USZ Universitäts Spital Zürich

Regional Lung Aeration and Ventilation Characteristics in Newborn Infants after Cesarean and Spontaneous Delivery

L. Ramin-Wright, V. Gaertner, C. Belting, A. Waldmann, V. Büchler, K. Gähwiler, D. Bassler, C. Rüegger

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Dr. med. Leandra Ramin-Wright, University Hospital Zurich, May 13th, 2025

USZ neonatal department

NEWBORN research ZURICH

University of Zurich[UZH]

Conflicts of Interest

- EIT monitor provided by SenTec AG free of charge for research projects
- No additional conflicts of interest

Agenda

- Background
- Methods
- Results
- Discussion

Background

Respiratory Transition after Birth

	Cesarean delivery	Spontaneous delivery
Birth Asphyxia	↘	↖
Birth Trauma	↘	↖
Meconium Aspiration	↘	↖

Gromann, et al. Swiss Med Weekly 2024
Li , et al. Arch of Gynecology and Obsterics 2019
Tita, et al. New England Journal of Medicine 2009
Sandall, et al. The Lancet 2019

Background

Respiratory Transition after Birth

	Cesarean delivery	Spontaneous delivery
Birth Asphyxia	↘	↖
Birth Trauma	↘	↖
Meconium Aspiration	↘	↖
Respiratory Distress	↖	↘
	9 %	3 %

Gromann, et al. Swiss Med Weekly 2024
Li , et al. Arch of Gynecology and Obsterics 2019
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Sandall, et al. The Lancet 2019

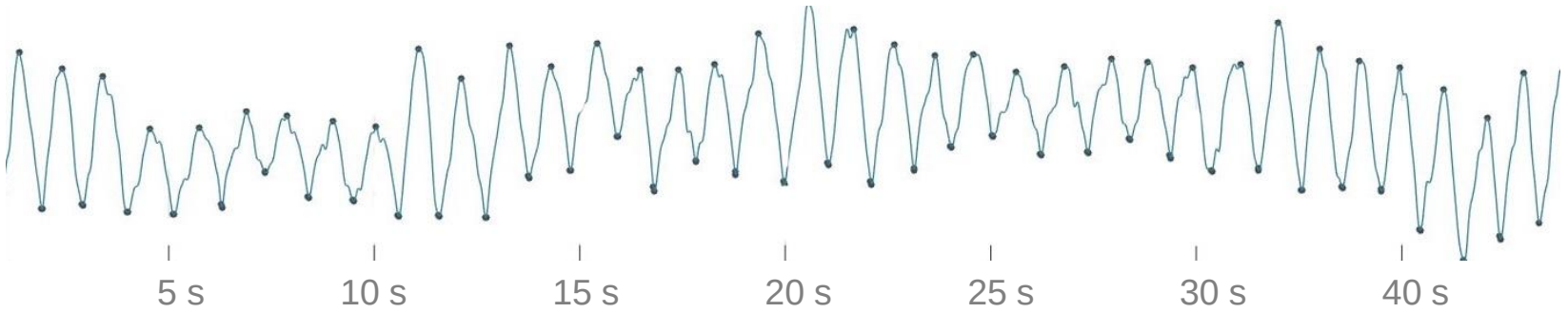
Background

Electrical Impedance Tomography

Lung volume imaging technique

- Non-invasive
- Radiation free
- Continuous real-time monitoring
- Regional

Continuous Regional Analysis Device for neonate Lung CRADL, Sentec EIT



Adler, et al. Physiol Meas 2012
Costa, et al. Curr Opin Crit Care 2009
Eckart, et al. Ecomed 2016

