Expiračná časová konštanta
u pacientov na umelej pľúcnej ventilácii

EXHALATION UNBIASED

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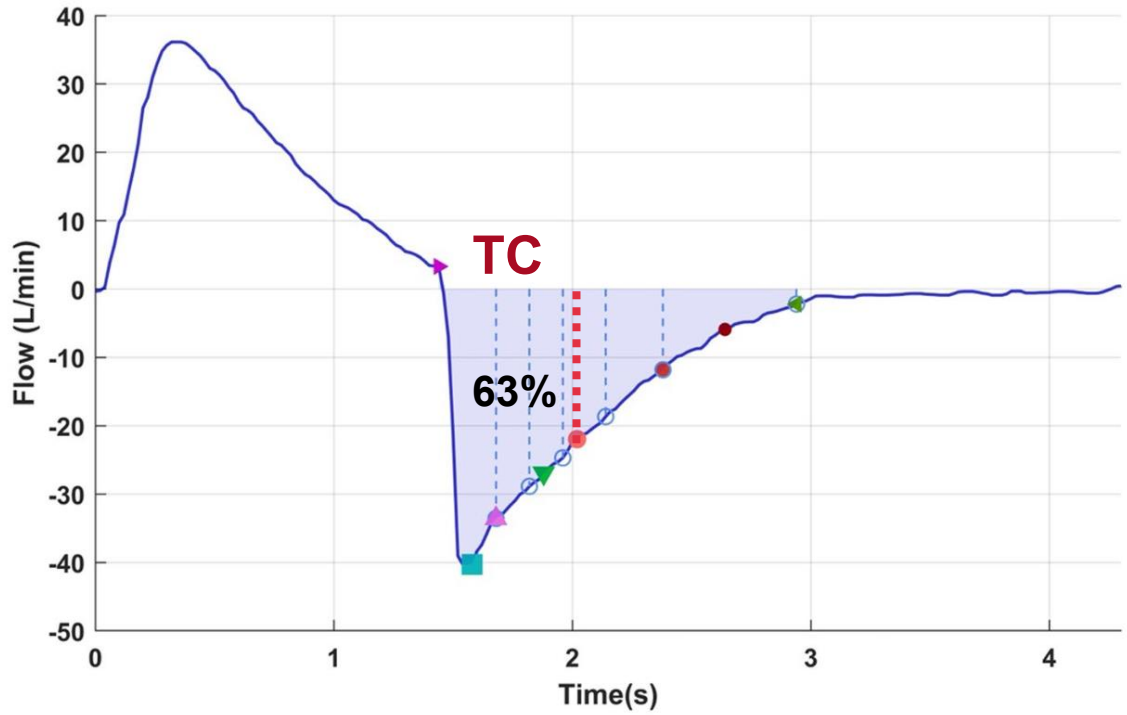
Definícia (RC_{EXP} = τ = TauE = TC)

TC je čas na vydýchnutie prvých ***63% V_T***

TC sa častejšie získava ako R a C ***(TC = Raw x Crs)***



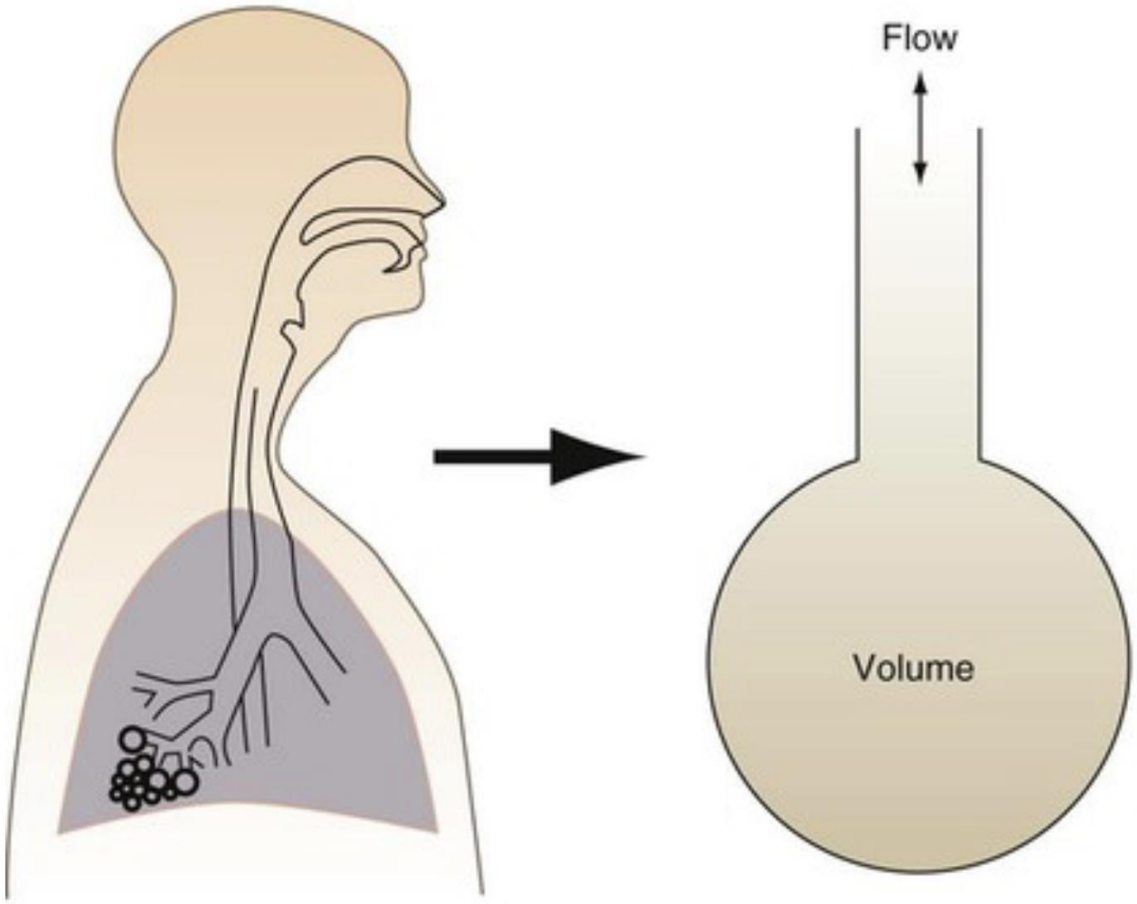
Referenčná hodnota:

