



## CHAPTER I

### INTRODUCTION

#### Background and Rationale

Since Griffith and Johnson (1942) reported the use of muscle relaxant (curare) in general anesthesia, the advantages of using it become so clear to anesthesiologists that its use has become a vital part in modern anesthetic management. The advantages of using muscle relaxants (Cullen and Larson, 1974) are: to cover-up deficiencies in total anesthetic management as in the prevention and the treatment of laryngospasm, to prevent movement in response to pain and also to reduce the problem of hypotension due to relative overdose of anesthetic or hypnotic drugs. On the other hand, there were reports both from the developed countries (Viby-Mogensen, JØrgensen and Ørding, 1979; Lennmarken and Löfström, 1984) and recently from Thailand (Worawut Lapisatepun et al., 1992) about high prevalence of residual curarization (42%, 25% and 34% respectively). These were probably because of the very wide dosage range and duration of action of muscle relaxants even in normal person. The high prevalence of residual curarization may

be one of the causes of postoperative respiratory complications such as respiratory failure, airway obstruction and aspiration pneumonitis from poor protective airway reflexes. There have been two approaches to the problem, using peripheral nerve stimulator to monitor the effect of muscle relaxants at neuromuscular junctions or using a new intermediate acting muscle relaxant. Christie and Churchill-Davidson (1958) first reported the use of peripheral nerve stimulator in St. Thomas's Hospital for the diagnosis of prolonged apnoea, but it did not gain popularity from practicing anesthesiologists. However, in the last decade there are models of peripheral nerve stimulator that are cheap and easy to use. There are also new modes of stimulation that are practical for use (Ali, 1985; Hudes and Lee Meng, 1987) e.g., train of four stimulation and its twitch count (Ali, Utting and Gray, 1970; Lee, 1975). In the 'train of four stimulation' mode, four supramaximal electrical stimulations are given in two seconds (2 Hz frequency) to the peripheral motor nerve and the responses will be noted by observation of the contraction of the corresponding supplied muscle. By counting of the numbers of twitch response will reflect the degree of neuromuscular blocking action, that is the more twitch responses counted, the lower degree of blockade left. This makes the use of peripheral nerve

stimulator a possible option without the need for more sophisticated equipment. From these developments, the use of peripheral nerve stimulators becomes more popular. On the other hand, there was only one study on the efficacy of using a newer drug to reduce the prevalence of residual relaxation (Andersen, 1988). Although a newer drug seems to be one of the practical solutions but this option is likely to increase the cost by at least 2-3 times more than older drugs. However, most of the anesthesiologists in developed countries have changed their clinical practice to use both new drugs and a peripheral nerve stimulator. In fact, it is recommended in those countries that a peripheral nerve stimulator should be used whenever muscle relaxant is used.

In Thailand although a research study (Worawut Lapisatepun et al., 1992) also showed that the prevalence of residual relaxation was as high as the studies from abroad (Viby-Mogensen, JØrgensen and Ørding, 1979; Lennmarken and Løfstrøm, 1984), there is still no standard approach to the problem. Here there are so many factors that are different from the developed countries and that should be considered before making the decision. There is still a problem of severe shortage of anesthesiologists in Thailand (only about 300-400 anesthesiologists/60 million population), so most

anesthetics given in this country especially outside Bangkok are administered by nurse anesthetists. It is likely that the problem of residual muscle relaxation may be higher and also more dangerous outside the teaching centers. The proposed solutions should also be as simple as possible for the personnel who are going to use it. The newer drugs seem to be very practical but choosing this option is likely to increase the cost. The option of using peripheral nerve stimulator is good in the sense that the cost may be less and it can also help to differentiate the residual relaxation as a cause of postoperative respiratory insufficiency. However both interventions (a newer relaxant and using peripheral nerve stimulator to guide muscle relaxant administration) will increase the cost for anesthetizing patients substantially as the technique of general anesthetics with relaxants is very common. Therefore it is important to have data on the efficacy of both options before accepting these technologies.

#### Review of related literature

1. Muscle relaxants are groups of drugs used in anesthetic practice to help provide optimal operative condition as these drugs will block the neuromuscular transmission of motor nerve impulses at the neuromuscular junction. In this study the muscle relaxants of interest

are long acting non-depolarizing muscle relaxant (i.e., pancuronium) which has the duration of action of about 45-120 minutes and intermediate acting muscle relaxant (i.e., vecuronium) which has the duration of action of about 30 to 45 minutes (Norman, 1985).

2. Peripheral nerve stimulator is an electronic device used for monitoring neuromuscular function. It works by giving 'supramaximal' electrical stimulation (usually about 30-40 mA) to any motor nerves (the ulnar nerve at the wrist for this study) and this electrical activity will travel along the nerve to initiate the release of transmitters at neuromuscular junctions. This release will induce electrical activity and finally contraction of the supplied skeletal muscle (in this study, the adductor pollicis muscle). Monitoring of the hand muscle is preferred to monitoring of the respiratory muscles not only because it is much easier to do but also because the recovery of this group of muscle will ensure the recovery of the respiratory muscles (Waud and Waud, 1972).

3. 'Train Of Four' (TOF) stimulation (Ali et al., 1970; Lee, 1975; Viby-Mogensen, 1990) is a pattern of nerve stimulation that is consisted of four supramaximal stimulations of 2 Hz frequency. This means that 4 consecutive stimulations of half a second apart and this

series of stimulation should not be given more often than every 10 seconds. The fading response to this stimulus is characteristic for this type of neuromuscular blocking agents.

4. Residual relaxation (curarization) means the residual effects of muscle relaxants. This can be detected by clinical examination and using equipment such as a peripheral nerve stimulator. Clinical examination needs the patient's cooperation to use his skeletal muscle against various work loads so it is impossible to use during anesthesia and difficult to apply during the immediate recovery period because of pain and problem about cooperation. Usually evaluation by using a peripheral nerve stimulator is the standard method and TOF stimulation is useful during a moderate to high degree of blockade (Viby-Mogensen, 1990). There are also other modes of stimulation such as single twitch stimulation, tetanic stimulation. The TOF stimulation is far better than single twitch stimulation because it does not need a control stimulation ( $T_1$  is used as a self control). It is also sensitive enough to be used during anesthesia without using other sophisticated equipment (to compare the new twitch height and the control) by using the twitch count instead. However, to be able to diagnose the residual relaxation, we need to use an

additional sophisticated equipment to enable us to compare the fourth twitch height ( $T_4$ ) and the control height ( $T_1$ ). Usually we diagnose the patient to have 'residual relaxation' when  $\%T_4/T_1$  is less than 70% (Viby-Mogensen, 1990). The use of tetanic stimulation especially in combination with TOF is more sensitive than using TOF stimulation alone, but it is a very painful stimulation, so its use is limited for anesthetized patients only.