Methods

Study Design and Participants

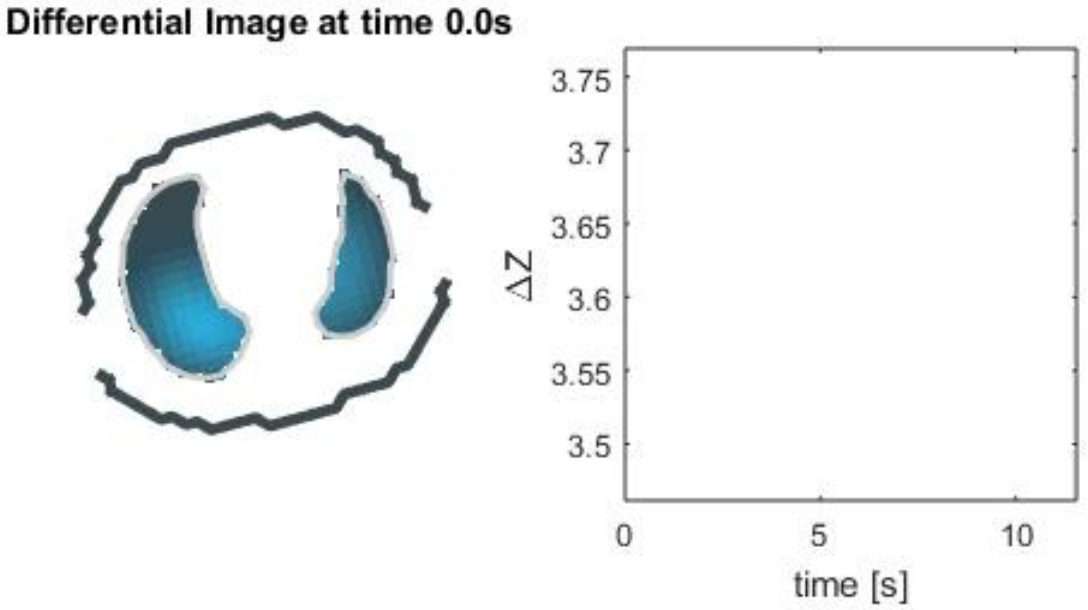
	Monocentric Secondary Analysis of 2 Observational Studies
Population	Term born infants > 37 weeks • Spontaneous delivery • Primary cesarean delivery
Exclusion criteria	Respiratory support
Primary aim	Description of differences in ventilation & aeration characteristics

Methods

Study Procedure

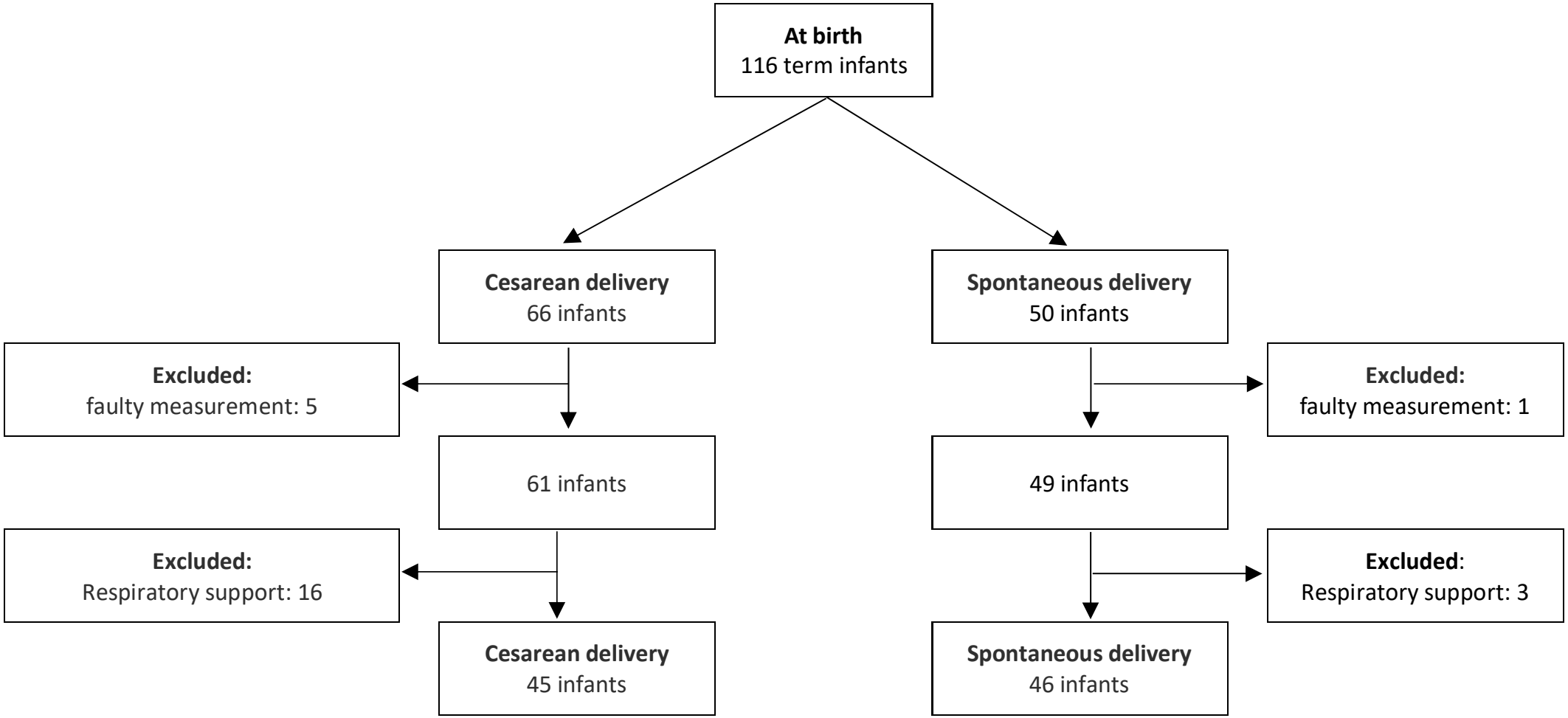
- EIT belt attached directly after birth
- 20 second segments selected at minute 1 to minute 10 of life