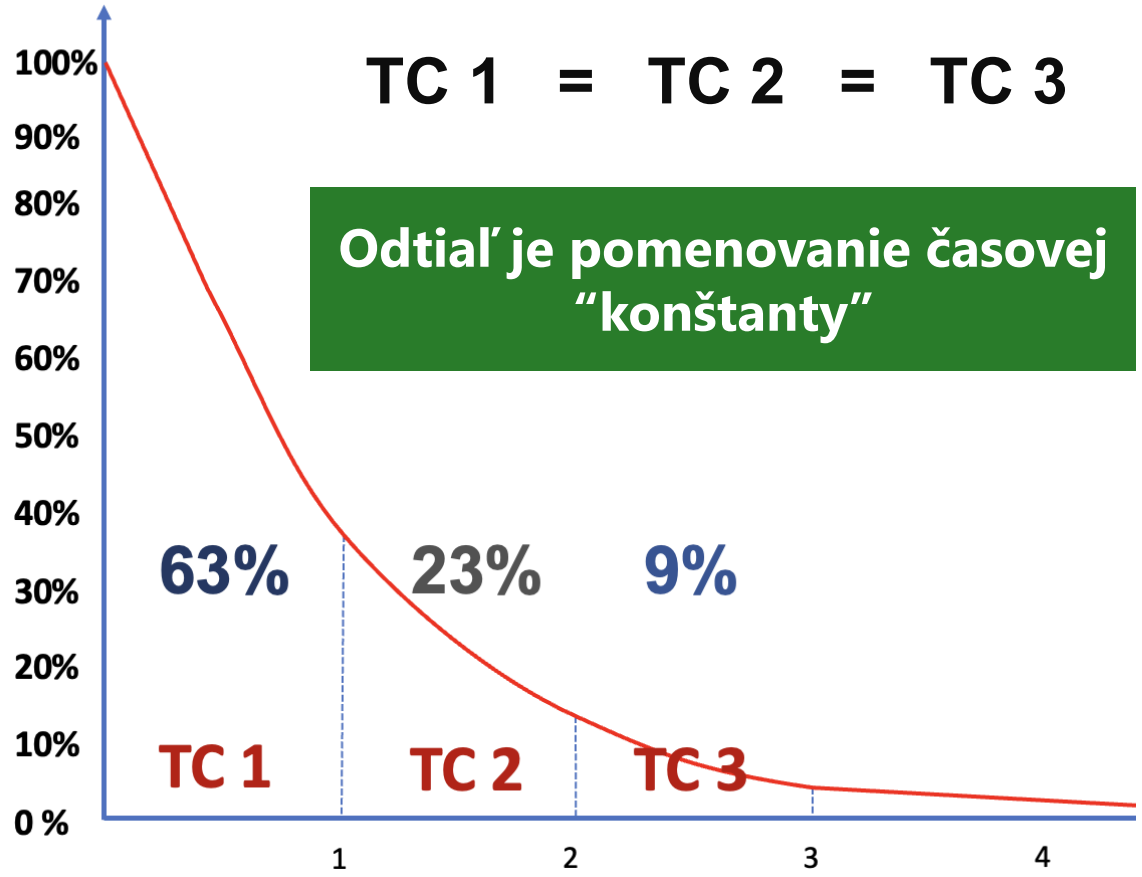
TC = 0.5 - 0.8s

Rovnica TC

$$\boldsymbol{RC_{EXP}} = \boldsymbol{C_{rs}}\ x\ \boldsymbol{R_{rs}} = \frac{L}{cmH_2O}\ x\ \frac{cmH_2O}{\frac{L}{s}} = L\ x\ \frac{s}{L} = \boldsymbol{s}$$

