randomized Controlled Trial

Thomas Mencke, M.D.,* Mathias Echternach, M.D.,† Stefan Kleinschmidt, M.D.,* Philip Lux,‡ Volker Barth, M.D.,† Peter K. Plinkert, M.D.,§ Thomas Fuchs-Buder, M.D.‖

Table 1. Scoring Conditions for Tracheal Intubation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intubation Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clinically Acceptable</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
</tr>
<tr>
<td>Laryngoscopy</td>
<td></td>
</tr>
<tr>
<td>Jaw relaxation</td>
<td>Relaxed</td>
</tr>
<tr>
<td>Resistance to laryngoscope</td>
<td>None</td>
</tr>
<tr>
<td>Vocal cords</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Abducted</td>
</tr>
<tr>
<td>Movement</td>
<td>None</td>
</tr>
<tr>
<td>Reaction to tube insertion or cuff inflation</td>
<td></td>
</tr>
<tr>
<td>Movement of limbs</td>
<td>None</td>
</tr>
<tr>
<td>Coughing</td>
<td>None</td>
</tr>
</tbody>
</table>

Intubation conditions: excellent = all qualities are excellent; good = all qualities are excellent or good. Excellent and good intubation conditions are summarized as clinically acceptable intubation conditions.
Table 4. Intubating Conditions and Intubating Scores

<table>
<thead>
<tr>
<th></th>
<th>Atracurium (n = 37)</th>
<th>Saline (n = 36)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intubation conditions</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cormack grades</td>
<td>1 (1–2)</td>
<td>1 (1–2)</td>
<td>0.613</td>
</tr>
<tr>
<td>Time of intubation (s)</td>
<td>26 (10–106)</td>
<td>29 (7–90)</td>
<td>0.920</td>
</tr>
<tr>
<td>Attempts (n)</td>
<td>1 (1–3)</td>
<td>1 (1–3)</td>
<td>0.919</td>
</tr>
<tr>
<td>Intubation scores</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Excellent</td>
<td>16</td>
<td>2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Good</td>
<td>19</td>
<td>22</td>
<td>0.55</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>12</td>
<td>0.006</td>
</tr>
<tr>
<td>Clinically acceptable</td>
<td>35</td>
<td>24</td>
<td>0.006</td>
</tr>
<tr>
<td>Non-excellent</td>
<td>21</td>
<td>34</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values are median and range (intubating conditions) or numbers.

Table 5. Incidence of Postoperative Hoarseness and Vocal Cord Sequelae

<table>
<thead>
<tr>
<th></th>
<th>Postoperative Hoarseness</th>
<th>Vocal Cord Sequelae</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Atracurium (n = 37)</td>
<td>Saline (n = 36)</td>
</tr>
<tr>
<td>PACU</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>At 24 h</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>At 48 h</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>At 72 h</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>&gt;72 h</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Days*</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Patients</td>
<td>6</td>
<td>16</td>
</tr>
</tbody>
</table>

Values are shown as numbers of patients (n).

* Days = number of days with PH or VCS. PH was first assessed in the PACU and thus, the day of surgery was takes as the first day with PH. VCS was first assessed at 24 h and thus, postoperative day 1 was taken as the first day with VCS. † Patients: number of patients with PH or VCS.

PACU = postanesthesia care unit; PH = postoperative hoarseness; VCS = vocal cord sequelae; NA = not assessed.
Table 6. Vocal Cord Sequelae: Stroboscopic Findings

<table>
<thead>
<tr>
<th></th>
<th>Atracurium (n = 37)</th>
<th>Saline (n = 36)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>2</td>
<td>11</td>
<td>0.030</td>
</tr>
<tr>
<td>Right</td>
<td>1</td>
<td>3</td>
<td>0.047</td>
</tr>
<tr>
<td>Bilateral</td>
<td>1</td>
<td>4</td>
<td>0.340</td>
</tr>
<tr>
<td>Morphology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hematoma</td>
<td>1</td>
<td>10</td>
<td>0.018</td>
</tr>
<tr>
<td>Thickening of mucosa</td>
<td>3</td>
<td>6</td>
<td>0.310</td>
</tr>
<tr>
<td>Granuloma</td>
<td>0</td>
<td>2</td>
<td>0.240</td>
</tr>
</tbody>
</table>

Values are shown as numbers of patients (n).
Is Pharmacological neuromuscular blockade reversal really necessary?
Residual Paralysis after Em:

Benoit Plaud, M.D., Ph.D.,* Bertrand Debaene, I
François Donati, Ph.D., M.D., F.R.C.P.C.,† Jean

The Incidence and Mechanisms of Pharyngeal and
Upper Esophageal Dysfunction in Partially Paralyzed
Humans

Pharyngeal Videoradiography and Simultaneous Manometry after
Atracurium

Eva Sundman, M.D.,* Hanne Witt, M.D., Ph.D.,† Rolf Olsson, M.D., Ph.D.,† Olle Ekberg, M.D., Ph.D.,†
Richard Kuylenstierna, M.D., Ph.D.,§ Lars I. Eriksson, M.D., Ph.D.,§
Not only......
P.O.R.C. (POST-OPERATIVE RESIDUAL CURARIZATION)

Residual curarizzazione means the insufficient recovery of the neuromuscular function in an estubated patient.

Residual curarizzazione was defined on a TOF ratios basis < 0.7. This value is now considered too low since numerous clinical effect of residual blockade have been observed with a TOF ratio between 0.7 and 0.9.

Actually a TOF ratio of 0.9 is considered as a new standard for an adequate recovery of neuromuscular function.


Frequenza di paralisi residua, in relazione al ritardo tra l’ultima somministrazione di curaro e l’arrivo in PACU.

n = numero di pazienti
Monitoring neuromuscular block: an update

T. Fuchs-Buder,¹ J.-U. Schreiber² and C. Meistelman³

1 Staff, Department of Anaesthesia and Critical Care, Centre Hospitalier Universitaire, Nancy Brabois, France
2 Staff, Department of Anaesthesia, Maastricht UMC, The Netherlands
3 Chairman, Department of Anaesthesia and Critical Care, Centre Hospitalier Universitaire, Nancy Brabois, France

---

**Posterior tibial nerve**

**The ulnar nerve**

**Popliteal nerve**

The electrodes for the posterior tibial nerve are placed behind the medial malleolus of the tibia.