Tingay, et al. AJRCCM 2021



Results

Patient Flowchart



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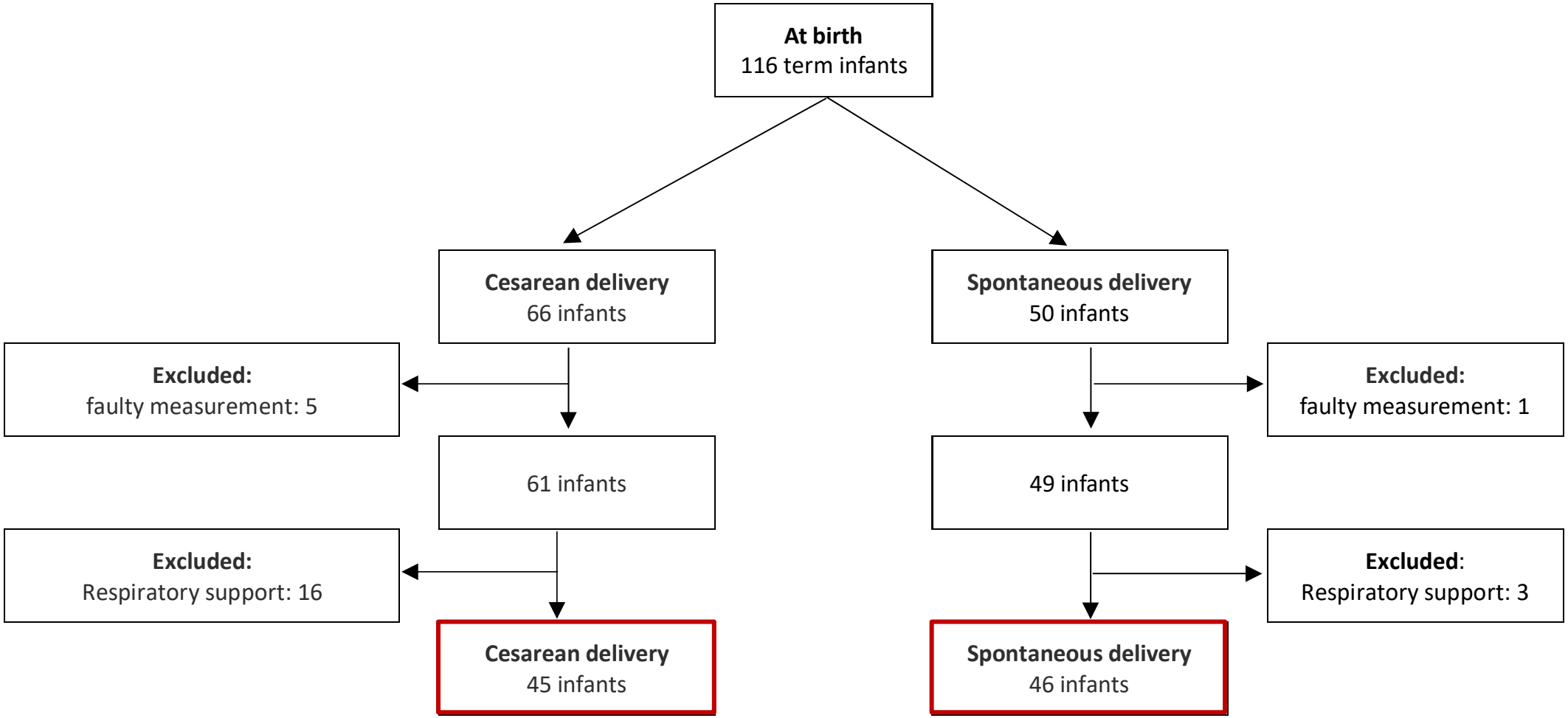

