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Pharmacoeconomic approach to the clinical effectiveness of combined use of intraoperative monitoring of neuromuscular blockade and sugammadex in reversing rocuronium block

José R. Ortiz-Gómez[1,2], Francisco J. Palacio-Abizanda[3], Inocencia Fornet-Ruiz[4]

[1] Masters in Management and Health Research Tools and Analytical Methods for Quantitative and Evidence-Based Medicine
[2] Department of Anesthesiology, Complejo Hospitalario de Navarra B. Hospital Virgen del Camino, Pamplona, Spain
[3] Department of Anesthesiology, Hospital Gregorio Marañón, Madrid, Spain
[4] Department of Anesthesiology, Hospital Puerta de Hierro Majadahonda, Madrid, Spain

Abstract

Background. Sugammadex allows fast reversal of rocuronium residual neuromuscular blockade (RNMB) but at a greater cost than neostigmine. The aim of this study evaluates the effectiveness (in daily clinical situations) and economic impact of the combined use of intraoperative neuromuscular blockade monitoring (INMBM) and reversal with sugammadex compared with the traditional reversal with neostigmine. ***Material and methods.*** A descriptive, observational and prospective study during a year in 85 patients analyzed the reversal with sugammadex (when needed) compared with data previously reported for neostigmine in the literature. ***Results.*** 11 patients were excluded because of INMBM deficiencies, loss of data or leaving the operating room intubated. Adequate INMBM allowed spontaneous recovery with TOF-ratio > 90% in 28 patients (37,8%) and represents an estimated savings of sugammadex of € 2.290,06 (€ 81,79 / patient). Reversal in 46 patients (62,2%) accounted for a total cost of € 3.768,30 in sugammadex. The average time saved in surgery resulting from use of sugammadex in place of neostigmine in the present series is therefore estimated at 15.16 hours (19,8 min/patient). The cost saving of time is at € 3.720,44 regarding reversal wit neostigmine (€ 245,41/ hour saved). ***Conclusions.*** Sugammadex shortens reversal of rocuronium, but at higher cost than with neostigmine. However, in certain circumstances this cost is beneficial if it allows increasing productivity, avoiding extensions of time or releasing the emergency operating room. Finally noted that proper INMBM allows a saving in the use (and expense) of RNMB reversal drugs. *Anestezjologia i Ratownictwo 2011; 5: 409-418.*

Keywords: anaesthesiology, cost-effectiveness analysis, neostigmine, no depolarizing neuromuscular blockade, pharmacoeconomics, sugammadex

Background

This study evaluates the combined use of intraoperative monitoring of neuromuscular blockade and sugammadex in reversing rocuronium block.

Good practice guidelines recommend monitoring quantitative neuromuscular blockade [1-2] to avoid the risks of residual curarization [3-7], even after a single intubating dose of non-depolarizing neuromuscular blocking agents [8]. Proper monitoring will allow us to assess the degree of residual curarization and opt for spontaneous or reversal decurarization with either sugammadex or neostigmine [9-10].

The incorporation of sugammadex (Bridion®,

Organon/Schering Plough/Merck USA) into clinical practice has provided anesthesiologists the ability to use rocuronium in a completely different way than before, allowing quick and safe reversal, with few side effects in different degrees of residual neuromuscular blockade, even allowing recovery after a failed intubation. Since its adoption, there have been numerous studies that attest these findings. But there are hardly any references from an economic perspective about the impact of sugammadex in anesthesiology.