Koncept pasívneho výdychu

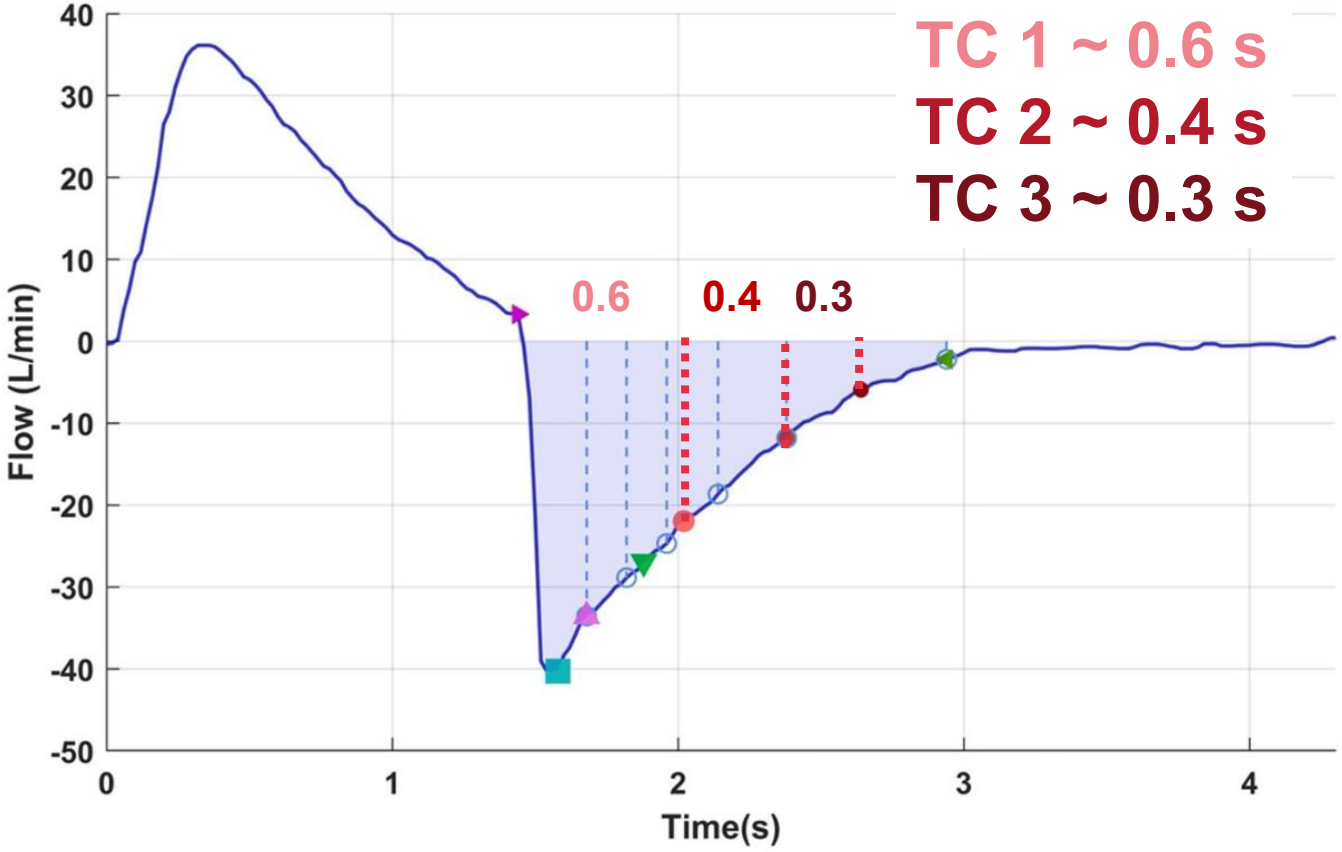




TC 1 = TC 2 = TC 3

Odtiaľ je pomenovanie časovej "konštanty"