Results

Demographical Characteristics

	Cesarean delivery (n = 45)	Spontaneous delivery (n = 46)	p-value
Perinatal			
Sex, male (%)	21 (43)	27 (60)	0.14
Gestational age at birth, weeks	38 3/7 (1)	39 6/7 (2)	< 0.001
Birth weight (g)	3288 (± 496)	3439 (± 445)	0.13
pH	7.32 (± 0.04)	7.24 (± 0.06)	< 0.001
pCO_2	6.5 (± 0.9)	6.9 (± 1.3)	0.14
BE	- 1 (± 2)	- 5 (± 3)	< 0.001
Lactate	2.3 (0.6)	5.6 (2.8)	< 0.001
Apgar score at 5 minutes	9 (0)	9 (0)	0.83

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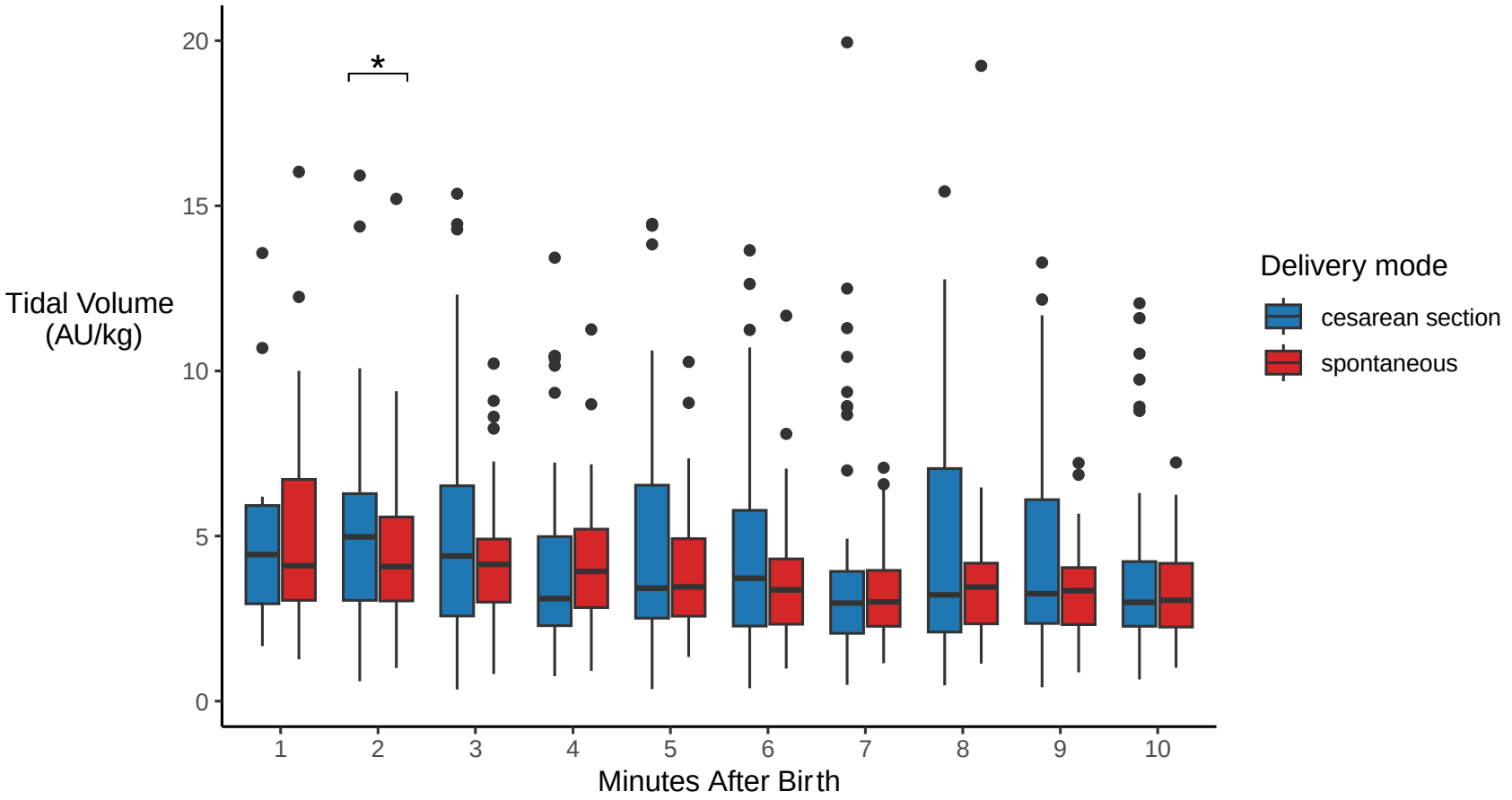
Results

