Sugammadex: Clinical and Economic Perspectives

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Introduction

Time is the currency of the operating theater. Hospital administrators frequently monitor volume, utilization rates, operational efficiency, and financial revenue as key performance indicators (KPI) for signs of a profitable and effective surgical program. Both surgical and anesthesia providers are mindful of many of these indicators, with mindfulness of the time spent during different phases of surgical procedures. The first case of the day sets the pace for the day, and the turnover time (TOT) is frequently the rate-limiting step for operational efficiency. Anesthesia providers who are highly skilled and trained with access to a variety of equipment and pharmaceuticals are vitally important to optimize patient safety and TOT efficiency.

There's a saying among anesthesia providers, "If you've met one Anesthesiologist, you've met one Anesthesiologist." The practice of anesthesia is as much art as it is science. It is a practice that continues to evolve over time, seeking to provide safe and effective care, maximize efficiency, and achieve high levels of satisfaction among both patients and operative staff. Neuromuscular blocking agents (NMBA) are frequently used to facilitate intubation and occasionally utilized intraoperatively to provide prolonged muscle relaxation for various types of procedures. Available forms of these medications are classified as steroidal (Rocuronium, Vecuronium, Pancuronium) and benzoisoquinoline (mivacurium, atracurium, cisatracurium), with the former typically preferred due to its rapid onset and lower side effect profile. With the continuation of muscle relaxation, safe and effective methods of reversal are necessary for patient emergence to reduce the risk of postoperative complications or continued mechanical ventilatory requirements. Historically, this was achieved with the use of a combination of acetylcholinesterase inhibitors and anticholinergic medications, such as neostigmine and glycopyrrolate, to facilitate the individual's own physiological mechanisms to outcompete NMBAs.

In 2015, the Food and Drug Administration approved the use of a novel modified gamma-cyclodextrin, sugammadex, that acts by chelating (encapsulating) steroidal NMBA to allow rapid reversal of neuromuscular blockade. Sugammadex has demonstrated rapid, effective reversal of NMBAs with a manageable side effect profile, leading to its widespread adoption into clinical practice. Several studies later discussed the call for this medication to become the first-line, standard of care, while others cite various concerns, calling for a selective approach in which each case is evaluated based on the needs of the case. Other programs still have restricted access to this medication, with cost stated and the most frequently encountered concern. The purpose of this investigation is to explore to what degree can the use of sugammadex as a first-line agent can impact throughput efficiency and the potential cost savings given its market value. Other areas of interest are the availability or restrictions for its use.

Methodology

To conduct this evaluation, a literature review was conducted utilizing Google Scholar and Anesthesia and Analgesia databases with keywords "sugammadex cost," "sugammadex financial impact," and "sugammadex adverse effects." Additionally, UpToDate, a generally accepted peer-reviewed resource that is updated monthly, was reviewed to establish current average wholesale prices to provide the most current medication costs. A rigorous method was utilized to review

over thirty articles, and sixteen were selected that covered the topics of management of NMBA reversal, sugammadex financial impact, sugammadex adverse events, and complications of prolonged neuromuscular blockade. The initial literature search generated a pool of potential articles, which were then rigorously filtered based on predefined inclusion and exclusion criteria. Articles were included if they were peer-reviewed, published in English, and contained original data or comprehensive analysis on the cost of sugammadex, its economic impact on healthcare systems, or direct comparisons of reversal efficacy and associated costs between sugammadex and conventional reversal methods (e.g., neostigmine). Excluded articles comprised non-English publications, editorials, and studies not directly addressing either cost or reversal methodology. This selection process resulted in a final cohort of 16 highly relevant articles for detailed examination. These articles were selected to illustrate the prevailing methodologies and preferences in the management of continued neuromuscular blockade, the risks associated with ineffective management of NMBA reversal, and to offer opposing viewpoints as to the advantages and disadvantages of modifying existing standards of care.

For each of the selected articles, critical data points were systematically evaluated. This included detailed information on reversal times, incidence of residual neuromuscular blockade, length of post-anesthesia care unit (PACU) stay, hospital discharge times, and direct drug acquisition costs. Furthermore, any reported analyses on cost-benefit or cost-effectiveness, as well as descriptions of different reversal strategies employed, were documented. The collected data were then analyzed to identify trends in economic impact, assess the efficiency of various reversal methods, and highlight clinical scenarios where the benefits of sugammadex may outweigh its higher acquisition cost, thereby providing a comprehensive perspective on its value proposition in anesthesia.

In the process of screening and selecting articles for review, it became apparent that reading cited or associated articles via the original resource contributed to a bias in selection. To reduce this tendency, if other articles were found to have similar opinions or were closely associated with the article under review, it was not selected. However, if a similar article was found to have similar results, but had a drastically different sample, it was allowed to be included to illustrate that similar results can be obtained across different sample populations [10,12].

Rather than presenting a favorable biased conclusion, the intention is to increase awareness of multiple methods with the potential for clinical and economic benefits in other methods of reversal of continued NMBA and to alleviate restrictions in systems that discourage or limit the use of novel methods in the reversal of neuromuscular blockade.

Results/or statistics

1. Efficacy of Sugammadex versus Neostigmine

Meta-analyses of randomized controlled trials (RCTs) demonstrated that sugammadex provides significantly faster reversal of moderate neuromuscular blockade (NMB) compared to neostigmine. The mean difference in time to reversal was approximately −1.79 minutes (95% CI, −2.07 to −1.52; $P < .0001$), favoring sugammadex [4]. Additionally, sugammadex was associated

with higher train-of-four (TOF) ratio values at extubation and a lower risk of postoperative residual curarization (TOF ratio < 0.9) compared to neostigmine (P < .01) [4].