The distal electrode is placed 1-2 cm proximal to the proximal skin crease, centered on the radial side of the tendon of the flexor carpi ulnaris muscle as identified by its insertion into the platform bone.

The electrodes for the popliteal nerve are placed lateral to the neck of the tibia.

The proximal electrode is placed along the line of the ulnar nerve or over the olecranon.
<table>
<thead>
<tr>
<th>Tipo</th>
<th>frequenza</th>
<th>durata</th>
<th>intervallo</th>
<th>ripetibilità</th>
<th>applicazioni</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>1 Hz</td>
<td>0,2 ms</td>
<td>1-10 sec</td>
<td></td>
<td>Induzione anestesia</td>
</tr>
<tr>
<td>TET</td>
<td>50 Hz</td>
<td>5 sec</td>
<td>&gt; 6 min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOF</td>
<td>2 Hz</td>
<td>2 sec</td>
<td>0,5 sec</td>
<td>10 sec</td>
<td>Induz. Mant. Estub. Recovery, ICU.</td>
</tr>
<tr>
<td>PTC</td>
<td>50 Hz</td>
<td>5 sec</td>
<td>&gt; 6 min</td>
<td></td>
<td>Blocco profondo</td>
</tr>
<tr>
<td>DBS</td>
<td>50 Hz</td>
<td>20 ms</td>
<td>750ms</td>
<td>&gt; 6 min</td>
<td></td>
</tr>
</tbody>
</table>
Intensity of blockade

- **Intense block**: no response to TOF or PTC stimulation
- **Deep block**: response to PTC but not to TOF stimulation
- **Moderate block**: return of TOF response

PTC, post-tetanic count; TOF, train-of-four.

Clinical tests cannot replace an instrumental monitoring

Tongue depressor test
Hand grip, 5 s
Head lift, 5 s
General weakness
Leg lift, 5 s
Smile, swallow, or speak

Positive Predictive Value for Identifying TOF <90%

Positive Predictive Value:
- Tongue depressor test: 0.52
- Hand grip, 5 s: 0.51
- Head lift, 5 s: 0.51
- General weakness: 0.51
- Leg lift, 5 s: 0.5
- Smile, swallow, or speak: 0.47
Clinical signs of residual curarization

- Moderate Hypoxaemia: 90% < SpO2 < 93% not improving after active interventions (↑O2 flow > 3 l./min., request to breath deeply, tactile stimulation)

- Severe Hypoxaemia: SpO2 < 90% not improving after active interventions (↑O2 flow > 3 l./min., request to breath deeply, tactile stimulation)

- Respiratory distress signs of ingravescent respiratory failure (respiratory rate > 20 / min., activation of supplementary muscles, tracheal stridor)

- Inhability to breath deeply when requested

- The patient reports weakness of respiratory muscles or upper airways (difficulty of ventilation, swallowing or languages)

- Patient requires intubation in PACU

- Clinical evidence of post tracheal estubation aspiration syndrome (gastric content observed in the oropharynx associated to hypoxaemia)

“Critical Respiratory Events” (CRE) associated to a residual neuromuscular blockade

**CREs Most Frequently Observed in the PACU (N = 61)**

<table>
<thead>
<tr>
<th>Type of CRE</th>
<th>Relative Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Hypoxemia</td>
<td>59</td>
</tr>
<tr>
<td>Upper Airway Obstruction</td>
<td>34,4</td>
</tr>
<tr>
<td>Mild Hypoxemia</td>
<td>19,7</td>
</tr>
<tr>
<td>Multiple CREs</td>
<td>34,4</td>
</tr>
</tbody>
</table>

*N = 61 represents the entire cohort of patients who experienced CREs. Only 42 of these patients were able to be matched with a control.

CRE, critical respiratory event; PACU, postanesthesia care unit.

WHICH REVERSAL ?????
The “ideal” reversal agent should...

- Allow a rapid and complete reversal from any kind of block (mild to deep)
- Have a direct activity
- Be a valid alternative to succinilcholine in terms of speed of action and duration
- Not have clinically relevant side effects
CLASSIFICATION

Muscle relaxant Reversors (MRR)

Antagonists

Neostigmine
Pyridostigmine
ANTAGONISTS

- Cholinesterase inhibitors act indirectly by inactivating the enzyme acetylcholinesterase (AChE) in the synaptic cleft of the neuromuscular junction (NMJ).

- Acetylcholine (Ach) concentrations increase dramatically, competing with NMBA molecules at the post-synaptic nicotinic receptors.

- Acetylcholinesterase activity gradually returns to normal as the concentration of the cholinesterase inhibitor in the plasma and thus at the NMJ decreases as a result of redistribution, metabolism and excretion.
Limitations of Cholinesterase Inhibitors

- Relatively slow in reversing neuromuscular blockade
- Limited ability to reverse deep blockade
- Efficacy influenced by maintenance anesthetics
- Well-known side effect profile
- Require concomitant administration of anticholinergics

The increase in Ach concentration induced by an anticholinesterase is not limited to the NMJ, but also occurs at muscarinic sites where Ach is the neurotransmitter.

**Muscarinic side-effects include:**

- Nausea & vomiting
Anticholinesterase side-effects

- Bradycardia & Q-Tc prolongation

Drug induced Q-Tc interval prolongation may precipitate life-threatening arrhythmias, is considered a precursor of torsades de pointes and may predict cardiovascular complications.

