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Cost Analysis of Neuromuscular Blockers Purchased by Royal Medical Services during the Years 2014-2016

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Abstract*— *Objective: *to find out the most cost effective drugs after analyzing the amounts purchased throughout the study period.* ***Methods:*** *studying tenders and/or sub-tenders between "2014-2016" for the daily usage in all Royal Medical Services hospitals. The comparison parameters include: the mean unit price in tender and sub-tender, the total costs, onset and duration of action, side effects profile and the rational for each neuromuscular blocker drug purchased during interval 2014-2016 and set of groups of recommendations and conclusions that insure the cost effectiveness of the items available.* ***Results:*** *Atracurium had the lowest mean cost in one ampoule cost ($1.39), followed by rocuronium ($1.60) and cisatracurium ($2.80). the cost is calculated based on patient assuming to have a weight of 70 kg using one ampoule, further more analyzing sub tenders Atracurium also had the lowest mean cost price in one ampoule ($1.48), followed by rocuronium ($2.22) and cisatracurium ($3.23). The main difference was in rocuronium due to high cost difference between the main tenders and sub tenders.* ***Conclusion:*** *Further investigations are required to determine that the purchases of NMBA's provided the most effective therapy and best cost*

I. INTRODUCTION

Non-depolarizing neuromuscular blocking agents (NMBA) are used as adjuvants in anesthesia with the aim of induce muscle relaxation and enable tracheal intubation and controlled ventilation. Drugs from this group vary in some characteristics such as onset time, duration of action, metabolic route, effectiveness, dosing schedules, adverse effects, and cost. Neuromuscular blocking agents can be classified according to their duration of action. Among those with an intermediate duration of action the most widely used drugs are Cisatracurium, rocuronium, atracurium.[1]

These three NMBA vary in pharmacokinetic characteristics and dosage schedules (Table 1). Respectively NMBA has some advantages and restrictions. As an example, atracurium is associated with histamine release [2], consequently in patients with severe cardiovascular diseases or in patients with an approximate tendency to histamine release this drug has to be given with precaution. Vecuronium and Rocuronium are generally eliminated through the liver [1], thus drug elimination is slower in patients with hepatic failure. Rocuronium has the shortest onset time. Cisatracurium is one of the ten Atracurium isomers [3] which is 3.3 times more potent than atracurium [4, 5], this NMBA has cardiovascular stability comparable to Vecuronium and an organ independent elimination like Atracurium [1]. The choice among the different drugs from the similar group should be based on safety, efficacy and efficiency principles. When anesthesiologists choose a neuromuscular blocker they have the following objectives: quick and adequate muscle relaxation, hemodynamic stability and an expectable and complete muscular recovery [6]. Nevertheless, if there is no reason to select one drug because of these criteria, it would be suitable to select the drug with the lowest cost [7]. As in other medical fields, owing to cost control and efficiency policies the health physician must select the least costly drug if the same clinical outcome can be accomplished with the different alternatives. If one drug is more expensive, this would be the drug of choice only when the clinical benefit is valuing the incremental cost. However, when costs are analyzed not only has the vial cost to be measured. It is also significant to consider the dose needed to achieve the same myorelaxant effect as well as other related costs, such as administration costs and adverse effect management. The costs of the three NMBA with an intermediate duration of action are diverse and shown in Table. To our knowledge, rare studies economically compare these neuromuscular blocking agents [8, 9]. Additionally, only one of these studies [8] includes cisatracurium among the drugs to be compared.

Table 1: Dosing schedules and pharmacokinetic characteristics of neuromuscular blocking agents included in the study.

NMBA's	Induction dose mg/kg	Maintenance dose mg/kg	Onset (min.)	Duration of induction	Duration of maintenance dose	Recover time (min)	Histamine release	Elimination
ATR	0.4-0.5mg/kg	0.08-0.2	1.5-2.5	20-35	15-35	35	Yes	Hofmann degradation
CIS	0.1-0.15mg/kg	0.03	1.2-2	40-55	20	30	No	Hofmann degradation
ROC	0.6-0.9mg/kg	0.15	1	30-40	13	25-30	No	Mainly hepatic

This study was very simple, and the authors even highlighted that many costs were not included and the study had to be redone. Therefore, a more detailed cost analysis was warranted. The main objective of this study was to analyze,

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evaluate and compare the amounts and costs of neuromuscular blockers purchased by Royal Medical Services between the four non-depolarizing neuromuscular blocking agents with an intermediate duration of action which are greatest used in anesthesia (cisatracurium, atracurium, and rocuronium).

II. METHODS

Studying tenders and/or sub-tenders between 2014-2016; for the daily usage in all Royal Medical Services hospitals. The comparison parameters include the mean unit price in tender and sub-tender, the total costs, onset and duration of action, side effects profile and the rational for each neuromuscular blocker drug purchased during the interval 2014-2016 and set of groups of recommendations and conclusions that insure the cost-effectiveness of the items available.

Retrospective cost analysis comparing three neuromuscular blocking agents, atracurium, cisatracurium and rocuronium was conducted. Costs of the drugs were taken from the Directorate of Royal Medical Services – pharmacy department. Some neuromuscular blockers have original and generic brands. The cost per ampoule of each of the drugs which were used in the analysis was pooled by using original and generics costs per milligram. All costs were changed into US Dollars with JOD/USD rate as 0.71 and calculated in USD (Table).

It was assumed that there were not any differences in other anesthetics that could be used in pre/per/post operations or in other procedures (inhaled anesthetics, anesthesia antagonists like neostigmine, etc.). For example, if an anesthesiologist wants to choose an NMBA in the same operation type, the only difference between NMBAs is the cost of drugs.

