

## A Nerve Stimulator for the Continuous Monitoring of Muscle Relaxant Action

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In a recent issue of ANESTHESIOLOGY, Churchill-Davidson stated, "The only satisfactory method of determining the degree of neuromuscular block is to stimulate a motor nerve with an electrical current and observe the contraction of the muscles innervated by that nerve."<sup>1</sup> In the same issue Katz reported, "Extensive experience with the routine use of a nerve stimulator during anesthesia and operation led to the conclusion that any time a neuromuscular blocking agent is given the use of a nerve stimulator to monitor the effects should seriously be considered."<sup>2</sup> There are many nerve stimulators available; these range from expensive research models to inexpensive homemade models.<sup>3</sup> After testing a variety of the nerve stimulators available, the author concluded that none of them had exactly the characteristics that he desired: (1) small, (2) simple, (3) portable, (4) battery or transistor operated, (5) inexpensive (less than \$100), (6) a single stimulus (twitch) continuously delivered every 3-4 seconds, (7) a switch permitting a change from a twitch to a tetanic rate of stimulation, (8) construction such that the stimulator would not break the first time it was dropped.

Approximately one year ago a nerve stimulator (Block-Aid Monitor) with these characteristics was developed and given to us for clinical testing. The present communication is based upon the experience of the author, attendings, house staff and students at Columbia-Presbyterian Medical Center with the Block-Aid Monitor.

The Block-Aid Monitor (fig. 1) is 5.25 inches long, 3 inches wide, 2.125 inches deep and weighs 1.25 pounds. It is powered by two 1.5-volt dry cell batteries which are replaced as needed. The electronic circuit pro-

vides an electrical pulse (twitch) of variable voltage, of approximately 0.2-msec. duration, delivered approximately once every four seconds as long as the switch is left in the "on" position. A voltage regulator is incorporated in the monitor. The maximum voltage obtainable when needle electrodes are placed subcutaneously is 30 volts, with a current output of 0.93 milliamperes (assuming 1,000 ohms skin resistance). To provide a tetanic stimulus, pulses are delivered 30 times a second. There is a signal light which flashes each time a stimulus is applied. The need for replacement of the batteries is indicated by a speed-up of the signal light flash when the monitor is in the twitch position.

Although surface electrodes can be used, the author prefers needle electrodes (standard 25 gauge steel hypodermic needles). With surface electrodes there is sometimes (1) difficulty in maintaining a constant position, (2) difficulty in obtaining a good response in obese patients, (3) skin necrosis due to the pressure of surface electrodes on the skin for 8 hours. These problems are usually eliminated by the use of needle electrodes. The author usually places the needles along the course of the ulnar nerve at the wrist or elbow (the elbow is often simpler) prior to or just after the intravenous injection of a thiobarbiturate.

The Block-Aid Monitor has been used for continuous monitoring as well as for intermittent testing. The author prefers continuous monitoring, which permits minute to minute control of muscle relaxation. With experience one is able to recognize small changes in finger movements and evaluate the magnitude of the muscle response of a given patient. With intermittent monitoring it is sometimes difficult to remember what a previous response was and to compare it with the present response. When a succinylcholine drip technique is used, continuous monitoring is especially helpful in maintaining a satisfactory level of re-

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laxation with minimal amounts of succinylcholine.

The routine clinical use of the Block-Aid Monitor has been found to be of value in determining: (1) the magnitude of the neuromuscular block and the need for additional neuromuscular blocking agents; (2) the need for antagonists of the muscle relaxants; (3) the nature of the block, *i.e.*, phase 1 depolarizing or phase 2 nondepolarizing;<sup>1, 2, 4-6</sup> (4) the role of the muscle relaxants in causing postoperative hypoventilation or apnea; and (5) the location of nerves during operation. In addition the Block-Aid Monitor has been invaluable as a teaching aid in the instruction of students and house staff in the use of muscle relaxants.

The nerve stimulator is no panacea. It is not a substitute for good clinical judgment. Like the blood pressure cuff, stethoscope, pulse monitor, EEG, ECG or anesthesia machine dials, the nerve stimulator is only another tool in the armamentarium of the anesthesiologist.

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FIG. 1.