Spring 5-4-2025

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In Partial Fulfillment of the Requirements for the Degree Doctor of Nursing Practice

2024

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Approved by: 4/11/24

Author Note

We have no conflicts of interest to disclose.

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Abstract

Obesity predisposes patients to heightened risks of adverse outcomes following surgery, including residual neuromuscular blockade and postoperative complications. The administration of non-depolarizing neuromuscular agents (NMBAs) is fundamental for muscle relaxation and optimal surgical conditions. However, the subsequent reversal of these blockers with agents like sugammadex or neostigmine is crucial to mitigate these risks. While sugammadex is recognized as a clinically superior choice due to its rapid and more complete reversal, its extensive use is often limited by cost, presenting challenges in obese patients who already face increased susceptibility to complications. This project evaluates the cost-effectiveness of sugammadex versus neostigmine in obese patients undergoing general anesthesia. Employing the PET process of the Johns Hopkins Nursing Evidence-Based Practice (EBP) Model, the project develops evidence-based recommendations. By conducting evidence review and analyzing literature on clinical and economic outcomes, including postoperative complications and costs, anesthesia providers will receive guidance in optimizing patient care and resource utilization.

Keywords: Non-depolarizing neuromuscular blockers, reversal agents, sugammadex, neostigmine, obese, post-operative outcomes, cost-analysis.

Introduction

Patients classified as obese, are defined as having a body mass index (BMI) of 30 or higher, face a heightened risk of experiencing residual neuromuscular blockade and postoperative complications following general anesthesia. Paralysis can lead to adverse postoperative complications. Extended hospital stays and greater healthcare expenses (Seyni-Boureima et al., 2022). Obese patients are particularly susceptible to complications arising from neuromuscular blockade reversal. Therefore, the administration of the most appropriate neuromuscular blockade reversal medication can have a considerable impact on enhancing the cost-effectiveness of the perioperative period for patients who are obese.

In the operating room (OR), the administration of non-depolarizing neuromuscular agents (NMBAs) is a vital element of anesthesia management, facilitating tracheal intubation and ensuring optimal surgical conditions. However, the use of NMBAs necessitates the use of a reversal agent, such as sugammadex or neostigmine, due to the potential risk of incomplete recovery, also referred to as residual neuromuscular blockade. The occurrence of residual neuromuscular blockade can result in benign or catastrophic outcomes, including postoperative complications that prolong the patient's perioperative stay, thereby compromising the cost-effectiveness of the reversal agent used (Seyni-Boureima et al., 2022, p. 8).

There is a lack of consensus on the most cost-effective reversal agent to use specifically in obese patients related to postoperative complications. Sugammadex is a newer and more expensive medication that has been shown to provide rapid and complete reversal of NMBAs, while neostigmine is an older, less expensive medication that is associated with incomplete reversal and residual neuromuscular blockade (Kheterpal et al., 2020, p. 1372). Furthermore, healthcare providers often face the challenge of balancing the clinical efficacy of sugammadex

with the economic considerations of neostigimine when deciding on the optimal reversal agent for obese patients.

Therefore, the aim of this project is to investigate whether the use of sugammadex for the reversal of amino-steroidal non-depolarizing blockers is more cost-effective than the use of neostigmine during the perioperative period for obese patients undergoing general anesthesia with paralysis and subsequent reversal. The project will compare the clinical and economic outcomes associated with the use of sugammadex versus neostigmine, including the postoperative complications, perioperative length of stay, and hospital cost. The results of this project will help guide anesthesia providers in selecting the most appropriate reversal agent for obese patients, with the ultimate goal of improving cost-effectiveness related to postoperative complications and optimizing healthcare resource utilization.

Background

Obesity and Postoperative Complications

Obesity is a pressing healthcare concern, affecting a significant portion of the population and resulting in substantial medical costs. In the United States, obesity among adults over the age of 18 has reached a prevalence rate of 41.9% (Centers for Disease Control and Prevention, 2022). This alarming statistic underscores the urgency of addressing obesity-related complications and the financial burdens associated with them.. Within the realm of managing obesity-related complications after surgery, the choice of neuromuscular blockers and their reversal agents plays a crucial role.

To gain a comprehensive understanding of the potential harm that NMBAs and the residual effects they may pose to obese patients, it is crucial to define obesity and explore its connection to postoperative complications based on existing literature. According to Flood et al.

(2021), obesity stands as the most prevalent and costly nutritional issue in the United States. By using the BMI formula (weight in kilograms divided by the square of the height in meters), 67% of adult males and 62% of adult females are considered overweight (BMI 25), while 27.5% of adult males and 34% of adult females are categorized as obese, defined by a BMI ≥ 30. Notably, obesity is associated with a significant three to four-fold increase in the risk of ischemic heart disease, stroke, and diabetes mellitus compared to the general population (Flood et al., 2021). In addition to this elevated risk, obese patients are more prone to anesthesia-related challenges, including mechanical difficulties such as airway management, positioning, and ventilation, as well as a higher prevalence of postoperative complications (Flood et al., 2021).

Neuromuscular Blockers

Within the realm of neuromuscular blockers, two distinct categories exist: depolarizing and non-depolarizing agents. Depolarizing NMBAs, such as succinylcholine, enact its effects through sustained depolarization of the postsynaptic neuromuscular junction (NMJ), inducing temporary muscle paralysis (Flood et al., 2021). These depolarizing agents don't need reversal agents due to swift disintegration catalyzed by the pseudocholinesterase enzyme. Conversely, non-depolarizing NMBAs operate via competitive inhibition of the post-junctional nicotinic acetylcholine (ACh) receptors at the NMJ. This inhibition prevents NMJ depolarization, resulting in a state of flaccid paralysis (Flood et al., 2021).

Non-depolarizing agents are further differentiated by distinct chemical compositions into two subcategories: benzylisoquinolinium and amino-steroidal. Among these, benzylisoquinoliniums like mivacurium, atracurium, and cisatracurium undergo organ-independent degradation to facilitate elimination. Due to the unique chemical structures, the paralysis of benzylisoquinoliniums is reversed via acetylcholinesterase inhibitors such as of

neostigmine. On the other hand, the two amino-steroidal agents—rocuronium and vecuronium—rely on end-organ processes for metabolism and elimination. Amino-steroidal agents can be metabolized by both acetylcholinesterase inhibitors and by modified gamma-cyclodextrin medications such as sugammadex. In obese patients, careful dosing adjustments and monitoring may be necessary due to altered pharmacokinetics and potential complications.

Reversal Options

Competitively binding to ACh receptors, both rocuronium, and vecuronium can be countered with acetylcholinesterase inhibitors, like neostigmine. Neostigmine works by temporarily hindering the degradation of ACh via reversible inhibition of the acetylcholinesterase enzyme, ultimately augmenting the concentration of ACh at the NMJ (Flood et al., 2021). This abundance of ACh surpasses the presence of rocuronium or vecuronium molecules, thereby permitting depolarization to transpire.

Regarding the pharmacokinetics of amino-steroidal versus benzylisoquinolinium neuromuscular blockers, it's essential to understand their onset, peak, and duration of action.. Rocuronium showcases an onset within one to two minutes, peaks around 90 seconds, and sustains its action for 20-35 minutes. In contrast, vecuronium's onset and peak manifest within three to five minutes, paralleled by a duration of action spanning 20-35 minutes (Flood et al., 2021). Neostigmine's onset extends from one to five minutes, reaching its peak between seven to fourteen minutes and retaining its efficacy for 30 to 60 minutes (Flood et al., 2021).

It's essential to recognize that the elevated ACh concentration not only impacts the NMJ but also affects the system at large, resulting in a gamut of side effects, including bradycardia, bronchoconstriction, excessive salivation, and heightened gastric motility (Flood et al., 2021). Additionally, neostigmine has been correlated with heightened occurrences of postoperative

nausea and vomiting. These effects emphasize the significance of vigilant management and monitoring when administering reversal agents such as neostigmine or sugammadex in clinical practice, especially in obese patients who may have predisposing factors or susceptibilities to these adverse events.

To counterbalance these potential drawbacks, the simultaneous administration of glycopyrrolate—a potent anti-cholinergic agent—becomes imperative. Glycopyrrolate effectively counteracts ACh at muscarinic receptor sites, effectively mitigating the systemic adverse effects associated with neostigmine (Flood et al., 2021). It's crucial to note that glycopyrrolate's effects on Ach do not extend to nicotinic receptor sites, such as those found within the NMJ.

The other viable reversal agent for amino-steroidal NMBAs is sugammadex. Functioning by irreversibly binding to amino-steroidal NMBAs, specifically rocuronium, and vecuronium, sugammadex is subsequently eliminated through urinary excretion (Flood et al., 2021). Nonetheless, it's noteworthy that sugammadex carries the potential for side effects like anaphylaxis, bradycardia, nausea, and even a reduction in the efficacy of hormonal contraceptives. The onset of sugammadex manifests within three minutes, and its half-life extends to two hours (Flood et al., 2021). In conclusion, while sugammadex effectively reverses amino-steroidal NMBAs, its use requires careful consideration due to its higher cost profile.