Obviously, sugammadex is more expensive than neostigmine. However, if we considered this subject in depth and not just only the price, more factors must be evaluated, not only the purchase price *per se*. These factors include the cost of processing, storage and preservation of the medication administered, medication waste, needles and syringes needed for injecting the medication, side effects and their impact on patient welfare, the cost of medication or actions necessary to alleviate or treat these side effects and finally, the impact on operating room and post-anesthesia care unit (PACU) occupation time. So, we must quantify both tangible and intangible costs so much as posible [11]. A lack of adequate studies on the subject, adds to the difficulty of assessing all the above factors, motivated in part by the inherent variability of the effect of neuromuscular blocking drugs [12], with differences between patients, and sometimes even with individual variability (i.e., the duration of the same dose of rocuronium can vary in the same patient if some factors change, such as calcium ion levels, potassium or magnesium or pH). It also happens that the great majorities of clinical studies available to date are based on controlled and uniform experimental conditions. These results measure the efficacy of sugammadex, but cannot be extrapolated to terms of effectiveness [11]. Therefore, when we apply the results of an experimental study to clinical practice, we assess to what extent can be extrapolated to the patients we treat, where each patient is different in age, sex, weight, associated pathology, degree of residual neuromuscular blockade, surgical requirements of rocuronium ...

So, the design of a study about the clinical effectiveness of sugammadex is difficult because we do not analyze a perfectly defined demographic group in a controlled environment. For this reason the present study has tried to be as faithful as possible to the reality of everyday clinical practice.

Material and methods

We performed a descriptive, observational and prospective study in 85 patients at a university hospital, randomly selected between the total surgical patients during the period of one year. We collected demographic variables (age, sex, weight, body mass index and ASA grade).

After obtaining informed anesthetic consent in all patients, general anesthesia was performed for both scheduled and urgent procedures of General Surgery, Orthopedics, ENT and Urology. Routine monitoring consist on continuous electrocardiography, pulse oximetry, capnography, noninvasive blood pressure, entropy, and quantitative neuromuscular blockade and skin temperature, with continuous recording of the *adductor pollicis* muscle responses to train of four stimulus (TOF) every 15 seconds by a TOF-Watch SX® (TOF-Watch SX®, Organon Teknika BV, Boxtel, The Netherlands). This monitor was previously calibrated and connected to a laptop to get the full record of neuromuscular blockade by TOF-Watch® program SX Monitor 2.2.INT version of Organon (© 2000). The phases of intense block were monitored by the application of Post-Tetanic Count (PTC) [13].

All patients received identical anesthetic induction technique, consisting on midazolam (0,03 $mg.kg^{-1}$ IV), fentanyl (0,002 $mg.kg^{-1}$ IV), propofol (2,5 $mg.kg^{-1}$ IV) and rocuronium, $2ED_{95}$ (0,6 $mg.kg^{-1}$ IV). After intubation, the patients were ventilated with a mixture of oxygen - air with 45% FiO_2.

Anesthetic maintenance was carried out with fractionated doses of fentanyl on demand and inhalational agents (sevoflurane or desflurane to 1,3 MAC) or propofol and remifentanil (TCI, Target Controlled Infusion) depending on patient characteristics and the availability of TCI infusion pumps in the operating room. All patients were given pantoprazole 40 mg IV and antibiotic prophylaxis for each surgery.

It is very important to note that the administration of rocuronium was guided by clinical and surgical needs of each patient, always under strict monitoring control. Rocuronium was administered in boluses, without using continuous infusions.

During surgery, several parameters of the first dose of rocuronium neuromuscular block [13] were collected, as the onset of action of 95 and 100%, the latency, the maximum block, duration of action of 5, 10, 25, 50, 75, 90, 95 and 100% recovery indexes of 5-95%, 10-90%

and 25-75%, and the times when appeared the 1st, 2nd, 3rd and 4th responses of TOF and the TOF-ratio values of 70%, 80%, 90%, 95% and 100%.

Depending on the needs of muscle relaxation, maintenance doses of rocuronium were administered, quantifying the duration of these.

