The Evolution of Surfactant Administration for Respiratory Distress Syndrome of the Premature Newborn

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1

1

Disclosure

I have no actual or potential conflicts of interest or financial relationships to disclose in relation to this presentation.

I will be discussing the off-label use of pulmonary surfactant as delivered by unapproved devices. The only FDA-approved device for surfactant administration at present is an endotracheal tube.

2

2

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Learning objectives

At the conclusion of this program, participants will be able to:

- Describe how administration of exogenous surfactant improves respiratory mechanics and lung function in the premature neonate
- Explain the differences between various exogenous surfactant preparations
- Identify different indications and mechanisms for surfactant administration as well as their advantages and disadvantages

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Respiratory Distress Syndrome

First identified as a disease of fetal lungs "not accepting atmospheric air" in 1700s

Hyaline membrane disease – characterized by:

- Hypoinflation
- Homogenous appearance ("ground-glass opacities") + air bronchograms on film
- Fibrin deposition

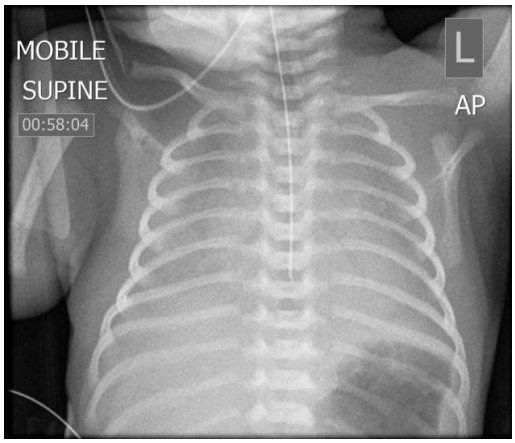

Image: https://radiopaedia.org/cases/severe-respiratory-distress-syndrome-rds?lang=us

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Obladen M. History of surfactant up to 1980. *Biol Neonate* **87** (2005): 308-16.

5

Discovery of the pathophysiology of RDS

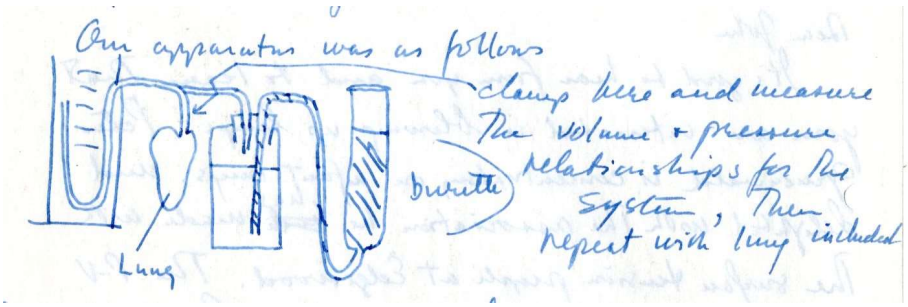

Image: https://collections.countway.harvard.edu/onview/exhibits/show/avery/item/5482.

Avery, 1959: identification of increased lung surface tension – due to decreased protein-laden phospholipid – as causative/associated etiologic agent in RDS

Chemical named pulmonary surfactant

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Avery ME and Mead J. Surface properties in relation to atelectasis and hyaline membrane disease. *Arch Pediatr Adol Med* **97** (1959): 517-23.

6

"All the News That's Fit to Print"

The New York Times.

LATE CITY EDITION

U. S. Weather Bureau Report (Page 56): Somewhat Mostly sunny today; clear and cool tonight. Sunny tomorrow. Temp. range: 64—67, yesterday: 85—68. Temp.-Hum. Index: mid-70's; yesterday: 78.

VOL. CXII..No. 38,547. © 1963 by The New York Times Company. Times Square, New York 36, N. Y. NEW YORK, THURSDAY, AUGUST 8, 1963. TEN CENTS

HAITI CLAIMS ROUT OF EXILE INVASION; ASKS O.A.S. INQUIRY

Embassy Says Force Fled and Cantave Escaped to Dominican Republic

REBELS DENY FAILURE

Accuse Duvalier Regime of Bluff—2d Band Reported Advancing From West

By HENRY RAYMONT
Special to The New York Times

WASHINGTON, Aug. 7 — Haiti announced through her embassy today that an invasion force had been dispersed in the northeastern part of the country.

Several rebels were killed or captured, an embassy spokesman said, but most of them appear to have fled to the Dominican Republic.

[Exiles in Santo Domingo, the Dominican capital, denied that the invaders had been defeated. They charged the Government with bluffing to limit the rebellion. There were reports that a column had landed in western Haiti in addition to the one that moved southwest from Cap Haïtien.]