Ventricular fibrillation related to reversal of the neuromuscular blockade in a patient with long QT syndrome

Reversal of neuromuscular block

A. Srivastava* and J. M. Hunter‡

University of Liverpool Critical Care Research Unit, School of Clinical Science, Duncan Building Daulby Street, Liverpool L69 3GA, UK

*Department of Anesthesia, ‡Department of Intensive Care, Trondheim, Norway

Bronchoconstriction

Cholinergic stimulation produce bronchocostriction, and anticholinesterase have the potential to increase airway resistance. Neostigmine stimulates the phosphatidylinositol response and thus causes bronchoconstriction.
Side Effects Associated With Current Reversal Agents

- **ChE inhibitors in the reversal of neuromuscular block can cause**
  - Bradycardia
  - Hypersalivation
  - Bronchospasm
  - Increased bronchial secretions
  - Urinary frequency
  - Nausea and vomiting

- **Coadministration of antimuscarinic agents aids in preventing cholinergic effects but may result in**
  - Tachycardia
  - Dryness of mouth and nose
  - Mydriasis
  - Urinary retention
  - Hypothermia

*Atropine use causes dose-dependent adverse effects. ChE, cholinesterase.*
CLASSIFICATION

Muscle relaxant Reversors (MRR)

- Antagonists
  - Neostigmine
  - Pyridostigmine

- Steroidal Muscle relaxant-Encapsulators (SMRE)
  - Sugammadex
WHEN SUGAMMADEX SHOULD BE ADMINISTERED?

WHICH IS THE RIGHT DOSAGE?
Sugammadex, a Selective Reversal Medication for Preventing Postoperative Residual Neuromuscular Blockade

Amir Abrishami, Joyce Ho, Jean Wong, Ling Yin, Frances Chung

BACKGROUND: Sugammadex is the first selective relaxant binding agent that has been studied for reversal of neuromuscular blockade induced by rocuronium and other steroidal non-depolarizing neuromuscular blocking agents (NMBAs).

OBJECTIVES: To assess the efficacy and safety of sugammadex in reversing neuromuscular blockade induced by steroidal non-depolarizing NMBAs and in preventing postoperative residual neuromuscular blockade.

SEARCH STRATEGY: We searched the Cochrane Central Register of Controlled Trials (CENTRAL) (The Cochrane Library 2008, Issue 3), MEDLINE (1950 to August 2008), and EMBASE (1980 to August 2008). In addition, we handsearched reference lists of relevant articles and meeting abstracts. Furthermore, we contacted the medication’s manufacturer for more information.

SELECTION CRITERIA: All randomized controlled trials (RCTs) on adult patients (≥ 18 years old) in which sugammadex was compared with placebo or other medications, or in which different doses of sugammadex were compared with each other. We excluded non-randomized trials and studies on healthy volunteers.

DATA COLLECTION AND ANALYSIS: We independently performed determination of trial inclusion, quality assessment, and data extraction. We applied standard meta-analytic techniques.

MAIN RESULTS: We included 18 RCTs (n = 1321 patients). Seven trials were published as full-text papers, and 11 trials only as meeting abstracts. All the included trials had adequate methods of randomization and allocation concealment. The results suggest that, compared with placebo or neostigmine, sugammadex can more rapidly reverse rocuronium-induced neuromuscular blockade regardless of the depth of the block.

We identified 2, 4, and 16 mg/kg of sugammadex for reversal of rocuronium-induced neuromuscular blockade at T2 reappearance, 1 to 2 post-tetanic counts, and 3 to 5 minutes after rocuronium, respectively. The number of trials are very limited regarding rocuronium and pancuronium. Serious adverse events occurred in < 1% of all patients who received the medication. There was no significant difference between sugammadex and placebo in terms of the prevalence of drug-related adverse events (RR 1.20, 95% CI 0.61 to 2.37; P = 0.59, I² = 0%, 5 RCTs). Also, no significant difference was found between sugammadex and neostigmine for adverse events (RR 0.98, 95% CI 0.48 to 1.98; P = 0.95, I² = 43%, 3 RCTs).

AUTHORS’ CONCLUSIONS: Sugammadex was shown to be effective in reversing rocuronium-induced neuromuscular blockade. This review has found no evidence of a difference in the instance of unwanted effects between sugammadex, placebo or neostigmine. These results need to be confirmed by future trials on larger patient populations and with more focus on patient-related outcomes.

Sugammadex: dose-response ratio

When dosage is increased, Sugammadex allows a rapid recovery even from higher levels of neuromuscolare blockade

*Sugammadex blockage induced by Rocuronium 0.6 mg/kg. PTC, post tetanic count

Sorgenfrei IF et al. Anesthesiology. 2006;104:667-674
### Time to TOF 0.9 after 16 mg/kg Sugammadex

**3 min. after 1.2 mg/kg Rocuronium**

<table>
<thead>
<tr>
<th></th>
<th>Rocuronium + sugammadex</th>
<th>Rocuronium + Placebo</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>65</td>
<td>5</td>
</tr>
<tr>
<td><strong>Mean (SD)</strong></td>
<td><strong>1.7</strong></td>
<td><strong>134.4</strong></td>
</tr>
<tr>
<td>95% CI</td>
<td>1.4-1.9</td>
<td>92.6-195.6</td>
</tr>
<tr>
<td>Median</td>
<td>1.5</td>
<td>129.7</td>
</tr>
<tr>
<td>Min-Max</td>
<td>0.5-14.3</td>
<td>87.3-209.1</td>
</tr>
</tbody>
</table>
CLINICAL PRACTICE

Reversal of rocuronium-induced neuromuscular block with sugammadex is faster than reversal of cisatracurium-induced block with neostigmine

E. A. Flockton¹*, P. Mastronardi², J. M. Hunter¹, C. Gomar³, R. K. Mirakhur⁴†, L. Aguilera⁵, F. G. Giunta⁶, C. Meistelman⁷ and M. E. Prins⁸†

<table>
<thead>
<tr>
<th>Recovery of TOF ratio to 0.7</th>
<th>Rocuronium–sugammadex (n=34)</th>
<th>Cisatracurium–neostigmine (n=39)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>32</td>
<td>36</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>Geometric mean</td>
<td>1.4</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Median (range)</td>
<td>1.2 (0.7–2.9)</td>
<td>4.7 (2.4–10.9)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recovery of TOF ratio to 0.8</th>
<th>n</th>
<th>Geometric mean</th>
<th>Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>32</td>
<td>1.6</td>
<td>1.5 (0.7–3.4)</td>
</tr>
<tr>
<td>Median (range)</td>
<td>36</td>
<td>6.5</td>
<td>5.9 (3.2–15.6)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recovery of TOF ratio to 0.9</th>
<th>n</th>
<th>Geometric mean</th>
<th>Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>32</td>
<td>1.9</td>
<td>1.9 (0.7–6.4)</td>
</tr>
<tr>
<td>Median (range)</td>
<td>34</td>
<td>9.0</td>
<td>7.3 (4.2–28.2)</td>
</tr>
</tbody>
</table>
Reversal of Profound Neuromuscular Block by Sugammadex Administered Three Minutes after Rocuronium

