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Ostap Dvorakevych
dvorakevych1@otterbein.edu

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Evidence-Based Recommendations for the Use of Neostigmine Versus Sugammadex in Patients Undergoing Thoracic Surgery

Ostap Dvorakevych, RN, BSN, Brian Garrett, DNP, CRNA, Amy Bishop, DNP, AGCNS-BC, Danielle Winch, DNP, CRNA
Otterbein University/OhioHealth Grant Medical Center Nurse Anesthesia Program

Abstract



PICOT Question

- In adult surgical patients undergoing thoracic surgery (P), does the use of Sugammadex for reversal of non-depolarizing neuromuscular blockers (I), compared to Neostigmine, affect postoperative pulmonary complications including respiratory failure, pneumonia, and atelectasis(O).

Objectives

- Synthesize evidence from the most recent evidence-based practice (EBP) literature on reversing non-depolarizing neuromuscular blocking agents (NMBAs) with either Sugammadex or Neostigmine.
- Develop EBP recommendations for reversing non-depolarizing NMBAs with Sugammadex versus Neostigmine in patients undergoing thoracic surgery.
- Develop a comprehensive plan to implement, monitor, and modify the EBP recommendation of utilizing Sugammadex instead of Neostigmine to reverse NMB in patients undergoing thoracic surgery.

Introduction

- Neuromuscular blocking agents (NMBAs) provide patient paralysis for anesthesia staff to perform tracheal intubation and for surgeons to have a motionless surgical field.
- At the end of surgery, the paralytic effects of NMBAs must be reversed with reversal agents.
- Incomplete NMBA reversal, known as residual neuromuscular blockade, impairs the patient's ability to maintain their airway, which can lead to various postoperative pulmonary complications (PPCs) such as respiratory failure, pneumonia, and atelectasis.
- Patients undergoing thoracic surgery are at high risk for residual NMB due to deep levels of paralysis required to keep the diaphragm motionless for surgical manipulation.
- Neostigmine has traditionally been the primary agent used for paralytic reversal; however, a newer alternative is available with the relatively recent introduction of Sugammadex.
- This evidence-based project evaluates the most up-to-date literature to identify, plan, and implement recommendations for an optimal paralytic reversal strategy in patients undergoing thoracic surgery at a level-one trauma center in the Midwest United States.

Background

- Sugammadex was launched in 2008 and FDA-approved in 2015
- Sugammadex is 6.6 times faster at reversing moderate NMB and 16.8 times faster at reversing deep NMB than Neostigmine.
- Costs:
 - Neostigmine 5mg/5ml = \$13.5
 - Sugammadex 200mg/2ml = \$99.74
 - Sugammadex 500mg/2ml = \$182.70
- Thoracic surgery patients require deep levels of paralysis to keep the diaphragm motionless for surgical manipulation, putting them at higher risk for residual NMB than other types of surgery.
- Thoracic surgery patients have pulmonary comorbidities and decreased respiratory reserves, which makes them more sensitive to residual NMB.

Johns Hopkins Evidence-Based Practice Model



Note. © 2022 Johns Hopkins Health System/Johns Hopkins School of Nursing

Significance to the Profession

- Residual neuromuscular blockade is associated with decreased functional residual capacity, impaired upper airway patency, and respiratory insufficiency → leads to various postoperative pulmonary complications (PPCs) such as respiratory failure, atelectasis, and pneumonia.
- There are 300 million yearly surgeries worldwide → 5% develop a significant PPC → \$100,000 per occurrence.
- Prolonged NMB reversal → increased OR time → \$37 per minute and potentially a decreased number of cases performed.

Problem Statement

- Thoracic surgical patients are at high risk for residual neuromuscular blockade
 - Postoperative pulmonary complications (PPCs) are prevalent in this patient population
 - Optimal NMB reversal must be incorporated to reduce residual NMB and subsequent PPCs
- Neostigmine has traditionally been used for NMB reversal
 - Less than optimal in efficacy, especially deep NMB reversal
 - Incomplete/slow reversal, nausea, vomiting
 - Hospitals often lack clear policies for choosing reversal agents and often discourage Sugammadex use due to its high cost.
 - Cost savings from fewer PPCs outweigh high initial Sugammadex cost