Situation Held Fluid

Overture by Peking To U.S. Is Hinted At Talk in Warsaw

By PAUL UNDERWOOD
Special to The New York Times

WARSAW, Aug. 7—The Ambassadors here of the United States and Communist China met today for one of the longest sessions in the eight-year series of diplomatic exchanges between the two countries.

The time devoted to the conversation—three hours and 35 minutes—heightened speculation in Warsaw that the Chinese might be exploring the possibility of easing tensions between Peking and Washington.

Such an effort has been predicted in some Eastern European quarters as a counter-move to Peking's widening rift with Moscow.

In the past, the meetings of the two envoys have lasted only about 80 to 100 minutes. The length of today's session indicated that more than routine topics had been discussed.

In accordance with their agreement to maintain silence on the substance of their ex-

Continued on Page 2, Column 6

U.N. ADOPTS CURB ON SOUTH AFRICA

Council, 9-0, Calls for Ban

KENNEDY TO SEND TEST BAN TREATY TO SENATE TODAY

Message Will Explain Pact and Urge Ratification—Opposition Waning

Special to The New York Times

WASHINGTON, Aug. 7 — President Kennedy will send the treaty on a limited nuclear test ban to the Senate tomorrow amid expectations of overwhelming approval.

He will also send a 3,000-word message explaining the agreement between the United States, Britain and the Soviet Union and urging the Senate to approve it.

Banning nuclear testing in the atmosphere, in space and under water, but not underground, the pact will become binding upon ratification by the three powers.

The ratification procedures are virtually automatic in Britain and the Soviet Union. But lengthy hearings and a floor debate will precede the vote in the Senate here, which will probably come next month.

Signature Is Needed.

In technical language, ratification will take place when the President signs the document expressing the Senate's advice and consent to the treaty.

[In Moscow, Soviet and Western officials indicated

2d Son Born to Kennedys; Has Lung Illness

Child Transferred to Boston After Birth at Cape Hospital

By WILLIAM M. BLAIR
Special to The New York Times

BOSTON Aug. 7—A second son, Patrick Bouvier Kennedy, was born to President and Mrs. Kennedy at Otis Air Force Base on Cape Cod today. A few hours later the premature infant was rushed to Boston for treatment of a respiratory ailment.

The President flew from Washington to Cape Cod but arrived 46 minutes after the baby was born. Tonight the President flew to Boston to be near the child.

Mrs. Kennedy's condition was reported to be "fine."

The baby's difficulty was described as trouble in breathing. There was no official report on his condition beyond a description of the trouble, which medical authorities here said was not uncommon in premature babies.

The boy was born five and a half weeks prematurely, according to Dr. John W. Walsh of Washington, Mrs. Kennedy's personal physician and obstetrician. He delivered the child by Caesarean section in the Otis Air Force Base Hospital.

The baby weighed 4 pounds 10½ ounces, and measured 17 inches long.

Shortly after his birth at 12:15 P.M., the baby was baptized by the Rev. John Scahill, a Roman Catholic priest at Otis.

The baby is named for his late great-grandfather, Patrick Joseph Kennedy, and his grandfather, Joseph Patrick Kennedy, the President's father and former Ambassador to Britain. His middle name is his mother's maiden name.

The President flew here from Otis to confer with doctors at Boston Children's Hospital Medical Center, to which the baby has been transferred by ambulance.

Mr. Kennedy arrived at Children's Hospital at 9:25 P.M. and spent 20 minutes on the fifth floor of the Farley Building, which is the division for new babies. He then went to the Ritz-Carleton Hotel for the night.

Tomorrow he will return to Otis to visit Mrs. Kennedy and

Continued on Page 18, Column 1

President Kennedy arriving last night at the Children's Hospital Medical Center in Boston. At right is Dr. Landon Snedeker, assistant to general director of the center.

Associated Press

PICKETING GOES ON AS LEADERS SPURN ROCKEFELLER PACT

Demonstration Due at U.N. in Move to Tie Up Work at the World's Fair

GOVERNOR DENOUNCED

Marchers Charge 'Sellout' as Ministers Call Off Protest in Brooklyn

By HOMER BIGART

Governor Rockefeller's accord with a group of Brooklyn Negro ministers who have charged discrimination in the building trade unions was rejected as inadequate yesterday by a joint committee of civil rights leaders.

This action by the six-group Joint Committee for Equal Employment Opportunity threatened to stir confusion and disunity on the civil rights front.

Last night the Brooklyn chapter of the Congress of Racial Equality announced that picketing at the Downstate Medical Center construction site would be resumed at 7 A.M. today. Demonstrations at the Brooklyn project had been ordered halted by the ministers, although

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What is a surfactant?