A Comparison with Spontaneous Recovery from Succinylcholine

Chingmuh Lee, M.D.,* Jonathan S. Jahr, M.D.,† Keith A. Candioti, M.D.,‡ Brian Warriner, M.D.,§ Mark H. Zornow, M.D.,|| Mohamed Naguib, M.D.†

- **Rocuronium 1.2 mg/kg**
- **Sugammadex 16 mg/kg**
- **Succinylcholine 1 mg/kg**

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Rocuronium</th>
<th>Sugammadex</th>
<th>Succinylcholine</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 to 10%</td>
<td>4.4 (n=56)</td>
<td>7.1 (n=54)</td>
<td>6.2 (n=56)</td>
</tr>
<tr>
<td>T1 to 90%</td>
<td></td>
<td></td>
<td>10.9 (n=54)</td>
</tr>
</tbody>
</table>

3 min Sugammadex administered
RSII with rocuronium followed by sugammadex allowed earlier re-establishment of spontaneous ventilation than with succinylcholine.
Reversal of Rocuronium-Induced Neuromuscular Block with the Novel Drug Sugammadex Is Equally Effective Under Maintenance Anesthesia with Propofol or Sevoflurane

Bernard F. Vanacker, MD, PhD*
Karel M. Vermeyen, MD, PhD†
Michel M. R. F. Struys, MD, PhD‡
Henk Rietbergen, MSc§
Eugene Vandermeersch, MD, PhD*
Vera Saldien, MD†
Alain F. Kalmar, MD‡
Martine E. Prins, MSc§

In this study we investigated whether the novel reversal drug, sugammadex, is equally effective at reversing rocuronium-induced neuromuscular block (NMB) in patients under propofol or sevoflurane maintenance anesthesia. After receiving propofol for induction, patients were randomized to propofol (n = 21) or sevoflurane (n = 21). Rocuronium 0.6 mg/kg was administered for tracheal intubation. NMB was monitored using acceleromyography. At reappearance of the second twitch of the train-of-four ratio, sugammadex 2.0 mg/kg was administered by IV bolus. The primary end-point was time from start of sugammadex administration to recovery of train-of-four ratio to 0.9. Mean recovery time was 1.8 min after both propofol and sevoflurane anesthesia. The 95% confidence interval for the difference in recovery time between the 2 groups (−0.5 to +0.4 min) was well within the predefined equivalence interval (−1 to +1 min), indicating that recovery from NMB was unaffected by maintenance anesthesia. Thirteen patients (propofol n = 4; sevoflurane n = 9) experienced adverse events; these were treatment-related in 4 patients (propofol n = 3; sevoflurane n = 1). There were no treatment-related serious adverse events and no discontinuations or deaths. No residual paralysis occurred. The safety profile of sugammadex was somewhat more favorable under propofol than under sevoflurane anesthesia.

(Anesthesiology 2007;107:563-8)

Table 3. Time (min) From Administration of Sugammadex (2.0 mg/kg) to Recovery of the Train-of-Four (TOF) Ratio
(Per Protocol Population)

<table>
<thead>
<tr>
<th>Treatment group</th>
<th>Propofol (n = 21)</th>
<th>Sevoflurane (n = 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to recovery of</td>
<td>1.8 (0.7) [0.9-3.4]*</td>
<td>1.8 (0.7) [1.1-4.5]</td>
</tr>
<tr>
<td>TOF ratio to 0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to recovery of</td>
<td>1.5 (0.5) [0.9-2.9]</td>
<td>1.5 (0.3) [1.1-2.1]</td>
</tr>
<tr>
<td>TOF ratio to 0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to recovery of</td>
<td>1.3 (0.5) [0.8-2.4]</td>
<td>1.3 (0.5) [0.7-1.9]</td>
</tr>
<tr>
<td>TOF ratio to 0.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values are mean (SD) [range]. TOF = train-of-four.
* Data missing for one patient, n = 20.
† Data missing for 1 patient.

*Rocuronium 0.6 mg/kg followed by Sugammadex 2 mg/kg.
Reversal of Rocuronium-induced Neuromuscular Blockade with Sugammadex in Pediatric and Adult Surgical Patients


![Graphs showing time to recovery of TOF ratio to 0.9 for children, adolescents, and adults.](image)

Fig. 1. Estimated dose-response relation between the time from the start of administration of sugammadex/placebo to recovery of the TOF ratio to 0.9 and the dose of sugammadex for (A) children (n = 22), (B) adolescents (n = 28), and (C) adults (n = 26) (per-protocol group). CI = confidence interval; TOF = train-of-four.
Learning points:

1. Sugammadex is effective in reversal of neuromuscular blockade with either vecuronium or rocuronium.
2. Sugammadex has been used effectively and safely in the infant age group.
3. Sugammadex should be considered when faced with the can't intubate - can't ventilate scenario in the pediatric population.

