Growth of the Lungs: Impact of EOS and Treatments

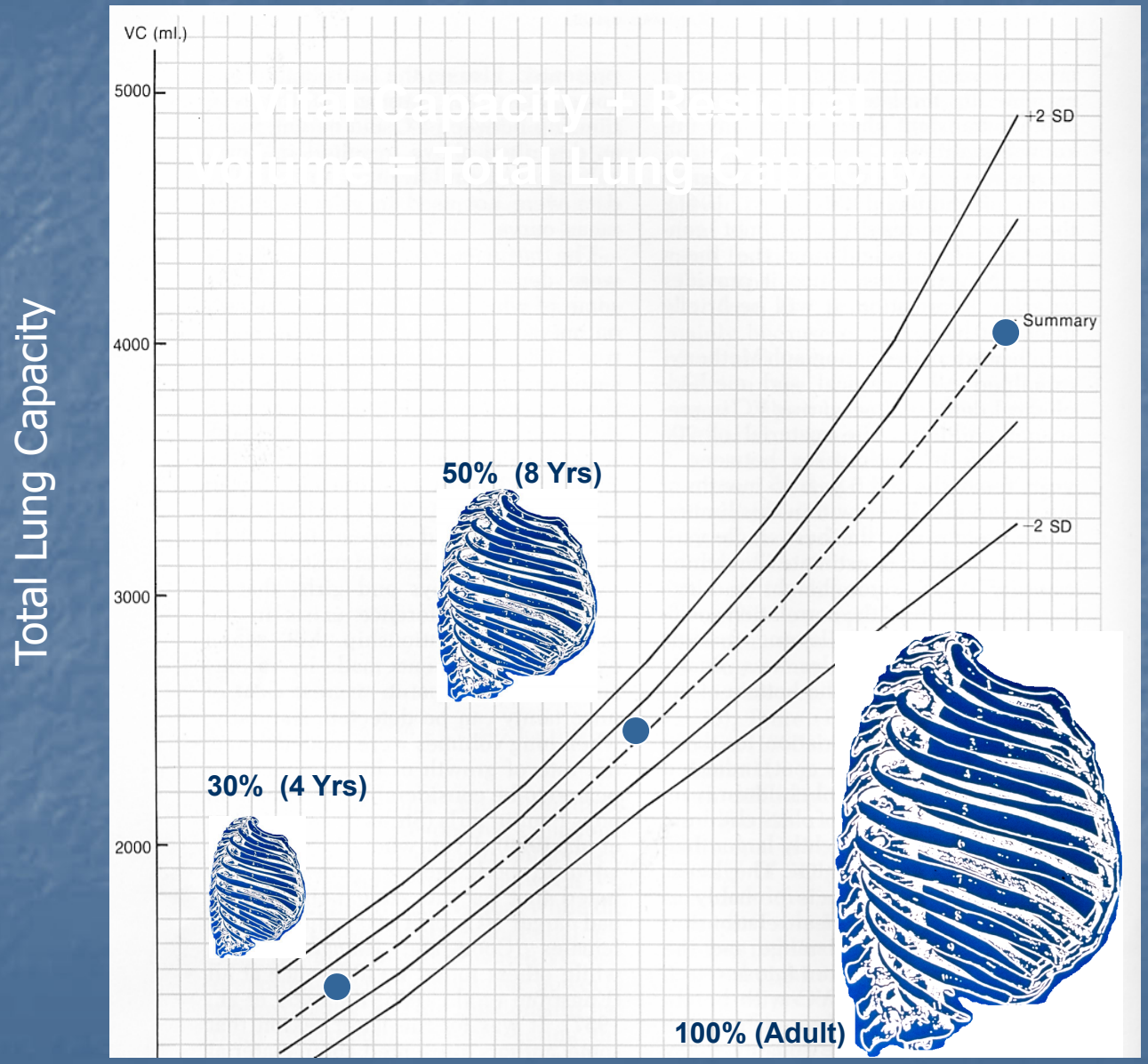
Gregory J. Redding, M.D.
University of Washington School of Medicine