Significance Related to Nurse Anesthesia

Obesity poses significant challenges in anesthesia care, requiring a comprehensive evaluation of strategies to enhance clinical outcomes and cost-effectiveness for obese patients undergoing general surgery. The selection of an appropriate reversal agent for neuromuscular blockade is a crucial consideration in anesthesia management. Comparing the cost-effectiveness

related to adverse outcomes of sugammadex and neostigmine in obese patients holds tremendous significance in optimizing patient care and resource utilization (Seyni-Boureima et al., 2022).

Recommendations for the selection of a suitable reversal agent for obese surgical patients can greatly benefit patients, anesthesia providers, and healthcare organizations. By identifying the most clinically effective and cost-efficient agent, anesthesia providers can improve patient care, minimize complications, and enhance the overall efficiency of healthcare delivery (Guerra-Farfan et al., 2022). The primary objective of this project is to develop recommendations that positively impact clinical outcomes by evaluating the cost-effectiveness of sugammadex and neostigmine in adult obese patients undergoing general anesthesia. These recommendations will address the existing information gap in anesthesia care, empowering anesthesia providers with evidence-based recommendations for optimal patient management. By bridging this knowledge gap, healthcare organizations can standardize practices, enhance patient safety, and optimize resource allocation.

PICOT Question

In patients with a BMI of 30 or higher undergoing general anesthesia with paralysis and subsequent reversal (P), how would the use of sugammadex for reversal of amino-steroidal non-depolarizing blockers (I), compared to neostigmine (C), affect cost-effectiveness related to specific pulmonary complications (O) and time in post-anesthesia care unit (PACU) (T)?

Projective Objectives

The primary objectives of the Doctorate of Nursing Practice (DNP) project were to establish a clear framework for accomplishing the goals of the scholarly project. Its specific focus is to provide a comprehensive understanding of the comparative effectiveness of sugammadex versus neostigmine as options for reversing amino-steroid NMBAs in surgical

patients with a BMI of 30 or higher. To accomplish this objective, an extensive synthesis of evidence obtained from the literature search is conducted. The primary emphasis of the project revolves around conducting a cost-benefit analysis and evaluating postoperative outcomes associated with the use of these two reversal medications. By thoroughly examining the available research, this project aims to contribute to the advancement of clinical decision-making and enhance patient care in surgical settings. The objectives established to fulfill the intent of this doctoral project are as follows:

- Synthesize evidence from the literature search regarding the use of sugammadex versus neostigmine as options for reversing amino-steroidal NMBAs in surgical patients with a BMI of 30 or higher.
- Generate EBP recommendations by conducting a cost-benefit analysis and evaluating patient outcomes derived from the literature search comparing the two reversal medications.
- Implement a quality improvement (QI) initiative to enhance the administration and monitoring of sugammadex and neostigmine in surgical settings, aiming to optimize patient safety and outcomes.

The DNP project aims to assess the cost-effectiveness of sugammadex versus neostigmine for reversing amino-steroid neuromuscular blocking agents in surgical patients with a BMI of 30 or higher. Through literature synthesis, cost-benefit analysis, and outcome evaluation, the project seeks to provide EBP recommendations and enhance patient care in surgical settings.

Literature Review

Literature Search

In order to examine the clinical outcomes and cost-effectiveness, a literature review was conducted using the established PICO question. The literature review utilized international electronic databases, including ScienceDirect.com, PubMed.gov, and the online database of Otterbein University's library. Key search terms were applied to each component of the PICO(T) question. For the patient population (P), the search terms: surgical patients, obese individuals, and BMI of 30 were utilized. To investigate the intervention (I), the search terms: sugammadex, neostigmine, amino-steroidal neuromuscular blocking agents, rocuronium, and glycopyrrolate were used. The search terms focused on the outcomes (O) included: postoperative patient outcomes, cost, cost-effectiveness, postoperative complications, residual neuromuscular blockade, length of hospital stay, and time in the PACU. The primary Boolean operator used was "and" to connect these keywords. All search results were narrowed down to peer-reviewed literature published within the last decade, conducted in or translated into English. Organization and summarization of the literature articles were completed utilizing a level of evidence synthesis table (Appendix A).

Literature Synthesis

Clinical Outcomes of Sugammadex versus Neostigmine as Reversal Agents

The administration of NMBAs carries the risk of postoperative complications due to residual neuromuscular blockade. This project focuses on amino-steroidal neuromuscular blocking agents, namely rocuronium, with some studies also examining vecuronium.. After administration of amino-steroidal NMBAs, sugammadex or neostigmine must be given to

reverse the paralytic effects and decrease the likelihood of residual neuromuscular blockade (NMB) that can lead to postoperative complications (Flood et al., 2021).

Sugammadex and neostigmine utilize different mechanisms of action to produce their effects on NMB. Neostigmine acts as an acetylcholinesterase inhibitor, increasing the concentration of ACh at the neuromuscular junction (Flood et al., 2021). ACh is the primary neurotransmitter involved in triggering motor neurons and influencing voluntary movement (Flood et al., 2021). On the other hand, sugammadex functions differently by forming a complex with rocuronium (and vecuronium), effectively removing these agents from the neuromuscular junction and promoting the restoration of muscle function (Flood et al., 2021).

The distinct pharmacological structures and divergent mechanisms of action likely account for the differences in the risk of certain adverse events (AEs), such as respiratory and cardiovascular AEs, between sugammadex and neostigmine. Among the most notable studies comparing the efficacy and safety of these drugs is a meta-analysis conducted by Carron et al., (2017), revealed that sugammadex exhibits both greater efficacy and safety compared to neostigmine in reversing NMB. Notably, sugammadex demonstrated clear superiority over neostigmine in reversing moderate and deep NMB, exhibiting a faster reversal of rocuronium or vecuronium (Carron et al., 2017). Additionally, it was associated with higher train-of-four (TOF) ratio values at extubation and a lower risk of postoperative residual curarization (PORC) after extubation (Carron et al., 2017). The study's findings also showed that the number of patients experiencing AEs considered definitely, probably, or possibly related to the usage of reversal drugs, as assessed by a blinded safety assessor, was significantly lower in the sugammadex group (78 out of 684 patients, accounting for 11.4%) compared to the neostigmine group (133 out of

630 patients, accounting for 21.1%). Furthermore, sugammadex outperformed neostigmine in terms of onset, particularly in reversing moderate neuromuscular blockade.

Gaszynski et al. (2012) conducted a randomized controlled trial comparing sugammadex and neostigmine as reversal agents in 70 morbidly obese patients undergoing general anesthesia. Sugammadex (2 mg/kg) led to a much faster recovery of neuromuscular function (mean time to 90% TOF: 2.7 minutes) compared to neostigmine (9.6 minutes), and TOF values at the PACU were significantly higher in the sugammadex group (109.8%) than the neostigmine group (85.5%). Subramaniet et al. (2021) conducted a systematic review and meta-analysis involving 386 morbidly obese patients undergoing bariatric surgery. In their study, while some neostigmine patients experienced PORC, none of the sugammadex patients did. Sugammadex significantly reduced the time to achieve a TOF ratio >0.9 (mean time: 2.5 min) compared to neostigmine (18.2 min). Sugammadex also resulted in fewer adverse events (21.2% versus 52.5% with neostigmine) and a lower risk of residual NMB, highlighting its superiority in reversing NMB in obese patients undergoing bariatric surgery.

Cost Associated with Sugammadex versus Neostigmine as Reversal Agents

When developing recommendations for the use of reversal agents, the utmost consideration is given to patient safety and clinical outcomes. However, hospitals must also factor in the costs associated with each drug and the potential expenses linked to any complications. To assess the level of neuromuscular blockade during surgery and just before administering a reversal agent, it is essential to employ TOF monitoring (Saenz, 2019). This monitoring method utilizes a peripheral nerve stimulator, commonly referred to as a "train of four" stimulator, which delivers four electrical impulses to the patient (Saenz, 2019). The number of twitches produced in response to the stimulation is then counted by the user. By using

peripheral nerve stimulation to gauge the depth of neuromuscular blockade, healthcare professionals can ensure proper medication dosing, ultimately leading to a reduced incidence of side effects (Saenz, 2019). Subsequently, the dose of the reversal medication is calculated based on the number of twitches observed and the patient's total body weight, ensuring a tailored and appropriate treatment approach (Flood et al., 2021).

The dosage of neostigmine varies based on the patient's total body weight, ranging from 0.02 mg/kg to 0.08 mg/kg, and is determined by the number of twitches elicited during peripheral nerve stimulation. If the patient exhibits two of four twitches with fade, the recommended dosage is 0.07 mg/kg of neostigmine. However, if three or four of four twitches with fade are observed, the dosage is reduced to 0.04 mg/kg (Flood et al., 2021). To counteract ACh-related side effects, glycopyrrolate must be administered concurrently with neostigmine (Flood et al., 2021). The recommended ratio is 0.2 mg of glycopyrrolate per 1 mg of neostigmine. The average acquisition cost of neostigmine is $32.63 for a 5mg/10ml vial. As mentioned earlier, glycopyrrolate is co-administered with this reversal agent, and its cost is $13.28 for a 0.4mg/2ml vial (Jiang et al., 2021).

