

# Economic Analysis of Sugammadex for Neuromuscular Block Reversal for Laparoscopic Surgery from a Single Hospital System in China

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## Background

- Neuromuscular blockade (NMB) and pneumoperitoneum (PP) are important factors to ensure successful laparoscopic surgery.
- Residual neuromuscular blockade (rNMB) may occur as long as neuromuscular blockade drugs are used. Clinically, rNMB is defined as the train-of-four ratio (TOFr) < 0.9 <sup>[1]</sup>. A real-world study in the Chinese population showed that the incidence of rNMB after tracheal extubation and arrival at post-anesthesia care unit (PACU) were 57.8% and 45.2%, respectively <sup>[2]</sup>
- Many potential complications can be caused by rNMB, such as hypoxemia, airway obstruction, muscle weakness, pulmonary related complications due to ineffective cough, pharyngeal dysfunction, etc <sup>[3]</sup>
- To provide a good surgical condition, PP must be made in laparoscopic surgery. But high-pressure PP can lead to potential side effects, such as nausea/vomiting, shoulder pain and others <sup>[4]</sup> <sup>[5]</sup>
- Deep NMB (post-tetanic count = 1 or 2) and low-pressure PP (less than 10 mmHg) are recommended in laparoscopic surgery by Chinese clinical guidelines [3]. It not only can improve laparoscopic surgical condition, but also can reduce PP side effects <sup>[3]</sup>.
- Sugammadex can quickly reverse or moderate deep NMB compared with neostigmine <sup>[6]</sup> <sup>[7]</sup>. It can potentially reduce rNMB risk and at the same time, maintain a desirable deep NMB state during laparoscopic surgery.

## Objective

This study aims to compare the incidence of residual neuromuscular blockade (rNMB) and postoperative complications for patients undergoing laparoscopy in China, as well as assessing the impact on operating room (OR) and post anesthesia care unit (PACU) efficiency, and the potential cost savings with use of sugammadex, neostigmine (NEO) or no reversal agent from the hospital perspective.

## Methods

A decision tree model was developed with the time horizon across the whole hospitalization. 1000 patients were simulated for each treatment group within the model. The incidence of postoperative complications were calculated, including rNMB- and pneumoperitoneum (PP)-related complications and treatment-related adverse events. The time spent in OR and PACU were also reported. Data in the model were obtained from published literature, public data and expert interviews. Costs were expressed in 2023 CNY (¥).

### Key data used in the decision model

Probabilities of different surgical strategies			
SUG	Deep NMB + Low PP pressure (8 mmHg)	77.67%	KOL*
	Moderate NMB + High PP pressure (12-15 mmHg)	22.33%	
NEO	Deep NMB + Low PP pressure (8 mmHg)	30.00%	
	Moderate NMB + High PP pressure (12-15 mmHg)	70.00%	
Spont recov	Deep NMB + Low PP pressure (8 mmHg)	21.43%	
	Moderate NMB + High PP pressure (12-15 mmHg)	78.57%	
Relative recovery times			
prolonged hospital stay due to rNMB (days)		0.49	[8]
prolonged hospital stay due to high PP (days)		0.25	[9]
average operation duration of laparoscopic (minutes)		114.6	RWD
prolonged extubation time due to rNMB (minutes)		18	[11]
prolonged PACU stay due to rNMB (minutes)		6	[11]

\* based on input from 30 anesthesiologists, representing experiences from tertiary teaching hospitals in major metropolitan cities in China.

Drug Price			
Sugammadex (Brand)	¥ 980	List price	
Sugammadex (Generic)	¥ 225	List price	
Neostigmine /atropine	¥ 71/ ¥ 21		
Nothing	-	-	
Prop. of rNMB			
Sugammadex (Brand)	1.2%	[12]	
Sugammadex (Generic)	2.7%	assumptions	
Neostigmine /atropine	15.40%	[13]	
Nothing	34.00%	[12]	
Subgroup (elderly patients)			
Sugammadex (Brand)	10%	[14]	
Sugammadex (Generic)	17%	assumptions	
Neostigmine /atropine	49%	[14]	

\* the difference of the prob.rNMB between brand-name sugammadex and generic sugammadex was assumed base on affinity data (the affinity of the generic sugammadex with rocuronium bromide is about 58% of the brand-name sugammadex).