Seattle Children's
HOSPITAL · RESEARCH · FOUNDATION

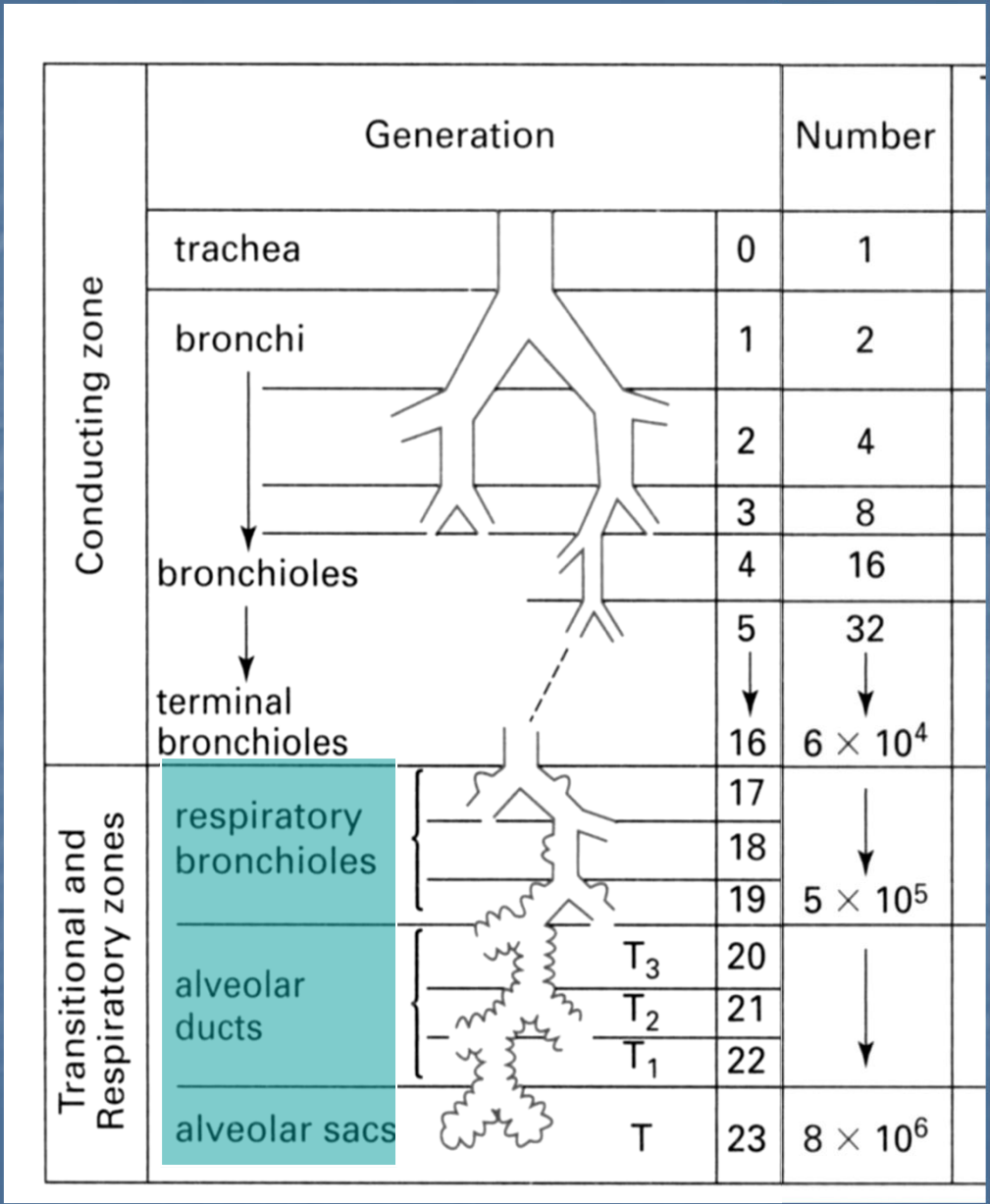
Disclosures

Paid speaker for Synthes and Stryker CE activities

Lung Volumes Change with Age and Height



Lung Structures & Postnatal Growth Patterns



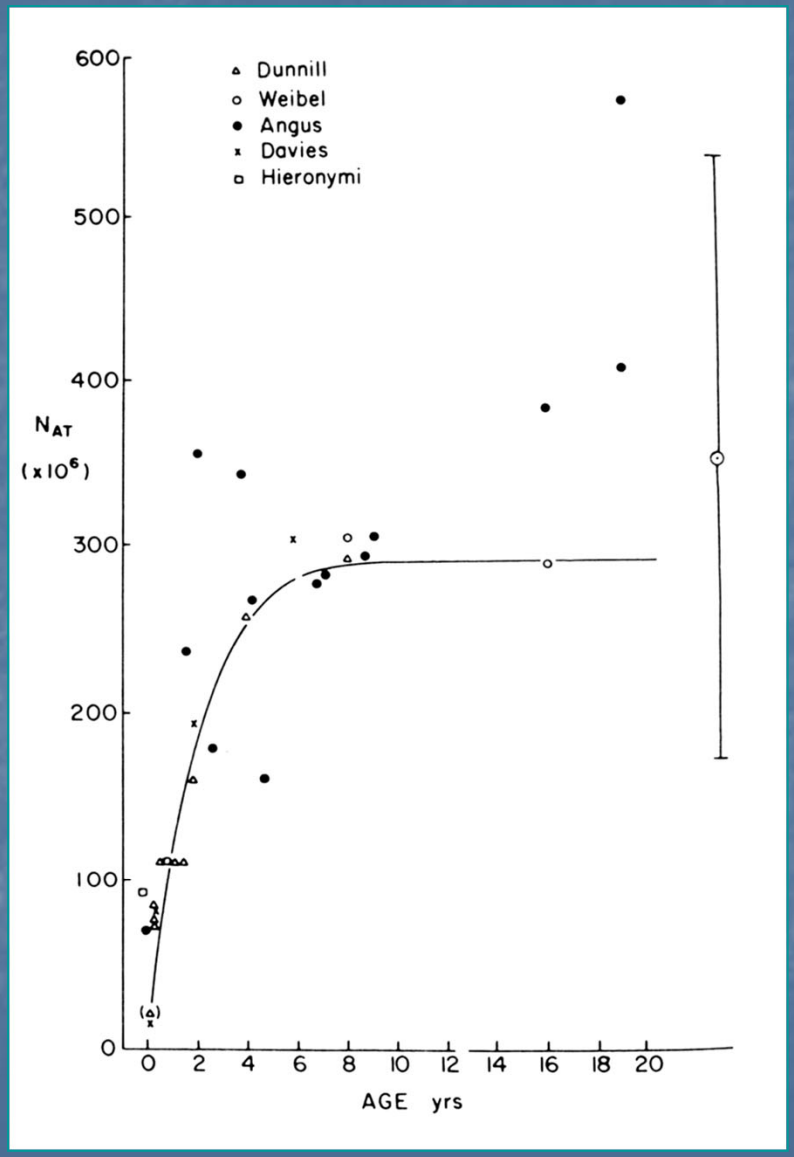
Levitzky MG. In: Pulmonary Physiology (6th Ed.) McGraw-Hill, Crawford, Indiana, 1:1-10, 2003.

Pulmonary Changes From Neonatal Period to Adulthood

	Adult/Neonatal Ratio
Bronchial Diameter	2.5
Bronchial & Bronchiolar Number	1
Alveolar Number	12.3
Alveolar Size*	5.5
Alveolar-capillary surface area	10-15

