

The use of muscle relaxants in patients with neuromuscular diseases

BY LOUIS-PHILIPPE FORTIER, MD

Therapeutic choices concerning muscle relaxants used in patients with neuromuscular diseases (NMD) should not be regarded as just a "curiosity" during an oral exam, but rather a part of a clinician's efficient and synthesized knowledge. With the exception of rapacuronium, the development of drugs for these disorders by pharmaceutical companies has been almost nonexistent for the last 10 years or more. As a result, there are not many new therapeutic choices for the vast majority of neuromuscular disorders encountered in general clinical practice. Moreover, individual centres rarely encounter a sufficient number of patients to allow the performance of prospective controlled studies on specific diseases. Hence, clinicians are unable to become familiar with any of the disorders and must rely on theoretical knowledge for their therapeutic choices. Another caveat in the study of these diseases is that a significant amount of the information available has been published in the form of case reports and in languages other than English. In the case of certain publications, valuable information must be extracted from abstracts. This issue of *Anesthesiology Rounds* presents the current level of knowledge for the 3 types of neuromuscular diseases, focusing on histological and functional abnormalities, common links between disorders, possible pathological responses, complications, treatment and, whenever possible, prevention.

Neuromuscular disorders can be classified based on their histological substratum, ie, whether they affect the neuronal or presynaptic, synaptic and muscular, or postsynaptic tissues. Most of these disorders are "orphan" diseases, affecting only a small number of patients. Nevertheless, they present the anesthesiologist with a significant challenge when muscle relaxation is necessary to conduct a medical or surgical procedure. Because respiratory failure and arrhythmias are the first and second causes of mortality and morbidity among these patients, they require vigilance on the part of the anesthesiologist. These diseases are also characterized by abnormal physiological responses to drugs commonly used in the perioperative period. Each disorder presents numerous complex abnormalities, but muscle relaxation produces only a few predictable, albeit significant, side effects.¹ Adverse reactions will result, either from a disproportionate effector response to drugs, eg, depolarizing agents and anticholinesterase drugs, or from a deeper and/or longer block than anticipated with a nondepolarizing agent. Denervated muscles will exhibit upregulation and the number of functional receptors activated by the depolarizing agent will create intracellular activation, resulting in pathological contractions or cell death. Nondepolarizing muscle relaxants (NMDR) will generate unpredictably longer relaxation, which is exacerbated by the fact that anticholinesterase agents should be avoided in these patients.

PRESYNAPTIC DISORDERS

One way to organize neuromuscular disorders is by the level of tissue disruption. All cerebral (cortical and subcortical) and cerebellar targets are grouped into the highest level of tissue disruption. The second level comprises the motoneuron diseases (upper and lower motoneurons) while the last or lower level encompasses peripheral nerve pathologies and polyneuropathies (Table 1).

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TABLE 1: Therapeutic advice for muscle relaxation in patients with presynaptic disorders

Cortical, subcortical and cerebellar lesions	Avoid succinylcholine ↑ sensitivity with NDMR
Neurodegenerative disorders	Avoid succinylcholine ↑ sensitivity with NDMR
Motoneuron disorders	Avoid succinylcholine ↑ sensitivity with NDMR
Peripheral neuropathies	Avoid succinylcholine ↑ sensitivity with NDMR

Cerebral or cerebellar diseases

Cerebral palsy is a general term describing a group of chronic, nonprogressive disorders that impair fine motor skills, walking, and balance. The clinical picture stems from abnormal neurological development and damage in the cortical or subcortical motor areas. Other cerebral disorders include strokes (ischemic or hemorrhagic), traumatic brain injuries, brain tumours, and neurodegenerative states. In the case of cerebral palsy, diffuse intracranial lesions, and brain tumours, abnormal responses to muscle relaxants occur when hemiplegia² and muscle wasting are present. Two well-studied neurodegenerative states are of specific interest. Multiple sclerosis³ is associated with both resistance and prolonged response following NDMR administration. It is also linked to important potassium release following succinylcholine injection. These contradictory observations likely demonstrate the different levels of lesions seen in this disorder. Parkinson's disease – the other disease for which curarization was once a treatment option – does not appear to cause problems regarding muscle relaxation⁴ except in a few isolated cases.