Literature Review

- Reversal Speed
 - Assessed with a peripheral nerve stimulator using the train-of-four (TOF) function (TOF > 0.9)
 - Sugammadex NMB reversal was faster than Neostigmine in patients undergoing thoracic surgery
 - Time to achieve TOF > 0.9 was 164.5 ± 27.7 seconds with Sugammadex and 562.9 ± 59.7 seconds with Neostigmine
- Residual Neuromuscular Blockade
 - Assessed with peripheral nerve stimulator using train-of-four (TOF) function (TOF < 0.9)
 - Patients undergoing thoracic surgery show lower rates of residual NMB at both tracheal extubation and PACU admission when reversed with Sugammadex versus Neostigmine.
 - Residual NMB was lower in the Sugammadex group vs Neostigmine at both tracheal extubation (6% vs 80%) and PACU admission (1% vs 61%)
- Postoperative Pulmonary Complications (PPCs)
 - No standardized definition → included studies integrated various specific complications in assessing overall PPC findings
 - In patients undergoing thoracic surgery, Sugammadex administration for reversal of NMB results in fewer PPCs compared with Neostigmine
 - Postoperative Hypoxic Episodes/Respiratory Failure
 - NMB reversal with Sugammadex decreased rates of postoperative hypoxic episodes/respiratory failure, compared with Neostigmine administration
 - Pneumonia
 - Incidences of pneumonia were reduced with Sugammadex administration after reversal of NMB, compared to Neostigmine.
 - Atelectasis
 - Rates of atelectasis are decreased with Sugammadex versus Neostigmine administration

Design & Methods

- Recommendation
 - In patients undergoing thoracic surgery, utilize Sugammadex for reversal of NMB unless contraindicated.
- Setting
 - Urban Level 1 Trauma Center in the Midwest United States
- Organizational Infrastructure
 - Comprised of individuals from various departments: anesthesia, information technology, quality improvement, and pharmacy
- Action Plan
 - Administer Sugammadex to all patients undergoing thoracic surgery unless: known Sugammadex allergy or reduced renal function (creatinine clearance < 30 ml/min).

Implementation Plan

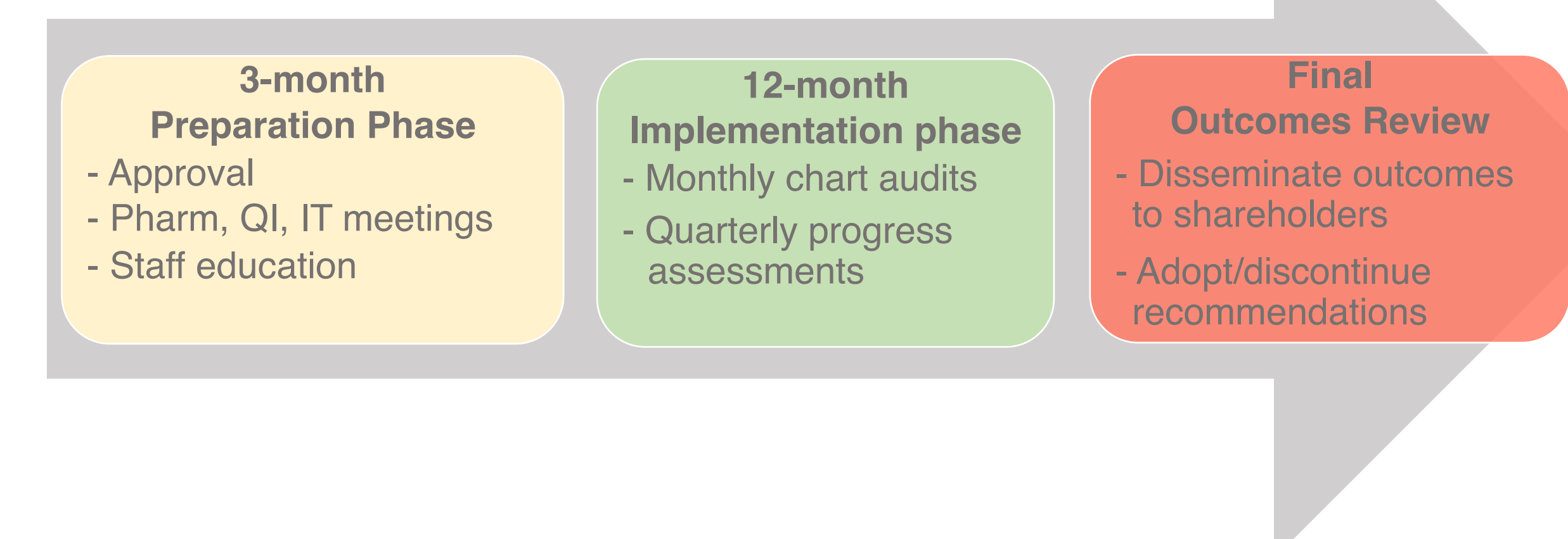
- Approval from the Institutional Review Board, Chief CRNA, and anesthesiologists.
- Discuss Sugammadex stock with the pharmacy department
- Collaborate with the Quality Improvement department to obtain baseline retrospective quantitative PPC data on thoracic surgeries over the past five years
 - Which reversal agent used
 - Desaturation occurrences (SpO2 < 90%, extubation to PACU discharge)
 - Reintubation occurrences in OR/PACU
 - Atelectasis and pneumonia within 72 hours of extubation
- Collaborate with the Information Technology department to create a "Pop-up" alert within the electronic medical system Epic.
- The project team leader and Chief CRNA compose an informational email to send to anesthesia staff, instructing them to use Sugammadex for thoracic cases unless contraindicated.
- The project team leader attends weekly staff meetings to inform anesthesia staff of the initiative and answer questions.
- The project team leader conducts randomized monthly chart audits to monitor compliance throughout the implementation phase.
- The project team leader conducts quarterly assessments comparing progress data to baseline figures.