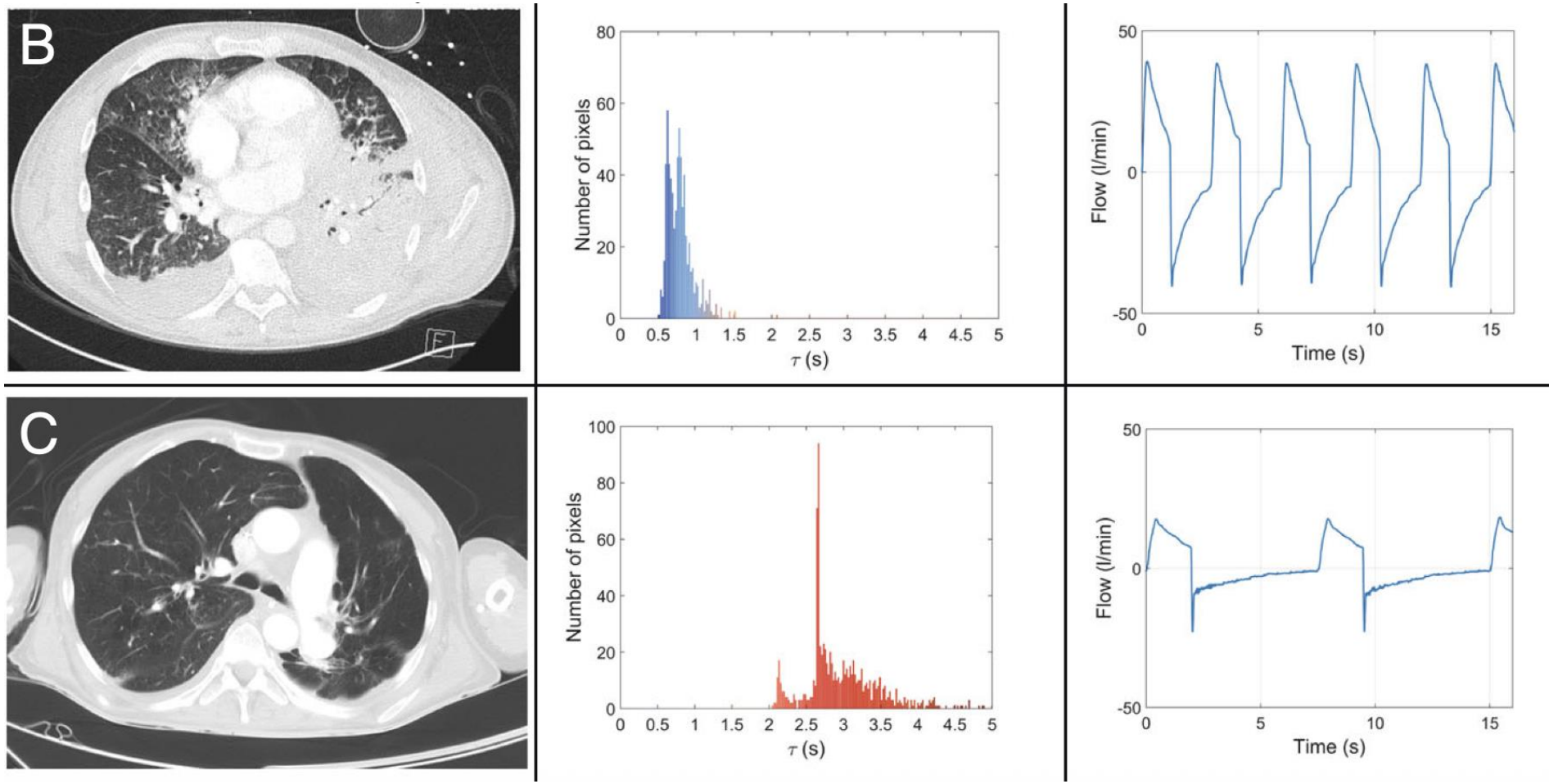
Realita



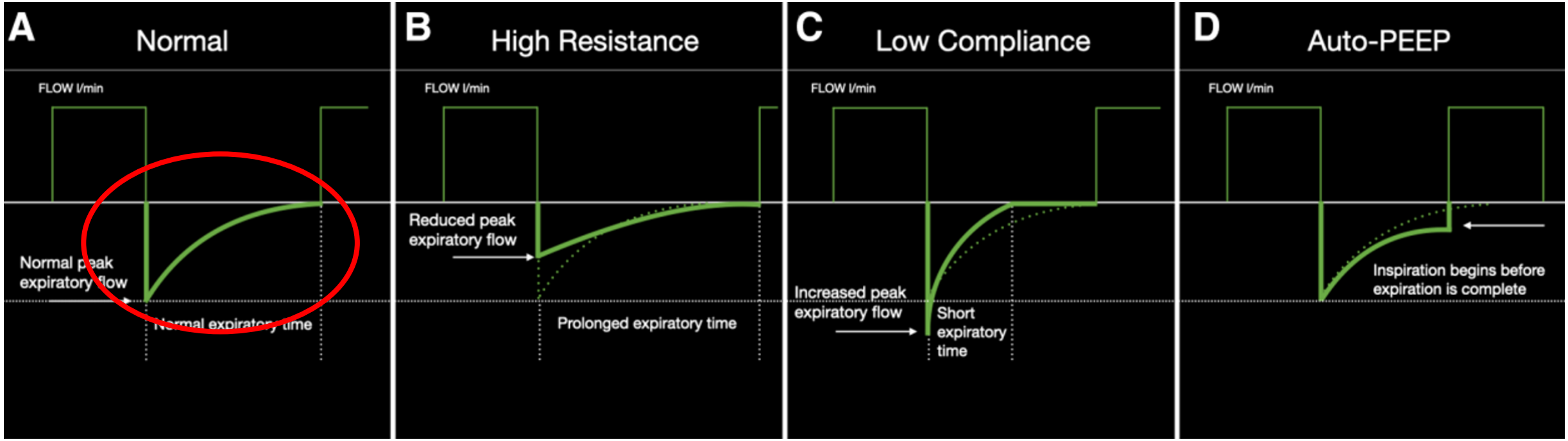
Termín “konstanta” zmizol z definície

Hlavné determinanty TC

1. ETT
2. V_T / driving P
3. PEEP / Recruitment
4. Heterogenita

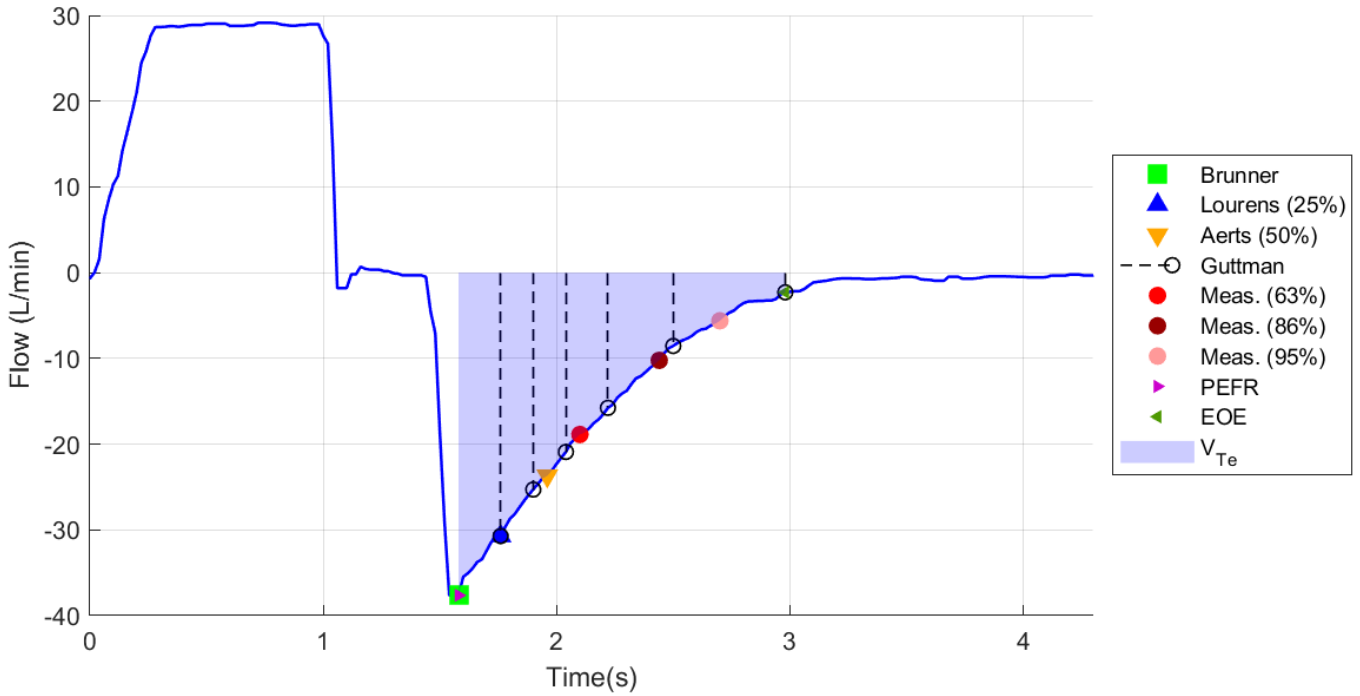


Jedno číslo na hodnotenie expiračnej krivky



Metódy na určenie TC

- MERANÁ TC
  - First 63% of exhaled Vt
- VYPOČÍTANÁ TC
  - Resistance x Compliance
  - V_T / PEFR
- ODVODENÁ TC z V/V krivky
  - Aerts
  - Guttmann
  - Lourens