Motoneuron diseases

Motoneuron diseases are classified as upper and lower motoneuron lesions. Classically, patients with upper motoneuron involvement (primary lateral sclerosis) demonstrate loss of fine motor skills, hyper-tonia, and hyperreflexia created by disruption of pathways between brain and medulla or spinal cord. A small prospective controlled study demonstrated decreased sensitivity to NDMR.⁵ Lower motoneuron lesions (progressive spinal muscular atrophy, segmental spinal muscular atrophy, and progressive bulbar palsy), on the other hand, produce fasciculations, weakness, and muscle atrophy arising from lesions between the spinal cord and muscle or effector. Amyotrophic lateral sclerosis, a rapidly progressive disorder, constitutes a crossover disease with both upper and lower motoneuron involvement. Only anecdotal knowledge exists, but close neuromuscular junction monitoring when using NDMR and avoidance of succinylcholine because of possible muscle wasting are mandatory.

Peripheral nerve pathologies and polyneuropathies

Peripheral neuropathies complete the group of presynaptic disorders. Particular characteristics creating potential problems during anesthesia relate to muscle function. The loss of motor fiber leads either to significant weakness or wasting. Etiologies for this deficit are numerous (genetic, traumatic, metabolic, autoimmune, ischemic, toxic, or infectious) and critical elements include the speed of progression and extent of tissue damage. Principal disorders are Guillain-Barré syndrome (acute idiopathic polyneuritis), chronic inflammatory demyelinating polyneuropathy (CIDP), Charcot-Marie-Tooth disease (peroneal muscular atrophy), and Friedreich's ataxia. Guillain-Barré sometimes involves lower motoneurons, resulting in flaccid paralysis which, in turn, promotes the risk of hyperkalemia and morbid arrhythmias when using a depolarizing agent. Nondepolarizing agents can produce deeper or longer relaxation than expected.⁶ On the basis of very limited observations, it has been suggested that NDMR produce prolonged effects in CIDP. Charcot-Marie-Tooth and Friedreich's ataxia diseases do not seem to harbour the same dangers.

Histological/functional change

All the presynaptic disorders produce a disruption in brain to spinal cord pathways or a disruption from spinal cord to effector (muscle). Denervation can create hypersensitivity of the effector and chronic loss of stimulation can produce atrophy and wasting.

Common link

Some presynaptic disorders present with positive signs (eg, spasticity and released flexor reflexes) or negative signs (eg, weakness and loss of selective control). At some point, they all, more or less, have the potential to produce atrophy and muscle wasting.

Possible pathological responses

When increased sensitivity to succinylcholine is observed, which can span a period from 24 hours to 6 months, hyperkalemia may be induced in the range of 7 to 9 mEq/L. In some cases, resistance to NDMR (eg, metocurine, atracurium, mivacurium, rocuronium, vecuronium, and pancuronium) is noted in the affected limbs, a situation that can make neuromuscular monitoring confusing. Most of the time, clinicians will note a heightened sensitivity to NDMR. Slower recovery is also a landmark in these situations.

Complications

Hyperkalemia following succinylcholine has produced severe cardiac arrhythmias, such as ventricular tachycardia culminating in cardiovascular collapse. Contractures and ensuing rhabdomyolysis can follow the administration of either succinylcholine or an

anticholinesterase. NDMR will produce deeper blocks and longer muscle relaxation, which can result in acute respiratory insufficiency, dysphagia, and inadequate airway protection. Case reports suggest that patients with neuromuscular diseases comprise a group of patients at higher risk of presenting malignant hyperthermia when exposed to succinylcholine. Therefore, the drug should be avoided until the results of an *in vitro* contracture test (IVCT) are known to be normal.⁷

Treatment/prevention

Hyperkalemia should be treated according to advanced trauma life support (ATLS) protocols; airway protection and ventilatory support may necessitate intubation. Avoidance of a muscle relaxant, when possible, clearly represents the safest alternative. Monitoring should be conducted in a nonaffected limb. It seems reasonable to avoid succinylcholine in the presence of muscle wasting (Table 1).

SYNAPTIC DISORDERS

Myasthenia gravis (MG) is the most common disorder of neuromuscular transmission. It is a chronic autoimmune disease with an early active stage and symptom progression, followed by relative stability after 15 to 20 years. With an incidence of 1/10,000-20,000, it affects women between the ages of 20 to 30 years and men at age 60, in a 2 to 1 ratio. The disease presents as weakness and rapid fatigue of voluntary skeletal muscles following repetition of actions, with only partial recovery after resting. Muscles innervated by cranial nerves lead to the classic symptoms of ptosis and diplopia. Involvement of bulbar innervated muscles places the patient at risk of inadequate airway protection. The clinical picture stems from inactivated or obliterated acetylcholine receptors, a byproduct of circulating autoantibodies. MG was heralded in the late 1970s and early 1980s as an opportunity to better understand neuromuscular transmission. It is the first neuromuscular disease residents hear about during training; however, the disorder remains a challenge for the anesthesiologist during the perioperative period (Table 2).