Sugammadex dosing is determined by both the number of twitches elicited during peripheral nerve stimulation and the patient's total body weight. If two out of four twitches are elicited, the recommended sugammadex dosage is 2mg/kg. In cases where no twitches are elicited, a higher dose of 4mg/kg can be administered. In emergency situations, after administering the maximum intubating dose of NMBD, a dose of 16mg/kg can be given. One notable advantage of sugammadex is that it doesn't require the co-administration of an anticholinergic agent such as glycopyrrolate (Flood et al., 2021). The average acquisition cost for

sugammadex is $99.74 for a single-dose 200mg/2ml vial and $182.70 for a 500mg/5ml vial (Jiang et al., 2021).

When evaluating the use of reversal agents in clinical practice, it is essential to consider not only the upfront price of the medications but also the costs associated with the time required for reversal and potential adverse events linked to the drugs. Carron et al., (2017) conducted a comprehensive systematic review and meta-analysis, analyzing data from six studies involving 518 patients. The main objective was to compare the effects of two reversal agents, sugammadex and neostigmine, on patient discharge rates. The results showed that sugammadex significantly accelerated patient discharge compared to neostigmine. The study found remarkable reductions in discharge time from the OR to the PACU and from the PACU to the surgical ward when sugammadex was used. Specifically, patients treated with sugammadex had a mean difference (MD) in discharge time from the OR to the PACU of 22.14 minutes compared to neostigmine. Additionally, sugammadex exhibited a MD of 5.58 minutes for the discharge-readiness period from the OR to the PACU when compared to neostigmine (Carron et al., 2017). These findings strongly suggest that incorporating sugammadex for reversing neuromuscular blockade can significantly expedite patient recovery and discharge after surgery, outperforming traditional neostigmine-based methods. Considering these results, anesthesia providers are encouraged to incorporate these findings into clinical considerations to optimize post-surgical recovery protocols and augment overall healthcare efficiency, which can have a positive impact on healthcare expenditure.

Postoperative Complications Associated with Obesity

The prevalence of obesity in Western countries has reached alarming levels, resembling an epidemic (Marco Romano et al., 2016). Anesthesia providers face significant challenges when

managing obese patients in the perioperative setting. To optimize ventilation and ensure adequate paralysis during surgery, the use of NMBAs is common practice. However, precise dosing of nondepolarizing NMBAs must be based on ideal body weight to avoid prolonged action and PORC (Marco Romano et al., 2016). Anesthesia providers play a crucial role in facilitating a complete and reliable recovery from neuromuscular blockade after surgery. Although often underestimated, PORC can lead to adverse respiratory events, with approximately 30% of patients receiving NMBAs showing signs of impaired pharyngoesophageal muscle activity and coordination, thereby increasing the risk of post-anesthesia complications (Marco Romano et al., 2016). Close monitoring of neuromuscular function has been recognized as an effective strategy to reduce the incidence of PORC and related complications in the postoperative period (Marco Romano et al., 2016). Consequently, the use of antagonists like neostigmine or sugammadex is strongly recommended when there is evidence of incomplete recovery from neuromuscular blockade (Marco Romano et al., 2016).

Surgical patients classified as obese, who receive a NMBA and subsequent reversal with sugammadex or neostigmine, face a higher risk of postoperative respiratory complications related to general anesthesia when compared to patients with lower BMIs (Subramani et al., 2021). Gasynski et al., (2012) conducted a randomized control trial involving 70 obese patients and found that postoperative respiratory complications were more frequently encountered in morbidly obese individuals than in non-obese patients undergoing anesthesia (33% vs. 26%). Additionally, a retrospective analysis of 79,474 patients observed that even mild postoperative complications could adversely affect patient outcomes and lead to increased healthcare costs (Wachendorf et al., 2023). Therefore, it is crucial to pay close attention to these risks and implement suitable interventions. A residual neuromuscular block is not only linked to an

elevated risk of postoperative respiratory complications but also leads to prolonged PACU length of stay, postoperative ICU admission, and increased costs (Wachtendorf et al., 2023).

Obesity and Reversal Agents

Romano et al. (2016) compared the recovery times of morbidly obese patients undergoing bariatric surgery who received either sugammadex or neostigmine for reversing neuromuscular blockade. The study revealed that sugammadex, although more expensive than neostigmine, resulted in significant time savings, equivalent to 19.4 hours. This time-saving could potentially allow for the completion of 12 additional laparoscopic sleeve gastrectomies. Moreover, the use of sugammadex reduced the duration of operating theater occupancy, which could lead to improved workflow efficiency or reduced personnel costs. Although the cost of sugammadex may limit its routine use, the considerable time saved by this agent could ultimately result in greater productivity and cost-effectiveness. The study suggests that adopting a TOF-driven protocol for neuromuscular blockade reversal in morbidly obese patients could be beneficial, and sugammadex might offer advantages in terms of faster recovery and potential economic implications.

In a study by Wachtendorf et al., (2023), the focus was on evaluating the effects of sugammadex on hospital costs of care in surgical patients. The study included a substantial cohort of 79,474 adult surgical patients who received neuromuscular blocking agents and were reversed with either sugammadex or neostigmine. The findings indicated that the administration of sugammadex was associated with lower direct costs of care, with a reduction of 1.3% compared to neostigmine. In the matched cohort, sugammadex use was linked to $232 lower total costs. Subgroup analysis revealed that sugammadex was associated with $1042 lower total costs in patients with lower risk (lower ASA physical status and ambulatory surgery). However,

in patients with higher risk (higher ASA physical status and preoperative hospitalization), sugammadex was associated with $620 higher total costs. Notably, sugammadex demonstrated greater cost-effectiveness in less complex procedures with shorter durations. Therefore, the cost-effectiveness of sugammadex appears to vary depending on the patient's perioperative risk profile.

Summary

In conclusion, the literature review and synthesis provide compelling evidence supporting the use of sugammadex over neostigmine to enhance cost-effectiveness in clinical outcomes in surgical patients classified as obese. The majority of studies demonstrate the superiority of sugammadex in reducing residual NMB and post-operative complications compared to neostigmine. Additionally, the literature consistently identifies obese patients as a high-risk population for postoperative complications following NMBD administration. Sugammadex emerges as a promising choice for anesthesia providers in managing obese surgical patients due to its ability to deliver enhanced clinical outcomes alongside cost-effectiveness.

Model Used for Project Framework

The John Hopkins Nursing Evidence-Based Practice Model (JHNEBP) (Dang et al., 2022) (Appendix B) served as the EBP framework for this project. Access to the EBP model and tools was granted through a "Copyright Permission Form" completed via John Hopkins Medicine Institution, as documented in Appendix B. The selection of this model was based on its effectiveness in addressing clinical decision-making challenges through EBP (Dang et al., 2022). Within the JHNEBP Model, the project utilized its signature three-phase PET process, described below. PET enables users to incorporate the latest practices into patient care efficiently (Dang et

al., 2022). These three phases involve posing a practice question (P), synthesizing the evidence (E), and translating the evidence into best practice (T) (Dang et al., 2022).

Design and Methods

JHEBP: Practice Question

The first phase of the PET process included identifying the practice question through a multi-step process (Dang et al., 2022). The presence of inconsistency within the current clinical practice was recognized to define the underlying problem. Specifically, in the context of reversing the effects of NMBAs, both sugammadex and neostigmine are utilized (Flood et al., 2021). Each drug exhibits a different mechanism of action and associated side effects (Flood et al., 2021). However, the absence of clear policies or guidelines creates ambiguity regarding the preferred drug choice. Furthermore, certain at-risk populations, such as individuals classified as obese with a BMI of 30 or greater, may exhibit heightened vulnerability to adverse side effects from reversing neuromuscular blockade. Thirdly, the following EBP question was formulated: "In patients with a BMI of thirty or higher undergoing general anesthesia with paralysis and subsequent reversal, how would the use of sugammadex for reversal of amino-steroidal non-depolarizing blockers, compared to neostigmine, affect cost-effectiveness related to postoperative complications and time in post-anesthesia care unit?". Stakeholders involved in this project were identified, including patients, certified registered nurse anesthetists (CRNAs), anesthesiologists, pharmacy personnel, the quality control team, hospital administration, and the healthcare organization. The importance of involving these stakeholders lies in their diverse perspectives and expertise, which collectively lead to well-informed decisions. By engaging stakeholders representing various facets of the healthcare ecosystem, the project can benefit from

a comprehensive understanding of the issue, ensuring that the findings are practical, relevant, and effectively implemented to improve patient care and outcomes.

JHEBP: Evidence

The second phase of the PET process involves a comprehensive exploration of the literature to gather and assess evidence quality (Dang et al., 2022). This begins with internal evidence collection through the quality control department, responsible for upholding predetermined quality standards across the organization, specifically regarding postoperative complications. Following this, external evidence was meticulously collected via a comprehensive literature search, which was subsequently synthesized to identify pertinent studies and assess the level of evidence they provided.The evidence review table, featured in Appendix A, offers a thorough overview of this evaluated evidence, enabling easy reference and assessment of findings' strength and implications. A meticulous search through various sources, including databases, journals, and professional guidelines, ensures a comprehensive literature review. The primary goal during the literature search was to attain high-quality evidence that guides decisions and tackles the initial EBP practice question within the context of this DNP project. By rigorously evaluating the literature's validity and applicability, the second step of the JHNEBP model facilitates the seamless integration of reliable evidence into clinical practice, highlighting the necessity for change. Notably, the evidence strongly supports sugammadex over neostigmine for reversing neuromuscular blocking agents for obese surgical patients, considering clinical outcomes and cost-effectiveness, ultimately leading to the development of recommendations for this practice transformation.