At the end of surgery, the degree of residual neuromuscular blockade was evaluated (TOF number of responses and the values of T1 (amplitude of the 1st response of TOF) and TOF-ratio). If the TOF-ratio was greater than 90%, no residual curarization was reversed, according to international standards of Good Practice in Pharmacodynamic Studies of neuromuscular blocking agents [1]. When the TOF-ratio were less than 90%, sugammadex was administered at doses internationally accepted of 2mg.kg^{-1} IV for moderate block (in the presence of 1-3 responses to TOF) and 4 mg.kg^{-1} IV for deep blocks (with 0 responses to TOF and PTC 1-2) [1]. In these situations, the time to reach TOF-ratios of 70, 80, 90, 95 and 100% was measured.

For economic calculations, official cost nationwide prices were used supplied by the Pharmacy of the Hospital in June 2011 (Table 1).

Then we proceeded to estimate the costs of reversal the residual neuromuscular blockade, comparing sugammadex at doses previously exposed to the reversal with neostigmine, 0,05 to 0,07 mg.kg^{-1} (either with vials of 0,5 or 2,5 mg) and atropine 0,01 mg.kg^{-1}. The patient's weight used for calculations was the statistically calculated mean weight in this series.

Other calculated variables were: the ideal cost/patient (cost of the exact dose of neuromuscular blockade antagonist required), the real cost/patient (here, it is included the cost of discarded medication, e.g. for a 80 kg patient reverted with 2 mg.kg^{-1} of sugammadex we need 160 mg, but the vial contains 200 mg, therefore 40 mg are discarded), the total cost (real cost multiplied by the number of patients in this group) and the global cost (cost of all patients receiving the same medication).

It is also specified the costs of medication needed to treat side effects (e.g. nausea and vomiting induced by neostigmine). At this point we should clarify that other factors can also induce nausea and vomiting in addition to neostigmine.

Finally we evaluated the difference of reversal times with sugammadex compared to previously published data for neostigmine [14-39] and estimated the cost of time saved with the antagonization with sugammadex compared to neostigmine using the data presented in the datasheet of sugammadex (Aurora and Signal trials) [40], with values (mean) of moderate recovery block (from the onset of the 2nd response TOF) of 1,4 min (0.9-5.4 min) for sugammadex at doses of 2 mg.kg^{-1} and 17,6 (3,7-106,9 min) for neostigmine at doses of 0,05 mg.kg^{-1} while for deep blocks (PTC 1-2) was 2,7 min for sugammadex 4 mg.kg^{-1} (1,2-16,1 min) and 49 min for neostigmine, 0,07 mg.kg^{-1} (13,3-145,7 min).

Statistical analysis was performed using SPSS 18.0, considering those results statistically significant at $p < 0.05$. The results of continuous variables are presented as mean and standard deviation. Analysis of normality was studied using the Kolmogorov-Smirnov

Table 1. Costs of medication (June 2011)

Drug	Brand names	Presentation	Cost / box	Cost / Unit
Sugammadex	*Bridion®*	10 vials of 200 mg	711,00	71,10
Rocuronium	*Esmeron®*	10 vials of 50 mg	32,28	0,33
Cisatracurium	*Nimbex®*	5 vials of 20 mg	34,55	6,91
Atracurium	*Tracrium®*	5 vials of 50 mg	12,01	1,38
Suxamethonium	*Anectine®*	100 vials of 100 mg	54,64	0,55
Neostigmine	*Neostigmina Braun®*	10 vials of 2,5 mg 100 vials of 0,5 mg	4,05 18,09	0,41 0,18
Ondansetron	*Yatrox®*	50 vials of 4 mg 50 vials of 8 mg	21,88 34,79	0,44 0,70
Droperidol	*Xomolix®*	10 vials of 2,5 mg	39,83	3,98
Dexametasone	*Fortecortin®*	100 vials of 4 mg	29,92	0,30
Atropine	*Atropina Braun®*	100 vials of 1 mg	25,58	0,26

Prices are in euros and include taxes.

The price of Bridion includes the 7,5% discount established in Royal Decree-Law 8/2010 of May 20 by the Government of Spain for extraordinary measures being taken to reduce the public deficit.

test. Categorical variables are presented by frequencies and percentages. The association between qualitative variables was studied by Pearson Chi-square or Fisher exact tests. The evolution of the different variables over time was studied with repeated measures ANOVA.

