

CHAPTER VI

DISCUSSION AND CONCLUSION

The Efficacy of the Interventions

The overall prevalence rate of residual relaxation at 30 min. in this study was 38.9% which was nearly the same as reported by Worawut Lapisatepun et al. (1992). However, there were several points that were different between these 2 studies. In the previous study, most of the relaxant used were pancuronium as it was a descriptive study while in this experimental clinical study, the types of relaxants used were pancuronium and vecuronium in equal number. In addition, in the previous study the time for testing of residual relaxation was not specified, while in this study it was fixed at 30 min. after reversal. In this study, we were able to show that the prevalence rate were significantly different in those patients who received different types of relaxants as in Table 5.9 (55.6% in pancuronium group and 22.2% in vecuronium group). Using PNS decreased the prevalence rate of residual relaxation as shown in Table 5.6 (35.6% in PNS group and 42.2% in no PNS group), but not statistically significant. We were unable to show the interaction effect of these two factors in this study



by subgroup analysis (Table 5.9, 5.10 and 5.11) and log linear model.

The difference in types of relaxants used also affected the $\%T_4/T_1$ ratio at 30 min., while the use of PNS and interaction between these two factors did not affect this ratio as shown in Table 5.4. The ratios in pancuronium groups were less than 70% (54.3% and 61.3%), while in vecuronium groups they were higher than 70% (76.4% and 88.2%). As $\%T_4/T_1$ ratio of 70% was the cutoff point for the diagnosis of residual relaxation, this analytic result supported the result from analysis using residual relaxation as the outcome variable. The power of this study to demonstrate the effect of using PNS and the interaction effect were only 0.474 and 0.033 respectively, so it was possible that we did not have adequate number of patients to show the effect of using PNS. However, the effect of using PNS might not be clinically significant, as it would not move the $\%T_4/T_1$ ratios at 30 min. across the cutoff point of 70% (54.3% and 61.3% in pancuronium groups and 76.4% and 88.2% in vecuronium groups).

The use of pancuronium instead of vecuronium increased the risk of residual relaxation (relative risk = 2.50, 95% C.I. = 1.63 - 3.84). This meant that the use of vecuronium could reduce the prevalence of residual

relaxation down to only 40% of the prevalence in pancuronium group. This risk reduction was less than expected in our research questions, but was still very beneficial clinically. As there was no study showing the efficacy of these interventions (using newer relaxant and PNS), so we have arbitrarily chosen a number that was possible to be the result of the study and likely to be clinical significant also for sample size calculation before we started data collection.

The average recovery times required by patients to reach $\%T_4/T_1$ ratio $\geq 70\%$ were significantly different as shown in Table 5.12. Both the use of newer relaxant and PNS were significant factors ($p = 0.000$ and 0.014 respectively) for explaining the difference. Although this was not the main outcome in this study, it might be important clinically as it would affect the time required for the patient to be closely observed in the recovery room.

We did not find any statistically significant difference in the time to extubation (time from reversal of muscle relaxant to the time that the patient was extubated) as shown in Table 5.13. This was because this time was determined by the impression that the patient could breathe adequately. This impression came from

assessment that patients had adequate tidal volumes and patients usually could have adequate tidal volumes in spite of residual relaxation (Viby-Mogensen, 1990). However, this adequate tidal volumes might not be good enough for assessing the degree of residual relaxation or preventing respiratory complications as the ability to cough required more powerful muscular activity.

In this study the most common complication was restlessness which occurred in 10 patients. Eight out of these 10 patients were restless because of the postoperative pain. The other two cases were restless because they felt that they were unable to cough and both cases had $\%T_4/T_1$ ratio much lower than 70%. These two cases were in group 2 (group of patients who received pancuronium guided by the use of PNS) and group 3 (group of patients who received vecuronium at fixed time interval). The one in group 3 also had a drop in oxygen saturation which responded to more reversal drug, indicating that her hypoxemia was a result of residual relaxation.

There were 3 cases that developed signs of mild airway obstruction which were noisy breathing (stridor) and retraction of suprasternal notch and intercostal spaces. The $\%T_4/T_1$ ratios at 30 min. in all these three cases were more than 70%. This meant that these events

were not caused by residual relaxation. Two of these cases were sleepy and showed these signs only during being asleep, so the best explanation for these 2 cases were because of the residual effect of the general anesthetic drugs on the tonic and phasic control of respiration. The third case had thyroidectomy about 20 years ago and during intubation in this study, she required endotracheal tube of the size smaller than normal. This meant that the likely cause of obstruction in this case was from stricture of trachea or small tracheal lumen.

Limitation

All patients in this study were females scheduled for lower abdominal surgery. This group of patients was selected as this would allow us to be able to collect enough cases in time. In addition, we did not expect that the $T4/T1$ ratio or the residual relaxation would depend on the types of surgery. However, interpreting results in the light of knowing the types of surgery is very important as they may affect the respiratory function differently, e.g., upper abdominal surgery will affect respiratory function of the patient more than lower abdominal surgery. The more, the respiratory function is disturbed, the higher, the

probability of respiratory complications becomes for the same $\%T_4/T_1$ ratio.