rNMB / PP related complications related inputs						
	PP related complications			PP related complications cost		
	< 12 mmHg	12-15 mmHg	Sources	prob. of intervention	Cost (Yuan)	Sources
Shoulder pain	6.5%	14.4%	[15]	61.21%	172	KOL
Nausea & Vomiting	2.5%	25.0%	[16]	77.41%	139	KOL
	rNMB related complications			rNMB related complications cost		
	rNMB	No rNMB	Sources	prob. of intervention	Cost (Yuan)	Sources
Upper airway obstruction	8.42%	1.68%	[17]	63.90%	216	KOL
Upper airway obstruction	1.58%	0.32%	[17]	88.45%	266	
Mild-moderate hypoxemia	23.00%	4.00%	[17]	91.03%	1,295	
Severe hypoxemia	7.00%	1.00%	[17]	85.86%	139	
Respiratory failure*	8.00% / (14.29%)	1.00% / (1.79%)	[17]/[22]	99.66%	781	
Muscular weakness*	16.00%/ (28.57%)	1.00% / (1.79%)	[17]/[22]	99.31%	29,494	
Pharyngeal dysfunction*	28.00% / (3.16%)	13.00% / (14.29%)	[18]/[22]	86.55%	1,467	
Pneumonia*	25.2% / (44.21%)	0.80% / (1.43%)	[19]/[22]	100.00%	1,050	
Unplanned reintubation*	1.6% / (1.89%)	0% / (0%)	[20]/[22]	100.00%	31,200	
ICU admission rate	3.3%	1.5%	[21]	100.00%	4,313	

\* Subgroup analysis data of elderly patients

## Results

Compared with NEO and spontaneous recovery, brand-name sugammadex would lead to 292 and 397 fewer postoperative complications respectively. Additionally, the OR time saw an decrease with brand-name SUG use (35.5 hours versus NEO and 82.0 hours versus spontaneous recovery), which could be used to perform 15 and 34 extra laparoscopic surgery respectively. The PACU time was also estimated to decline by 42.6 hours and 98.4 hours respectively. Total time saved in PACU with brand-name SUG could be used to monitor 31 and 71 extra patients. Compared to the finding in the overall patients groups, SUG was found with more encouraging efficacy in elderly subgroups, and with higher subsequent economic benefits and OR/PACU running efficiency for Chinese hospital (mean net monetary gain were 442 yuan versus generic SUG and 4,887yuan versus NEO).

Clinical and economic impact per 1000 laparoscopic surgery done (compared with brand SUG)		
	vs NEO	vs Spont recov
difference of the frequency of postoperative complications (rNMB / PP)	-292	-397
OR time saved with SUG (minutes)	2,130	4,920
PACU time saved with SUG (minutes)	2,556	5,904
No. of surgeries could be done with the saved OR time	14.79	34.17
No. of patients could be monitored with the saved PACU duration	30.55	70.57
Subgroup analysis for elderly patients (≥ 60 years)		
	vs SUG generic	vs NEO
difference of the frequency of postoperative complications (rNMB / PP)	-44	-364
OR time saved using SUG (minutes)	1,086	5,850
PACU time saved using SUG (minutes)	1,303	7,020
No. of surgeries could be done with the saved OR time	8.90	47.95
No. of patients could be monitored with the saved PACU duration	11.98	64.54
Mean Net monetary gain (CNY, ¥)	442	4,887
Abbreviations: SUG, sugammadex group; NEO, neostigmine group; Spont recov, spontaneous recovery group; OR, operating room; PACU, postanesthesia care unit.		

## Conclusions

Sugammadex could effectively avoid postoperative complications compared with either NEO or spontaneous recovery, meanwhile reducing both the OR and PACU occupancy, despite a substantially higher medication cost might be followed. It indicates that sugammadex is likely to be an acceptable reversal agent choice in laparoscopy from the Chinese hospital perspective.

## Limitations

- The study assumed that the incidence of rNMB / PP related complications in laparoscopic surgery for different diseases was the same. However, via the interviews, more than 50% of KOLs believed that the incidence of rNMB / PP related complications in laparoscopic surgery for different diseases was the same so we deemed this an appropriate assumption.
- The cost data and proportion of intervention of this study were estimated based on input from 30 anesthesiologists, representing experiences from tertiary teaching hospitals in major metropolitan cities in China. In the future, a nation level study for cost should be carried out to improve the quality of data.
- Finally, the difference of the probability between brand-name sugammadex and generic sugammadex was assumed base on affinity data (the affinity of the generic sugammadex with rocuronium bromide is about 58% of the brand-name sugammadex).

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