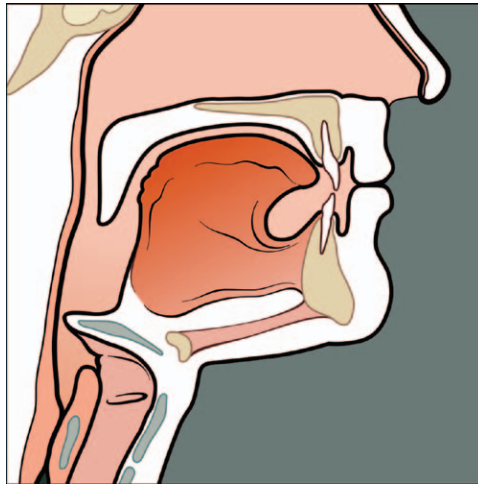


# Residual Neuromuscular Blockade after Anesthesia

## A Possible Cause of Postoperative Aspiration-induced Pneumonia

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**P**ULMONARY aspiration is rare during daily life, thanks to amazingly well-organized protective mechanisms, such as swallowing (and coordinated cessation of breathing during swallowing), coughing, and laryngeal closure.<sup>1</sup> If any part of these mechanisms is impaired, the risk of aspiration increases. In this issue of *ANESTHESIOLOGY*, Hårdemark Cedborg *et al.*<sup>2</sup> have shown that in asymptomatic elderly people, pharyngeal function is often impaired, and that residual effect of a neuromuscular-blocking agent after general anesthesia would worsen the impairment. The research group extended their previous works performed in healthy young volunteers<sup>3-5</sup> and provides physiological evidence for partial paralysis as a possible cause to postoperative aspiration-induced pneumonia in elderly people.



***“... in asymptomatic elderly people, pharyngeal function is often impaired, and [they are thus potentially at higher risk of aspiration].”***

### Key Findings

Hårdemark Cedborg *et al.*<sup>2</sup> infused rocuronium to 17 elderly fit volunteers to produce an adductor pollicis muscle train-of-four (TOF) ratios (fourth to first twitch) of 0.7 to 0.9. Before infusion of rocuronium, one third of the subjects had pharyngeal dysfunction. Dysfunction of the pharynx was observed at the TOF ratio 0.7 and 0.8 (but not at 0.9). Resting upper esophageal sphincter tone was significantly decreased even at a TOF ratio of 0.9. In contrary to hypothesis by Hårdemark Cedborg *et al.*,<sup>2</sup> partial neuromuscular blockade did not significantly affect the coordination between breathing and swallowing.

### Predisposing Factors to Aspiration after General Anesthesia

Elderly people are at risk of aspiration, since, as noted in the current study, pharyngolaryngeal function is often impaired.<sup>6</sup>

Incomplete recovery from neuromuscular blockade is common after general anesthesia and is a major cause of respiratory complications.<sup>7,8</sup> Several researchers (including Hårdemark Cedborg *et al.*<sup>2</sup>) have shown that partial neuromuscular blockade disturbs pharyngolaryngeal function.<sup>7,8</sup> In the study by Hårdemark Cedborg *et al.*,<sup>2</sup> no aspiration beyond the glottis was observed in these partially paralyzed elderly volunteers. In this study, swallowing was initiated voluntarily, and the function of the afferent pathway of the swallowing reflex was not studied. Therefore, there is a possibility that swallowing reflex in face of unexpected or silent regurgitation of gastric contents is impaired, and thus aspiration occurs.<sup>9,10</sup> In addition, during postoperative period, risk of aspiration would be increased by additional inhibitory effects of residual inhalational anesthetics, by depressed conscious level,<sup>11</sup> and by the use of opioids<sup>12</sup> on pharyngeal and laryngeal function.

The risk of postoperative aspiration is particularly higher, when the trachea was being intubated during anesthesia, as tracheal intubation (even for a short period) is known to inhibit laryngeal reflexes.<sup>13</sup>

### Reversal of Neuromuscular Blockade

In the past, a TOF ratio greater than 0.7 has been considered to indicate sufficient recovery from neuromuscular blockade. However, several reports have indicated that this does not guarantee sufficient recovery, and partial paralysis at a TOF ratio of 0.7 or even at 0.8, there is an increased risk of postoperative complications, such as upper airway obstruction and hypoxia. In addition, as in the study by Hårdemark Cedborg *et al.*,<sup>2</sup> a TOF ratio 0.7 or 0.8 is not sufficient for recovery of pharyngolaryngeal function, and the incidence of pulmonary aspiration is

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increased.<sup>14</sup> Hårdemark Cedborg's findings are endorsing the importance of complete reversal of neuromuscular blockade after general anesthesia.

### Residual Muscle Paralysis as the Cause of Postoperative Pneumonia

In the intensive care unit, silent pulmonary aspiration is the main cause of ventilator-associated pneumonia.<sup>15</sup> We propose that postoperative pneumonia may also be caused by silent aspiration. In elderly patients who are partially paralyzed after anesthesia, pharyngeal secretion is likely to be retained and bacterial overgrowth may occur. The retained secretion may then be misdirected to the laryngeal inlet, predisposing to silent aspiration-induced pneumonia. If this hypothesis is true, assurance of complete reversal of neuromuscular blockade may reduce the incidence of postoperative aspiration-induced pneumonia, together with other respiratory complications.

