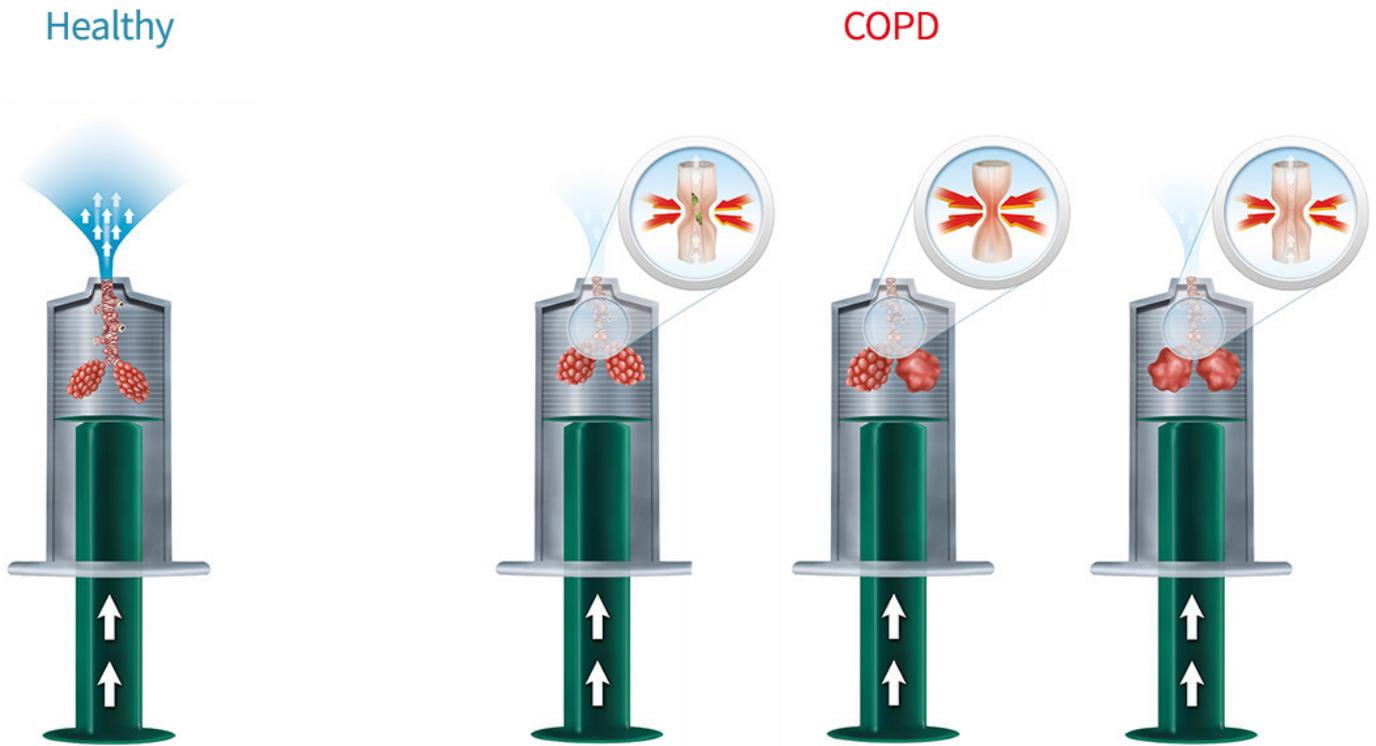


# Exhalation Time Increases



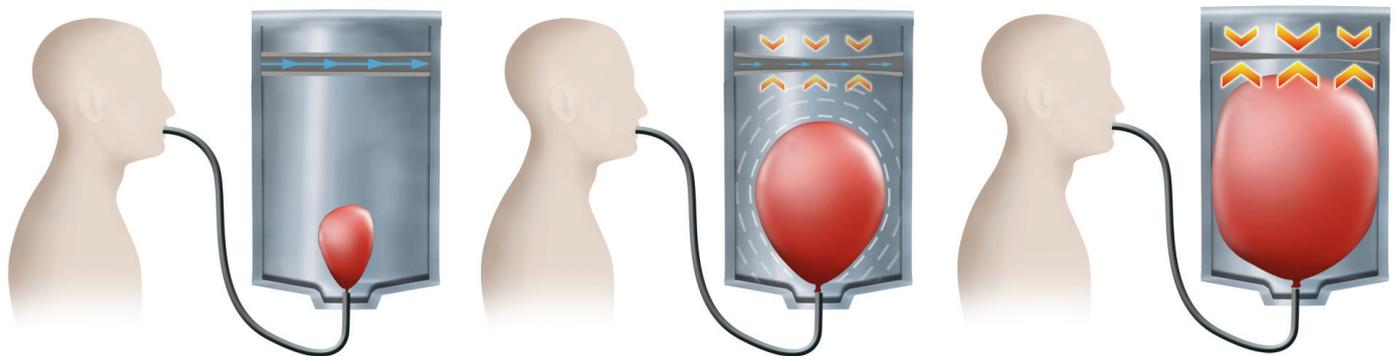
Consequences of COPD: exhalation time increases. Comparison to the “syringe model”

	<b>obstruction = narrowing</b>	<b>emphysema = pressure</b>	<b>collapsing airways</b>
The airways are clear and stable. The air can flow freely.	This is caused by the swelling of the mucosa and the secretion which “clogs” the airways.	Emphysematous bullae increase pressure in the rib cage. This pressure is transmitted and presses from the outside on the surrounding airways. Little air flows through airways which end in emphysematous bullae.	Due to the inflammation, the airways become unstable. The pressure causes them to rupture during exhalation; the air on the other side “is trapped”

In comparison to people with a healthy lung, the time necessary to exhale is prolonged due to narrowed airways. Altogether, the amount of air which can be moved per time is reduced. The following figure illustrates the many different causes (in the 3-4 million smallest airways) which contribute to this process.

The compressed, narrow and unstable (due to the inflammation) airways prevent the amount of air, which is moved back and forth, from being freely increased. At a certain point, when an individually varying amount of air becomes necessary for a given work rate, there is not enough time left to perform a complete exhalation. With each breath the amount of air that remains in the air sacs increases as does the pressure in the lung. More and more airways collapse during exhalation [dynamic air way collapse].