III. RESULTS

Atracurium had the lowest mean cost in one ampoule cost ($1.39), followed by rocuronium ($1.60) and cisatracurium ($2.80) (Table 2). the cost is calculated based on patient assuming to have a weight of 70 kg using one ampoule, furthermore analyzing sub tenders Atracurium also had the lowest mean cost price in one ampoule ($1.48), followed by rocuronium ($2.22) and cisatracurium ($3.23) fig. 1. The main difference was in rocuronium due to high cost difference between the main tenders and sub tenders fig. 2.

IV. DISCUSSION

Several patients experience anesthesia every year and receive muscle relaxants. The percentage of hospital operating costs focused on anesthetic medications is negligible, approximately 0.20% of hospital budget [10] nevertheless they are a great proportion of variable anesthetic supply costs [11]. Decision- makers progress innovative policies to reduce anesthetic costs and maintain the quality of health care. Since neuromuscular blocking (NMB) drugs found almost 30% of the total anesthesia drug budget in the United States [12], these drugs are appropriate goals for cost-minimization plans in anesthesia [11].

A cost analysis was performed to compare the direct costs of different neuromuscular blocking agents purchased by main tenders and sub-tenders during the period of 2014-2016. In the main tenders. There is a little difference between the mean unit price for main tenders and sub- tenders purchases for atracurium, more differences of mean unit price for main tenders and sub-tenders for cistracurium. While the highest mean unit price difference was for rocuronium fig (2).

Table 2. The common neuromuscular agents

NMBA's	Intubating Dose (2xED 95)	Vial	Vials to intubate 70) kg patient	Cost in main tenders / vial (JD)	Cost in main tenders / vial (USD)	Cost in sub tenders / vial (JD)	Cost in sub tenders / vial (USD)
ATR	0.4-0.5mg/kg	50mg	1	0.988	1.39	1.055	1.48
CIS	0.1-0.15mg/kg	20mg	1	1.988	2.80	2.295	3.23
ROC	0.6-0.9mg/kg	50mg	1	1.136	1.60	1.58	2.22

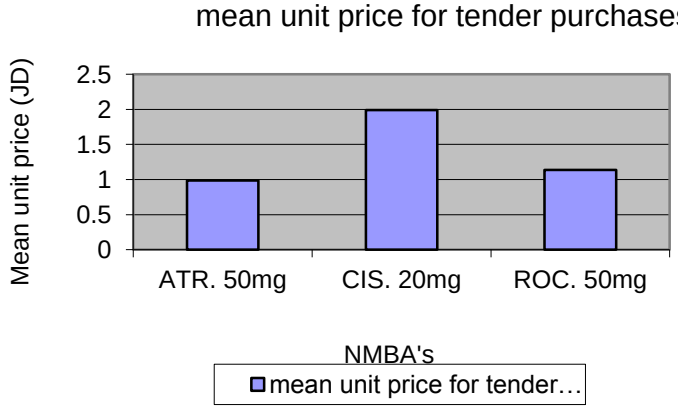

Fig. 1.

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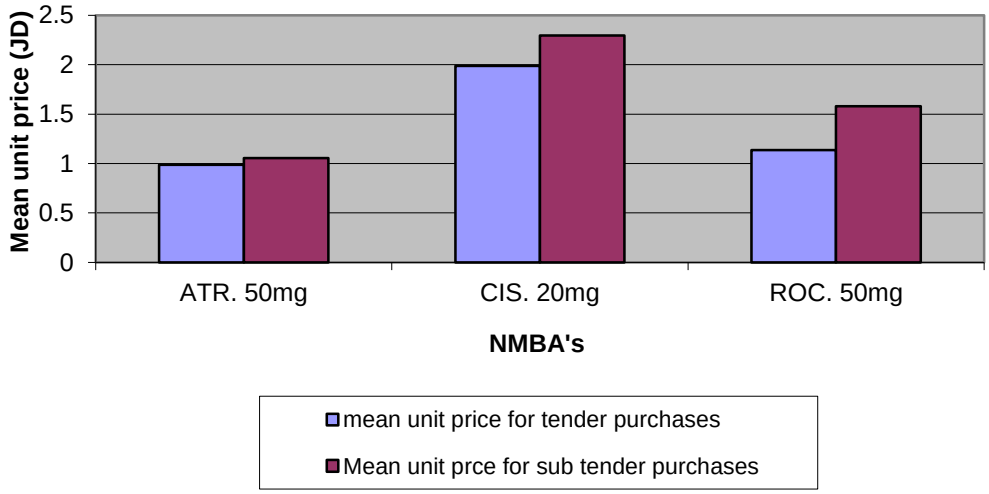

Fig. 2.

All costs and benefits or substitutions are measured in financial terms by Cost-benefit analysis, the outcome may be stated as a ratio (benefit to cost), or in terms of net cost or benefit. The obvious problem with this type of analysis is the difficulty of converting some non- financial units. Because of that, cost-effectiveness analysis is more frequently used. A study conducted in turkey showed that managements of hospitals or hospital groups which are in Turkey can select atracurium and vecuronium in operations less than 30 minutes, vecuronium in operations 30-60 minutes and more than 60 minutes in their neuromuscular blocker (NMB) formularies for creating cost reductions from NMBs.[13]

V. Conclusion

Further investigations are required to determine that the purchases of NMBA's provided the most effective therapy and best cost, such investigations may include a comparison between purchased prices of NMBA's in DRMS and in another institute such the Ministry of health during the same period. Adopting NMBA's that will enhance safety and are likely to produce less or unexpected events. Limiting the number of NMBA's purchased, and purchasing sufficient quantities will ensure continuous availability of these drugs and will prevent sub tender purchases which tend to be more expensive. Accurate estimation of quantity and type of NMBA's required will prevent over stock or shortage in stock and will save both effort and money.

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