Tidal Volumes Decrease in Early Postnatal Phase

- Progressive decline in TV in both delivery groups ($p < 0.001$)
- Higher TV at 2 min in cesarean delivery ($p = 0.02$)



Higher V_t initially facilitates lung liquid clearance

Melissa, et al. Applied Physiology 2009

Results

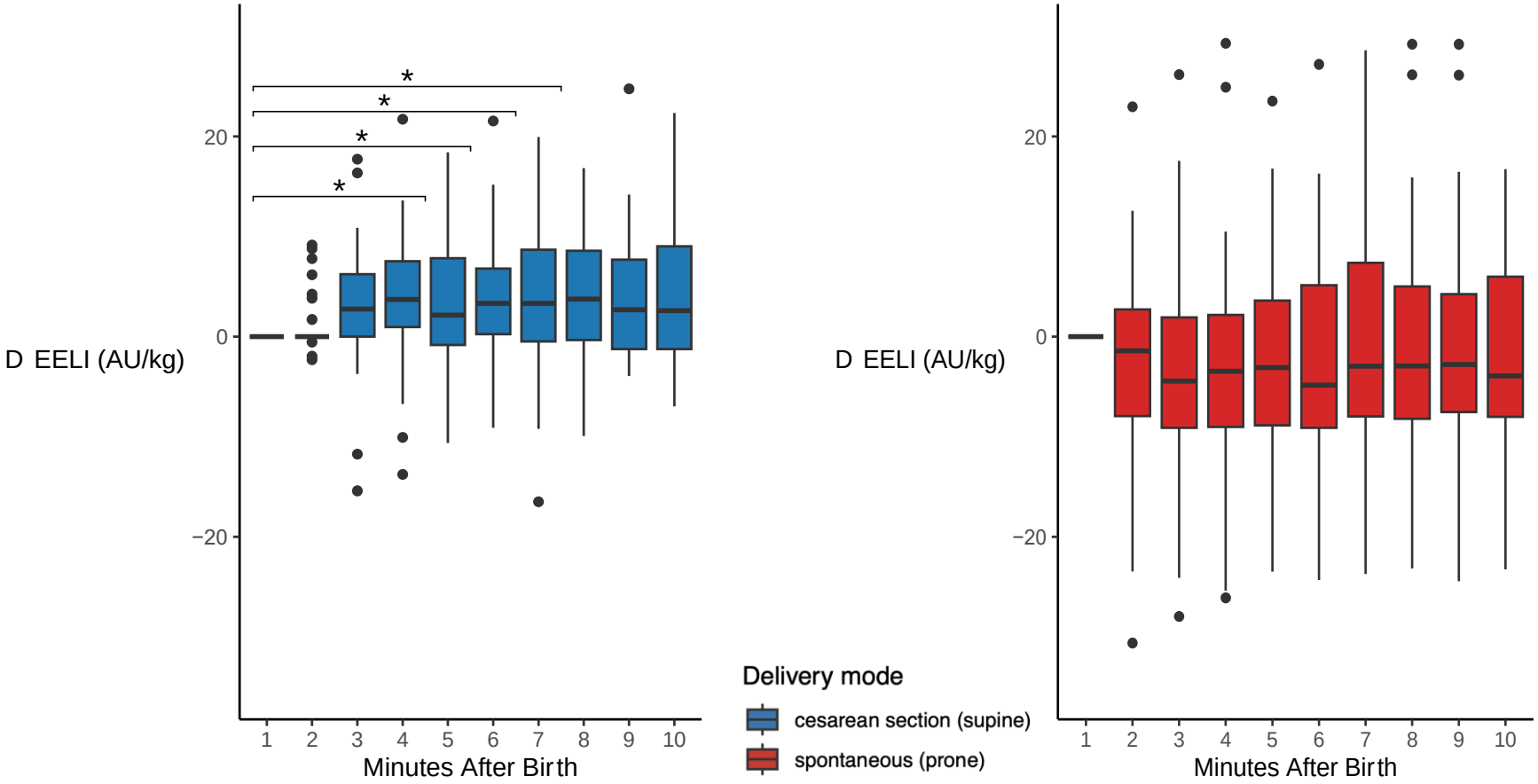
Changes in End-Expiratory Lung Volume

- No significant changes in spontaneous delivery

↳ Spontaneous delivery promotes earlier increase

Gaertner, et al. unpublished

- Postnatal increase in cesarean delivery (ΔEELI $p < 0.05$)



End-expiratory lung volumes increase in cesarean delivery over the first **minutes** of life

