Mechanisms of Cough

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Which cough?


<table>
<thead>
<tr>
<th>Cough Reflex</th>
<th>Expiratory Reflex</th>
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<tbody>
<tr>
<td>Initiation</td>
<td>Irritation of the larynx, trachea or bronchi (esophagus?)</td>
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<tr>
<td>Brainstem</td>
<td>Processing through “cough center” with potential for cortical “override” to stop a cough</td>
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<tr>
<td>Inhalation: Inspiratory Phase</td>
<td>Strong inspiratory effort using diaphragm, intercostal, abdominal and accessory muscles to total lung capacity (TLC)</td>
</tr>
<tr>
<td>Glottis</td>
<td>Closure at TLC</td>
</tr>
<tr>
<td>Exhalation: Compressive Phase</td>
<td>Forced effort-dependent and effort-independent (elastic recoil) exhalation from TLC against a closed glottis increases intrathoracic pressure</td>
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<tr>
<td>Opening of glottis: Expulsive Phase</td>
<td>High air flow rate (air velocity, force)</td>
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<tr>
<td>Sound</td>
<td>Initial loud, “hard” BANG (10-20 msec) due to glottic closure followed by longer (200 msec), “soft” harmonic “huff” during exhalation with high flow rates and higher intrathoracic pressures</td>
</tr>
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Modulation of Cough Mechanisms

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<th>Cough Reflex</th>
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<tr>
<td>Perception</td>
<td>Sensation of “urge to cough”, therefore activation to thalamic and cortical (insula?) levels</td>
</tr>
<tr>
<td>Neonates</td>
<td>Develops after birth as lung volume increases</td>
</tr>
<tr>
<td>Hering-Breuer reflex</td>
<td>Inconsistent effects</td>
</tr>
<tr>
<td>High PaCO2</td>
<td>Depress cough reflex</td>
</tr>
<tr>
<td>Slow wave</td>
<td>Depress cough reflex</td>
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</table>
Patterns of Coughs

1. The single “textbook” cough
   Irritation ➔
   ➔ Brainstem reflex with cortical analysis
   ➔ Inhalation
   ➔ Glottic closure with loud sound (~10 msec) and strong muscular response to generate an high intrathoracic pressure (“compressive phase”)
   ➔ Opening the glottis leads to maximum change in air flow and pressure and the prolonged (~200 msec) expiratory “huff”

2. Cough epoch, attack, paroxysm
   Repeated inhalation and exhalation phases with glottic closures

3. Initial Expiration Reflex
   Irritation ➔
   ➔ Brainstem
   ➔ Rapid onset of reflex
   ➔ Glottic closure (prevents inhalation) (loud bang)
   ➔ Compressive phase by muscular contraction against a closed glottis
   ➔ Exhalation
   ➔ May be followed by another expiration reflex without inhalation
   ➔ Multiple expiration reflexes invariably must be followed by inhalation and potentially initiation of the cough reflex

Laryngeal Responses to Chemical Stimuli
   Low dose ➔ glottic closure with respiratory muscle activation
   Moderate dose ➔ cough reflex (inhalation)
   High dose ➔ expiratory reflex with glottic closure and exhalation (“laryngeal cough”)

Expiratory reflex is vital to prevent aspiration in stroke, Parkinsonism, and other at risk diseases

GORD / GERD
   A. Oesophageal sensory receptors respond to acid, pepsin, or volume expansion of the lower oesophagus
   B. Upper oesophageal sphincter laxity while upright with acid or gastric content entry into the supraglottic / piriform sinus region
   C. Cough or expiration reflex(es)?

Post-Nasal Drip Syndrome: “Throat Clearing Cough”
   Cough vs. Expiratory reflex activation?
   Stimuli may include mucus (mechanical “bungee cord” effect), inflammatory mediators in mucus, laryngeal irritation, sensitization of the cough (expiratory?) reflex by tracheobronchial inflammation (e.g. asthma, bronchitis)