Case Report

Sugammadex Use in the Reversal of Deep Neuromuscular Block in a Six-Year-Old Child after an Emergency Procedure in Ear, Nose and Throat Surgery Department

Paolo Murabito, Giovanni Savarino, Caren Conticello, Marco Farina, Carmela Stissi and Marinella Astuto

Department of Anaesthesia and Intensive Care, “Policlinico” University Hospital, Catania, Italy
Efficacy, Safety, and Pharmacokinetics of Sugammadex for the Reversal of Rocuronium-induced Neuromuscular Blockade in Elderly Patients

David L. McDonagh, M.D.,* Patrick E. Benedict, M.D.,† Anthony L. Kovac, M.D.,‡
David R. Drover, M.D.,§ Neil W. Brister, M.D., Ph.D.,¶ Jovino B. Morte, M.D.,#, Terri G. Monk, M.D., M.S.**

Anesthesiology 2011; 114:318–29

Table 2. Time from the Start of Administration of Sugammadex to Recovery of the TOF Ratio to 0.9, 0.8, and 0.7 by Age Group (ITT Population)

<table>
<thead>
<tr>
<th>Time Variables</th>
<th>Adult Subjects Aged 18–54 yr (n = 48)</th>
<th>Elderly Subjects Aged 55–74 yr (n = 42)</th>
<th>Old Elderly Subjects Aged 75 yr or Older (n = 43)</th>
<th>Subjects Aged 65 yr or Older (n = 122)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to recovery of the TOF ratio to 0.9 (imputed analysis), No. of subjects</td>
<td>48</td>
<td>62</td>
<td>40</td>
<td>102</td>
</tr>
<tr>
<td>Geometric mean (95% CI)</td>
<td>2.5 (2.0–2.6)</td>
<td>2.5 (2.0–2.6)</td>
<td>3.6 (3.4–3.6)</td>
<td>2.9 (2.7–3.2)</td>
</tr>
<tr>
<td>Median</td>
<td>2.5</td>
<td>2.5</td>
<td>3.0</td>
<td>3.3</td>
</tr>
<tr>
<td>Minimum–maximum</td>
<td>1.2–2.4</td>
<td>0.9–3.8</td>
<td>1.0–3.6</td>
<td>0.9–9.6</td>
</tr>
<tr>
<td>P value*</td>
<td>0.027</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to recovery of the TOF ratio to 0.8 (imputed analysis), No. of subjects</td>
<td>48</td>
<td>62</td>
<td>40</td>
<td>102</td>
</tr>
<tr>
<td>Geometric mean (95% CI)</td>
<td>2.1 (1.6–2.5)</td>
<td>2.1 (1.9–2.4)</td>
<td>3.4 (3.0–3.9)</td>
<td>2.7 (2.5–3.3)</td>
</tr>
<tr>
<td>Median</td>
<td>2.2</td>
<td>2.6</td>
<td>3.2</td>
<td>3.3</td>
</tr>
<tr>
<td>Minimum–maximum</td>
<td>1.2–3.6</td>
<td>0.9–3.6</td>
<td>1.0–3.6</td>
<td>0.9–9.6</td>
</tr>
<tr>
<td>P value*</td>
<td>0.017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to recovery of the TOF ratio to 0.7 (imputed analysis), No. of patients</td>
<td>48</td>
<td>62</td>
<td>40</td>
<td>102</td>
</tr>
<tr>
<td>Geometric mean (95% CI)</td>
<td>1.0 (0.7–2.0)</td>
<td>2.2 (1.8–3.4)</td>
<td>2.6 (2.4–3.3)</td>
<td>2.2 (1.7–2.8)</td>
</tr>
<tr>
<td>Median</td>
<td>1.2</td>
<td>2.1</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Minimum–maximum</td>
<td>1.1–3.2</td>
<td>1.7–3.8</td>
<td>0.6–2.2</td>
<td>0.7–8.8</td>
</tr>
<tr>
<td>P value*</td>
<td>0.035</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Time data are given in minutes.
* Comparison between the adult group (aged 18–54 yr) and the elderly/old-elderly group combined 65 yr or older.
CI = confidence interval; ITT = intention-to-treat; TOF = train-of-four
Sugammadex & pulmonary diseases
Sugammadex administration (2 mg/kg and 4 mg/kg) has been demonstrated to be safe to antagonise neuromuscular blockade in patients with pulmonary diseases.
The use of rocuronium in a patient with cystic fibrosis and end-stage lung disease made safe by sugammadex reversal

MV Porter, MS Paleologos
Department of Anaesthetics, Royal Prince Alfred Hospital, Sydney, New South Wales

Summary
While the pharmacology of sugammadex has been extensively reviewed, there is limited literature regarding its use in specific clinical settings. Authors describe the use of sugammadex in a patient with severe bronchiectasis related to cystic fibrosis who required neuromuscular block for percutaneous endoscopic gastrostomy insertion. The use of rocuronium for neuromuscular block was preferred in order to avoid the potential complications associated with the use of suxamethonium. However, they wished to ensure complete neuromuscular block reversal for this short duration procedure in this high-risk patient and also to avoid the side-effects of traditional reversal agents. Overall, the combination of rocuronium and sugammadex improved perioperative surgical and anaesthetic management in this patient.
Sugammadex & liver diseases
In patients with severe hepatic diseases, sugammadex should be administered carefully.

Hepatic disease
To date, no animal studies or clinical trials have been conducted in subjects with hepatic impairment. However, a population pharmacokinetic-pharmacodynamic interaction model of sugammadex has been used to simulate the reversal of rocuronium-induced neuromuscular block in patients with hepatic impairment (data on file with Schering-Plough). Scenarios representing immediate reversal, reversal of profound neuromuscular block, and reversal at reappearance of T2 were simulated in subjects with hepatic impairment. Worst case scenarios, which assume that sugammadex is affected by hepatic impairment, demonstrated that recovery following sugammadex 4 mg·kg⁻¹ administered 15 min after rocuronium 1.2 mg·kg⁻¹ may take up to 4.12 min longer in patients with severe hepatic impairment than normal patients. When sugammadex 2 mg·kg⁻¹ is given at the reappearance of T2, the model predicts that the recovery time will be prolonged by 2.55 min in severe hepatic impairment. Hepatic impairment had little effect on the predicted recovery time after sugammadex 16 mg·kg⁻¹ given 3 min after rocuronium. Thus, in patients with hepatic impairment, it could be speculated that recovery after sugammadex will still be faster than after neostigmine, although not as quick as in healthy subjects. The explanation for the findings from these simulations is not yet understood.
Rapid reversal of neuromuscular blockade by sugammadex after continuous infusion of rocuronium in patients with liver dysfunction undergoing hepatic surgery

Ai Fujita 1, 2*, Natsuki Ishibe 2, Tatsuya Yoshihara 1, Jun Ohashi 3, Hideichi Makino 4, Mizuko Ikeda 2, Hidekazu Setoguchi 5