JHEBP: Translation

In the third phase of the PET process, the focus shifts towards translating evidence into actionable implementation (Dang et al., 2022). This step involves a methodical approach, including a comprehensive organizational evaluation aimed at monitoring pertinent outcomes and data points. The project team takes charge of data collection, extracting and analyzing quality control data to establish a foundational understanding of existing practices and outcomes. Specifically targeting surgeries involving obese patients and the choice between sugammadex and neostigmine, the assessment provides insights into postoperative complication rates associated with each medication. These insights are then shared with relevant stakeholders and departments within the healthcare organization, complemented by external evidence synthesized from a comprehensive literature review. Through this integrative approach, the third step of the JHNEBP model bridges research with practical application, facilitating evidence-based decision-making among anesthesia providers while considering the interplay between costs and benefits.

Recommendations

Based on the information gathered from the literature search, the use of sugammadex for the reversal of amino-steroidal non-depolarizing blockers in patients categorized as obese exhibited a reduction in the occurrence of postoperative complications. Therefore, the following recommendations for neuromuscular reversal should be considered.

1. ***Prior to surgery, measure the weight and height of each patient to calculate their BMI.***

- Upon admission, obese patients will undergo risk statification. Timely identification of these patients at the beginning of the perioperative process is crucial for proper management and monitoring.

2. ***If a patient's BMI exceeds 30, sugammadex should be employed for reversal.***

- An analysis of the literature review demonstrated an elevated occurrence of pulmonary complications in obese patients. Additionally, the review highlighted a reduction in postoperative complications when sugammadex was used for reversal in these patients. Consequently, the administration of sugammadex is recommended for obese patients to mitigate postoperative complications. Adhere to the manufacturer's guidelines for dosing sugammadex.

3. ***If a patient's BMI is less than 30, the choice of reversal agent should be deferred to clinician judgment with consideration of other patient comorbidities.***

- While sugammadex is acknowledged in clinical practice as the superior reversal agent, according to the literature, its application should not be unrestricted. As mentioned earlier, sugammadex is the recommended choice for reversal in obese patients with BMIs exceeding 30, aiming to mitigate post-operative complications in this vulnerable group. For populations without an elevated risk of postoperative complications, neostigmine remains a viable consideration. Additionally, evaluating patient comorbidities, particularly obesity, is crucial, and the choice between administering sugammadex or neostigmine should be based on individual considerations, carefully balancing the associated risks and benefits for each case.

Implementation

The project team has developed a comprehensive plan for future implementation within a hospital organization, targeting all surgical patients with obesity. To ensure the successful execution of the project, the initial step involves conducting an in-depth retrospective chart audit, which entails an analysis of all surgical patients requiring general anethesia with a BMI of 30 or

higher who were administered rocuronium or vecuronium during induction. This audit will capture crucial data points, including the specific reversal agent used and its dosage, the time interval from reversal agent administration to the patient's departure from the OR, the duration of the patient's stay in the PACU, instances of reintubations either in the PACU or OR, the extent of oxygen desaturation below 90% after extubation until PACU discharge, and the overall length of the patient's stay. Subsequently, an in-depth analysis and synthesis of the literature search will be performed (Appendix A), accompanied by a concise summary of the cost-benefit analysis.

Upon securing approval within the healthcare facility, the project will transition to the next phase, entailing the dissemination of these recommendations across the organization. This educational effort will be initiated through staff meetings and will be supported by the distribution of educational handouts (refer to Appendix C). These handouts will be strategically placed within ORs and sent out via work emails. This multifaceted approach ensures the widespread awareness and successful adoption of these recommendations throughout the organization.

Cost-Benefit Analysis

A cost-benefit analysis serves as a valuable tool for assessing the financial ramifications of a decision. As previously discussed, the substantial upfront cost linked to the utilization of sugammadex is often cited as the predominant factor driving its exclusive use for emergency medication reversal. It is imperative to undertake a comprehensive cost-benefit analysis that juxtaposes neostigmine and sugammadex to determine the most economically efficient method for reversing neuromuscular blockade in obese patients.

The data gathered through the chart audit should be condensed and used to complete the cost-benefit analysis. Factors such as the average duration from reversal administration to OR

departure, PACU stay duration, incidence of adverse outcomes, and the extended length of stay linked to adverse events should all be factored in for each medication. The initial costs of the medications should be juxtaposed with the expenses related to the average duration from reversal administration to OR departure, typical PACU duration, adverse events, and any resulting extended stays. An example of this cost-benefit analysis can be found in Appendix D. The medication demonstrating the most favorable overall cost, following this in-depth comparison of upfront and associated costs, should be recognized as the most cost-effective choice.

Timeline

The implementation timeline for project leaders at the designated facility spans one year. Initially, the focus is on educating key stakeholders, including anesthesiologists, CRNAs, PACU nurses, unit managers, OR pharmacists, and the facility's quality department. To ensure a successful implementation, project leaders will conduct in-person meetings with each department. In the early stages, it's advisable to have more frequent meetings, such as bi-weekly or monthly, to provide comprehensive education and address any immediate concerns. As the project progresses and stakeholders become more familiar with the changes, meetings can transition to quarterly or as-needed basis. The project's kickoff week involves intensive 30-minute in-person meetings with the anesthesia department, PACU, and pharmacy. Simultaneously, educational materials will be distributed throughout every OR and procedural area where general anesthesia is administered. To support this, the pharmacy will collaborate to guarantee that every medication dispensing machine is stocked with sugammadex during this initial rollout week. Coordinating with the pharmacy to ensure that every medication dispensing machine is stocked with sugammadex may require a few days, as it involves inventory management and distribution logistics. Considering all these factors, a one to two-week

timeframe should allow for a thorough and effective implementation during the kickoff week. Furthermore, the PACU nurse manager and nursing staff will receive clear instructions on specific clinical data to monitor and accurately document. Concurrently, the quality department will diligently monitor AEs and compliance with the recommendations to gather the necessary data for a comprehensive assessment of clinical outcomes and a thorough cost-benefit analysis upon project completion. Weekly or bi-weekly monitoring can help identify any immediate issues that need addressing as the changes are rolled out.

Following the initial rollout of recommendations, the project leaders will shift their focus towards sustaining compliance and providing ongoing reminders. To ensure a proactive approach, project leaders will conduct periodic retrospective chart audits, with the frequency being higher in the early stages of the project. After the completion of the first year, project leaders will initiate a comprehensive retrospective chart audit, spanning from the second week of the project's launch to the one-year mark. During this audit, the same data points as before, along with compliance data from the quality department, will be collected once more.

Subsequently, these data points will be meticulously organized and analyzed periodically, comparing to the initial chart audit results to assess the project's progress. If, at any point during the year, the project recommendations do not demonstrate a reduction in postoperative complications or costs, the recommendations will be subject to review and potential adjustment or discontinuation. Instead, emphasis will be placed on encouraging anesthesia providers to follow preferences. This adaptive approach ensures that the project remains responsive to practical outcomes and continually strives for improvement, with a heightened focus on financial considerations and prompt corrective action if necessary.

Budget

The project budget will encompass anticipated expenses related to both the rollout and ongoing monitoring of the recommendations. A significant portion of this budget will be allocated to product cost of sugammadex vials, so that every surgical patient, classified as obese, who receives a amino-steroidal NMBA can be reversed with sugammadex. The average acquisition cost for sugammadex is well-documented at $99.74 for a single-dose 200mg/2ml vial and $182.70 for a 500mg/5ml vial (Jiang et al., 2021). Consequently, extrapolating this data to the facility's daily surgical caseload, it's estimated that maintaining a daily inventory of 50 sugammadex vials is best. This allocation will comprise 35 vials of 200mg and 15 vials of 500mg, resulting in a daily sugammadex budget totaling $6,231.40.

However, it's important to note that this sum will not be expended daily, as sugammadex usage will be closely monitored. Considering that the prevalence of obesity in the United States stands at 41.9% among adults over the age of 18 (CDC, 2022), it is essential to acknowledge that not all surgical patients will fit the criteria for obesity. In fact, according to recent 2023 data from the National Surgical Quality Improvement Program, approximately 44.6% of surgical patients are categorized as obese (Sauer, 2023). Thus, precautions will be taken to avoid overstocking and ensure fiscal responsibility.

After meeting with the pharmacy department during the project's initial rollout week, it was determined that the increased amount of sugammadex and its proper stocking within the medication cart would not require any additional work from the pharmacists, thus having no impact on the financial budget of the project. This is because the pharmacy department already stocks the medication dispensing machines in the mornings as part of their daily routine.

Presenting the recommendations at the mandatory weekly staff meetings should not incur any additional monetary expenses, ensuring that the budget remains unaffected in this regard.

In addition to the paper materials required for presenting evidence-based literature findings, a budget allocation of $100 has been set aside for these material expenses. Furthermore, other expenses, including the time dedicated to conducting a literature search, synthesis, meetings with stakeholders, and project development, were taken into account. The project leaders will incur these time-related costs, which will not impact the overall financial budget of the project.