Eaton-Lambert myasthenic syndrome (ELMS) is a curiosity. ELMS numbers are approximate, but gravitate around 4/million, therefore, there are an estimated 400 patients in the USA. It is also an autoimmune disease and is associated with pulmonary small-cell carcinoma 60% of the time. In fact, about 3% of patients with small-cell carcinoma also suffer from ELMS. There is no gender difference; ELMS creates gradual onset of weakness in individuals between the ages of 50 and 70 years. Proximal shoulder or pelvic girdle muscles, lower extremities, and the trunk are involved, as well as oropharyngeal muscles in 25% of patients. Exercise improves performance. The deficit comes from inactivation of a voltage-gated calcium-channel

TABLE 2: Therapeutic advice for muscle relaxation in patients with synaptic disorders

Myasthenia gravis	Delayed onset of action of succinylcholine (↑dose) ↑ sensitivity with NDMR
ELMS	↑ sensitivity with succinylcholine ↑ sensitivity with NDMR

(VGCC) at the active zone of the presynaptic nerve terminal. Freeze-fracture electron microscopy demonstrates ELMS as an ion channel placed in a double row on the presynaptic side. Our research team, and others, have developed monoclonal antibodies directed against these structures to better understand their implication in synaptic processes and neuromuscular diseases. Clinically, ELMS has an elevated sensitivity to both depolarizing and nondepolarizing agents; as a result, anticholinesterase drugs may not be effective.

Histological/functional change

ELMS is characterized by the disappearance or inactivation of an essential functional element in synaptic transmission.

Common link

All these disorders have a heightened sensitivity to NDMR.⁸ The clinician may also note a fade, despite the administration of adequate reversal agent doses.⁹ Preexisting weakness can be exacerbated in the postoperative period by a residual blockade from NDMR. With closer observation in ELMS, a prolonged recovery index would likely be observed, ie, the time required to recuperate from 25% to 75% of the original T1 twitch strength. In both MG and ELMS, signs of a presynaptic effect (fade) are found only with steroid agents and there is no link between dosage requirements and the need for postoperative ventilatory support,¹⁰ illustrating the complexities of perioperative management. Pyridostigmine treatment prolongs onset time of neuromuscular blockade and diminishes the peak effects.¹¹

Possible pathological response

Both diseases will present with heightened sensitivity to NDMR agents. The response to succinylcholine is slower in MG for unknown reasons, while succinylcholine produces stronger effects in ELMS.¹²

Adverse effects

These are related to the higher sensitivity to muscle relaxants leading to possible acute respiratory insufficiency and pulmonary aspiration in the postoperative period (possibility of oropharyngeal muscle involvement in 25%). Pulmonary aspiration of gastric contents may occur during induction with succinylcholine in MG, if intubating conditions do not allow for successful rapid-sequence intubation.

Treatment/prevention

Titration of doses with neuromuscular monitoring is suggested. Higher doses of succinylcholine in MG may be indicated for rapid-sequence intubation. The treatment plan should avoid aminoglycoside antibiotics. Pyridostigmine should be suspended 2-4 hours preoperatively and neostigmine started postoperatively for 24 hours. A possibly superior reversal solution for MG would contain a mixture of neostigmine and 3,4-diaminopyridine (Olmitfon™), 15-60 mg; the latter is a potassium channel blocker that prolongs the action potential and acetylcholine release.

POSTSYNAPTIC DISORDERS

The last group of disorders includes muscular dystrophies, inflammatory myopathies, and ion channel diseases. Even if each of these 3 families of effector pathologies account for numerous distinct diseases, only a few have been the subject of case reports on curarization and even fewer are the subject of prospective controlled studies (Table 3).