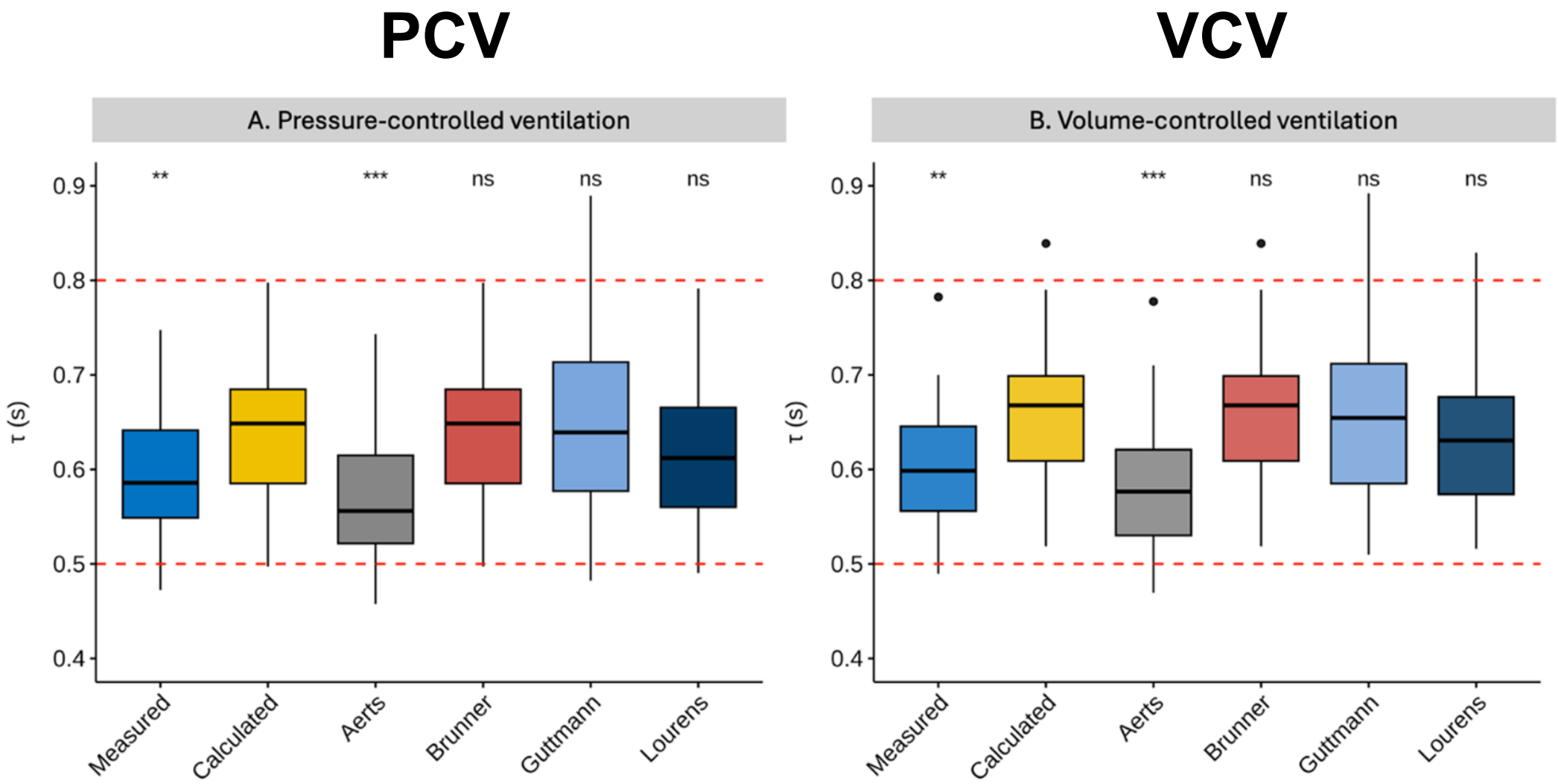


Fig. 1 Physiological values of RC_{EXP} in passive, healthy postoperative patients under pressure-controlled ventilation (PCV) and volume-controlled ventilation (VCV) using different methods to obtain RC_{EXP}. The upper and lower limits of the reference range are displayed as dashed red lines [14]

EXHALATION UNBIASED ?

INSPÍRIUM je aktívne kontrolované

- PIP, Pplat, dP
- **Static vs Dynamic Compliance**
- Odpor (Raw),
- V_T
- Mechanická energia (MP)

EXPÍRIUM je pasívne (menší bias?)

- **TC**

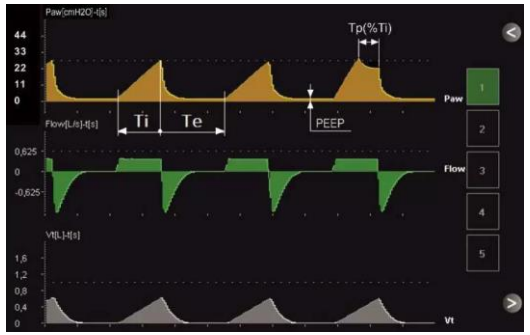
Prečo ju používať?