However, it's important to note that several components of this project, particularly the efforts of the QI department and CRNAs, are seamlessly integrated into existing roles and responsibilities. This collaborative project doesn't introduce additional budgetary costs in terms of labor because the QI department is naturally invested in improving patient outcomes, and CRNAs are carrying out their regular duties. By leveraging existing resources and aligning the project with the QI department's interests, it ensures that the project's recommendations are implemented without incurring additional financial burdens while promoting a culture of QI within the organization.

Comprehensive Plan for Monitoring and Measuring Recommendations

The primary outcomes to monitor include the time from NMB reversal administration to the patient's exit from the OR, the total duration of the patient's stay in the PACU, and complications related to residual blockade, such as re-intubation and occurrences of oxygen desaturation. If complications arise due to inadequate reversal, the secondary outcome involves assessing the overall length of the patient's stay. Oxygen desaturation is defined as SpO2 saturation falling below 90% before PACU discharge. To ensure compliance with the

recommendations, data will be collected on the choice of reversal agent used and the administered dosage. The data points can be collected by the QI department and presented to the project leaders at the appropriate timeline intervals.

The data analysis will involve comparing the most recent data with the results from the initial chart audit. Success in implementing the recommendations should manifest as a reduction in OR time, shorter PACU stays, and a decrease in respiratory complications associated with inadequate reversal. Additionally, the collected data will be scrutinized for adherence to the recommendations. Non-compliance with these recommendations could potentially distort the data, making it appear as if the recommendations have not been effective.

Comprehensive Plan for Revisions

Before proceeding with the comparison between the initial chart audit and the latest data, a thorough investigation into recommendation compliance will be conducted to safeguard the data's integrity. Subsequently, if the proposed recommendations are determined to be ineffective, necessary revisions will be made. In cases where recommendation compliance is unsatisfactory, additional education and follow-up measures will be implemented for providers not adhering to the recommendations. In response to potential challenges identified in the comparison between the initial chart audit and recent data, adjustments may include reassessing recommendations, and enhancing educational. If, upon concluding the one-year interval, no clear difference in cost-effectiveness or clinical outcomes is observed, the proposed recommendations will be reconsidered, and provider preference will be encouraged as an alternative approach.

Dissemination

The project leaders will use the literature review findings to create a poster presentation. This poster will share the key information from the research, explain how the project will be put

into action, how it will be monitored, and what changes might be made. The presentation will be given to the project team, important stakeholders, and faculty staff. Leaders will start by giving background information and highlighting the topic's importance, followed by a brief research summary. Finally, a plan for introducing the project in a healthcare facility will be outlined.

Limitations and Barriers

Although the recommendations provide guidance for handling obese surgical patients, some limitations should be noted. Focusing solely on sugammadex may overlook alternative approaches. Secondly, the recommendations target patients with a BMI over 30, potentially excluding others who could benefit from the medicationNM. Additionally, relying on retrospective audits and cost analyses may miss real-time clinical details. Lastly, ensuring provider compliance and resource availability could pose implementation challenges. Addressing these limitations through ongoing monitoring and stakeholder engagement is crucial for improving patient care in this population.

Conclusion

The literature review confirmed that patients classified as obese face a higher risk of post-operative complications related to residual NMB. Currently, there are limited evidence-based recommendations for reversing NMB in obese patients. A synthesis of the literature indicated that using sugammadex is associated with a reduced incidence of post-operative complications in obese patients. This can significantly reduce the costs associated with such complications. After a thorough literature review, the project team concluded that all surgical patients should have their NMB reversed based on BMI before the procedure. Patients with a BMI above 30 should receive sugammadex upon administration of an amino-steroidal neuromuscular blocker. However, further research is needed before recommending the unrestricted use of sugammadex

in all patient populations, including those with BMIs below 30. For patients with a BMI below 30, the use of neostigmine is a viable option, but healthcare providers should consider factors like the type of surgery and other patient comorbidities. Outcomes for the project include enhanced patient safety, reduced complications, and potential cost savings.

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Appendix A

Evidence Review Table

APA Citation:
Carron, M., Zarantonello, F., Tellaroli, P., & Ori, C. (2016). Efficacy and safety of sugammadex compared to neostigmine for reversal of neuromuscular blockade: A meta-analysis of randomized controlled trials. *Journal of Clinical Anesthesia*, *35*, 1–12. https://doi.org/10.1016/j.jclinane.2016.06.018

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: not evident	-Meta-analysis -A comprehensive search was conducted using PubMed, Web of Science, and Cochrane Library electronic databases to identify English-language randomized controlled trials. Two reviewers independently selected the trials; extracted data on reversal times, incomplete reversals of NMB, and adverse events (AEs); and assessed the trials' methodological quality and evidence level. Only AEs that were related to study drug by a blinded safety assessor were considered for meta-analysis.	-A total of 1384 patients from 13 articles were included in this meta-analysis. -University medical hospital	**Independent variables:** -Type of drug used for reversing neuromuscular blockade (NMB). The two drugs compared are sugammadex and neostigmine. **Dependent variables:** 1.Reversal times: The time taken for NMB to be reversed by sugammadex or neostigmine. 2.Incomplete reversals of NMB: The occurrence of incomplete reversal of NMB after administration of sugammadex or neostigmine.	-The primary outcomes for this meta-analysis were efficacy outcomes. -The secondary outcomes involved these safety evaluations.	Statistical tests: -For binary outcome data: Odds ratios (OR) and 95% confidence intervals (CI) were computed. -For continuous outcome data: Mean differences (MD) and 95% CI were computed. -A Shapiro-Wilk test for normality was conducted for continuous data when the number of combined studies was larger than 3. Analysis of reversal times:	**Findings:** This meta-analysis found that sugammadex is more effective and safer than neostigmine in reversing neuromuscular blockade. Sugammadex rapidly reverses the effects of rocuronium or vecuronium, resulting in higher muscle function and lower risk of residual curarization. It has a lower incidence of respiratory and cardiovascular adverse events compared to neostigmine. Neostigmine is associated with bronchospasm, pulmonary complications, bradycardia, and changes in arterial pressure. Generalized weakness and muscle weakness are also more	I	**Strengths:** - The study utilized a meta-analysis design, which allows for a comprehensive evaluation of multiple studies. - A comprehensive search strategy was employed, including multiple electronic databases, to identify relevant studies. -Two independent reviewers were involved in the study selection and data extraction process, enhancing the reliability of the results. -The study included a substantial number of patients (1384) from 13 articles, which increases the statistical power and

			3.Train-of-four ratio values at extubation: The measurement of neuromuscular function using the train-of-four ratio, indicating the level of recovery from NMB at the time of extubation. 4.Risk of postoperative residual curarization: The likelihood of residual neuromuscular blockade after extubation. 5. Adverse events (AEs): Any adverse events associated with the use of sugammadex or neostigmine for NMB reversal, including global AEs, respiratory AEs, and cardiovascular AEs.		-Reversal times, expressed in minutes, were analyzed using geometric means and their CI bounds after log transformation. -Only studies that reported data as geometric means were included in the analysis.	common with neostigmine. Pain and postoperative nausea and vomiting do not significantly differ between the two drugs. Overall, sugammadex demonstrates superior efficacy and safety in reversing neuromuscular blockade.		generalizability of the findings. **Limitations:** - Possible language bias due to exclusion of non-English studies.

Annotated Bibliography statement (may be several sentences summarizing the article based upon the information above using professional APA writing style):
This meta-analysis compares the effectiveness and safety of sugammadex and neostigmine for reversing neuromuscular blockade in adults. The study includes 13 randomized controlled trials involving 1384 patients. The findings indicate that sugammadex outperforms neostigmine in terms of faster reversal of neuromuscular blockade, higher train-of-four ratio values at extubation, reduced risk of postoperative residual curarization, and lower occurrence of adverse events. The authors conclude that sugammadex is both more effective and safer than neostigmine for reversing neuromuscular blockade in adult patients. This meta-analysis provides valuable insights for clinicians in selecting appropriate pharmacological agents for managing neuromuscular blockade.

Thematic Analysis **Key Themes or FSP related significance:** **1.** Superior effectiveness of sugammadex: The meta-analysis suggests that sugammadex is more effective in rapidly and reliably reversing neuromuscular blockade compared to neostigmine. Sugammadex achieves a higher degree of recovery from paralysis, allowing for better restoration of normal muscle function. **2.** Enhanced safety profile of sugammadex: The study findings indicate that sugammadex is associated with a lower risk of postoperative respiratory complications and adverse events compared to neostigmine. **3.** Clinical implications for sugammadex use: Sugammadex can offer advantages in scenarios where rapid recovery from neuromuscular blockade is crucial, such as during general anesthesia with paralysis. It may particularly benefit patients with a higher BMI, who may be more prone to prolonged paralysis and respiratory complications.