Results

Eleven patients were excluded (74 patients were considered valid), because of deficiencies in the neuromuscular blockade record, loss of data or these patients who leave the operating room intubated.

Demographic variables (mean ± SD) were 52,4±16,7 years, 70,1±13,9 kg, 164,1 ± 10,1 cm and 26,0 ± 4,3 $kg.m^{-2}$ body mass index. A 43,2% of patients were male and the other 56.8%, women. Concerning the associated pathology, 36,5% were ASA I patients, 20.3% ASA II, 37.8% ASA III and 5.4% ASA IV.

This series includes various surgical procedures in General Surgery (85,8%), Traumatology (8,4%), ENT (2.9%) and Urology (2,9%) under anesthesia with desflurane (24,3%), sevoflurane (63,5%) or propofol (12,2%).

After appropriate calibration of the monitor (stimulus intensity 54,5±9,6 mA and sensitivity 249,6±95,4; mean ± SD) neuromuscular blockade values were recorded (Table 2). It should be noted that the number of cases is variable in this table between the different parameters because not all patients had a complete spontaneous recovery of the intubating dose of rocuronium, because some patients received maintenance doses according to surgical needs, while in other patients, residual blockade was reversed. A 37,8% of patients received one maintenance dose of rocuronium of patients, 22,9% two, three 10.8%, 5,4% four and a 2,7% of patients received five doses of rocuronium.

When surgery finished, we assessed the residual neuromuscular blockade, with TOF-ratio greater than 90% in 37,8% of patients (it was not necessary therefore sugammadex). Sugammadex 2 $mg.kg^{-1}$ was administered in 52,7% of patients, and decurarization with 4 $mg.kg^{-1}$ was needed in the remaining 9,5%. Table 3 shows the values of residual block before

Table 2. Neuromuscular blockade values

Neuromuscular blockade values		N	Mean	Standard deviation
Onset (min)	**95%**	71	1,7	0,8
	100%	62	2,2	1,1
Maximum block (Percentage)		73	99,4	1,7
Latency (min)		71	2,2	1,1
Duration of action (min)	**5%**	67	31,8	13,6
	10%	64	36,1	14,9
	25%	56	41,2	16,0
	50%	40	47,6	20,2
	75%	30	54,9	27,0
	90%	23	54,3	16,6
	95%	19	57,0	17,7
	100%	17	57,4	19,6
Time to recurrence of the x response of TOF (min)	**1ª**	65	27,9	13,4
	2ª	59	33,7	13,4
	3ª	52	37,8	14,4
	4ª	50	39,1	13,5
TOF-Ratio (min)	**70%**	23	59,0	18,2
	80%	21	62,3	19,4
	90%	19	67,7	21,1
	95%	19	69,6	21,4
	100%	19	71,8	22,5
Recovery index (min)	**5-95%**	19	31,8	15,2
	10-90%	22	24,5	12,6
	25-75%	28	22,3	20,8

Table 3. Values of residual block (T1 and TOF-ratio) before sugammadex administration and reversal times after its administration

		N	Mean	Standard deviation
T1 height (*single twitch*) (percentage)		46	38,5	32,2
TOF-ratio (percentage)		44	19,2	21,7
Time to get a TOF-ratio of (min)	**70%**	45	1,6	0,9
	80%	45	2,3	3,5
	90%	44	2,2	1,2
	95%	44	2,6	1,5
	100%	44	2,9	1,8