Surfactant = surface-active agent

Chemicals that reduce the surface tension between two adjacent substances

- Wetting agents
- Detergents

Consist of hydrophilic and hydrophobic parts

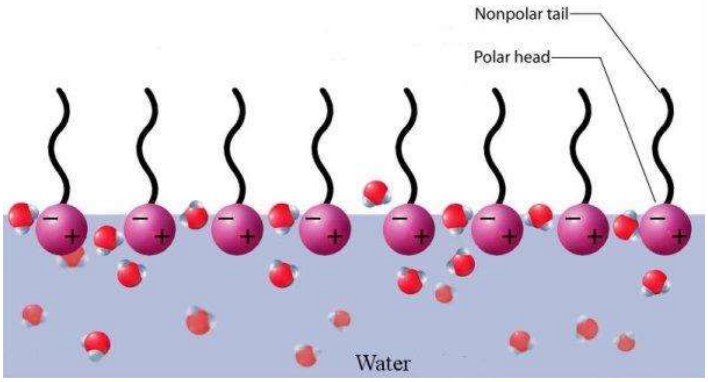

Image: https://sagescript.com/2012/03/03/what-is-a-surfactant/.

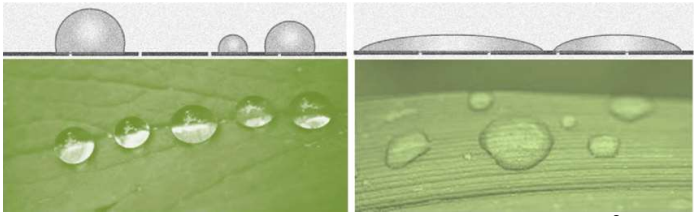

Image: https://www.researchgate.net/figure/Water-droplet-without-left-and-with-surfactant-right-Agricultural-surfactants-can_fig3_341867348.

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Pulmonary surfactant

Secreted by type II alveolar cells (pneumocytes)

Consists of two major components:

- Phospholipids (DPPC, others)
  - Reduce surface tension at air-liquid interface
- Proteins (SP-A, SP-B, etc.)
  - Support PL stability
  - Immunological activation
  - Recycling

Lines the interior surface of the alveolar sac

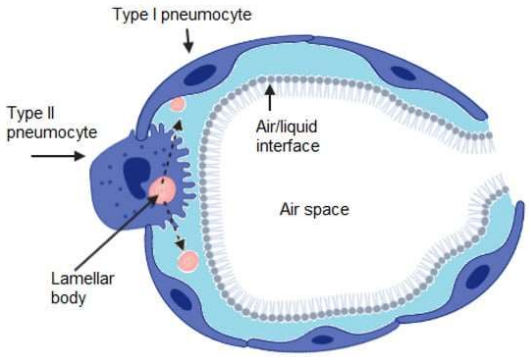

Image: Dziura et al. Simulated breathing: application of molecular dynamics simulations to pulmonary lung surfactant. *Symmetry* **13** (2021): 1259.

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Functionality of surfactant

- Increases pulmonary compliance $$C = \frac{\Delta V}{P_{alv} - P_{pl}}$$
- Decreases alveolar/small airways collapse at the end of expiration (atelectasis)
- Allows for inflation/expansion of collapsed alveoli/segments
- Prevents collapse of smaller alveoli into larger ones

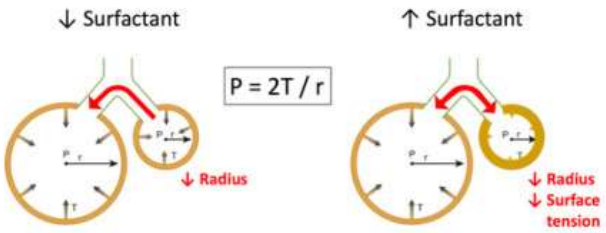

Image: https://www.tumblr.com/mcatmemoranda/179266358111/according-to-the-lw-of-laplace-if-the-surface.

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10

Pathophysiology of RDS

Immature lung structure and function → decreased endogenous surfactant effect

- Decreased number of type II pneumocytes
- Decreased pool of surfactant (2-10% of term infants)
- Immature surfactant composition

Other factors

- Structural maturity of terminal airways
- Decreased diaphragmatic musculature
- Decreased chest wall rigidity
- Immature respiratory drive

Hallmarks of RDS
Decreased lung compliance → hypoinflated lungs
Pulmonary edema ("ground-glass opacities" and "air bronchograms")
Impaired O_2 and CO_2 diffusion between pulmonary vasculature and airspaces
Increased dead space
Tachypnea, retractions
Respiratory failure requiring mechanical ventilation

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Ainsworth SB. Pathophysiology of neonatal respiratory distress syndrome. *Treat Resp Med* **4** (2005): 423-37.