1 Department of Clinical Pharmacology, Faculty of Medical Sciences, Kyushu University, Fukuoka, Japan
2 Department of Anesthesiology and Critical Care Medicine, Kyushu University Hospital, Fukuoka, Japan
3 Doctoral Program in Life System Medical Sciences, Graduate School of Comprehensive Human Sciences, University of Tsukuba, Ibaraki, Japan
4 Shiraiishi Hospital Diabetes Center, Imabari, Ehime, Japan
5 Department of Anesthesiology, Kyushu Medical Center, Fukuoka, Japan

Conclusion: Sugammadex can rapidly reverse NMB after continuous infusion of rocuronium in patients with liver dysfunction undergoing hepatic surgery. Sugammadex was found to be safe and well tolerated. However, further studies of sugammadex under similar conditions should be conducted involving a large number of patients with liver dysfunction undergoing hepatic surgery.
Sugammadex & heart diseases
Neuromuscular blocking drugs and their antagonists in patients with organ disease

R. G. Craig\textsuperscript{1} and J. M. Hunter\textsuperscript{2}

There were no statistically significant differences compared to placebo
Reversing Rocuronium 0.6 mg/kg With Sugammadex or Neostigmine From 1 to 2 PTCs: Blood Pressure

*Neostigmine 70 βg/kg combined with glycopyrrolate 14 βg/kg.
NEO, neostigmine; PTC, posttetanic count; SUG, sugammadex

Data from Signal trial.
**Background and objective** The present randomized, safety-assessor blinded, placebo-controlled trial was designed to assess safety and efficacy of sugammadex, a novel selective relaxant-binding agent, in patients with underlying cardiovascular disease undergoing noncardiac surgery.

**Results** There were no significant differences between groups in terms of QTc (Fridericia) interval. Three serious adverse events, one in each treatment group, considered to be possibly drug-related according to the investigator, were cases of mild QTc (Bazett) interval prolongation.

Blood pressure and heart rate decreased after initiation of anaesthesia and remained stable in all groups up to 10 min after administration of study drug. Blood pressure was significantly higher ($P<0.05$) in both sugammadex dose groups compared with placebo at 30 min. The decrease in heart rate from baseline (prestudy drug) was significantly greater in the 2.0 mg kg$^{-1}$ sugammadex group at 2 and 5 min, and, for both sugammadex groups, the increase at 30 min was greater compared with placebo. Both sugammadex doses resulted in considerably shorter time to recovery of the T4/T1 ratio to 0.9 compared with placebo.

**Conclusion** The findings indicate sugammadex 2.0 and 4.0 mg kg$^{-1}$ can be given safely and effectively for the reversal of rocuronium-induced neuromuscular blockade in patients with cardiovascular disease undergoing noncardiac surgery. *Eur J Anaesthesiol* 26:874–884 © 2009 European Society of Anaesthesiology.

*Sugammadex administration (2 mg/kg and 4 mg/kg) has been demonstrated to be safe in patients with cardiac diseases.*
CONCLUSION

Because of alterations in the physiology of the transplanted heart, major consequences related to denervation, variable reinnervation over time, and unexpected side effects of medications like anticholinesterases and anticholinergics can occur perioperatively. Understanding the newly established functions of a transplanted heart, practicing careful anesthetic management and using new reversal agents like sugammadex can provide an uncomplicated perioperative period. Further studies and case reports will help nontransplant specialists, especially, when heart transplant patients present new health problems, sometimes many years after their transplant.

ARTICLE IN PRESS

CASE REPORT

Use of Sugammadex in a Heart Transplant Recipient: A Case Report and Brief Review of the Unique Physiology of the Transplanted Heart

Büşra Tezcan, MD, Alev Şaylan, MD, Demet Bölükbaşı, MD, Rabia Koçulu, MD, and Ümit Karadeniz, MD
Sugammadex & kidneys diseases
Multicentre, parallel-group, comparative trial evaluating the efficacy and safety of sugammadex in patients with end-stage renal failure or normal renal function

L. M. Staals¹*, M. M. J. Snoeck², J. J. Driessen¹, E. A. Flockton³, M. Heeringa⁴ and J. M. Hunter³

<table>
<thead>
<tr>
<th></th>
<th>Impaired renal function</th>
<th>Normal renal function</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRCL &lt; 30 ml/min</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td>2.0</td>
<td>1.65</td>
</tr>
<tr>
<td><strong>Range</strong></td>
<td>1.2-3.7</td>
<td>0.9-3.1</td>
</tr>
</tbody>
</table>

No significant difference

<table>
<thead>
<tr>
<th>Patient group</th>
<th>CL₉₀&lt;30 ml min⁻¹ (n=15)</th>
<th>CL₉₀≥80 ml min⁻¹ (n=14)</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery to TOF ratio</td>
<td>1.45 (0.47)</td>
<td>1.17 (0.38)</td>
<td>NS</td>
</tr>
<tr>
<td>0.7, mean (sd)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery to TOF ratio</td>
<td>1.69 (0.57)</td>
<td>1.32 (0.45)</td>
<td>NS</td>
</tr>
<tr>
<td>0.8, mean (sd)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovery to TOF ratio</td>
<td>2.00 (0.72)</td>
<td>1.65 (0.63)</td>
<td>NS</td>
</tr>
<tr>
<td>0.9, mean (sd)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusions. Sugammadex administered at reappearance of T₂ rapidly and effectively reverses NMB induced by rocuronium in renal failure and healthy patients. Sugammadex was well tolerated by all patients. Further safety studies on sugammadex in patients with severe renal impairment are warranted.
Reduced clearance of rocuronium and sugammadex in patients with severe to end-stage renal failure: a pharmacokinetic study

KEY POINTS

After administration of sugammadex, the concentration of rocuronium showed a plateau or even an increase.

Available evidence suggests that the rocuronium-sugammadex complex remains stable over time. The sugammadex- rocuronium complex exists in equilibrium with a very low dissociation rate (Kd=0.1x10^{-6}M) because of strong binding.