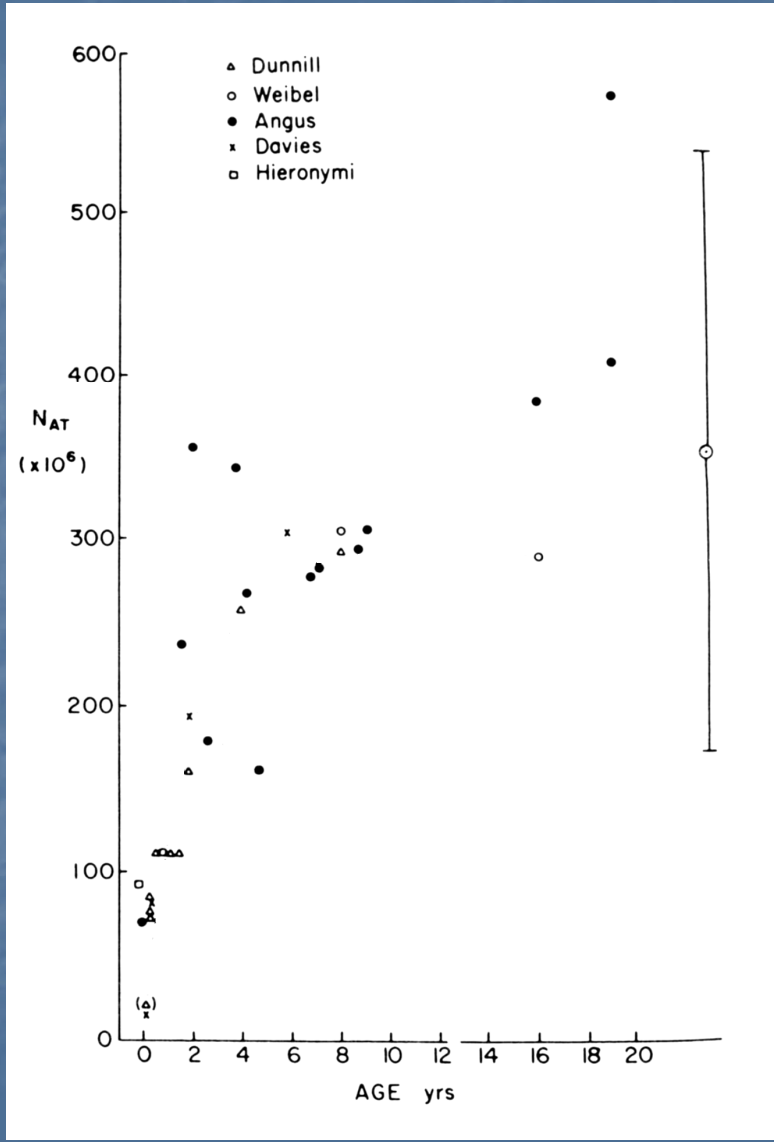
**Does account for increased alveolar configuration complexity and capillary development which contribute to alveolar-capillary surface area*

Postnatal Lung Development: Alveolar Number



Murray JF. In: The Normal Lung (2nd Ed.), W.B. Saunders, Philadelphia, 2:23-60, 1986.

Postnatal Lung Development: Alveolar Number



Alveolar number increase with somatic growth

Alveolar growth is more rapid in children <2 years of age

Murray JF. In: The Normal Lung (2nd Ed.), W.B. Saunders, Philadelphia, 2:23-60, 1986.