11

Other clinical conditions

Most common: RDS of the premature infant

Exposure to maternal diabetes: delayed lung maturation

Surfactant inactivation:

- Meconium aspiration syndrome
- Inflammatory lung injury

Genetic mutations associated with surfactant dysfunction

- SP-B
- ABCA3
- SP-C

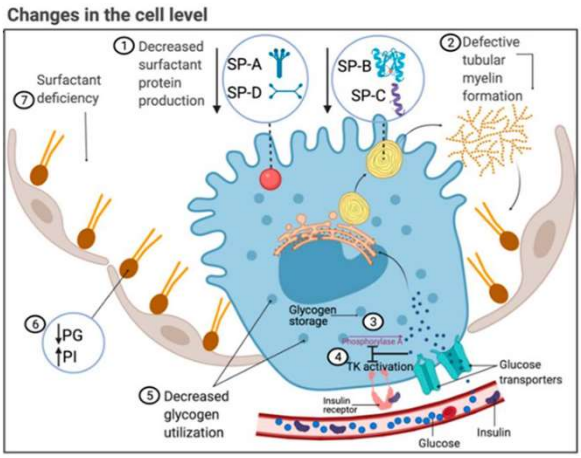

Image: Atar HY et al. Molecular mechanisms of maternal diabetes effects on fetal and neonatal surfactant. *Children* **8** (2021): 281.

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12

Treating & preventing RDS

Prevent prematurity

Optimize maternal glucose control in diabetes

Promote surfactant production and maturation

- Fetal stress *in utero*
- Maternal antenatal steroids
- Inflate the lungs (CPAP)
- Time (4-5 days)

Prevent complications

- Prevent barotrauma/volutrauma → avoid/minimize MV → permissive hypercapnia, gentle ventilation
- Support spontaneous breathing → caffeine, avoidance of sedation

Exogenous surfactant therapy

13

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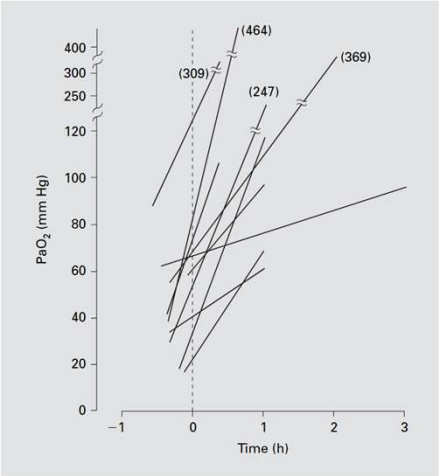
History of surfactant replacement

Various chemical compounds

- Nebulized tyloxapol detergent mist ("Alevaire")
- Principal phospholipid in natural surfactant: DPPC

Natural surfactants

- Preclinical experiments in rabbits and lambs
- Fujisurf (1980)
  - Saline-extracted minced bovine lung
  - 10 premature infants (GA ~ 28-33 weeks) with HMD
  - Mechanically ventilated on high settings without improvement
  - Instilled via ETT
  - Improved PaO2 and reduced FiO2 in all babies



14

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Fujiwara T et al. Artificial surfactant therapy in hyaline-membrane disease. *Lancet* **315** (1980): 55-9.

14

Effectiveness of surfactant

1980s-90s: trials to prove Fujiwara's findings

- Fujiwara's experiment consistently replicated with both natural (animal-derived) and synthetic surfactants
- RCT's vs. control (no therapy) demonstrated:
  - Improved short-term pulmonary outcomes (oxygenation, incidence of PIE and air leak)
  - Improved survival
  - Modest improvement in rates of BPD and BPD or death

Outcome	Prophylactic Surfactant		Rescue Surfactant	
	Animal Derived	Synthetic	Animal Derived	Synthetic
	N RR (95% CI)	N RR (95% CI)	N RR (95% CI)	N RR (95% CI)
Neonatal mortality	8 0.60 (0.47–0.77)	7 0.70 (0.58–0.85)	10 0.68 (0.57–0.82)	6 0.73 (0.61–0.88)
Pneumothorax	9 0.40 (0.29–0.54)	6 0.67 (0.50–0.90)	12 0.42 (0.34–0.52)	5 0.64 (0.55–0.76)
PIE	6 0.46 (0.36–0.59)	2 0.68 (0.50–0.93)	8 0.45 (0.37–0.55)	4 0.62 (0.54–0.71)
BPD[a]	8 0.91 (0.79–1.05)	4 1.06 (0.83–1.36)	12 0.95 (0.84–1.08)	5 0.75 (0.61–0.92)
BPD/death[a]	8 0.80 (0.72–0.88)	4 0.89 (0.77–1.03)	12 0.83 (0.77–0.90)	4 0.73 (0.65–0.83)

N, number; PIE, pulmonary interstitial emphysema.
[a] Defined at 28 d.