Budget

- The author estimated 88 monthly thoracic surgery cases → 100 vials of Sugammadex available per month

Sugammadex	Cost	Quantity	Total
200 mg/2mL	\$99.74	70	\$6,981.8
500 mg/2mL	\$182.70	30	\$5,481
			\$12,462.80

Timeline



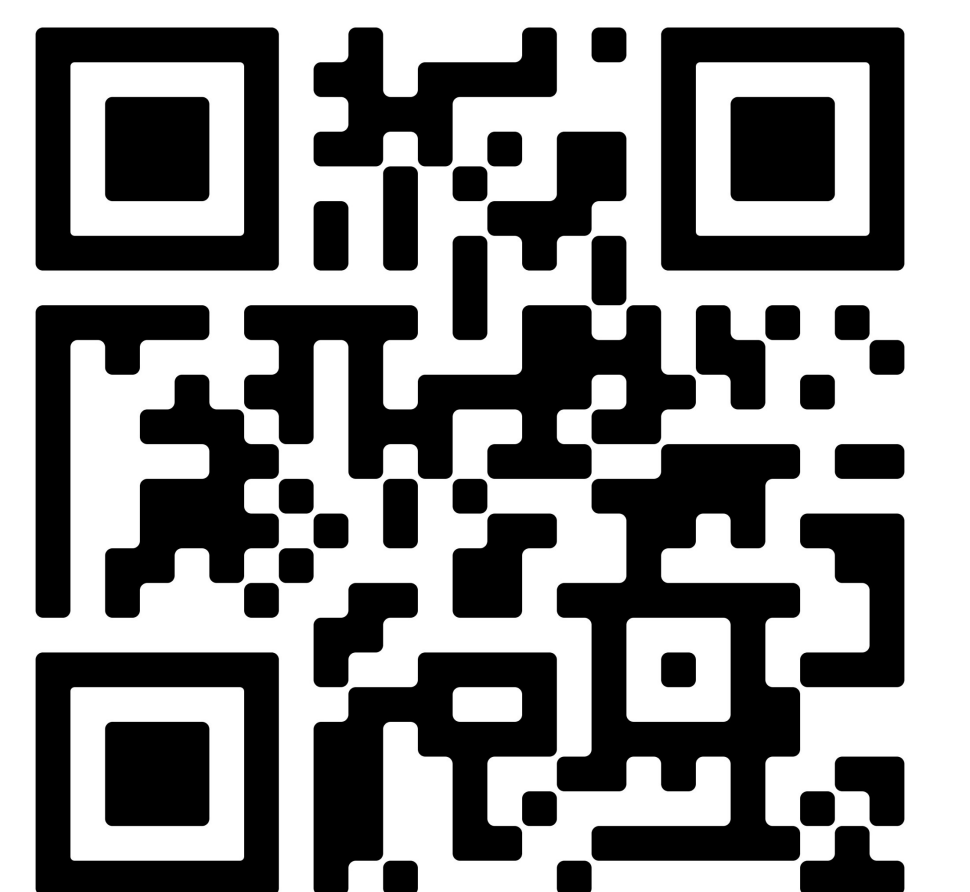
Outcomes & Analysis

- The primary outcome monitored is the occurrence of PPCs → divided into four subgroups: postoperative hypoxic episodes, respiratory failure requiring re-intubation, pneumonia, and atelectasis.
- If the recommendations are successful, a finding of reduced PPCs will be noted.
- While all four subgroups of PPCs will be analyzed and tracked individually, the information gathered will be united to present overall PPC findings.
- If there is at least a 5% reduction in any subgroup, the findings will support a successful EBP model.

Conclusion

- The extensive literature search in this final scholarly project confirmed that patients undergoing thoracic surgery are at higher risk for residual NMB and subsequent PPC complications such as respiratory failure, atelectasis, and pneumonia.
- A literature synthesis concluded that NMB reversal with Sugammadex, instead of Neostigmine, reduces the incidence of residual NMB and associated PPCs in patients undergoing thoracic surgery.

References



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