Efficacy, safety and pharmacokinetics of sugammadex 4 mg kg$^{-1}$ for reversal of deep neuromuscular blockade in patients with severe renal impairment


$^1$Department of Anaesthesia, Canisius-Wilhelmina Hospital, Nijmegen, The Netherlands, $^2$Department of Anaesthesia, Central Manchester University Hospitals NHS Foundation Trust UK, Manchester, UK, $^3$Department of Anaesthesia and Intensive Care Medicine, Feldkirch Hospital, Austria, $^4$MSD, Oss, The Netherlands, and $^5$Department of Anaesthesiology, University of Amsterdam (AMC), Amsterdam, The Netherlands
Dialysability of sugammadex and its complex with rocuronium in intensive care patients with severe renal impairment

G. Cammu¹*, B. Van Vlem², M. van den Heuvel⁴, L. Stet⁵, R. el Galta⁶, S. Eloot² and I. Demeyer³

¹ Department of Anaesthesiology and Critical Care Medicine, ² Renal Unit, and ³ Department of Emergency Medicine, Onze-Lieve-Vrouw Ziekenhuis, Moorselebaan 164, 9300 Aalst, Belgium
⁴ Clinical PKPD, ⁵ CNS Global Clinical Trial Management, and ⁶ Biostatistics and Research Decision Sciences, MSD, Oss, The Netherlands

Conclusions. Haemodialysis using a high-flux dialysis method is effective in removing sugammadex and the sugammadex–rocuronium complex in patients with severe renal impairment.
**Conclusion:** in this retrospective study on patients at high risk for postoperative bleeding, sugammadex at 2 to 4 mg/Kg doses was not associated with higher risk for bleeding. Patients who receive higher doses of sugammadex (> 4mg/kg) or patients with altered coagulation profiles should be analysed.
Effect of Reversal of Neuromuscular Blockade with Sugammadex versus Usual Care on Bleeding Risk in a Randomized Study of Surgical Patients

Niels Rahe-Meyer, M.D., Ph.D., Hein Fennema, Ph.D., Sam Schulman, M.D., Ph.D., Walter Klimscha, M.D., Michael Przemeck, M.D., Manfred Blobner, M.D., Hinnerk Wulf, M.D., Marcel Speek, R.N., C.R.N.A., Christine McCrary Sisk, B.S., Debora Williams-Herman, M.D., Tiffany Woo, M.S., Armin Szegedi, M.D., Ph.D.

Results: Of 1,198 patients randomized, 1,184 were treated (sugammadex n = 596, usual care n = 588). Bleeding events within 24 h (classified by an independent, blinded Adjudication Committee) were reported in 17 (2.9%) sugammadex and 24 (4.1%) usual care patients (relative risk [95% CI], 0.70 [0.38 to 1.29]). Compared with usual care, increases of 5.5% in activated partial thromboplastin time (P < 0.001) and 3.0% in prothrombin time (P < 0.001) from baseline with sugammadex occurred 10 min after administration and resolved within 60 min. There were no significant differences between sugammadex and usual care for other blood loss measures (transfusion, 24-h drain volume, drop in hemoglobin, and anemia), or risk of venous thromboembolism, and no cases of anaphylaxis.

Conclusion: Sugammadex produced limited, transient (<1 h) increases in activated partial thromboplastin time and prothrombin time but was not associated with increased risk of bleeding versus usual care. (Anesthesiology 2014; 121:969-77)
Sugammadex and anaphylaxis

Abstract


Hypersensitivity associated with sugammadex administration: a systematic review.

Tsur A¹, Kalansky A.

Summary
Sugammadex is a drug used to reverse neuromuscular blockade induced by rocuronium or vecuronium. It has not yet been approved by the Food and Drug Administration in the USA due to concerns regarding hypersensitivity. The objective of this review was to identify similarities in the presentation of hypersensitivity reactions to sugammadex. A comprehensive search was performed in PubMed, Scopus and Web of Science for cases reporting hypersensitivity reactions to sugammadex. In addition, we contacted regulatory agencies and the company marketing the drug for unpublished reports. Reports were included if they were in English, primary investigations, lacked an alternative probable explanation for the reaction and included a comprehensive description of the hypersensitivity. We identified 15 cases of hypersensitivity following sugammadex administration. All cases that reported exact timing (14/15) occurred in 4 min or less. Most of the patients (11/15; 73%) met World Anaphylaxis Organization criteria for anaphylaxis. Awareness must be raised for the possibility of drug-induced hypersensitivity during the critical 5-min period immediately following sugammadex administration.
Abstract

Background: Sugammadex has a unique mechanism of action and is widely used because of its safety and efficacy. A few recent reports have described allergic reactions to clinical doses of sugammadex. We hereby describe another series of cases of possible anaphylaxis to sugammadex.

Case presentation: We present three suspected cases of sugammadex-induced anaphylactic shock, including a 13-year-old boy who underwent laparoscopic appendectomy, a 75-year-old woman who underwent left knee arthroplasty, and a 34-year-old man who underwent left pansinectomy for sinobronchitis. All three patients received general anesthesia with rocuronium and their tracheas were intubated. Shortly after injection of sugammadex for reversal of rocuronium, all of them experienced a decrease in blood pressure along with mucocutaneous erythema. In the most severe case, reintubation after extubation was required due to difficulty in manual ventilation. All patients recovered with anti-allergic therapy. On later investigation, all three patients had a positive skin reaction to sugammadex.

Conclusion: Our results suggest that physicians using sugammadex should be aware of the possibility of sugammadex-induced anaphylaxis.

Keywords: Sugammadex, Anaphylactic shock, General anesthesia
Acute Cardiac Failure after Muscle Block Reversal with Sugammadex for Unexpected Difficult Intubation

Carmelina Gurrieri, Paolo Murabito, Giovanni Buscema, Danilo Grasso, Marinella Astuto
Department of Anesthesiology and Intensive Care, Policlinico-Vittorio Emanuele University Hospital, via Santa Sofia 78, 95123 Catania, Italy

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Sugammadex in special clinical settings
Duchenne muscular dystrophy (DMD) is the most common muscular dystrophy in pediatric patients (Hayes et al, 2008)

It is caused by a mutation of the dystrophy gene at the Xp21 locus and results in a deficit of dystrophine and its related proteins (necessary for the appropriate formation of the postsynaptic membrane of the NMJ).