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Polin RA and Committee on Fetus and Newborn. Surfactant replacement therapy for preterm and term infants with respiratory distress. *Pediatrics* **133** (2014): 156-63.

15

Prophylactic vs. selective surfactant

Prophylactic surfactant: all infants born under a certain GA are intubated in the delivery room and given surfactant → prevent RDS from developing

Selective (rescue) surfactant: administered when infant's respiratory status decompensates to a predetermined level → treatment of established RDS

Both are beneficial! But…

- With the recent (2000 onward) increased use of CPAP in the delivery room, the benefit of prophylactic surfactant in prevention of mortality and BPD disappears;
- In modern trials (i.e. SUPPORT) where antenatal steroid use is high, there is significantly increased BPD in the prophylaxis group

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Rojas-Reyes MX, Morley CJ, Soll R. Prophylactic versus selective use of surfactant in preventing morbidity and mortality in preterm infants. *Cochrane Database Syst Rev* **14** (2012).

16

Surfactant preparations

Initial studies performed with "natural surfactant" – animal preparations

- Bulk of RCT's and subsequent meta-analyses have demonstrated superiority of surfactant generated from minced porcine lung (Curosurf) over other animal-derived surfactants especially at higher dose

First generation synthetic surfactants (colfosceril = Exosurf) were protein-free preparations and had no survival advantage, taken off the market

Second-generation synthetic surfactant (luminactant = Surfaxin) not inferior to natural surfactants but haven't captured widespread use

Ref.	First author	Year	Dose of Curosurf mg/kg	Curosurf n/N	Survanta* n/N
32	Speer	1995	200	1/33	5/40
45	Halahakoon	1999	100	5/17	3/10
35	Baroutis	2003	100	5/27	6/26
36	Ramanathan	2004	200	3/99	8/98
36	Ramanathan	2004	100	6/96	8/98
37	Malloy	2005	200	0/29	3/29
Total				20/301	33/301

Halliday HL. History of surfactant from 1980. *Biol Neonate* **87** (2005): 317-22.

17

17

Approved surfactant preparations in USA

Preparation	Brand Name	Source	Method	Dose
Colfosceril palmitate	Exosurf®	Protein-free 100% DPPC		5 mL/kg
Beractant	Survanta®	Calf lung	Minced	4 mL/kg
Calfactant	Infasurf®	Calf lung	Lavage	3 mL/kg
Poractant	Curosurf®	Porcine lung	Minced	2.5 mL/kg
Lucinactant	Surfaxin®	DPPG + POPC + sinapultide (21-AA peptide mimicking SP-B)		5.8 mL/kg

18

Jeon GW. Surfactant preparations for preterm infants with respiratory distress syndrome: past, present and future. *Korean J Pediatr* **62** (2019): 155-61.

18

Indications for surfactant use

At risk preterm infants who:

- Require intubation and mechanical ventilation due to
  - Unstable apnea
  - Respiratory failure necessitating MV for O_2 delivery or CO_2 clearance
- Are managed by non-invasive ventilatory support but meet prespecified thresholds for surfactant benefit:
  - FiO_2 (often 40%)
  - PCO_2 (often > 65 mmHg following recruitment maneuvers)
- Most effective when administered in the first two hours of life

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Rojas-Reyes MX, Morley CJ, Soll R. Prophylactic versus selective use of surfactant in preventing morbidity and mortality in preterm infants. *Cochrane Database Syst Rev* **14** (2012).

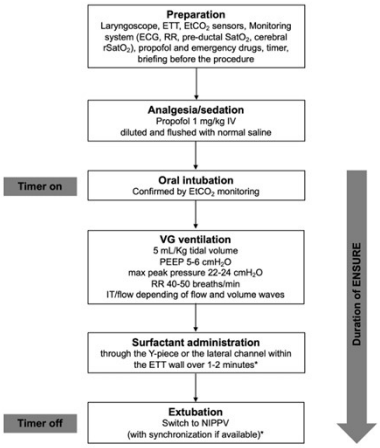
19

Avoiding prolonged mechanical ventilation: INSURE

Traditional approach: intubation and mechanical ventilation for infants meeting criteria

INSURE

- Described by Verder et al. in 1992
- INtubate, SURfactant, then Extubate
- Limits exposure to mechanical ventilation
- Limitations
  - Rapidly changing compliance → risk of air leak
  - Poorly characterized → ENSURE
  - Extubation failure (~10%)
  - Concerns about lung injury even with brief exposure to MV



Fortas F et al. Enhanced INSURE (ENSURE): an updated and standardized reference for surfactant administration. *Eur J Pediatr* **181** (2022): 1272

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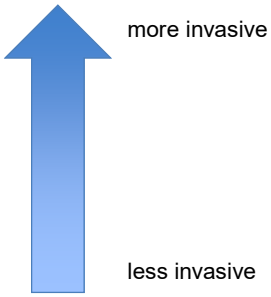
Ng EH and Shah V. Guidelines for surfactant replacement therapy in neonates. *Paediatr Child Health* **26** (2021): 35-41.