In a prospective randomized trial involving outpatient abdominal surgeries, sugammadex significantly reduced the median time to achieve a TOF ratio ≥ 0.9 (180 seconds vs. 540 seconds; P = 0.0052) compared to neostigmine, indicating faster and more predictable recovery. Time from incision closure to extubation and from reversal administration to extubation was slightly shorter with sugammadex but did not reach statistical significance [6].

2. Safety and Postoperative Outcomes

Analysis of postoperative delirium in a large cohort (N=49,468) using propensity score weighting showed no significant difference in the incidence of postoperative delirium between sugammadex and neostigmine groups (OR 1.33; 95% CI, 0.91–1.95; P = 0.147). However, sugammadex was associated with a higher odds of early delirium within 24 hours post-extubation (OR 1.71; 95% CI, 1.07–2.72; P = 0.025) [17].

Residual neuromuscular blockade (PRNB) incidence was markedly reduced with the implementation of protocols combining quantitative neuromuscular monitoring and reversal with sugammadex or neostigmine, with some studies reporting 0% PRNB at extubation [20]. However, the use of sugammadex in some cases led to underutilization of quantitative measures recommended as the standard of care to monitor adequate reversal [1]. Residual blockade was frequently associated with prolonged postanesthesia care unit (PACU) length of stay and increased oxygen administration requirements [7].

3. Economic Impact

At the time of this review, cost analyses combining clinical and economic data indicate that while sugammadex has a higher direct drug cost compared to neostigmine, these costs may be offset by reductions in postoperative pulmonary complications (PPCs) and shorter recovery times. A US-based hypothetical cohort model showed sugammadex reduced PPC incidence from 4.8% (with neostigmine) and generated net cost savings related to decreased PPC management, despite higher reversal agent costs [10].

In a Taiwanese medical center, propensity score-matched analysis indicated sugammadex was associated with shorter extubation times and operating room (OR) turnover times without increasing overall perioperative costs [12]. This aligns with other studies reporting no increase in PACU or OR costs despite faster recovery with sugammadex [6]. In one study, an increase in cost of care utilizing sugammadex as opposed to neostigmine plus glycopyrrolate ($4,285.7 versus $4,764.1; p = 0.44) was found in this study, however, the higher cost of medication appears to be offset by a reduction in PACU costs from reduced admission times, however these values were not found to have no significant difference [6].

In a cost analysis simulated in a hypothetical, mid-sized health system performing approximately 18,000 neuromuscular blockade reversals annually, sugammadex became the preferred strategy when OR time was valued at $8.60 per minute or higher, reflecting realistic hospital cost

estimates ($32.49/min used as base case). Neostigmine was favored only when OR costs were very low or negligible [9].

4. Operating Room Efficiency

A clinical trial implementing a multimodal strategy combining parallel processing during anesthesia induction and the use of sugammadex demonstrated significant reductions in nonoperative time (NOT). Median NOT decreased from 48.0 minutes in the control group to 25.0 minutes in the active group ($P < .001$). Components, including induction time (IT), emergence time (ET), and turnover time (TOT), were all significantly shortened (IT: 14.5 to 7.0 min; ET: 12.0 to 8.0 min; TOT: 17.0 to 10.0 min). Surgeon satisfaction was significantly higher in the intervention group with 70.9% strongly satisfied versus 17.9% in controls ($P < .001$), while patient satisfaction showed no significant difference [11]. This study cautioned that such a model would require investments in facilities that could accommodate a parallel strategy of separate rooms for induction and additional anesthesia providers.

5. Clinical Practice and Monitoring

Surveys of anesthesiologists in Australia and New Zealand reveal variable practice patterns in the use of neuromuscular monitoring and reversal agents. Although a majority recognize the significance of postoperative residual neuromuscular paralysis (PRNB), quantitative TOF ratio monitors are not universally considered part of minimal monitoring standards [16]. Standardized use of quantitative monitoring combined with selective use of sugammadex may optimize patient outcomes while controlling costs [20].

Discussion

As of June 2025, the cost of sugammadex sold under the trade name Bridion costs $81.68 for 200 mg/2 mL and $59.84 for 500 mg/5 mL, as represented by the average wholesale price[19]. There currently is not a generic equivalent; however, this is expected to change within the next few years. A bulletin published in Rothwell Figg's Biosimilars stated Merck's current patent for sugammadex was extended on February 4, 2020, for a five-year patent term extension and is now expected to expire on January 27, 2026. Hikma, a British multinational pharmaceutical company, has sought FDA approval for the generic version of sugammadex [13]. Hikma notified Merck in February 2024 of its intention. Generic medications drastically reduce the cost of these medications, and if standard reductions follow the general market trends of an average of a 20% decrease in the cost of sugammadex would constitute significant savings [15]. Further cost analysis will be indicated if and when a generic form of sugammadex becomes available.

Conclusion

Unrestricted access to sugammadex is supported and encouraged to facilitate the development of modern processing strategies of patient flow through the operative departments. The collected data indicate that sugammadex provides faster and more reliable reversal of neuromuscular blockade compared to neostigmine, with associated improvements in recovery profiles and potential reductions in postoperative complications. While drug costs for sugammadex are

currently higher, economic models and clinical studies suggest net cost benefits through decreased pulmonary complications and enhanced operating room efficiency. Furthermore, the costs of sugammadex and projected to dramatically decrease once a generic formulation becomes available. If programs implement quantitative neuromuscular monitoring protocols alongside selective use of sugammadex, this will optimize both clinical outcomes and resource utilization.

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