Table 4. Costs (€) of residual neuromuscular blockade antagonization

Reversal		Ideal cost / patient	Real cost / patient	Total cost	Global cost
Spontaneous		0	0	0	0
Sugammadex	**2 mg.kg^{-1}**	49,92	71,10	2772,90	3768,30
	4 mg.kg^{-1}	99,82	142,20	995,40	
Neostigmine (2,5 mg vials)	**0,05 mg.kg^{-1}**	0,58	0,82	37,72	47,86
	0,07 mg.kg^{-1}	0,81	0,82	37,72	47,86
	Atropine (0,01 mg.kg^{-1})	0,18	0,26	10,14	
Neostigmine (0,5 mg vials)	**0,05 mg.kg^{-1}**	1,26	1,44	66,24	76,38
	0,07 mg.kg^{-1}	1,77	1,80	82,80	92,94
	Atropine (0,01 mg.kg^{-1})	0,18	0,26	10,14	

It has been used the mean patient weight in the calculations: 70,2 kg.
The ideal cost/patient is the cost of the exact dose of neuromuscular blockade reversal drug required, the real cost/patient include the cost of drugs discarded, the total cost is the actual cost multiplied by the number of patients in this group and the global cost is the cost of all patients receiving the same medication (in the case of neostigmine was added the cost of atropine)

Table 5. Residual neuromuscular blockade reversal times

	Drug	From:	n	Mean	Range
Moderate block (from the onset of T2)	**sugammadex 2 mg.kg^{-1}**	Aurora trial	48	1,4	0,9-5,4
		Series	39	2,3	0,7-5,5
	neostigmine 0,05 mg.kg^{-1}	Aurora trial	48	17,6	3,7-106,9
Deep Block (PTC 1-2)	**sugammadex 4 mg.kg^{-1}**	Aurora trial	37	2,7	1,2-16,1
		Series	7	2,1	1,7-2,75
	neostigmine 0,07 mg.kg^{-1}	Aurora trial	37	49	13,3-145,7

sugammadex administration and reversal times after its administration.

Table 4 shows the costs of different alternatives of decurarization. We must also add to these costs those derived of treating neostigmine complications such as bradycardia (atropine has a cost of € 0,26/patient) and sometimes nausea and/or vomiting, with a variable cost depending on the medication used: ondansetron 4 mg (€ 0,44/patient), 8 mg (0,70 €/patient), droperidol (€ 3,98/patient) and dexamethasone 8 mg (€ 0,60/patient).

We analyzed the reversal times in this series with the data presented in the datasheet of sugammadex (Aurora and Signal trials) [40], finding no significant differences between groups (Table 5).

The average save time resulting from using sugammadex in the operating room instead of neostigmine in this series is therefore estimated at 909,7 minutes (15,16 hours), approximately 19,8 min per patient. The cost of this time saving is € 3720,44 (compared with reversal with neostigmine vials of 2.5 mg), € 245,41 for every hour saved. Using neostigmine vials of 0,5 mg the cost

stands at € 3691,92 (€ 243,53/hr) if we antagonize with 0,05 mg.kg^{-1} or € 3675,36 (€ 242,44/hr) administering neostigmine 0,07 mg.kg^{-1}.

Discussion

There are several qualifications that must be performed before analyzing the results of the study. First, there are no references up to date of effectiveness pharmacoeconomic studies with sugammadex. In fact there are only 3 studies on pharmacoeconomics and sugammadex [31,41,42] made by the same workgroup. One of them focuses exclusively on the emergency reversal of the blockade (i.e. in a situation of failed intubation with difficult ventilation), which did not happened in our series and therefore is not considered, other article is a review for *Health Technol Assess* and only one is dedicated to the usual situation in the reversal of moderate residual blockade. All of them are based on data of previously published controlled trials for the assessment of costs. However, this approach has a serious bias, since it is based on data obtained in a controlled environment on young patients, ASA I-II (patients clearly not representative of routine clinical reality in any hospital). Therefore, shortening of the reversal times obtained in these patients are possibly the best values of that type we could find and may not be fully representative of older patients with multiple diseases, for example.

This study is a cost-effectiveness analysis, not a cost-efficacy analysis (the first relates to common clinical conditions while the second analyze only controlled experimental situations [11], carried out on an own set of patients drawn randomly in a real clinical setting over a year.

