Commentary

Is succinylcholine appropriate or obsolete in the intensive care unit?

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Abstract

Muscle relaxants in intensive care unit (ICU) patients are predominantly administered to facilitate intubation. The adverse effect profile of succinylcholine is such that its use in the ICU must be considered obsolete. Suitable alternatives are the intermediately long-acting nondepolarizing relaxants, of which rocuronium is probably preferable.

Keywords cholinesterase, depolarizing muscle relaxants, intubation, neuromuscular nondepolarizing agents, succinylcholine

The use of muscle relaxants in intensive care patients is rapidly declining. The most important reason for this is the apparent development of a nondepolarizing, relaxant-induced neuropathy, which leads to difficulty in weaning patients from artificial ventilation, among other problems [1]. Some frequently used drugs, such as corticosteriods and aminoglycoside antibiotics, contribute to this neuropathy [2]. Therefore, nowadays relaxants are only administered in the ICU for specific indications, such as when decreased muscle tone is required, for treating patients who fight the ventilator and in order to allow permissive hypercapnia.

Relaxants are still needed frequently in surgical anaesthesia to facilitate quick procedures such as endotracheal intubation. The depolarizing muscle relaxant succinylcholine is often used for this purpose. Its ultra-short duration of action renders rapid return of spontaneous breathing possible if intubation fails. The situation in the ICU is different, however. During anaesthesia, intubation and artificial ventilation are only indicated to facilitate surgery by ensuring an open airway. In the ICU these are absolute indications, and rapid return of spontaneous ventilation is not necessary, given that intubation is mainly indicated to start artificial ventilation.

The potassium problem

Succinylcholine is known to have many unwanted effects. Its mechanism of action (depolarization of muscle cell membrane) results in the release of intracellular potassium by upregulating acetylcholine receptors, especially outside the motor endplate, and changing their characteristics [3–5]. Potassium release is already massively increased in a number of circumstances and diseases that are frequently present in ICU patients, including long-term immobilization, extensive muscle trauma, many neuromuscular diseases, denervation of muscles, burns, sepsis, encephalitis and acute renal failure. Potassium release can be further augmented by acid–base balance disturbances and by corticosteroids [6,7]. The induced hyperkalaemia causes arrhythmias and sometimes cardiac arrest. When such an arrest occurs it is difficult to resuscitate the patient. In patients with myopathy or those receiving long-term treatment with corticosteroids, succinylcholine can contribute to rhabdomyolysis. It is likely that cardiac arrest in such cases has an even higher mortality rate than cardiac arrest in succinylcholine-induced hyperkalaemia alone [8].

Unpredictable activity

In intensive care patients there is large variability in the activity of plasma cholinesterase, an enzyme that metabolizes

ICU = intensive care unit.

Table 1

Suitability of relaxants for use in the ICU

Parameter	Vecuronium	Rocuronium	Atracurium	Cisatracurium	Mivacurium
Onset of action	±	++	±	±	±
Duration	±	±	±	±	+
Histamine	+++	+++	–	±	–
Cardiovascular	++	+	±	+	+
Noncumulative	–	–	+	+	+

The number of '+'s or '–'s indicates the degree to which the drug is favourable or unfavourable with respect to the parameter under question.

succinylcholine. For example, many drugs decrease plasma cholinesterase activity, including ecothiopate, bambuterol, corticosteroids, cytotoxics, anticonceptives and oestrogens. Heart–lung machines that are used during cardiac surgery induce a decrease in plasma cholinesterase activity, which lasts for approximately 10 days [9]. Repeated plasma exchange decreases plasma cholinesterase activity [10]. In pregnancy (i.e. in patients with HELLP syndrome [haemolysis, elevated liver enzymes, low platelets], eclampsia, etc.), plasma cholinesterase activity is markedly decreased, resulting in a prolonged succinylcholine effect [11]. The same holds for patients with sepsis, malignancy, burn trauma and liver disease [12]. In such patients there is a wide variability in the neuromuscular blocking effect, onset and duration of paralysis caused by succinylcholine [13,14].

Other side effects

Muscle hypertonia, myalgia, hypersalivation, elevated intraocular and intracranial pressures, and induction of malignant hyperthermia are also side effects of succinylcholine [15]. Occasionally, harmful cardiovascular effects also occur following succinylcholine administration, caused by stimulation of nicotinic receptors in the autonomic ganglia (sympathetic and parasympathetic) and of cardiac muscarinic receptors [16]. Furthermore, succinylcholine increases plasma noradrenaline (norepinephrine) concentrations, resulting in cardiovascular effects. Finally, the histamine-releasing properties of muscle relaxants are well known, and succinylcholine has the strongest histamine-releasing effect of all such agents.

Alternatives to succinylcholine

Given the profile described above, it is unlikely that many authorities would approve succinylcholine for registration if it were presented today as a new drug. Nondepolarizing muscle relaxants do not have the deleterious effects connected with depolarization. In order to be useful for facilitating endotracheal intubation in the ICU, they must have an acceptable speed of onset, have a relatively short to intermediate duration of action, be noncumulative, and preferably should not have cardiovascular side effects or induce histamine release.

Candidates to replace succinylcholine for intubation include vecuronium, rocuronium, atracurium, cisatracurium and mivacurium. The features of each drug are summarized in Table 1. The onset of action of atracurium, cisatracurium and vecuronium is rather long, and atracurium and cisatracurium can release histamine. Rocuronium has an onset of action similar to that of succinylcholine, and provides similar intubation conditions 1 min after administration [17]. However, its duration of action is longer. The duration of action of mivacurium is shorter, but it has a slower onset, the intubation conditions are comparable only after 4–5 min, and it has stronger histamine-releasing properties than does rocuronium. Because mivacurium is metabolized by plasma cholinesterase, the interindividual variability in effect is as wide as with succinylcholine [18]. Many studies have shown that rocuronium is a highly acceptable replacement for succinylcholine in the ICU; therefore, in my opinion, succinylcholine is obsolete.

Competing interests

None declared.

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