Results

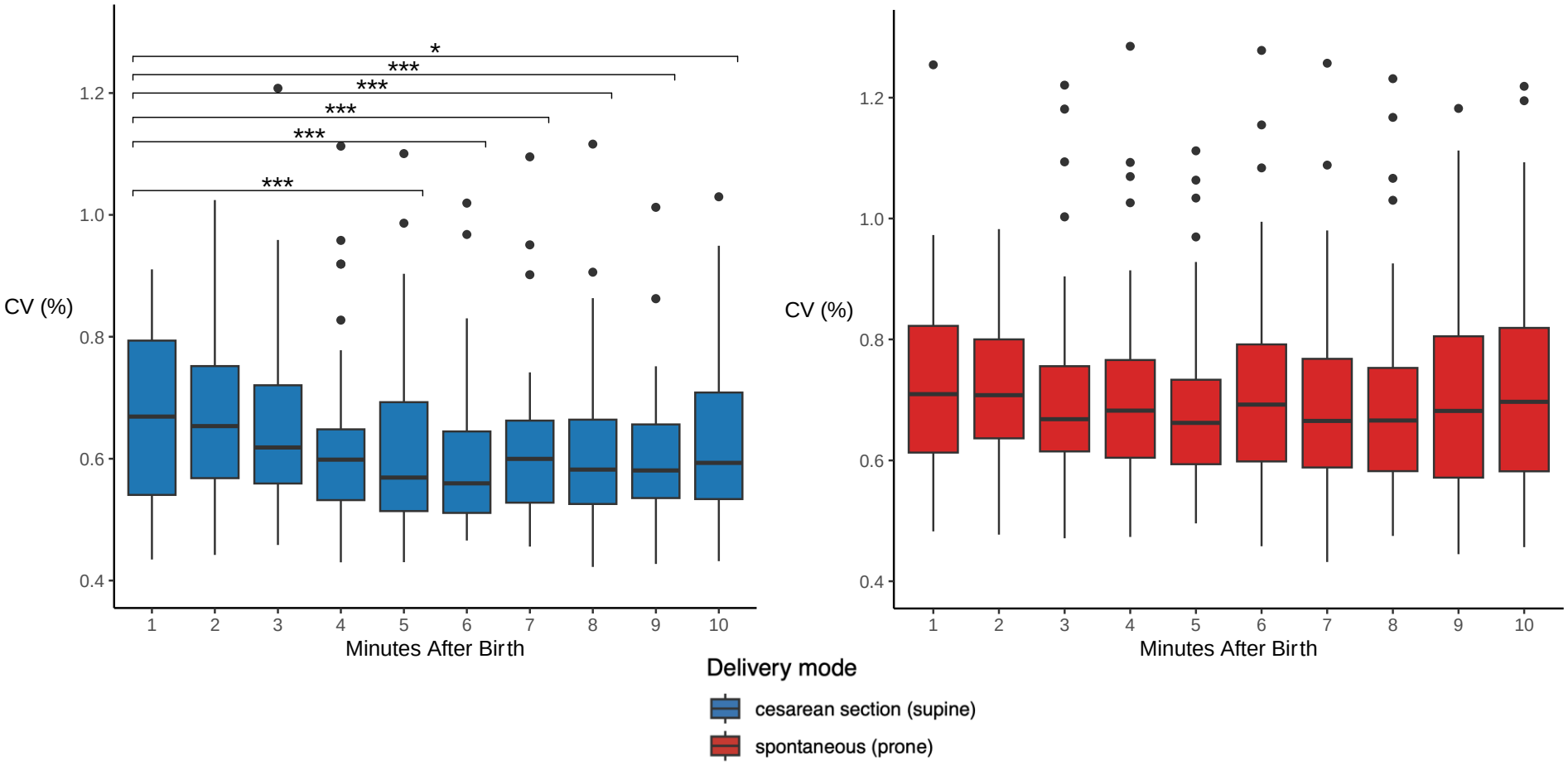
Lung Homogeneity

- Stable CV in spontaneous delivery

↳ Spontaneous delivery promotes earlier decrease

Gaertner, et al. unpublished

- Decreasing CV in cesarean delivery



Increasing homogeneity in cesaean delivery over the first **minutes** of life