Pulmonary Pathophysiology of EOS

Spine and Thoracic Cage Deformities

Low Lung Volumes*

Hypoxemia
Poor sleep
Cor pulmonale

Reduced Chest Wall Distensibility and Excursion

Increased Work

Poor Somatic Growth

Reduced Respiratory Muscle Force and Movement

Reduced Exercise Tolerance

Respiratory Failure

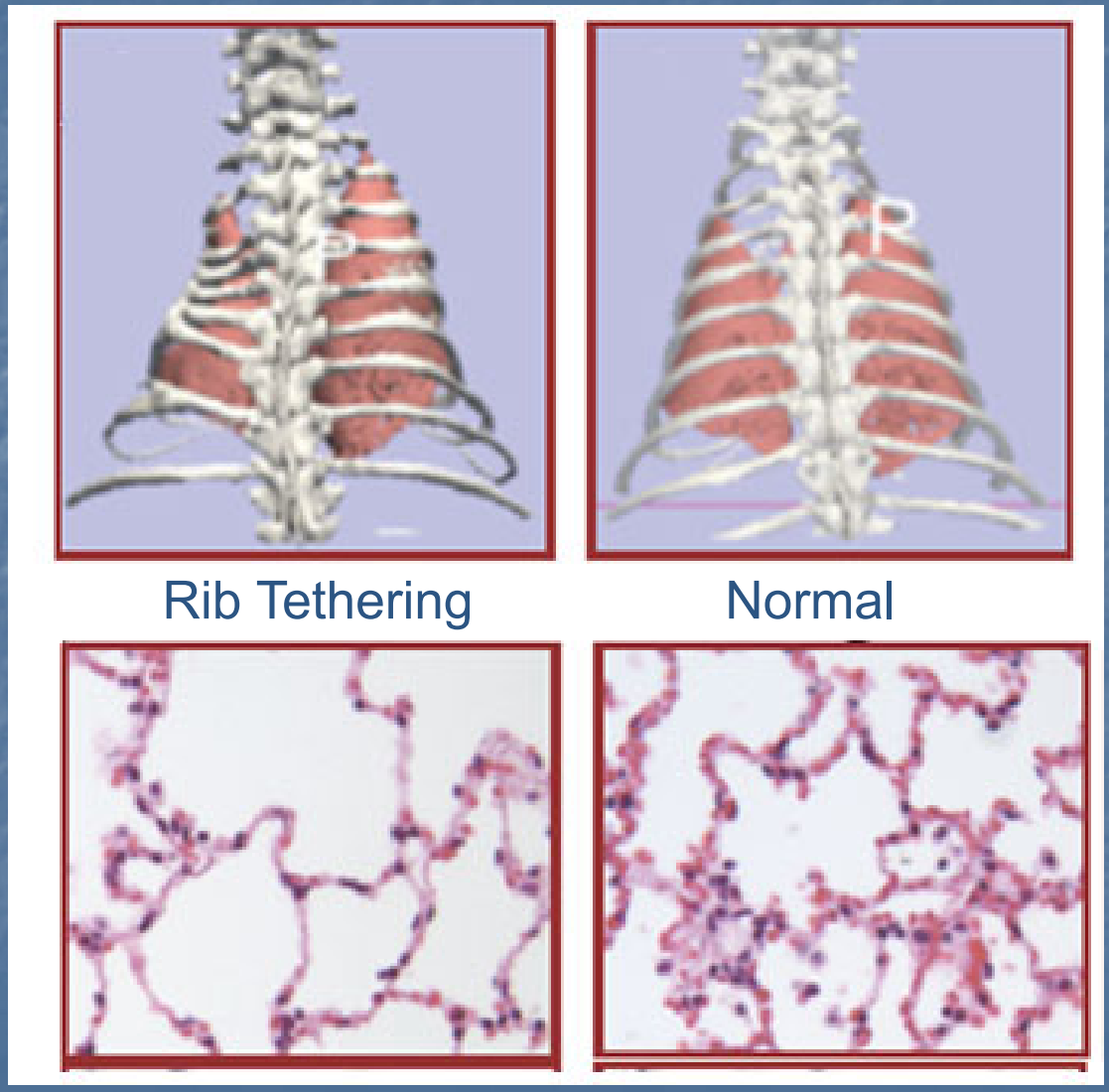
Reduced Lung Volumes and Diffusion Capacities in Adults with Early Onset Scoliosis*

Group	n	FVC	TLC	DLCO
#1: Untreated	6	97+/-11%	97+/-10%	93+/-17%
#2: Fusion *after* 10 years of age	6	58+/-16%	71+/-16%	80+/-20%
#3: Fusion *before* 10 years of age	10	41+/-20%	50+/-15%	58+/-35%

Studied at 21 +/-4 years of age

Goldberg CJ, et al. *Spine* 28(20):2397-2406, 2003.

Chest Wall Constraints: Post-natal Pulmonary Hypoplaisa Syndrome?



Olson JC, Kurek KC, Mehta HP, et al. Evaluation of Pulmonary Cellular Response to Treatment of thoracic Insufficiency Syndrome Using Expansion Thoracoplasty in Scoliotic Rabbit Model

Consequences of Lung Hypoplasia*

- Increased lung stiffness
- Loss of capillary surface area (with increased risk of Pulmonary Hypertension)
- Limited exercise tolerance