### Conclusions

Since respiratory complications were found to be major causes of anesthesia-related death and brain damage,<sup>16</sup> every effort has been made to reduce respiratory complications during anesthesia.<sup>17,18</sup> Such efforts have left pulmonary aspiration to be the commonest cause of anesthesia-related death and brain damage.<sup>19,20</sup> Despite the fact that the incidence of respiratory complications may be higher after than during anesthesia,<sup>11</sup> relatively less attention has been paid to physiological changes which underlie these postoperative complications. Consequently, the incidence and the underlying mechanisms for dysfunction of pharyngolarynx after general anesthesia are still not well elucidated. Hårdemark Cedborg *et al.*<sup>2</sup> have clearly shown that aging and residual neuromuscular blockade can be risk factors, but we are still at the start point of knowing the entire picture of postoperative aspiration-induced pneumonia and other respiratory complications. It is time for us to elucidate the incidence of, and predisposing factors to, postoperative respiratory complications, and to establish preventative methods, to achieve safe and smooth recovery from anesthesia.

### Competing Interests

The authors are not supported by, nor maintain any financial interest in, any commercial activity that may be associated with the topic of this article.

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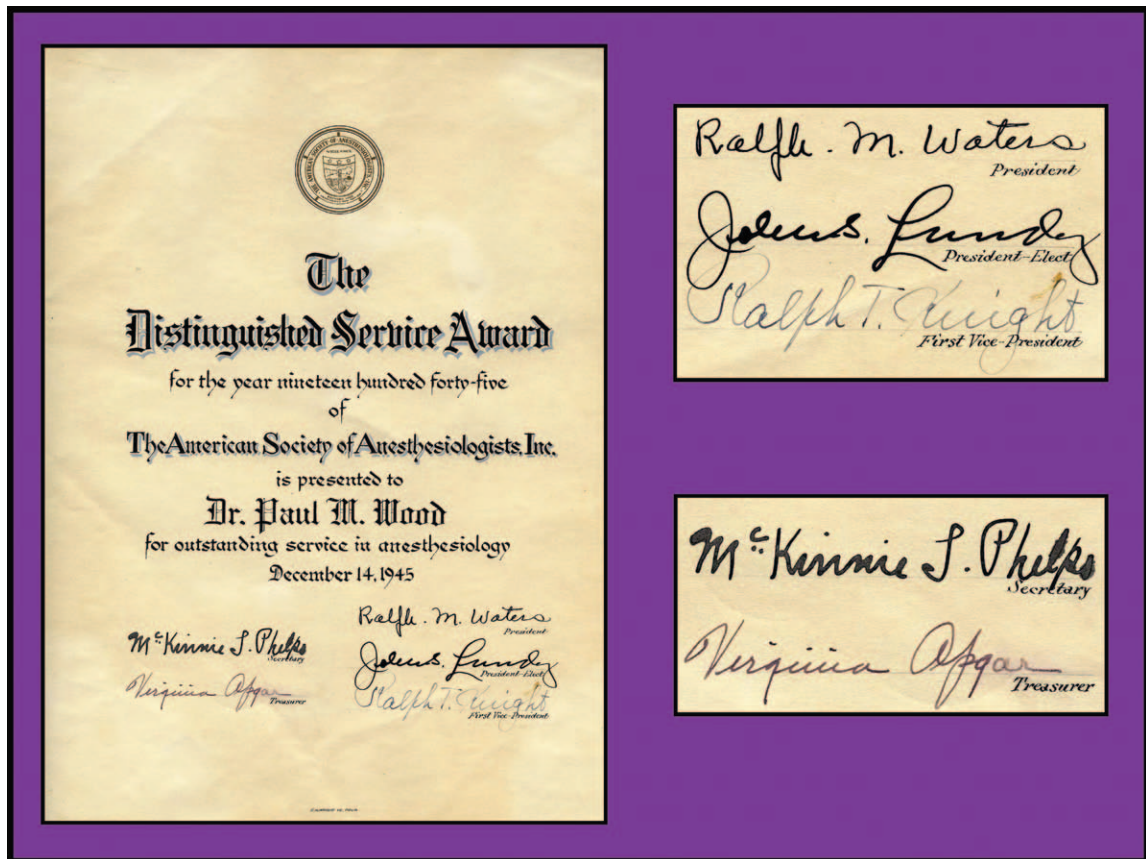
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In New York City during World War II, Dr. Paul Meyer Wood (1894–1963) managed to practice clinical anesthesia from 5 to 11 AM and then spend the balance of his day on the affairs of the American Society of Anesthetists, its journal ANESTHESIOLOGY, its “library-museum,” and the newly formed American Board of Anesthesiology. On December 14, 1945, Dr. Wood was presented with the inaugural Distinguished Service Award (“D.S.A.”, left) of his grateful Society, which he had just helped rename as the “American Society of Anesthesiologists.” Signing Wood’s D.S.A. (close-up, right) were President Ralph M. Waters, President-Elect John S. Lundy, First Vice-President Ralph T. Knight, Secretary McKinnie S. Phelps, and Treasurer Virginia Apgar. (Copyright © the American Society of Anesthesiologists, Inc.)

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