Conclusion

Delayed Respiratory Transition after Cesarean Delivery

★ Higher V_t in immediate postnatal period in all patients

Cesarean delivery results in

★ Slightly higher V_t

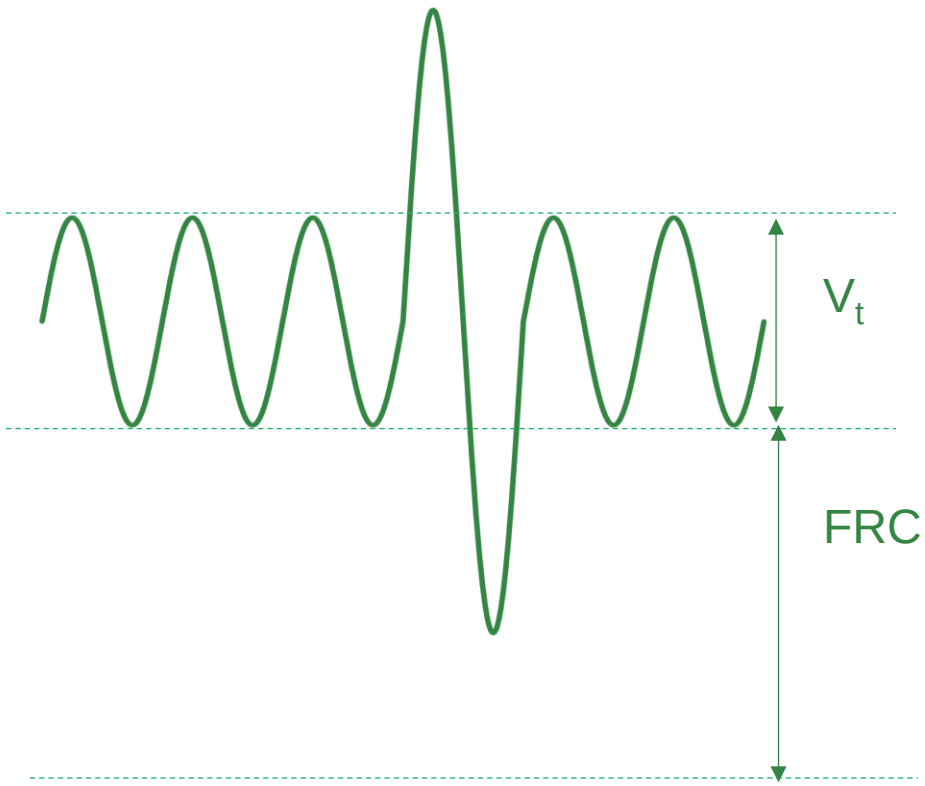
★ Delayed increase in end-expiratory lung volume