APA Citation: Carron, M., Zarantonello, F., Lazzarotto, N., Tellaroli, P., & Ori, C. (2017). Role of sugammadex in accelerating postoperative discharge: A meta-analysis. *Journal of Clinical Anesthesia*, *39*, 38–44. https://doi.org/10.1016/j.jclinane.2017.03.004								
Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: not evident	-Systematic review and meta-analysis.	-518 patients from six studies were included. -University medical hospital	**Independent variables:** -Type of drug used for reversing neuromuscular blockade (NMB). The two drugs compared are sugammadex and neostigmine. **Dependent variables:** 1. Time to discharge from the OR to the PACU. 2. Time to discharge from the PACU to the surgical ward. 3. Discharge-readiness from the OR to the PACU. 4. Discharge-readiness from the PACU to the surgical ward.	The outcome measurements in this study are used to compare the speed of postoperative discharge and readiness for discharge between sugammadex and neostigmine in patients undergoing general anesthesia.	The statistical analysis involved meta-analyses using frequentist methods, calculating mean differences and 95% confidence intervals for continuous outcome data. Random-effects and fixed-effects models were used, with inverse-variance weighting. Heterogeneity was assessed using the I2 statistic, with a threshold of $p < 0.1$ indicating heterogeneity. An I2 value of 50% or more was considered substantial. When the number of studies was small, the Q test was used to identify heterogeneity. No tests for publication bias were conducted.	**Findings:** The meta-analysis found that sugammadex, compared to neostigmine, was associated with significantly faster discharge times from the OR to the PACU and from the PACU to the surgical ward. The mean difference (MD) for discharge from OR to PACU was 22.14 minutes (95% CI: 14.62, 29.67, $p < 0.0001$, I2 = 0%), and from PACU to surgical ward was 16.95 minutes (95% CI: 0.23, 33.67, $p = 0.0469$, I2 = 98.4%). Discharge readiness from OR to PACU was also shorter for sugammadex compared to neostigmine, with an MD of 5.58 minutes (95% CI: 3.03, 8.14, $p \leq 0.0001$, I2 = 0%). However, there was no significant difference in discharge readiness between the two groups	I	**Strengths:** -The systematic review and meta-analysis design allows for a comprehensive evaluation of the available evidence. -A comprehensive search strategy was employed, including multiple databases, to identify relevant studies. -Two reviewers independently selected studies, extracted data, and assessed methodological quality, which enhances the reliability of the findings. **Limitations:** - The number of included studies was limited, which may affect

						for patients moving from the PACU to the surgical ward, with an MD of -1.10 minutes (95% CI: -5.69, 3.50, p = 0.6394, I2 = 25.3%). -Conclusion: Based on the results of this meta-analysis, sugammadex appears to accelerate postoperative discharge of patients after general anesthesia compared to neostigmine.		the generalizability of the findings.

Annotated Bibliography statement (may be several sentences summarizing the article based upon the information above using professional APA writing style):
This article aimed to review the existing research on the use of sugammadex and neostigmine for reversal of neuromuscular blockade after general anesthesia and assess their impact on patient discharge time. The systematic review and meta-analysis included six studies involving 518 patients. The results showed that sugammadex was associated with significantly faster discharge times from the OR to the PACU and from the PACU to the surgical ward compared to neostigmine. Additionally, discharge-readiness was shorter for sugammadex in the OR to PACU transition. The findings suggest that sugammadex accelerates postoperative discharge compared to neostigmine. Overall, this article provides valuable insights into the efficacy of these two agents in facilitating patient recovery and discharge after general anesthesia.

Thematic Analysis
Key Themes or FSP related significance:
1. Sugammadex was found to significantly reduce the time for discharge from the OR to the PACU compared to neostigmine.
2. Patients who received sugammadex were discharge-ready sooner when moving from the OR to the PACU.
3. Findings suggest that sugammadex can expedite postoperative discharge compared to neostigmine

APA Citation: Gaszynski, T., Szewczyk, T., & Gaszynski, W. (2012). Randomized comparison of sugammadex and neostigmine for reversal of rocuronium-induced muscle relaxation in morbidly obese undergoing general anaesthesia. *British Journal of Anaesthesia*, *108*(2), 236–239. https://doi.org/10.1093/bja/aer330								
Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: not evident	-Randomized control trail.	- The study included a sample of 70 morbidly obese patients with a BMI of 40 kg/m^2 or higher who required general anesthesia and received rocuronium for muscle relaxation.	**Independent variables:** -Type of medication used for reversal of neuromuscular blockade. Two groups were compared: the sugammadex group (Group SUG) and the neostigmine group (Group NEO). **Dependent variables**: 1. Time to achieve 90% of train-of-four (TOF) score: This refers to the time it takes for the patients' neuromuscular function to recover to 90% of the baseline level, indicating safe extubation. 2. Presence of postoperative residual	-Time to achieve 90% of train-of-four (TOF) score: This outcome represents the time it takes for the patients' neuromuscular function to recover to 90% of the baseline level, indicating safe extubation. -Presence of postoperative residual curarization: This outcome indicates whether there was residual influence of neuromuscular blocking agents in the postoperative period. It was assessed by a blinded investigator upon the patients' arrival in the PACU. -These outcomes were measured to evaluate the	- The qualitative aspects of the study include the assessment of patient characteristics, such as age, weight, height, and BMI, as well as the monitoring of neuromuscular function. Adverse effects and side-effects of the administered drugs were also evaluated qualitatively.	**Findings:** -Patients in the sugammadex group (Group SUG) achieved 90% of train-of-four (TOF) score, indicating recovery of neuromuscular function, in a significantly shorter time compared to patients in the neostigmine group (Group NEO). The mean time to 90% TOF was 2.7 minutes in the sugammadex group and 9.6 minutes in the neostigmine group. -The TOF score at the PACU was significantly higher in the sugammadex group (109.8%) compared to the neostigmine group (85.5%). This suggests a more complete recovery of neuromuscular function in the sugammadex group. -The mean dose of rocuronium, the neuromuscular blocking agent, administered during anesthesia was similar between the two groups (87.9 mg in the sugammadex	II	**Strengths:** -Randomized controlled trial design. The study used a randomized design, which helps minimize bias and increase the reliability of the results. -Blinded investigator: The presence of a blinded investigator in the post-anaesthesia care unit (PACU) reduces the risk of subjective assessment and enhances the objectivity of the findings. -Adequate sample size. The study included 70 morbidly obese patients, which enhances the statistical power and generalizability of the findings. **Limitations:** -Short-term follow-up. The study examined the immediate postoperative period in the PACU, and longer-term outcomes or complications beyond this period were not investigated.

			curarization (PORC): This variable indicates whether there was residual influence of neuromuscular blocking agents in the postoperative period. It was assessed by a blinded investigator upon the patients' arrival in the PACU.	effectiveness and recovery profile of sugammadex compared to neostigmine in reversing neuromuscular blockade in morbidly obese patients.		group and 85.6 mg in the neostigmine group). -Based on these findings, it can be concluded that the administration of sugammadex resulted in faster recovery of neuromuscular function and prevented postoperative residual curarization (PORC) in morbidly obese patients, whereas neostigmine did not provide the same benefits.		

Annotated Bibliography statement (may be several sentences summarizing the article based upon the information above using professional APA writing style):
The article focuses on the importance of complete and fast recovery of neuromuscular function in morbidly obese patients undergoing surgery. The study compares the effectiveness of two drugs, sugammadex and neostigmine, in reversing muscle relaxation induced by rocuronium and preventing postoperative residual curarization (PORC). The results show that sugammadex provides a faster recovery of neuromuscular function and prevents PORC in morbidly obese patients, while neostigmine does not. The study highlights the significance of monitoring neuromuscular function during anesthesia and suggests sugammadex as an effective option for reversing muscle relaxation in these patients. Overall, the findings emphasize the need for careful management of neuromuscular function in morbidly obese individuals to ensure optimal respiratory function in the postoperative period.

Thematic Analysis
Key Themes or FSP related significance:
1. Complete and fast recovery of neuromuscular function is crucial in morbidly obese patients to avoid postoperative residual curarization (PORC) and its potential negative impact on respiratory function.
2. Sugammadex was found to significantly reduce the time to achieve 90% of train-of-four (TOF) score compared to neostigmine.
3. The incidence of PORC was significantly lower in the sugammadex group compared to the neostigmine group. All patients in the sugammadex group achieved TOF scores above 90% at the post-anaesthesia care unit, while the neostigmine group had lower TOF scores.
4. The study highlights the importance of selecting appropriate reversal agents for neuromuscular blockade in morbidly obese patients and suggests that sugammadex is a preferred choice due to its fast and effective action in preventing PORC.