There are no control groups with neostigmine for two reasons. First, reversal with neostigmine has more risk of adverse effects that sugammadex, as is well known. This fact alone was an ethical dilemma enough to not include a group with neostigmine. Second, due to inter and even intra-individual variability of neuromuscular blockade by rocuronium the only real way to properly assess a difference between sugammadex and neostigmine to antagonize the residual neuromuscular blockade should be that the same patient receive both medications in similar situations, that is, each patient should be the control of himself, once receiving sugammadex and neostigmine another. Obviously this is impossible. For these two reasons we did not include a neostigmine group.

This cost-effectiveness analysis seeks to accurately reflect the heterogeneity of our daily practice, both from the standpoint of population (both sexes, different ages, healthy or with associated pathology...) and the surgery (different types of surgeries) and especially the anesthetic, individualized anesthetic techniques depending on the patient (which is the basis for our common good practice, setting the anesthesia to the patient and not the patient to a fixed protocol) and above all, maintaining a level of neuromuscular blockade as appropriate to the situation as possible. Obviously, the only way to achieve this is using quantitative neuromuscular blockade monitoring (without monitorization or using qualitative monitoring, such as peripheral neurostimulators, it is impossible). Anesthetic maintenance was performed with halogenated gases or propofol, an aspect that does not affect the reversal of rocuronium with sugammadex, as has been demonstrated [39].

Secondly, and it is very important, this aspect has not been provided previously by the few existing pharmacoeconomic studies [28,31,41,42]. In the present study, we allowed spontaneous recovery if it was viable (a 37,8% of patients). That is, in the remaining patients we did not manipulate neuromuscular block to fit a certain degree according to a previous protocol. Stresses in particular that none of the articles valued above [31,41,42] contemplated the possibility that the cheapest option is the complete spontaneous reversion. Obviously this may not be feasible for all patients or for certain types of surgery that may require intense neuromuscular blockade, with PTC = 0 (e.g. Ophthalmology, Neurosurgery…), but it could be applicable to other patients. In this series the estimated savings by not reversing sugammadex in 37,8% of the patients was € 2290,06, corresponding to € 81,79/patient. That savings could be used to provide adequate quantitative monitoring neuromuscular block at each operating room, something that with proper training in better neuromuscular blockade control could therefore reverse in greater savings over a medium - long period. It is true that most of Anesthesiology Departments of many countries are not capable of economic self-management, and therefore can not decide which items earmark the savings, but we can present this information to the Hospital Managers, with prospects savings (other than patient safety) in order to obtain adequate monitoring of neuromuscular block for all operating rooms.

On this point, it should be noted that some authors [31] interpret that the possibility of reversing with sugammadex any degree of residual neuromuscular blockade (including deep blocks) makes unnecessary the use of neuromuscular monitors and therefore this should represents a cost savings. We do not share this point of view for two reasons: first, the saving in not buying neuromuscular monitoring happens only once, whereas the saving in sugammadex is continuous in time. Secondly, we must also remember that the use of quantitative monitoring is recommended by most of Anesthesiology Societies [2].

Comparing the costs of sugammadex and neostigmine, the difference is obvious. However we must not fall into an overly simplistic point of view and use the cheapest option based only in the economics. This could be an error, as it happened with the recommendation to use only cheaper drugs such as pancuronium and suxamethonium (instead of atracurium - vecuronium), which was more expensive because the costs of prolonged residual neuromuscular block and complications were not estimated [43]. Different publications have reported a reduction in overall costs properly using more expensive drugs [44]. We must therefore assess each drug may have its indication.

Reversal times obtained in this series with sugammadex are consistent with those reported in the analyzed literature. It should be noted that the average time in reversing moderate blocks in this series is higher than in reversing deep blocks (Table 5). This may be due to several reasons. First the small number of patients with deep block, and especially to the presence of 4 patients with elongated time (specifically, 3,2 to 5,75 min), among the series of 39 patients reversed with moderate block, a fact that prolong the overall average. The existence of patients with sugammadex decurarization times more elongated has been described previously [37,45]. This is unusual but possible. White et al. 35 report that 84% of patients return to a TOF ratio of 90% within 5 min after administration of sugammadex regardless of the residual curarization degree.