Muscular dystrophies

There are 9 types of muscular dystrophy, a group of genetic, degenerative diseases primarily affecting voluntary muscles. Of this group, only myotonic dystrophy (Steinert's disease) shows sustained contractures following stimulation. Risk of sudden cardiac arrest associated with succinylcholine and inhalational agents is invariably caused by the absence of a prior diagnosis¹² of neuromuscular disease. The most common form of muscular dystrophy is Duchenne's or pseudohypertrophic muscular dystrophy (DMD), with an incidence of 1/6000. Incidences for less-frequent disorders (eg, oculopharyngeal dystrophy) are not available. This explains, in part, the lack of experimental data on each disorder and the poor theoretical guidance for clinical planning.

DMD has been the subject of recent clinical investigations^{13,14} on perioperative muscle relaxation. The prospective method employed and the number of patients included make these studies more insightful than simple case reports. All reports observe longer durations of muscle relaxation following NDMR administration and onset time varies with the agent. There were no pharmacokinetic measures for vecuronium. Mivacurium onset in DMD patients is similar to controls, while rocuronium has a slower onset. There is no evidence that pharmacokinetics account for these observations, since no report exists of pathological kinetic variations for these diseases. On the other hand, morphological changes are well documented at the neuromuscular junction. What

TABLE 3: Therapeutic advice for muscle relaxation in patients with postsynaptic disorders

Muscular dystrophies	Avoid succinylcholine ↑ sensitivity with NDMR
Myotonia dystrophica (Steinert's disease)	Fasciculations/contractions with succinylcholine ↑ sensitivity with NDMR
Channelopathies	Fasciculations/contractions with succinylcholine NDMR, confounding factor with muscle weakness
Inflammatory myopathies	Fasciculations/contractions with succinylcholine NDMR, confounding factor with muscle weakness

remains to be determined is the relative importance of structural changes on NDMR effects. Muscular dystrophy will disrupt acetylcholine-receptor (achR) anchorage. Progression of the disease produces fibrosis and achR partially reverts to an immature form. Hence, the total number of normal receptors will decrease or undergo conformational changes, abnormal connective tissue will proliferate at the neuromuscular junction (NMJ) producing perisynaptic clutter, or mechanical characteristics of muscle fibers will deteriorate. Experimental models like the DMD mouse hemidiaphragm can help to compare different molecules in a well-controlled environment. Laboratory work is aimed at determining the mechanisms responsible for altered pharmacology in DMD. Explanations relating to the size of the molecule, charge interactions between the NDMR and perisynaptic fibroid tissues, or conformational change at the receptor site in denervated muscle fibers, are all plausible.

Becker's dystrophy is less severe than DMD, but still carries the same perioperative risks. It is difficult to find even a case report on Emery-Dreifuss disease in the current scientific literature; it is presumed that the disease presents with the general risks of that family of disorders;¹⁵ recovery, on the other hand, is variable. Congenital myotonic dystrophy has been the subject of a case report where the impact of NDMR on anesthesia was not evaluated. No articles on limb-girdle and distal muscular dystrophies were found during a computerized research on pathological responses to muscle relaxants. Knowledge concerning oculopharyngeal dystrophy has benefitted from a prospective controlled study¹⁶ in which 20 affected patients were enrolled. All measures were similar in both groups except for onset and, surprisingly, affected patients demonstrated a resistance to cisatracurium.

Myotonic dystrophy (Steinert's disease) should be described separately, since it is the only disorder in this family of diseases that is characterized by contractures following stimulation. Even if this is a rare disease (2.4-5.5/100,000), the severity of possible multisystemic sequelae require a thorough understanding of possible risks related to muscle relaxant use. If the patient is not already intubated, contractures can make airway management difficult¹⁷ when they develop and it can also make ventilation troublesome. There is at least one prospective study,¹⁸ involving 13 patients, which demonstrates the safety of atracurium, even when using an infusion. Multiple case reports confirm the safety of NDMR in myotonic dystrophy. At least one report exists of prolonged recovery and heightened sensitivity that did not necessitate reversal agents. Reversal agents should be avoided to minimize the risk of contractures.¹⁹

Inflammatory myopathies

Inflammatory myopathies (polymyositis and dermatomyositis) represent a group of muscular diseases characterized by inflammation of muscle fibers or surrounding tissue through an autoimmune response. The trigger in the predisposed patient could be viral or chemical. Attention to possible respiratory muscle weakness and abnormal swallowing suggest titrated use of NDMR. It is still unclear if heightened sensitivity truly exists or if the observations are due to concomitant muscle dysfunctions. Prudence recommends limiting dosages and careful monitoring. Succinylcholine does not produce deeper or prolonged effects, but the fasciculations/contractures²⁰ observed could herald profound metabolic disturbances. Therefore, the use of succinylcholine is not recommended.