APA Citation:

Marco Romano, G., Zito Marinosci, G., De Robertis, E., Piazza, O., Iannuzzi, M., Cirillo, F., De Simone, S., & Servillo, G. (2016). The use of sugammadex for bariatric surgery: Analysis of recovery time from neuromuscular blockade and possible economic impact. *ClinicoEconomics and Outcomes Research*, *Volume 8*, 317–322. https://doi.org/10.2147/ceor.s109951								
Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: not evident	Retrospective study	-The study includes 99 patients who underwent laparoscopic bariatric surgery.	**Independent variables:** -Type of reversal agent used for neuromuscular blockade during bariatric surgery. There are two groups: the SUG group (sugammadex) and the NEO group (neostigmine). **Dependent variables:** 1.Latency to achieve a train-of-four (TOF) ratio >0.9 after reversal agent administration: This variable measures the time it takes for the patients to recover from neuromuscular blockade and regain muscle function. 2.Time to achieve an Aldrete score of ten: The Aldrete score is used to assess the recovery of patients from anesthesia and surgery. A score of ten indicates that the patients are ready to be discharged from the postanesthesia care unit (PACU). This variable measures the time it takes for patients to reach a score of ten. 3.Duration of operating theater occupancy: This variable measures the time from the start of anesthesia to when the patient is transferred to the	-The study aims to compare the costs and recovery times associated with sugammadex and neostigmine administration, as well as estimate the time of OR occupancy.	- The qualitative analysis in the study involved analyzing and comparing the costs and recovery times associated with the use of sugammadex and neostigmine. The authors also discussed the potential economic impact of using sugammadex by calculating the time saved and estimating the number of additional surgical procedures that could be performed with the saved time.	**Findings:** -The results showed that the mean recovery time from reversal administration to a TOF ratio ≥0.9 was significantly quicker in the SUG group compared to the NEO group. The SUG group also experienced a shorter duration of OR occupancy and a shorter time to achieve an Aldrete score of 10. There were no significant differences in oxygen saturation at admission or discharge in the postanesthesia care unit or in the length of hospital stay between the two groups. -The study analyzed the costs associated with sugammadex and neostigmine.	III	**Strengths:** -Retrospective Analysis. The study utilizes a retrospective analysis of patient records, allowing for the examination of a large sample size and real-world data. This approach can provide valuable insights into actual clinical practice. -Comparison of Outcomes: The study compares various outcomes between the sugammadex and neostigmine groups, such as the time to achieve a train-of-four (TOF) ratio >0.9, duration of operating theater occupancy, incidence of postoperative desaturation, and length of hospital stay. This comparison helps evaluate the effectiveness and efficiency of the two reversal agents.

			PACU. It reflects the time the operating theater is occupied for each surgery. 4. SpO2 at PACU admission and discharge: SpO2 (peripheral oxygen saturation) is a measure of the oxygen level in the blood. This variable assesses the oxygen saturation levels of patients upon admission to the PACU and at the time of discharge. 5. Length of stay in the hospital: This variable measures the duration of hospitalization for each patient following bariatric surgery. 6. Cost of reversal drugs: This variable represents the cost associated with the administration of reversal agents, either sugammadex or neostigmine.			The calculated cost per treatment was higher for sugammadex compared to neostigmine. However, the time saved using sugammadex instead of neostigmine was estimated to be 23 minutes per surgery. The analysis showed that with the time saved using sugammadex, 12 additional laparoscopic sleeve gastrectomies could be performed. This resulted in a net gain in terms of reimbursement.		**Limitations:** -Small sample size. The study included a relatively small sample size, with 50 patients in the sugammadex group and 49 patients in the neostigmine group. A larger sample size would increase the statistical power and reliability of the findings.

Annotated Bibliography statement (may be several sentences summarizing the article based upon the information above using professional APA writing style):
This article presents a retrospective study comparing the recovery times and economic impact of sugammadex versus neostigmine administration in morbidly obese patients undergoing bariatric surgery. The study found that reversal from neuromuscular blockade was significantly faster with sugammadex, leading to shorter times to achieve certain recovery criteria and reduced duration of OR time. Despite being more expensive, the time saved with sugammadex allowed for potential workflow improvements or cost reductions. The study suggests that the use of sugammadex in these patients can lead to improved recovery times and economic benefits. However, the high cost of sugammadex should be considered in routine clinical practice, with its economic benefit dependent on the efficient use of saved time.

Thematic Analysis
Key Themes or FSP related significance:
1. Sugammadex administration resulted in significantly faster recovery from neuromuscular blockade compared to neostigmine.
2. The duration of OR occupancy was significantly reduced in the sugammadex group.
3. Sugammadex was more expensive compared to neostigmine, accounting for 2.58% of the total cost per surgery.
4. The time saved with sugammadex could potentially be used to perform additional surgeries, leading to a potential economic benefit.
5. The study highlights the potential benefits of using sugammadex in terms of faster recovery and improved workflow in the OR, despite its higher cost.

APA Citation:

Subramani, Y., Querney, J., He, S., Nagappa, M., Yang, H., & Fayad, A. (2021). Efficacy and safety of sugammadex versus neostigmine in reversing neuromuscular blockade in morbidly obese adult patients: A systematic review and meta-analysis. *Anesthesia: Essays and Researches*, *15*(1), 111. https://doi.org/10.4103/aer.aer_79_21

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement(s)***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: not evident	Systematic Review and Meta-Analysis	Sample: Included a total of 386 participants. These participants were morbidly obese patients undergoing bariatric surgery. The sample size was derived from seven studies that met the inclusion criteria. Setting: The studies included in the review were conducted in various healthcare settings where bariatric surgeries are performed. The specific settings were not mentioned in the provided information.	**Independent variables:** the type of drug used for the reversal of neuromuscular blockade. The comparison is between sugammadex and neostigmine. **Dependent variables:** 1.Recovery time: The primary objective of the study is to determine the recovery time from drug administration to a train-of-four (TOF) ratio >0.9 from a moderate or deep NMB. The recovery time is measured in minutes. 2.Composite adverse events: The number of patients who experienced composite adverse events is another dependent	-This study evaluated the efficacy and safety of sugammadex compared to neostigmine in reversing neuromuscular blockade in morbidly obese patients undergoing bariatric surgery.	Statistical analysis: -Recovery time: The mean difference (MD) in recovery time between sugammadex and neostigmine groups was calculated and reported with 95% confidence interval (CI). The MD value (-14.52) indicates the difference in minutes between the two groups, with sugammadex showing a significantly reduced recovery time compared to neostigmine. -Composite adverse events: The odds ratio (OR) was calculated to compare the occurrence of composite adverse	**Findings:** -Recovery Time: Sugammadex significantly reduced the time of reversal of moderate NMB-to-TOF ratio >0.9 compared to neostigmine. The mean recovery time with sugammadex was 2.5 minutes (SD 1.25), while with neostigmine it was 18.2 minutes (SD 17.6). The mean difference (MD) between the two groups was -14.52 minutes, indicating that sugammadex led to a significantly faster recovery from NMB compared to neostigmine. -Composite Adverse Events: The number of patients experiencing composite adverse events was significantly lower with sugammadex compared to neostigmine. In the sugammadex group, 21.2% of patients had composite	I	**Strengths:** -Sample size. The review included a total of seven studies with a combined sample of 386 participants, providing a substantial amount of data to draw conclusions. -Clear conclusions. The study's conclusions are straightforward, highlighting the superiority of sugammadex over neostigmine in terms of both efficacy (reversal time) and safety (adverse events). **Limitations:** -Limited data. The review acknowledges that data on sugammadex and

			variable. It is compared between the two drugs (sugammadex and neostigmine) and expressed as a percentage of patients.		events between sugammadex and neostigmine groups. The OR value (0.15) indicates the likelihood of having adverse events in the sugammadex group compared to the neostigmine group. The OR of less than 1 suggests a significantly lower incidence of adverse events in the sugammadex group.	adverse events, whereas in the neostigmine group, 52.5% of patients experienced adverse events. The odds ratio (OR) for composite adverse events was 0.15, indicating a significantly lower likelihood of adverse events with sugammadex compared to neostigmine. -Based on these findings, the study concludes that sugammadex is more effective in rapidly reversing NMB with a shorter recovery time and has a lower incidence of adverse events compared to neostigmine in MO patients undergoing bariatric surgery.		neostigmine in bariatric patients was limited.

Annotated Bibliography statement (may be several sentences summarizing the article based upon the information above using professional APA writing style):
This systematic review and meta-analysis compared the efficacy and safety of sugammadex versus neostigmine in reversing neuromuscular blockade (NMB) in morbidly obese patients undergoing bariatric surgery. The primary objective was to determine the recovery time from drug administration to a train-of-four (TOF) ratio >0.9 from a moderate or deep NMB. The review included seven studies with 386 participants and found that sugammadex significantly reduced the time of NMB reversal compared to neostigmine, with a mean time of 2.5 minutes versus 18.2 minutes, respectively. Additionally, sugammadex showed a lower incidence of composite adverse events (21.2% of patients) compared to neostigmine (52.5% of patients). The study concluded that sugammadex reverses NMB more rapidly with fewer adverse events in morbidly obese patients undergoing bariatric surgery.

Thematic Analysis
Key Themes or FSP related significance:
1. Sugammadex significantly reduces the time for moderate NMB to reach a TOF ratio >0.9 compared to neostigmine, with a mean time of 2.5 minutes versus 18.2 minutes, respectively.
2. The incidence of composite adverse events (such as pain, bradycardia, and postoperative nausea and vomiting) is significantly lower with sugammadex (21.2% of patients) compared to neostigmine (52.5% of patients).
3. Sugammadex is associated with a lower risk of residual neuromuscular blockade and a shorter time to discharge from the PACU compared to neostigmine.
4. Sugammadex is more effective and safer than neostigmine in reversing neuromuscular blockade in morbidly obese patients undergoing bariatric surgery.

