

Residual Neuromuscular Blockade: Is It A Problem In The Geriatric Patient?

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Residual neuromuscular blockade is a common complication observed in the postanesthesia care unit (PACU). Recent large-scale clinical investigations have demonstrated that up to 24% to 42% of surgical patients arrive in the PACU with evidence of incomplete neuromuscular recovery (1,2). Pharmacokinetic studies suggest that elderly patients may be at greater risk of residual neuromuscular blockade in the postoperative period. This review will examine 3 questions related to residual blockade in the geriatric patient: 1) Is spontaneous neuromuscular recovery prolonged in the elderly? 2) Is the incidence of residual blockade increased in geriatric patients? and 3) Are the elderly more susceptible to respiratory complications directly related to residual block?

The physiologic changes that occur with aging can alter the pharmacokinetics of neuromuscular blocking agents (NMBAs) and prolong recovery from neuromuscular blockade. Glomerular filtration rate and liver blood flow decrease approximately 1% per year after the age of 40. Therefore, the duration of effect of NMBAs that are metabolized and eliminated by the liver and kidneys may be prolonged. Muscle mass and total body water is reduced and fat tissue is increased in the elderly; dosing of NMBAs on a milligram per kilogram basis in the elderly may therefore produce a prolonged effect. Furthermore, the elderly are more susceptible to hypothermia in the perioperative period, which significantly increases the duration of action of most NMBAs. A relatively large number of studies have examined the pharmacokinetics of NMBAs in the elderly. The recovery times of aminosteroid NMBAs are longer in geriatric surgical patients. In most clinical studies, the time until 25% recovery of T_1 after an intubating dose of an aminosteroid NMBA is significantly prolonged in older patients:

	Young	Elderly	P value	Reference
Pancuronium	44 min	73 min	<0.01	(3)
Vecuronium	36 min	50 min	<0.01	(4)
Rocuronium	27.5 min	42.4 min	<0.01	(5)

In contrast, 25% recovery of T_1 times of benzylisoquinolinium agents appears minimally affected by the aging process:

	Young	Elderly	P value	Reference
Atracurium	47 min	46 min	NS	(4)
Cisatracurium	55.6 min	61.1 min	NS	(6)

In addition, the variability of duration of action of spontaneous recovery of vecuronium and rocuronium is significantly greater in the elderly (7). This unpredictability in recovery may predispose some elderly patients to residual muscle weakness in the PACU. Furthermore, the time required for anticholinesterases to fully reverse neuromuscular blockade may be longer in elderly patients compared to younger subjects (8).

All of these factors discussed above suggest that the risk of residual block may be increased in elderly surgical patients. Evidence supporting this hypothesis is limited,

however. No previous studies have specifically examined the effect of age on the incidence of residual neuromuscular blockade as a primary end-point. In addition, many clinical investigations that have studied postoperative residual paresis have excluded patients older than 65 from enrollment. Four recent large-scale studies, each with over 500 patients, have determined the incidence of residual block in postoperative surgical patients. Two of these studies did not analyze age as a risk factor (9,10). A third study specifically excluded elderly subjects (1). The fourth study did observe that the average age of patients with residual blockade was significantly higher than those patients without residual blockade (2). A recent multi-institution investigation examined neuromuscular recovery times in adult (18-64 years) and elderly (≥ 65 years) patients (7). In the subjects randomized to receive vecuronium, the percentage of patients not achieving acceptable neuromuscular recovery (TOF ratio ≥ 0.8), resulting in delays in discharge from the operating room, was significantly higher in the elderly subjects (41.1%) compared to adult patients (23.9%, $P < 0.05$). Further studies are needed to clearly establish whether age is a risk factor for postoperative residual blockade.

Small degrees of residual muscle weakness (TOF ratios 0.7-0.9) induced by NMBAs can produce adverse effects on the respiratory system. TOF values of 0.7-0.9 may be associated with impaired pharyngeal function, upper airway obstruction, reduced hypoxic ventilatory drive, increased risk of aspiration, and postoperative hypoxemia and respiratory complications (11). If the elderly are at greater risk of postoperative residual paresis, they may also be at increased risk of respiratory complications associated with residual neuromuscular block. Data supporting this hypothesis is limited and indirect. In a landmark study by Pedersen et al, 7,306 patients were examined to determine risk factors for postoperative pulmonary complications. Multiple logistic regression analysis revealed that age >70 years and prolonged procedures using pancuronium were primary risk factors for postoperative pulmonary complications (12). In a randomized study by this same group, the relationship between postoperative residual block and postoperative respiratory complications was assessed (13). Multiple regression analysis revealed that increasing age and residual paresis following pancuronium were significant risk factors for pulmonary complications. An observational study by Murphy et al. examined the relationship between critical respiratory events (CREs) in the PACU and residual neuromuscular blockade (14). Data was collected on 7,459 general anesthesia patients over a 1-year period. CREs occurred in 61 patients (0.8%). Residual block (TOF ratio < 0.9) was present in 90.5% of these patients. The average age of patients with CREs and residual paresis (63.7 years) was significantly higher than those patients without CREs (51.2 years). The data from these investigations demonstrates that adverse respiratory events occur more frequently in the elderly and in patients with residual neuromuscular blockade. At the present time, the relationship between these two risk factors (age and residual block) and adverse postoperative respiratory events remains to be determined.

In conclusion, current evidence suggests that the geriatric patient may be at increased risk for residual neuromuscular blockade following general anesthesia. Due to the physiologic changes of the aging process, the duration of action of most NMBAs and recovery from neuromuscular blockade is prolonged in patients older than 65-75 years. Limited data also suggests that the incidence of residual blockade and respiratory complications related to residual paresis is increased in the geriatric patient population. As the number of elderly patients requiring surgery is increasing, additional study is needed

to assess the incidence and relevance of residual neuromuscular blockade in this high-risk patient population.

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