**Supplementary Information**

**Effects of long-acting muscarinic antagonists on promoting ciliary function in airway epithelium**

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**Additional file 1.**

Cilia-driven flow over the murine tracheal surface using small polystyrene beads under the condition treated with PBS intranasally for 7 days

**Additional file 2.**

Cilia-driven flow under the condition treated with GLY intranasally for 7 days

**Additional file 3.**

Ciliary motility under the condition treated with PBS intranasally for 7 days

**Additional file 4.**

Ciliary motility under the condition treated with GLY intranasally for 7 days

**Additional file 5.**

Figure S1-S2

Figure S1. Changes of intracellular calcium ion concentration by Tapsigargin treatment

Figure S2. ATP concentration in the culture supernatant