The remaining air which is behind those airways in the air sacs is trapped. This collapsing of the airways causes the audible “wheezing” during exhalation. Altogether, the amount of air in the rib cage is further increasing and is compressing the airways even more. Sooner or later “one pumps up like a cockchafer” and is forced to stop walking, this means termination of exertion due to breathlessness.



### Dynamic hyperinflation

The more the balloon is pumped, the higher the pressure in the piston and on the airways inside, respectively. Similar to the model above, COPD patients “pump” themselves up. The mechanism described before stays the same.

### Double hyperinflation?

This “filling up with air/pumping up/ hyper inflating/ taking shorter breaths/having less air/hardening in or at the rib cage” on exertion is medically referred to as “dynamic hyperinflation”. It is a type of hyperinflation caused by exertion (more air per time is required) in addition to hyperinflation caused by the emphysema at rest. With progressed emphysema and a high degree of severity of COPD, the maximum amount of air which fits into the rib cage (normally approx. 5 litres), can be increased by more than 2 litres. Depending on the extent of damage in the lungs and on the personal fitness level, pace becomes slower and performance (e.g. climbing the stairs) is interrupted by more frequent and longer breaks.

The maximum “generating of pressure” (increasing the amount of air up to e.g. 7 litres in a space where usually only 5 litres should be), which happens many times a day, has long term effects on all other organs in the rib cage. It is advisable to get the cardiovascular system’s state checked by a doctor on a regular basis.