1. "Jedno číslo" vyjadrujúce rýchlosť výdychu
2. Odráža zmeny pľúcnej mechaniky (lung congestion, ARDS, pneumonia, etc) **bez nutnosti HOLD manévrov**
3. **AutoPEEP** – dlhá TC (> 0.8)
4. **Weaning** – krátka TC (< 0.5)
5. Inteligentné ventilačné režimy

Ako používam TC ja?

Neznámi pacient uprostred noci

Titrace PEEP



Depta et al. BMC Anesthesiology (2022) 22:387
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BMC Anesthesiology

RESEARCH Open Access

Time constant to determine PEEP levels in mechanically ventilated COVID-19 ARDS: a feasibility study

Filip Depta[1,2*], Neil R. Euliano[3], Marko Zdravkovic[4,5], Pavol Török[1,2] and Michael A. Gentile[6]

Optimálny PEEP založný na pasívnom expíriu?

53 PEEP titrací u COVID-19 ARDS: 29 pronacná poloha + 24 supinačná poloha

	PRONE POSITION *n* = 29	
	Recruitable	**Non-recruitable**
n	21	8
PEEP TauE (cmH_2O)	8 (3)	4 (4)
PEEP C_{RS} (cmH_2O)	7 (2)	5 (4)
PEEP Range TauE (cmH_2O)	6—10	1—8
PEEP Range C_{RS} (cmH_2O)	5—14	0—11

	SUPINE POSITION *n* = 24	
	Recruitable	**Non-recruitable**
n	19	5
PEEP TauE (cmH_2O)	9 (4)	5 (3)
PEEP C_{RS} (cmH_2O)	11 (4)	5 (2)
PEEP Range TauE (cmH_2O)	7—12	1 – 7
PEEP Range C_{RS} (cmH_2O)	6—15	0—10

Al-Rawas *et al. Critical Care* 2013, **17**:R23
http://ccforum.com/content/17/1/R23

CRITICAL CARE

RESEARCH Open Access

Expiratory time constant for determinations of plateau pressure, respiratory system compliance, and total resistance

Nawar Al-Rawas[1], Michael J Banner[1*], Neil R Euliano[2], Carl G Tams[2], Jeff Brown[1], A Daniel Martin[1,3] and Andrea Gabrielli[1,4]

Conclusions: We found the T_E method was just as good as the EIP method for determining Pplt, Crs, and Rtot for various modes of ventilatory support for patients with acute respiratory failure. It is unclear if the T_E method can be generalized to patients with chronic obstructive lung disease. T_E is determined during passive deflation of the lungs without the need for changing the ventilatory mode and disrupting a patient's breathing. The T_E method obviates the need to apply an EIP, allows for continuous and automatic surveillance of inspiratory Pplt so it can be maintained ≤ 30 cm H_2O for lung protection and patient safety, and permits real time assessments of pulmonary mechanics.

Al-Rawas *et al. Critical Care* 2013, **17**:R23
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Stále nie sú implementované vo ventilátore …

$$Pplt = PEEP + \frac{(V_T \times Paw) - (V_T \times PEEP)}{V_T + T_E \times \text{Inhaled flow rate}}$$

$$Crs = \frac{V_T + T_E \times \text{Inhaled flow rate}}{Paw - PEEP}$$

$$Rtot = \frac{Paw - PEEP}{\frac{V_T}{T_E} + \text{Inhaled flow rate}}$$

Publications

Depta *et al.*
Intensive Care Medicine Experimental (2025) 13:40
https://doi.org/10.1186/s40635-025-00745-9

Intensive Care Medicine
Experimental

REVIEWS Open Access

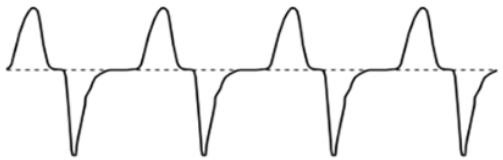
Expiratory time constants in mechanically ventilated patients: rethinking the old concept—a narrative review

Filip Depta[1*], Richard H. Kallet[2], Michael A. Gentile[3] and Elias N. Baedorf Kassis[4]

Viliam Donič[6] and Marko Zdravkovic[7,8]

RC_{EXP}

Short
< 0.5 s

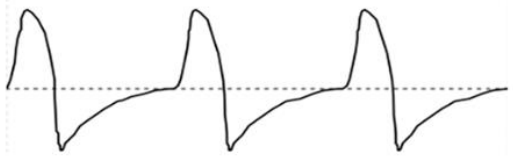


↓ Lung compliance
(Fast elastic recoil)

- Nonrecruitable **ARDS**
- Acute **pulmonary edema**
- Pulmonary **fibrosis**

Optimize **PEEP**
Lower V_T (4-6 ml/kg/PBW)

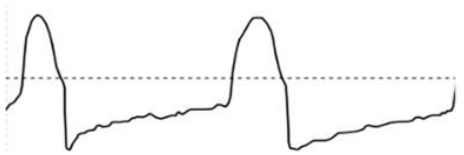
Normal
0.5 – 0.8 s



Recruitable lungs
(Normal lungs)