Third, in terms of cost per hour saved, we must point out that: reversal with cholinesterase inhibitors is contraindicated in certain patients (e.g., asthma, heart disease, treatment with beta blockers...) and is ineffective in reversing deep blocks [6,20,46], therefore not all patients are suitable for antagonization with neostigmine. We must also specify that we have worked with statistical averages. However, the reversal time ranges are much broader with neostigmine (Table 5). So if the patient reversed with neostigmine is at the right end of the range, times may increase significantly and therefore reduce the cost per hour saved by using sugammadex.

To demonstrate the cost-effectiveness of sugammadex it is necessary to assess two things: first, to verify that sugammadex shortens the reversal of rocuronium compared with neostigmine (proven fact in the data previously published and verified by our series), and second, that the time saved is productive.

In the UK, considering the salaries, insurance and pension contributions made by an operating room composed of two surgeons (one consultant), an anesthesiologist and three nurses, has been estimated at 4.4 pounds/min (€ 299,32/hr) [31]. Unfortunately we have no data in our country showing the average cost of operating room time. Even within the same hospital, the cost can vary depending on numerous factors including: the number of staff assigned to the operating room, their experience (a first year resident does not charge the same as a senior consultant), if activity is scheduled or extraordinary...

In any case it is certain that exceed € 245/hr saved that involves the use of sugammadex. Here we have to add another qualification again. Neostigmine has a number of adverse effects that can lead to complications, loss of patient welfare and the need to use medication to counter them, such as nausea and vomiting [47-49], so the total cost could be reduced.

Furthermore, without going into the medical indication concerning what drug should be used to antagonize residual neuromuscular blockade of rocuronium, sugammadex or neostigmine (and we remark this point), it is necessary to analyze in which situation occurs the decurarization, to determine whether the time savings impact on productivity. If it happens in scheduled interventions, the timesaving will only be useful if it can leverage the availability of the operating room, increasing performance. In closed surgical list that finish during working hours, reversal with sugammadex will be an added cost with no benefit over do it with neostigmine. If the same surgery is prolonged, the timesaving will offset the Administration in the event that the operating room staff claims this extraordinary activity over time.

In programmed theaters with increasing the number of interventions, the use of sugammadex is more beneficial, because the timesaving are proportionately

higher than in single interventions. In the emergency operating room, taking all measures that save time is indicated, including the reversal with sugammadex, in order to promote the availability of this operating room for treatment life threatening emergencies.

Finally, the authors also note that all patients in this study left the operating room with a TOF-ratio greater than or equal to 90%. Lower TOF-ratio values can lead to the occurrence of any complications arising from the existence of residual curarization, well known by anesthesiologists, in addition to be an impact on patient welfare, and also an economic impact on the overall cost of hospital care.

In conclusion, the introduction of sugammadex has allowed anesthesiologists to control more effectively the residual block by rocuronium, shortening the time of reversal, but at higher cost than with neostigmine. However, in certain situations this cost of € 245/hr saved is beneficial if it allows to increase productivity, avoid extraordinary extensions of working hours or release the emergency operating room. Finally, it should be noted that the proper monitoring of neuromuscular blockade allows a saving in the use (and expense) of residual curarization reversal drugs.

Correspondence address:
José Ramón Ortiz Gómez.
Complejo Hospitalario de Navarra B. Hospital Virgen del Camino, Servicio de Anestesiología y Reanimación
C/ Irunlarrea 4; 31008 Pamplona, Navarra, Spain
☎ 848429400
✉ j.r.ortiz.gomez.md.phd@gmail.com

Konflikt interesów / Conflict of interest
Brak/None

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