Ion-channel disorders

Ion-channel disorders form the last group of neuromuscular diseases producing physiological changes that require special attention when using muscle relaxants. Myotonia congenita and paramyotonia, the rarest forms of myotonic syndrome, result from gene mutations. The gene mutation in myotonia congenita involves a chloride channel and there is no evidence that NDMR evoke pathological responses. The ion-channel defect associated with paramyotonia concerns a sodium channel. Patients with both these disorders will exhibit sustained contractures upon stimulation; characteristically, paramyotonia's contractures only develop with exposure to cold. Familial periodic paralysis leads to bouts of muscle weakness. Two forms of the disorder exist; hyperkalemic where high potassium levels interact with an abnormal sodium channel and hypokalemic

where low levels of potassium affect abnormal calcium channels. Acute respiratory distress during the postoperative period likely stems from the disease itself more than from an abnormal response to NDMR. Succinylcholine will induce masseter spasms and muscle rigidity; it may impede normal ventilation and should be avoided.

Histological/functional changes

This is by far the most heterogeneous group of neuromuscular disorders. Nevertheless, they can be characterized as either structurally degenerative or presenting with abnormal ionic conductance. Muscular dystrophies and inflammatory myopathies belong to the first group where abnormal or absent dystrophin-associated complexes play a pivotal role. Inflammatory disorders are characterized by lymphocytic infiltration; familial occurrence supports a genetic predisposition where angiopathic changes precede muscle destruction. Easily depolarizable sarcolemmal membranes for myotonias and abnormal sodium or calcium channels for channelopathies form the conductance perturbations responsible for abnormal contraction patterns.

Common link

All postsynaptic disorders will display some level of loss of contractile force, often culminating in muscle destruction. Myotonias will also cause slowed muscle relaxation following voluntary contractions.

Possible pathological response

Since almost all these disorders show excitation-contraction dysfunction, it is possible to observe contractures or spasms leading to massive potassium release with or without rhabdomyolysis. Malignant hyperthermia, even if it has not been observed for all postsynaptic disorders remains a major concern.²¹

Complications

Bulbar involvement may increase the risk for aspiration of gastric contents. Diaphragmatic lesions can produce acute respiratory failure during the immediate postoperative period. Masseter spasm can result in a difficult intubation; general contractures can make positive pressure ventilation problematic.

Treatment/prevention

Succinylcholine and reversal agents should not be used. In order to avoid problems, dosage restriction of the NDMR (as low as 1/10 of the normal doses) and careful neuromuscular monitoring are imperative. Vigilance after general anesthesia will minimize the risk of aspiration

since fasting does not always ensure the desired level of safety and gastrointestinal transit can be affected. Hyperkalemia and myoglobinuria, as well as malignant hyperthermia, should be dealt with in the usual manner and contractures treated with phenytoin or quinine.

CONCLUSION

None of these "orphan" disorders are common enough to affect the anesthesiologist's daily practice. On the other hand, they form a constellation of diseases that present with similar perioperative risks and therefore, they require a systematic understanding of the safest way to approach them.^{22,23} Denervation pathologies have the potential to trigger a proliferation of extrajunctional achR. This will increase the risk of contractures, spasms, hyperkalemia, rhabdomyolysis, and myoglobinuria. Since neuromuscular function is already abnormal, NDMR may produce more intense or prolonged responses.

Synaptic disorders, because of disrupted transmission, put the affected patient at risk of pulmonary aspiration of gastric contents, acute respiratory insufficiency, and generalized weakness. Effector disorders carry the risk of core disease, abnormal conductance, and metabolic disruption of intracellular calcium. It makes patients affected by these disorders sensitive to a loss of regulatory mechanisms and malignant hyperthermia.

