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Neonatal Experience of Improving Ventilation





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Mount Pilatus



Main Topics

- History of neonatal ventilation
 - Milestones in the treatment of neonatal lung disease
- Impact of improved mechanical ventilation strategies
 - The Lucerne experience
- Current strategies

- State-of-the-Art

Historical Background



Philip Drinker & Louis Agassiz Shaw



Respiratory Support 1950s



Kate Campbell

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Campbell K.

Intensive oxygen therapy as a possible cause of retrolental fibroplasia in premature infants.

Am J Ophthalmol 1951;2:48-50





Poliomyelitis Epidemic



Poliomyelitis Epidemic



Poul B. Astrup and Bjorn Ibsen



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Very Early Reports: Modified Drinker



Donald I, Lord J.

Augmented respiration: Studies in atelectasis neonatorum.

Lancet 1953;1:9-17



Very Early Reports: Modified Drinker



Very Early Reports: Engström

Acta Anaesthesiologica Scandinavica An International Journal of Anaesthesiology and Intensive Care, Pain and Emergency Medicine

Benson F, Celander O, Haglund G, et al.

Positive-pressure ventilator treatment of severe pulmonary insufficiency in the newborn infant.

Acta Anesthesiol Scand 1958;2:37-43



Mary Ellen Avery



Patrick Bouvier Kennedy



born Aug. 7, 1963; died Aug. 9, 1963

Robert H. Usher

PEDIATRICS

Usher R.

Reduction of mortality from RDS of prematurity with early administration of intravenous glucose and sodium bicarbonate.

Pediatrics 1963;32:966-975





Daniel Stowens

American Journal of Clinical Pathology

Stowens D.

Hyaline membrane disease: morbid anatomy, hypothesis of its pathogenesis, and suggested method of treatment.

Am J Clin Pathol 1965;44:259-270



The Deadly Membrane

Last week Dr. Daniel Stowens, a Louisville pathologist, said he had found the explanation of H.M.D. and a simple, effective treatment: Epsom salts enemas.

Early PPV: East Radcliffe Pump



Heese HD, Wittman W, Malan AF.

The management of the respiratory distress syndrome of the newborn with positive-pressure respiration.

S Afr Med J 1963;37:123-126







Early PPV: Bird Mark VIII

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Archives of Disease in Childhood

Papadopoulos MD, Swyer PR.

Assisted ventilation in terminal hyaline membrane disease.

Arch Dis Child 1964;39:481-484







Early NPV: Emerson

the New York Academy of Sciences

Stahlman MT, Young WC, Gray J, Shepard FM.

The management of respiratory failure in the idiopathic respiratory distress syndrome of prematurity.

Ann N Y Acad Sci 1965;121:930-941







Graham Liggins

PEDIATRICS

Liggins GC, Howie RN.

A controlled trial of antepartum glucocorticoid treatment for the prevention of RDS in premature infants.

Pediatrics 1972;50:515-525







Glucocorticoids



Glucocorticoids



Functional maturation
surfactant (PC, SP-A, SP-B)
ACE(SCD, Cat, CP)

Structural maturation

thinning of alveolar septa
microvascular maturation

Extrapulmonary effects

improved hemodynamics

Microvascular Maturation



Roth-Kleiner M, Berger TM, Tarek MR, et al. Dev Dynam 2005;233:1261-1271

Neonatal dexamethasone induces premature microvascular maturation of the alveolar capillary network



Microvascular Maturation



Roth-Kleiner M, Berger TM, Tarek MR, et al. Dev Dynam 2005;233:1261-1271

Neonatal dexamethasone induces premature microvascular maturation of the alveolar capillary network







High incidence of air leaks High mortality associated with air leaks Prophylactic chest tubes

Air Leaks

PEDIATRICS

Kuhns LR, Bednarek FJ, Wyman ML, Roloff DW, Borer RC.

Diagnosis of pneumothorax or pneumomediastinum in the neonate by transillumination.

Pediatrics 1975;56:355-360





William Northway



The New England Journal of Medicine

Northway WH Jr, Rosan RC, Porter DY.

Pulmonary disease following respiratory therapy of hyaline membrane disease: Bronchopulmonary Dysplasia.

N Engl J Med 1967;267:357-368









George Gregory



The New England Journal of Medicine

Gregory GA, Kitterman JA, Phibbs RH, Tooley WH, Hamilton WK

Treatment of the idiopathic respiratory-distress syndrome with continuous positive airway pressure.

N Engl J Med 1971;284:1333-1340





John Kattwinkel

PEDIATRICS

Kattwinkel J, Fleming D, Cha CC, Fanaroff AA, Klaus MH

A device for administration of continuous positive airway pressure by the nasal route.