★ Delayed increase in lung homogeneity

Leandra.ramin-wright@usz.ch

Discussion

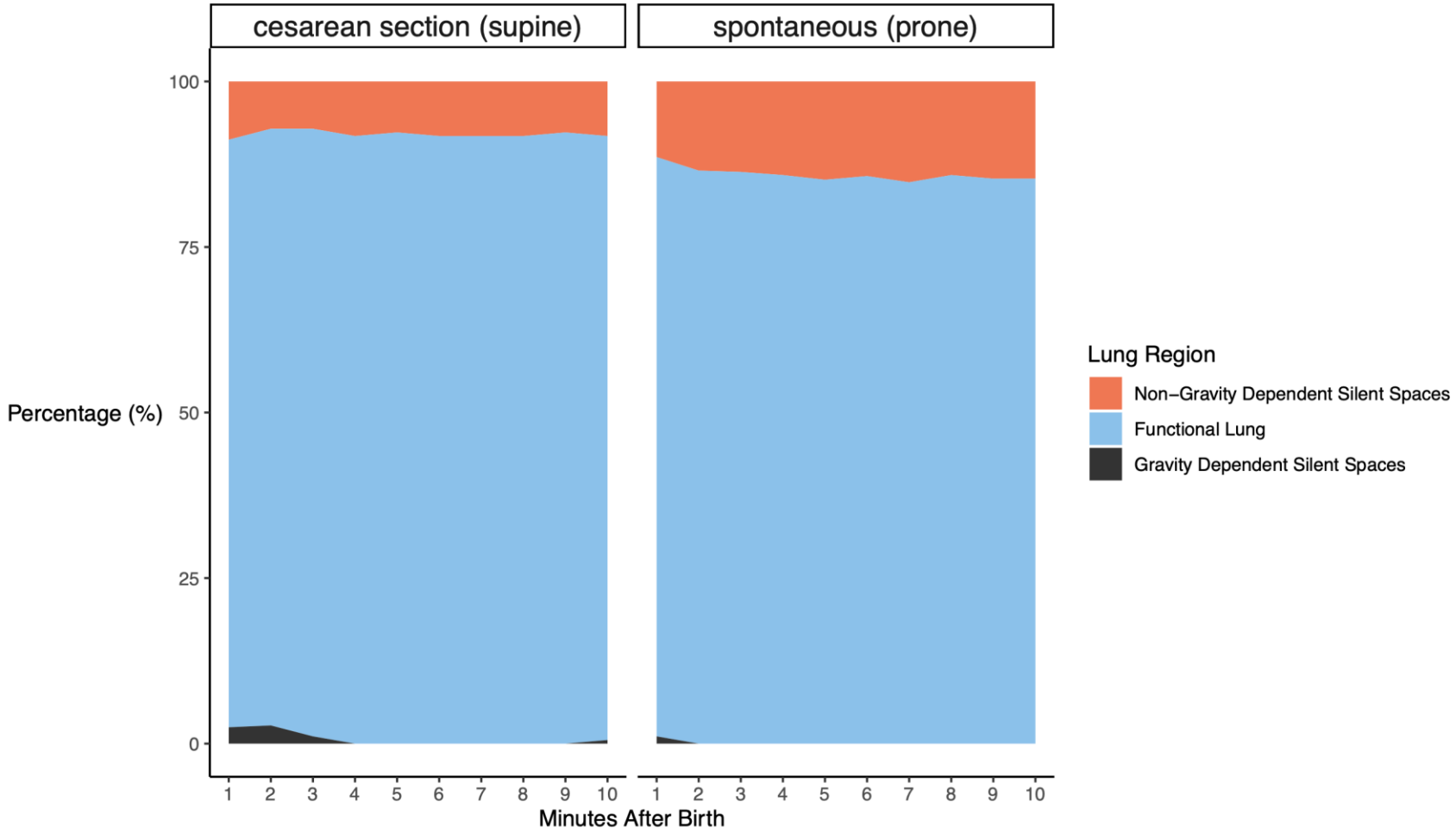
Tidal Volumes and Functional Lung



Results

Functional Lung Size and Silent Spaces

- Less non-gravity dependent silent spaces in cesarean delivery
- More gravity dependent silent spaces



More atelectasis in cesarean delivery