20

Less invasive methods for surfactant administration

A variety of approaches have been suggested and studied:

- Thin-catheter technique: direct laryngoscopy and surfactant delivery via endotracheal intubation with small-bore tube
- Surfactant delivery via supraglottic/laryngeal airway
- Pharyngeal administration of surfactant
- Nebulized surfactant



Control comparisons either with CPAP alone or INSURE (measuring intubation rates)

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21

Nebulized surfactant

Many putative advantages

- Non-invasive, avoids direct laryngoscopy
- Low equipment costs – everyone has a nebulizer

Few published studies, mostly low-quality

2021 meta-analysis (mostly unreviewed data) suggests that effect is limited to more mature babies and is modest

Dani C et al. A randomized, controlled trial to investigate the efficacy of nebulized poractant alfa in premature babies with respiratory distress syndrome. *J Pediatr* **246** (2022): 47.e2.

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Gaertner VD et al. Surfactant nebulization to prevent intubation in preterm infants: a systematic review and meta-analysis. *Pediatrics* **148** (2021): 1-9.

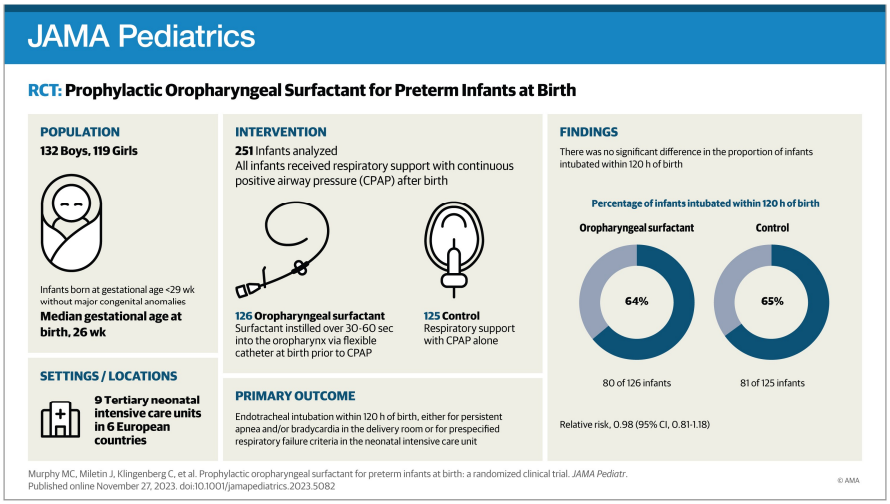
22

Pharyngeal instillation of surfactant

Takes advantage of spreading properties of surfactant compounds

Only one RCT (POPART):

- Found no difference compared with CPAP alone


JAMA Pediatrics

RCT: Prophylactic Oropharyngeal Surfactant for Preterm Infants at Birth

POPULATION
132 Boys, 119 Girls
Infants born at gestational age <29 wk without major congenital anomalies
Median gestational age at birth, 26 wk

SETTINGS / LOCATIONS
9 Tertiary neonatal intensive care units in 6 European countries

INTERVENTION
251 Infants analyzed
All infants received respiratory support with continuous positive airway pressure (CPAP) after birth
126 Oropharyngeal surfactant Surfactant instilled over 30-60 sec into the oropharynx via flexible catheter at birth prior to CPAP
125 Control Respiratory support with CPAP alone

PRIMARY OUTCOME
Endotracheal intubation within 120 h of birth, either for persistent apnea and/or bradycardia in the delivery room or for prespecified respiratory failure criteria in the neonatal intensive care unit

FINDINGS
There was no significant difference in the proportion of infants intubated within 120 h of birth
Percentage of infants intubated within 120 h of birth
Oropharyngeal surfactant 64% (80 of 126 infants)
Control 65% (81 of 125 infants)
Relative risk, 0.98 (95% CI, 0.81-1.18)

Murphy MC, Miletin J, Klingenberg C, et al. Prophylactic oropharyngeal surfactant for preterm infants at birth: a randomized clinical trial. *JAMA Pediatr*. Published online November 27, 2023. doi:10.1001/jamapediatrics.2023.5082
© AMA

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Murphy MC et al. Prophylactic oropharyngeal surfactant for preterm newborns at birth: a randomized clinical trial. *JAMA Pediatr* **178** (2024): 117-24.

