Mechanisms of Cough

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Which cough?

Widdicombe J, Fontana G. Cough: what's in a name? Eur Respir J. 2006 Jul;28(1):10-5.

	Cough Reflex	Expiratory Reflex
Initiation	Irritation of the larynx, trachea or bronchi (esophagus?)	Mechanical or chemical irritation of the vocal cords (and/or trachea)
Brainstem	Processing through "cough center" with potential for cortical "override" to stop a cough	Rapidly acting involuntary "subcortical" defensive reflex
Inhalation: Inspiratory Phase	Strong inspiratory effort using diaphragm, intercostal, abdominal and accessory muscles to total lung capacity (TLC)	No inspiration
Glottis	Closure at TLC	Immediate closure to prevent entry of laryngeal material into the tracheobronchial tree
Exhalation: Compressive Phase	Forced effort-dependent and effort-independent (elastic recoil) exhalation from TLC against a closed glottis increases intrathoracic pressure	Weaker force generation and intrathoracic pressure against glottis by compression of air already in the lungs (muscular and elastic recoil)
Opening of glottis: Expulsive Phase	High air flow rate (air velocity, force)	Variable, modest airflow rate that depends on the initial degree of lung inflation
Sound	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	Initial BANG (10-20 msec) of glottic closure only. Quieter than cough

Modulation of Cough Mechanisms

	Cough Reflex	Expiratory Reflex
Perception	Sensation of "urge to cough", therefore activation to thalamic and cortical (insula?) levels	No sensation described
Neonates	Develops after birth as lung volume increases	Present at birth; appears first More important in Darwinian terms?
Hering-Breuer reflex	Inconsistent effects	Hering-Breuer inhalation reflex strongly augments the expiratory reflex (paradoxical)
High PaCO2	Depress cough reflex	No effect
Slow wave	Depress cough reflex	Lesser effect

sleep		
Anaesthesia	Inconsistent effects	Decreases expiratory reflex
Consciousness	Voluntarily reproducible to maximum explosive effect	Not consciously reproducible
Opiates	Inhibit cough	No effect

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 Reponses 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)