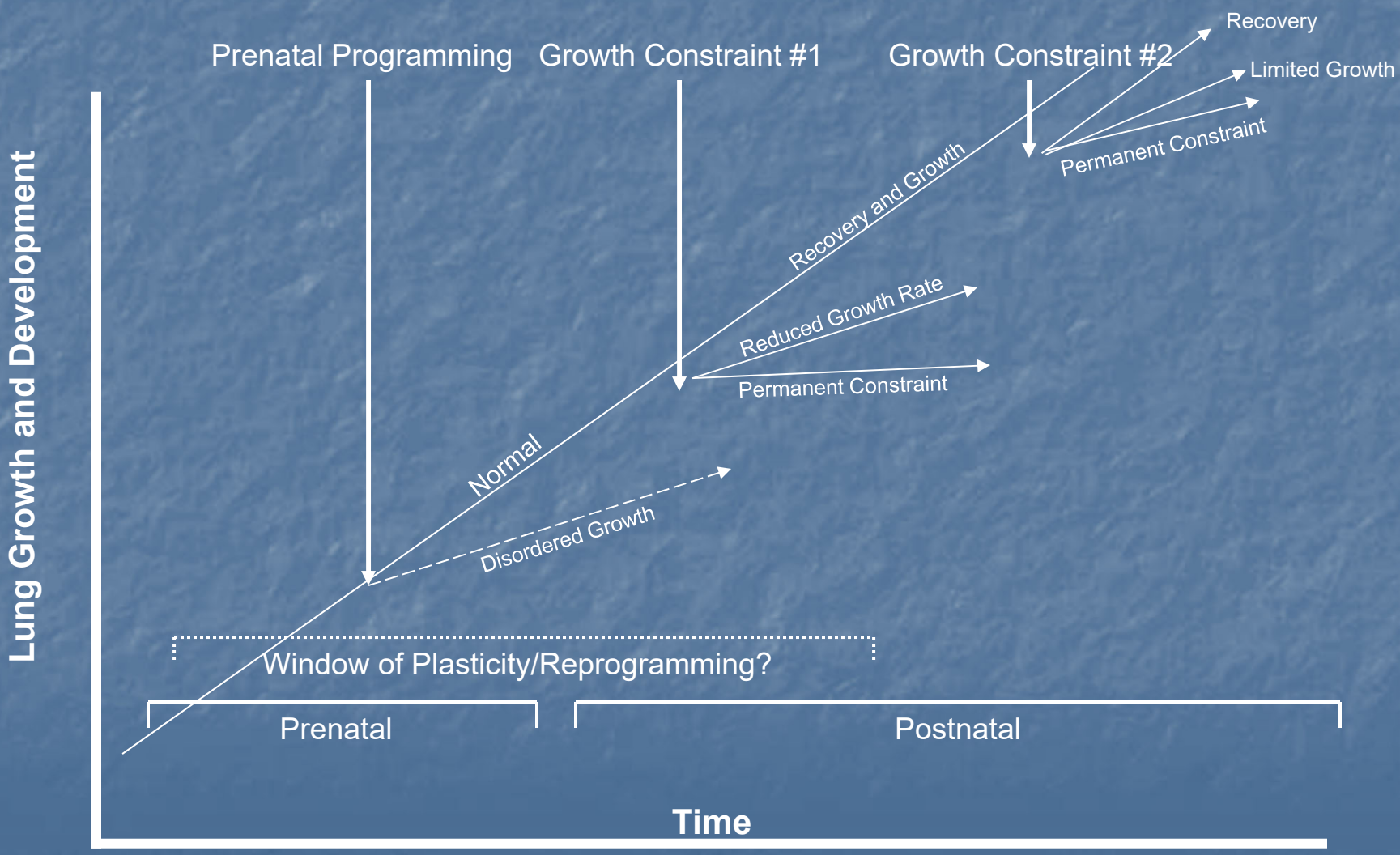
In addition to pulmonary pathophysiology of EOS

Compensatory Lung Growth Considerations (Post-pneumonectomy studies)