23

Surfactant via supraglottic airway

SALSA technique: blind insertion of supraglottic airway device (SAD, i.e. laryngeal mask airway) followed by administration via Y-site adapter to spontaneously breathing infant

First described in early 2000s, first RCT in 2013

- Avoids the needs for personnel skilled at laryngoscopy
- Supraglottic airway already a part of NRP training
- Relatively non-invasive
- Maintenance of PEEP

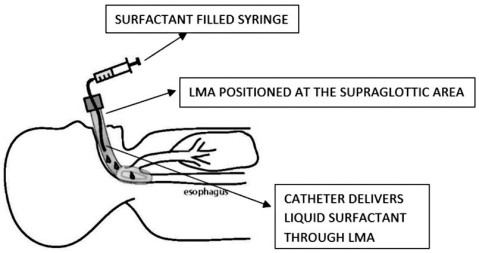

Image: Mani S and Rawat M. Less invasive surfactant administration: a viewpoint. *Am J Perinatol* **41** (2024): 212.

Use cases:

- LMIC → Azerbaijan and Jordan experiences, also Tanzania and Brazil
- HIC: community settings

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Zapata HA et al. Surfactant administration through laryngeal or supraglottic airways (SALSA): a viable method for low-income and middle-income countries. *Front Pediatr* **10** (2022): 1-9.

24

Video: Guthrie SO and Roberts KD. Less invasive surfactant administration methods: who, what and how. *J Perinatol* **44** (2024): 472-77.

25

Use of SALSA

2024 Cochrane systematic review of 510 infants across 8 randomized trials:

- All compared SALSA with endotracheally-administered surfactant
- No head-to-head trials with other less-invasive methods (LISA)
- Results: little to no effect on composite death or BPD outcome, but may reduce need for mechanical ventilation at any time
  - Insufficient data to support or refute SALSA in smallest babies < 1500 grams or 32 weeks GA

Other limitations:

- No availability of supraglottic airways for infants < 1250 grams
- Limited SAD availability at present in LMIC
- Limited surfactant availability especially in LIC

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26

Abdel-Latif ME, Walker E, and Osborn DA. Laryngeal mask airway surfactant administration for prevention of morbidity and mortality in preterm infants with or at risk of respiratory distress syndrome. *Cochrane Database Syst Rev* **25** (2024).

26

Thin catheter techniques

Most invasive and best studied of the less-invasive approaches

Nomenclature

- LISA: less invasive surfactant administration – Cologne method: flexible catheter (4 Fr feeding tube) inserted below vocal cords using Magill forceps
- Take Care: flexible catheter (shortened 5 Fr feeding tube) inserted below vocal cords without Magill forceps
- MIST: minimally-invasive surfactant therapy – Hobart method: stiff catheter (16 Ga vascular catheter) inserted below vocal cords without Magill forceps

Some evidence that stiff catheter technique is faster and easier

Magill forceps (used for nasal intubation) are not frequently used for neonatal airway instrumentation in USA