The use of neuromuscular blocking drugs is of great concern in DMD patients. Depolarizing NMBDs are contraindicated because of the risk of hyperkalemia, rhabdomyolysis or even cardiac arrest. (Hayes et al., Pediatr. Anesth. 2008 – Ihmsen et al, Anesthesiology 2009)
MG is an autoimmune disease affecting neuromuscular transmission.

Auto antibodies against the acetylcholine receptor reduce the total amount of Ach receptors resulting in an unpredictable response to administered neuromuscular blocking drugs. (Paton WD, The Journal of Physiology 1967)
A retrospective analysis of the introduction of sugammadex on the incidence of respiratory failure after bariatric surgery

Mulier J.P., Dillemans B., Van Lancker P., Van Cauwenberge S

Obesity Surgery, August 2011, (1051-1052)
DOSAGE ???

ORIGINAL ARTICLE
Ideal versus corrected body weight for dosage of sugammadex in morbidly obese patients

P. Van Lancker,1 B. Dillemans,2 T. Bogaert,3 J. P. Mulier,1 M. De Kock4 and M. Haspeslagh5

1 Specialist Anaesthetist, 3 Resident Anaesthetist, Department of Anaesthesia, 2 Specialist Surgeon, Department of Surgery, 5 Biostatistics and Clinical Research Associate, AZ Sint-Jan Brugge-Oostende AV, Belgium
4 Professor of Anaesthesia, Dep

Summary
To date, the dosing of sugammadex is based on real body weight without taking fat content into account. We compared the reversal of profound rocuronium-induced neuromuscular blockade in morbidly obese patients using doses of sugammadex based on four different weight corrections. One hundred morbidly obese patients, scheduled for laparoscopic bariatric surgery under propofol-sufentanil anaesthesia, were randomly assigned four groups: ideal body weight; ideal body weight + 20%; ideal body weight + 40%; and real body weight. Patients received sugammadex 2 mg.kg⁻¹, when adductor pollicis monitoring showed two responses. The primary endpoint was full decurarisation. Secondary endpoints were the ability to get into bed independently on arrival to the post-anaesthetic care unit and clinical signs of residual paralysis. There was no residual paralysis in any patient. Morbidly obese patients can safely be decurarised from rocuronium-induced neuromuscular blockade T1-T2 with sugammadex dosed at 2 mg.kg⁻¹ ideal body weight + 40% (p < 0.0001).
Conclusion: A sugammadex dose calculated according to IBW is insufficient for complete reversal of muscle blockade in morbidly obese patients. We conclude that sugammadex cannot be safely calculated for morbidly obese patients on the basis of IBW. Until a dose regimen that works well in the majority of morbidly obese patients is established, we can expect to see a large number of slow responders and even outliers. The implication seems to be that neuromuscular monitoring of depth is necessary in the morbidly obese so that a second dose of sugammadex can be given as soon as it is clear that response is slow.

Sugammadex Ideal Body Weight Dose Adjusted by Level of Neuromuscular Blockade in Laparoscopic Bariatric Surgery

Sandra Llauradó, M.D.,* Antoni Sabaté, M.D., Ph.D.,† Eva Ferreres, M.D.,* Inmaculada Camprubí, M.D.,* Anna Cabrera, M.D.*

Anesthesiology, V 117 • No 1 July 2012
PREGNANCY
Rocuronium and sugammadex for rapid sequence induction of obstetric general anaesthesia

R. M. WILLIAMSON, S. MALLAIAH and P. BARCLAY
Liverpool Women's Hospital, Liverpool, UK

Sugammadex is a novel, nondepolarising, rapid acting neuromuscular blocking agent used for the reversal of neuromuscular blockade induced by nondepolarising agents. We report a series of seven Caesarean section cases, undergoing general anaesthesia with thiopental (6 mg kg\(^{-1}\)) and rocuronium (0.6 mg kg\(^{-1}\)) who were given desflurane and fentanyl for maintenance of anaesthesia after delivery. The action of rocuronium may be prolonged in pregnant women. At the end of the operation, all patients had a significant degree of neuromuscular block. In five patients, there was no single twitch response and no TOF ratio, one patient had one twitch detectable, and in one patient, a TOF ratio of 3% was detected. The recommended dose of sugammadex for reversal of profound block (4 mg kg\(^{-1}\)) or moderate block (2 mg kg\(^{-1}\)) was given. In all patients, sugammadex provided rapid and sufficient reversal to TOF > 0.9 within 2 min. All patients were monitored after operation, and no signs of recurarization occurred in any patient and no signs of neuromuscular weakness were observed.
Case report

Use of sugammadex in a ‘can’t intubate, can’t ventilate’ situation

R. Curtis, S. Lomax and B. Patel*
Department of Anaesthesia, Royal Surrey County Hospital, Guildford GU2 7XX, UK
* Corresponding author. E-mail: bhavesh.patel@nhs.net

Editor’s key points

- Sugammadex reversal of rocuronium has been suggested for management of a difficult airway.

- In a patient with upper airway pathology, attempts at tracheal intubation resulted in a ‘can’t intubate, can’t ventilate’ situation.

- Sugammadex reversed the rocuronium but did not restore airway patency.

- Alternative strategies for airway management must be immediately available.
Persistent 'can't intubate, can't oxygenate' crisis despite reversal of rocuronium with sugammadex: the importance of timing.

Curtis RP.
Critical Hemoglobin Desaturation Will Occur before Return to an Unparalyzed State following 1 mg/kg Intravenous Succinylcholine

Jonathan L. Benumof, M.D.,* Rachel Dagg, M.S.,† Reuben Benumof, Ph.D.‡

*Department of Anesthesiology, University of California, San Diego, La Jolla, California
†Department of Anesthesiology, Southampton General Hospital, United Kingdom
‡Department of Anesthesiology, University of Virginia, Charlottesville, Virginia

TIME TO HEMOGLOBIN DESATURATION WITH INITIAL $F_{AO_2} = 0.87$

[Graph showing time to hemoglobin desaturation with initial $F_{AO_2} = 0.87$.]
"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."