

CORRESPONDENCE

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Comment:—The letter from Dr. Gronert and the reply from Dr. MacLennan *et al.* were also sent to Dr. Jeevendra Martyn, a well-known expert on the subject of nicotinic cholinergic receptor upregulation. His response follows.

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In Reply:—MacLennan *et al.*¹ probably have taken the more conservative and safer approach when they suggest that succinylcholine should not be used beyond 24 h after a burn injury. However, there are no reports in the literature of succinylcholine-induced hyperkalemia in humans occurring within 1 week after a burn injury. Based on published human studies, some other investigators might therefore assert that succinylcholine is safe up to 1 week after burn injury. Nevertheless, it is important to point out that these studies, relative to succinylcholine and burns, were performed almost 30 yr ago.²⁻⁴ In these reports, the number of patients studied within 1 week after burn injury totaled only three in the three publications.

The treatment modality at that time (three decades ago) was that most burn patients, especially those with big burns, did not undergo excision and grafting procedures until the burn eschar had separated from the wound. This spontaneous separation of eschar takes at least 2 weeks. Early excision and grafting of burns, especially of major burns, was not routine at that time. Therefore, it is not surprising that only a total of three-patient studies were reported for the first week in three publications. Most likely, the three patients reported suffered only minor burns.

In contrast to the conservative approach to treatment of burns of the past, current practice advocates early excision and grafting of burn wounds, especially of patients with major burns.¹ The upregulation of acetylcholine receptors (AChRs) after burns occurs at sites immediately beneath and distant from the burn^{5*}; a positive correlation between AChR number and the intensity of the hyperkalemia after succinylcholine has been confirmed.⁶ The upregulation of AChRs that occurs in muscles beneath the area of the burn is as profound as after denervation and occurs as early as 72 h after burn.* Evidence for upregulation of the immature isoform has also been provided by assessment of messenger RNAs for the γ -subunit. When depolarized, the immature isoform has a prolonged open channel time, which may exaggerate the K^+ efflux that occurs with depolarization. We have recently reconfirmed this AChR upregulation with expression of the γ -subunit as early as 3 days after a 5% burn over the tibialis anterior

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muscle in the rat (unpublished). Thus, the potential for profound, denervation-type upregulation of AChRs is present as early as 3 days after burn injury when the burn-injured area is adjacent to muscle. The dramatic upregulation of AChRs on all muscles beneath the burn is also accompanied by the expression of the immature isoform of the receptor. In fact, burn injury of a single limb (8-9% body surface area) is sufficient to cause potentially lethal hyperkalemia.⁴ The concomitant presence of immobilization with and without prolonged administration of muscle relaxants can accentuate the upregulation of AChRs.⁶ Immobilization alone can induce modest upregulation as early as 3-4 days.⁷

Thus, the lack of clinical reports of hyperkalemia before 7 days after burn injury is probably a result of the following: (1) the previous treatment philosophy of not treating major burns aggressively with early excision and grafting did not provide the opportunity for challenge of major burns with succinylcholine within the first week; and (2) increased awareness of the dangers of hyperkalemia with succinylcholine has resulted in its lack of use in burn patients as early as 1 week during early excision and grafting of major burns.

Thus, it is my view that succinylcholine is probably safe up to 48 h after burn injury, but it may be wise to avoid it beyond that period. Patients may be particularly vulnerable if they have been immobilized in bed because of severity of illness or concomitant disease (*e.g.*, inhalation injury and fractures) or if they have received prolonged muscle relaxant therapy to facilitate mechanical ventilation.⁶

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2. Schaner PJ, Brown RL, Kirksey TD, Gunther RC, Ritchey CR, Gronert GA, Dotin CW, Mason AD: Succinylcholine-induced hyperkalemia in burned patients: I. *Anesth Analg* 1969; 48:764-70

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* Martyn JAJ, Nosek M: Increased expression of transcripts of γ -subunit of acetylcholine receptor (AChR) in area immediately beneath burn injury. *ANESTHESIOLOGY* 1996; 85:A700