All patients in this study did not have any serious illnesses. This would possibly limit the usefulness of the study in seriously ill patients. However, it is likely that the problem of residual relaxation will be more common in seriously ill patients and all the possible interventions will be used including the possibility of postoperative mechanical support which will alleviate the problem of residual relaxation.

There were only 2 cases who had clinical problem caused by residual effect of muscle relaxants, one in group II and the other in group III. This could be explained by the very few occurrence of respiratory complications. It was likely that if we were be able to collect more cases, we could show the difference in number of respiratory complication caused by residual relaxation.

Economic Analysis

The economic analysis in this study was done from the health care provider viewpoint. In Table 6.1, the data were summarized for economic analysis. The prevalence of residual relaxation at 30 min. decreased as more interventions were introduced (57.8%, 53.3%, 26.7

and 17.8% in group I, II, III and IV respectively). These differences were statistically significant and explained by the use of the newer relaxant, but not by the use of PNS.

The costs of pancuronium and vecuronium at Siriraj Hospital are 7.75 and 11.40 baht/mg. respectively. The cost of one peripheral nerve stimulator in Thailand is 10,000 baht. If this equipment can be used for 5 years, its cost per year will be 2000 baht. We assume that we use this equipment only 8 hours per day, 5 days per week for every week in each year, the cost per hour of this equipment will be 0.96 baht. Therefore the total cost of using muscle relaxants per hour in each group of patients were 29.08, 27.96, 57.76 and 59.53 baht respectively.

The cost of anesthesia in 4 groups of patients were different only in the cost of relaxants used and the cost of PNS, so the average total marginal cost for each group of patients were 29.08, 27.96, 57.76 and 59.53 baht respectively.

Not considering the effectiveness of PNS, the marginal cost of using PNS was lower in pancuronium group while it was higher in vecuronium group. This meant that when the muscle relaxant used was pancuronium, using PNS

would save money, but when the muscle relaxant used was vecuronium, we would spend more money using PNS.

	Gr I	Gr II	Gr III	Gr IV
<u>Cost</u>				
cost MR/hr	29.08	27.00	57.76	58.57
Cost of PNS/hr	0	0.96	0	0.96
Total cost/hr	29.08	27.96	57.76	59.53
<u>Effectiveness</u>				
Prevalence of residual relaxation at 30 min. (%)	57.8	53.3	26.7	17.8
Clinical significance (cases)	0	1	1	0

Table 6.1 This shows the summary of data on cost and effectiveness in each of the 4 group of patients in this study for economic analysis.

	Pancuronium group	Vecuronium group
<u>Cost</u> for 100 cases		
cost of MR/hr (baht)	2804	5816
<u>Effectiveness</u> for 100 cases		
Prevalence of residual relaxation at 30 min. (cases)	56	22
Clinical significance (cases)	0.56	0.56

Table 6.2 This is the summary of data on cost and effectiveness in relation to the types of relaxant used for economic analysis.

As the only efficacious intervention shown in this study was changing types of relaxants, we should further consider the economic analysis of these 2 options. The data for economic analysis of these two options were summarized in Table 6.2. The average marginal costs of using pancuronium and vecuronium were 28.04 and 58.16 baht/hr., and the effectiveness were

55.6% and 22.2% respectively. For every 100 patients, the cost effectiveness ratio of using vecuronium instead of pancuronium would be $(5816 - 2804)/(22 - 56)$. This resulted in the cost-effectiveness ratio of - 88.59. This meant that by choosing vecuronium instead of pancuronium, we could reduce the prevalence of residual relaxation by 1 patient in 100 patients if we pay 88.59 more baht/hr for the cost of newer, better muscle relaxant. At Siriraj Hospital there are about 16,000 operations each year that muscle relaxants are used. If the average duration for the operation is about 2 hours like in this study, then the cost of muscle relaxant will increase 963,840 $(16,000 \times 2 \times 30.12)$ baht. This amount of money will be expected to prevent the number of cases that have residual relaxation by 5440 $(34 \times 16000/100)$ cases. As in this study, there were 2 clinically significant cases and both of them had residual relaxation ($\%T_4/T_1$ ratio less than 70%). It seems logical that the intervention that reduces the number of cases with residual relaxation, should be able to help reducing the number of cases that have respiratory complications.

In addition, changing to use newer relaxant or PNS may have other direct benefit of reduction in duration of stay in recovery room as both these factors reduce the time to 70% T_4/T_1 ratio significantly.

Conclusions

This study showed that choosing newer relaxant would reduce the number of cases that had residual relaxation significantly. If we have calculated the cost effectiveness analysis of using newer relaxant to reduce the number of cases that have residual relaxation, and found that it was cost-effective. We expect that this will result in reduction of respiratory complications.

Although we were unable to show to efficacy of PNS to reduce the prevalence of residual relaxation, may be because the sample size was too small, the use of PNS in patients who received pancuronium was still justified. This was because by using PNS, we used less amount of pancuronium resulting in reduction of total cost.

In addition, we might have other direct benefit from using newer relaxant or PNS, as both factors significantly reduced the time required to reach 70% T_4/T_1 ratio. However, this was not the research questions in this study, so it was difficult to be certain that this was the factor that required the longest duration for recovery room stay. We recommend that there should be more researches to explore further this matter.