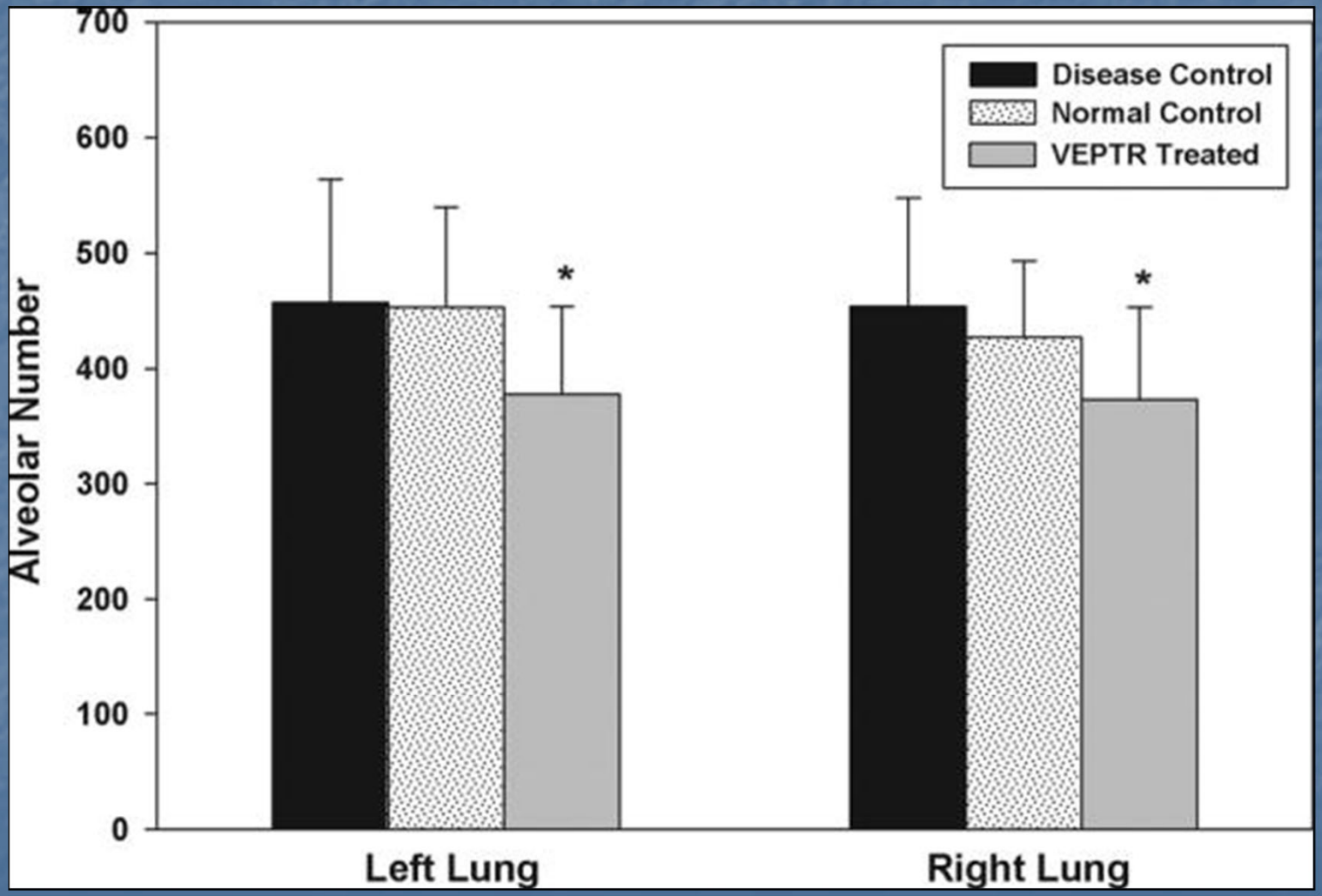
- Lung stretch (phasic and tonic) and space available for lung growth
- Alveolar Hypoxia
- Postnatal Plasticity/Maturation
- Adrenal and other endocrine function
- In-utero and post-natal tobacco smoke

Hsia CC, J *Appl Physiol* 97:1992-1998, 2004.

Windows of Responsiveness to Insults and Interventions



Alveolar Numbers with Expansion Thoracoplasty in Rabbits



Mehta HP, et al. *Spine* 35(2):153-161, 2010.

Summary

- There is circumstantial and experimental evidence that EOS can produce postnatal pulmonary hypoplasia.
- Postnatal lung hypoplasia can worsen lung function associated with spine & chest wall deformities.
- Strategies to prevent lung hypoplasia and perhaps promote compensatory lung growth should be considered a goal of treatments.