References

1. Klingler W, Lehmann-Horn F, Jurkat-Rott K. Complications of anaesthesia in neuromuscular disorders. *Neuromuscul Disord* 2005;15(3):195-206.
2. Muller R, Knuttgen D, Vorweg M, Doehn M. Neuromuscular monitoring in a patient with hemiparesis. Resistance of the paralysed musculature to non-depolarizing muscle relaxants. *Anaesthesist* 2002;51(8):644-9.
3. Brett RS, Schmidt JH, Gage JS, Scharrel SA, Poppers PJ. Measurement of acetylcholine receptor concentration in skeletal muscle from a patient with multiple sclerosis and resistance to atracurium. *Anesthesiology* 1987;66(6):837-9.
4. Muzzi DA, Black S, Cucchiara RF. The lack of effect of succinylcholine on serum potassium in patients with Parkinson's disease. *Anesthesiology* 1989;71(2):322.
5. Shayevitz JR, Matteo RS. Decreased sensitivity to metocurine in patients with upper motoneuron disease. *Anesth Analg* 1985;64(8):767-72.
6. Fiacchino F, Gemma M, Bricchi M, Giudici D, Ciano C. Hypo- and hypersensitivity to vecuronium in a patient with Guillain-Barre syndrome. *Anesth Analg* 1994;78(1):187-9.
7. Ording H, Brancadoro V, Cozzolino S, et al. In vitro contracture test for diagnosis of malignant hyperthermia following the protocol of the European MH Group: results of testing patients surviving fulminant MH and unrelated low-risk subjects. The European Malignant Hyperthermia Group. *Acta Anaesthesiol Scand* 1997;41(8):955-66.
8. Nilsson E, Meretoja OA. Vecuronium dose-response and maintenance requirements in patients with myasthenia gravis. *Anesthesiology* 1990;73(1):28-32.
9. Baraka A, Taha S, Yazbeck V, Rizkallah P. Vecuronium block in the myasthenic patient. Influence of anticholinesterase therapy. *Anaesthesia* 1993;48(7):588-90.
10. Kadoi Y, Hinohara H, Kunimoto F, Nijima A, Saito S, Goto F. Is the degree of sensitivity to nondepolarizing muscle relaxants related to requirements for postoperative ventilation in patients with myasthenia gravis? *Anaesth Intensive Care* 2004;32(3):346-50.
11. Tripathi M, Kaushik S, Dubey P. The effect of use of pyridostigmine and requirement of vecuronium in patients with myasthenia gravis. *J Postgrad Med* 2003;49(4):311-4; discussion 314-5.
12. Breucking E, Reimnitz P, Schara U, Mortier W. Anesthetic complications. The incidence of severe anesthetic complications in patients and families with progressive muscular dystrophy of the Duchenne and Becker types. *Anaesthesist* 2000;49(3):187-95.
13. Wick S, Muenster T, Schmidt J, Forst J, Schmitt HJ. Onset and duration of rocuronium-induced neuromuscular blockade in patients with Duchenne muscular dystrophy. *Anesthesiology* 2005;102(5):915-9.
14. Schmidt J, Muenster T, Wick S, Forst J, Schmitt HJ. Onset and duration of mivacurium-induced neuromuscular block in patients with Duchenne muscular dystrophy. *Br J Anaesth* 2005;95(6):769-72.
15. Nitahara K, Sakuragi T, Matsuyama M, Dan K. Response to vecuronium in a patient with facioscapulohumeral muscular dystrophy. *Br J Anaesth* 1999;83(3):499-500.
16. Caron MJ, Girard F, Girard DC, et al. Cisatracurium pharmacodynamics in patients with oculopharyngeal muscular dystrophy. *Anesth Analg* 2005;100(2):393-7.
17. Mitchell MM, Ali HH, Savarese JJ. Myotonia and neuromuscular blocking agents. *Anesthesiology* 1978;49(1):44-8.
18. Bennun M, Goldstein B, Finkelstein Y, Jedeikin R. Continuous propofol anaesthesia for patients with myotonic dystrophy. *Br J Anaesth* 2000;85(3):407-9.
19. Mathieu J, Allard P, Gobeil G, Girard M, De Braekeleer M, Begin P. Anesthetic and surgical complications in 219 cases of myotonic dystrophy. *Neurology* 1997;49(6):1646-50.
20. Eielson O, Stovner J. Dermatomyositis, suxamethonium action and atypical plasmacholinesterase. *Can Anaesth Soc J* 1978;25(1):63-4.
21. Azar I. The response to patients with neuromuscular disorders to muscle relaxants: A review. *Anesthesiology* 1984;61:173-187.
22. Lehmann-Horn F, Knorr-Held S. Muscle diseases relevant to the anesthetist. *Acta Anaesth Belg* 1990;41:113-118.
23. Kurihara T. New classification and treatment for myotonic disorders. *Intern Med* 2005;44:1027-32.

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Disclosure Statement: Dr. Fortier has stated that he has no disclosures to announce in association with the contents of this issue.

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This publication is made possible by an educational grant from
Organon Canada Limited