- Recruitable **ARDS / Pneumonia**
- **Mixed** etiologies causing **"pseudonormal" τ**

Long
> 0.8 s



↑ Airway resistance
(Expiratory flow limitation)

- **COPD**
- **Emphysema**
- Asthma

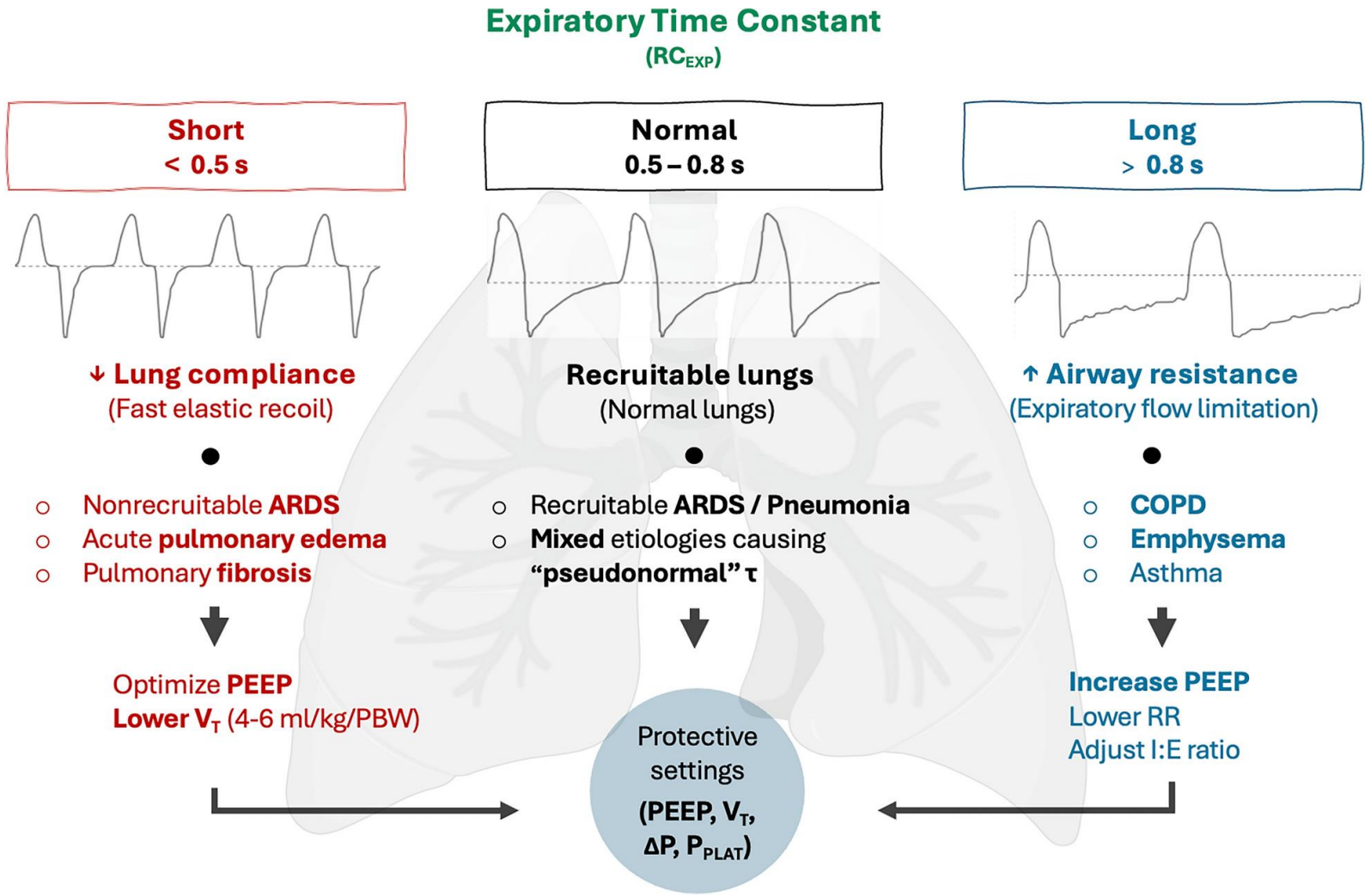
Increase PEEP
Lower RR
Adjust I:E ratio

OPTIMIZE

Due to its limitations …

1. Jednoduché, bedside, neinvazívne posúdenie expíria
2. Objektívne číselné vyjadrenie výdychu ktoré doplňuje ventilátorovú grafiku
3. Hodnotenie zhoršenia / zlepšenia mechaniky pľúc
4. **Should be less biased than inspiratory variables**

?? Rutínne hodnotenie u pacientov na UPV ??



Ďakujem za pozornosť