Pediatrics 1973;52:131-134





Tetsuro Fujiwara

THE LANCET

Fujiwara T, Maeta H, Chida S, Morita T, Watabe Y, Abe T

Artificial surfactant therapy in hyalinemembrane disease.

Lancet 1980;1(8159):55-59



Barotrauma and/or Volutrauma



Respiratory and Critical Care Medicine

Dreyfuss D, Soler P, Basset G, Saumon G

High inflation pressure pulmonary edema. Respective effects of high airway pressure, high tidal volume, and positive end-expiratory pressure.





Am Rev Resp Dis 1988;132:1159-1164

Barotrauma and/or Volutrauma



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Oxygen Toxicity and Biotrauma

Journal of Applied Physiology

Kawano T, Mori S, Cybulsky M, Burger R, Ballin A, Cutz E, Bryan AC

Effect of granulocyte depletion in a ventilated surfactantdepleted lung.

J Appl Physiol 1987;62:27-33



Oxygen Toxicity and Biotrauma



Oxygen Toxicity and Biotrauma



Respiratory and Critical Care Medicine

Uhlig S, Ranieri M, Slutsky AS

To the Editor: Biotrauma hypothesis of ventilator-induced lung injury.

Am J Resp Crit Care Med 2003;167:314-315

Dreyfuss D, Ricard JD, Saumon G

From the Authors

Am J Resp Crit Care Med 2003;167:315



The Lucerne Experience



The Lucerne Experience



Berger TM, Bachmann II, Adams M, Schubiger G

Impact of improved survival of very low birth weight infants on incidence an severity of bronchopulmonary dysplasia.

Biol Neonate 2004;86:124-130

Study population

- retrospective single center cohort study
- three eras with distinct respiratory support strategies
- consecutive admissions of VLBW infants to the NCU

Era I: 1986-1990

Respiratory support		
Surfactant		

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Era I: 1986-1990

	Cohort A 1986-1990 (n=97)	
Respiratory support	CPAP, cIMV	
Surfactant	none	

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Era II: 1993-1994

	Cohort A 1986-1990 (n=97)	Cohort B 1993-1994 (n=100)	
Respiratory support	CPAP, cIMV	CPAP, cIMV	
Surfactant	none	Exosurf ®	

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Era III: 2000-2001

	Cohort A 1986-1990 (n=97)	Cohort B 1993-1994 (n=100)	Cohort C 2000-2001 (n=135)
Respiratory support	CPAP, cIMV	CPAP, cIMV	CPAP, sIMV HFOV
Surfactant	none	Exosurf [®]	Survanta [®]

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The Lucerne Experience

Biology of the Neonate

Berger TM, Bachmann II, Adams M, Schubiger G

Impact of improved survival of very low birth weight infants on incidence an severity of bronchopulmonary dysplasia.

Biol Neonate 2004;86:124-130

Conclusion

Changes in neonatal care of VLBW infants in our institution, including increased use of antenatal corticosteroids and modified respiratory support strategies, have resulted in dramatically improved survival rates over the past 15 years without increasing the incidence of moderate to severe BPD.

State-of-the-Art



Lung Protection



- 1. Lung protection starts in the delivery room
- ventilate gently
- use an oxygen blender and pulse oxymetry
- use early CPAP
- use a (natural) surfactant (early)

Lung Protection

2. Avoid atelecto- and volutrauma



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Lung Protection



Carney D, DiRocco J, Nieman G **Dynamic alveolar mechanics and VILI.** Crit Care Med 2005;33:S122-S128





Lung Protection



Carney D, DiRocco J, Nieman G **Dynamic alveolar mechanics and VILI.** Crit Care Med 2005;33:S122-S128











Lung Protection



Sick lungs are small lungs

Lung Protection



- 3. Do not normalize blood gases in a patient with sick lungs
 - avoid hypocapnia

- consider permissive hypercapnia
- consider permissive hypoxemia

Monitoring Technology

4. Monitor tidal volumes and observe flow-time curves to choose optimal inspiratory times (remember: TC = Cx R)



Sick premie lungs are fast lungs

Ventilator Technology



- 5. Available modes of ventilation should be viewed as different options with none having been shown to be clearly superior to the others
 - SIMV versus HFOV
 - invasive versus non-invasive ventilation

Ventilator Technology



6. The importance and potential impact of many recent technology refinements remain unclear

Today, we find ourselves surrounded by technologically advanced equipment with a veritable alphabet soup of neonatal ventilatory modes: IMV, SIMV, A/C, PSV, VG, PCV, BiPAP, APRV, PRVC

> Mark C. Mammel J Perinatol 2005; 25:624-625

Technology Assessment



It's the driver, not the machine.

It's not what you use, but how you use what you use.



Technology Assessment



Technology Assessment







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