APA Citation:

Wachtendorf, L. J., Tartler, T. M., Ahrens, E., Witt, A. S., Azimaraghi, O., Fassbender, P., Suleiman, A., Linhardt, F. C., Blank, M., Nabel, S. Y., Chao, J. Y., Goriacko, P., Mirhaji, P., Houle, T. T., Schaefer, M. S., & Eikermann, M. (2023). Comparison of the effects of sugammadex versus neostigmine for reversal of neuromuscular block on hospital costs of care. *British Journal of Anaesthesia*, *130*(2), 133–141. https://doi.org/10.1016/j.bja.2022.10.015

Conceptual Framework or Model	***Design or Method***	***Sample & Setting***	***Major Variables Studied & their Definitions, if any***	***Outcome Measurement***	***Data Analysis***	***Findings***	***Level of Evidence***	***Quality of Evidence: Critical Worth to Practice***
Theoretical basis for the study: not evident	Retrospective analysis	-79,474 adult surgical patients who received neuromuscular blocking agents and reversal from two academic healthcare networks between 2016 and 2021.	**Independent variables:** the type of drug used for the reversal of neuromuscular blockade. The comparison is between sugammadex and neostigmine. **Dependent variables:** 1. Direct costs of care 2. Total costs of care	-The study aimed to assess the effects of sugammadex on hospital costs of care, including both direct costs and total costs.	-The study primarily relied on quantitative data analysis techniques, such as multivariable generalised linear models, propensity-score matching, and quantile regression. These methods were used to examine the association between the use of sugammadex and neostigmine and various outcomes, including hospital costs.	**Findings:** -Administration of sugammadex was associated with lower direct costs of care compared to neostigmine. The analysis of registry data showed a 1.3% reduction in direct costs associated with sugammadex (95% CI: -0.5 to -2.2%; P=0.002). -In the matched cohort analysis using data from the Healthcare Cost and Utilization Project-National Inpatient Sample, sugammadex use was associated with a $232 decrease in total costs of care (95% CI: -$376 to -$88; P=0.002). -Subgroup analysis based on perioperative risk profiles revealed that sugammadex was associated with a significant decrease in total costs of care in patients with lower risk. In this subgroup, sugammadex was associated with a $1042 reduction in total costs (95% CI: -$1198 to -$884; P<0.001).	I	**Strengths:** - Large sample size. The study analyzed data from 79,474 adult surgical patients, which provides a substantial sample size for drawing meaningful conclusions. -Use of multiple databases. The study utilized data from two academic healthcare networks as well as matched data from the Healthcare Cost and Utilization Project National Inpatient Sample, enhancing the generalizability of the findings. **Limitations:** - Retrospective design. The study relied on retrospective analysis of existing data.

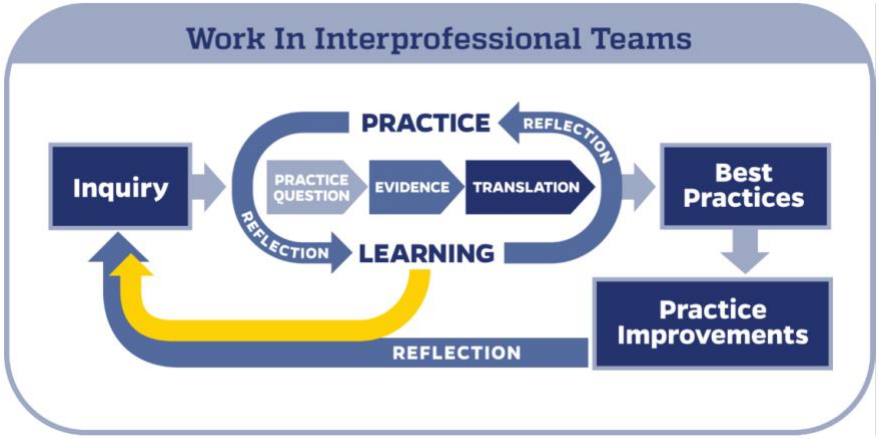
						-However, in patients with a higher risk (American Society of Anesthesiologists physical status ≥3 and preoperative hospitalization), sugammadex use was associated with higher total costs of care. These patients experienced an increase of $620 in total costs (95% CI: $377 to $865; P<0.001). -Conclusions: The effects of using sugammadex on costs of care are dependent on the patient's risk profile, which is determined by comorbidities and admission status. Lower costs of care were observed with sugammadex in patients with lower risk, while higher costs were observed in hospitalized surgical patients with severe comorbidities.		

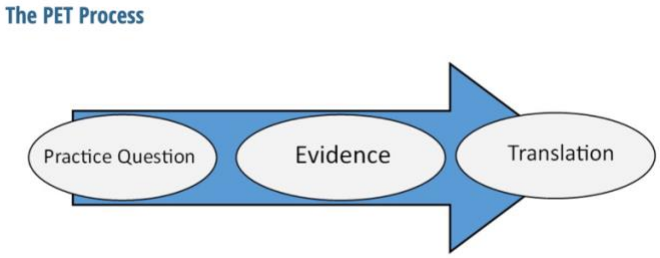
Annotated Bibliography statement (may be several sentences summarizing the article based upon the information above using professional APA writing style):
This retrospective analysis study examines the effects of sugammadex on hospital costs of care in different clinical scenarios. The study analyzes data from 79,474 adult surgical patients who underwent a surgical procedure under general anesthesia and received either sugammadex or neostigmine for reversal of neuromuscular block. The results show that the use of sugammadex is associated with lower direct costs compared to neostigmine (-1.3% lower costs). Additionally, sugammadex is associated with lower total costs in patients with lower risk but higher costs in hospitalized surgical patients with severe comorbidities. The findings suggest that the effects of using sugammadex on costs of care depend on patient risk factors and admission status. The study highlights the importance of considering patient characteristics when assessing the economic impact of sugammadex in clinical practice.

Thematic Analysis
Key Themes or FSP related significance:
1. The administration of sugammadex was associated with lower direct costs compared to neostigmine, with a 1.3% reduction in costs.
2. Sugammadex use was associated with $232 lower total costs compared to neostigmine.
3. Sugammadex was associated with significantly lower total costs in patients with lower risk, but higher total costs in patients with a higher risk (ASA physical status ≥3 and preoperative hospitalization).
4. Sugammadex's effects on costs of care are not solely dependent on drug acquisition costs but also on factors such as OR efficiency and the risk of postoperative complications.
5. The findings indicate that sugammadex may be a cost-effective option in patients with lower risk, but its use may increase costs in hospitalized surgical patients with severe comorbidities.

Appendix B

John Hopkins Nursing Evidence-Based Practice Model





JOHNS HOPKINS EBP MODEL AND TOOLS- PERMISSION

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Appendix C

RECOMMENDATIONS FOR REVERSING AMINO-STEROIDAL NEUROMUSCULAR BLOCKING AGENTS IN OBESE SURGICAL PATIENTS (BMI>30)

CURRENT PRACTICE

In the majority of patients, neostigmine and glycopyrrolate are used to reverse amino-steroidal neuromuscular blocking agents, with sugammadex reserved for emergency situations.

Recommendation #1

Prior to surgery, measure the weight and height of each patient to calculate their BMI.

- Recognition of obese patients upon admission is essential.
- Preoperative screening for obesity should be conducted for every patient to facilitate proper management and monitoring.

Recommendation #2

If a patient's BMI exceeds 30, sugammadex should be employed for reversal.

- Literature analysis reveals a higher incidence of pulmonary complications in obese patients.
- The review indicates a decrease in postoperative complications with sugammadex as the reversal agent in obese patients.
- Sugammadex administration is recommended for obese patients to reduce postoperative complications.
- Follow the current manufacturer's dosing guidelines for sugammadex.

Recommendation #3

If a patient's BMI is less than 30, the choice of reversal agent should be deferred to clinician judgment with consideration of other patient comorbidities.

- Sugammadex is recognized as the superior reversal agent in clinical practice.
- However, the literature suggests its application should not be unrestricted.
- Sugammadex is recommended for obese patients with BMIs over 30 to reduce post-operative complications.
- For populations at lower risk of postoperative complications, neostigmine is a viable option.
- Assessing patient comorbidities is crucial.
- The choice between sugammadex and neostigmine should be made individually, considering the risks and benefits on a case-by-case basis.

Appendix D

Cost-Benefit Analysis for Neuromuscular Blockade Reversal			
Factors and Costs	Neostigmine	Sugammadex	Benefit
Upfront Medication Cost	$X	$Y	(X - Y)
Duration to OR Departure	$A	$B	(A - B)
PACU Stay Duration	$C	$D	(C - D)
Incidence of Adverse Events	$E	$F	(E - F)
Extended Length of Stay	$G	$H	(G - H)
Total Cost	(X + A + C + E + G)	(Y + B + D + F + H)	(Total Cost Neostigmine - Total Cost Sugammadex)

In this table:

- "Upfront Medication Cost" represents the initial cost of acquiring each medication.
- "Duration to OR Departure" indicates the average duration from reversal administration to Operating Room departure for each medication.
- "PACU Stay Duration" represents the typical Post-Anesthesia Care Unit stay duration for each medication.
- "Incidence of Adverse Events" quantifies the occurrence of adverse events for each medication.
- "Extended Length of Stay" signifies the additional time patients spend in the hospital due to adverse events for each medication.
- "Total Cost" includes the sum of upfront medication cost, duration to OR departure, PACU stay duration, incidence of adverse events, and extended length of stay for each medication.
- The "Benefit" column calculates the difference between the corresponding costs or durations for neostigmine and sugammadex.