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27

27

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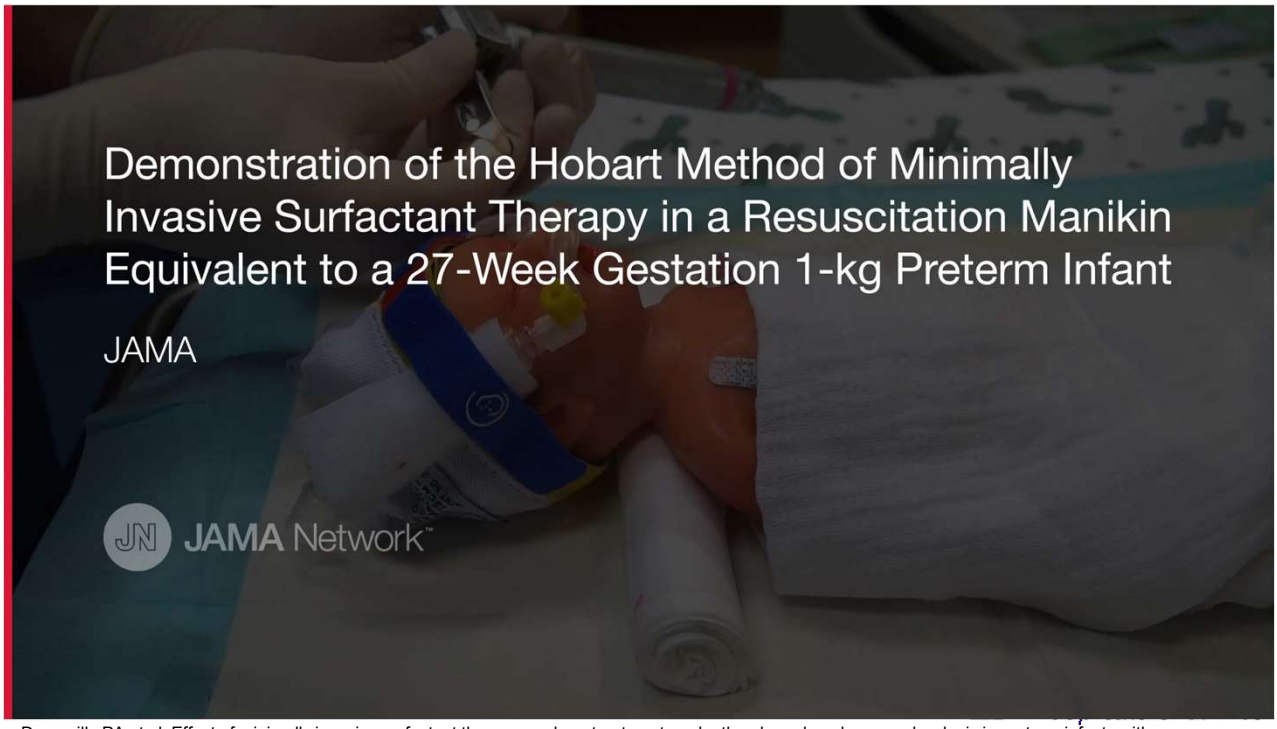
28

Video: Göpel W et al. Avoidance of mechanical ventilation by surfactant treatment of spontaneously-breathing preterm infants (AMV): an open-label, randomized, controlled trial. *Lancet* **378** (201): P1627-34.

28



Video: Dargaville PA et al. Effect of minimally invasive surfactant therapy vs sham treatment on death or bronchopulmonary dysplasia in preterm infants with respiratory distress syndrome: the OPTIMIST-A randomized clinical trial. *J Am Med Assoc* **326** (2021): 2478-87.

29

Evidence supporting thin catheter techniques

Numerous observational studies as well as RCTs, all in modern era of CPAP-based post-delivery care

2024 umbrella review

Comparator: INSURE

Findings:

- Reduced risk of death or BPD
- Less need for intubation
- Reduced complication rate
- Decreased NEC?

Outcome	Abdel-Latif et al 2021 [9]	Aldana-Aguirre et al 2017 [10]	Bellos et al 2021 [15]	Cao et al 2020 [16]	Isayama et al 2016 [17]	Lau et al 2017 [18]	Rigo et al 2016 [19]	Silveira et al 2023 [21]	Wu et al 2021 [20]
Death or BPD									
Death									
BPD									
Intubation (72 hours)									
IVH (Grade 2 or more)									
Pneumothorax									
NEC									

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30

Kuitunen I and Räsänen K. Less invasive surfactant administration compared to intubation, surfactant, rapid extubation method in preterm neonates: an umbrella review. *Neonatology* (2024): 1-9.

30

Recommendations from consensus bodies

Most recent UK guideline (2019):

Surfactant

1.2.2 Give surfactant to preterm babies who need invasive ventilation for stabilisation in the early postnatal period.

1.2.3 When giving surfactant to a preterm baby who does not need invasive ventilation, use a minimally invasive administration technique. If this is not possible, for example, in units without the facilities or trained staff to carry out these techniques, use endotracheal intubation to give surfactant, with early extubation afterwards.

European consensus guidelines (2022):

Recommendations

1. If a preterm baby <30 weeks of gestation requires intubation for stabilisation, they should be given surfactant (A2).
2. Babies with RDS needing treatment should be given an animal-derived surfactant preparation (A1).
3. LISA is the preferred method of surfactant administration for spontaneously breathing babies on CPAP (A1).

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National Institute for Health and Care Excellence. Specialist neonatal respiratory care for babies born preterm: NICE guideline NG124 (2019).
Sweet DG et al. European consensus guidelines on the management of neonatal respiratory distress syndrome: 2022 update. *Neonatology* **120** (2023): 3-23.

31

Considerations for using thin catheter techniques

When?

- CPAP > 6 cm / FiO_2 > 0.3

Patient selection

- Optimization of non-invasive support
- Avoid using for infants who require mechanical ventilation
  - Rapidly worsening respiratory disease
  - Unstable apnea

Unanswered questions

- Sedation/analgesia
- Co-administration of early caffeine therapy
- Role of video laryngoscopy
- Long term neurodevelopmental outcomes

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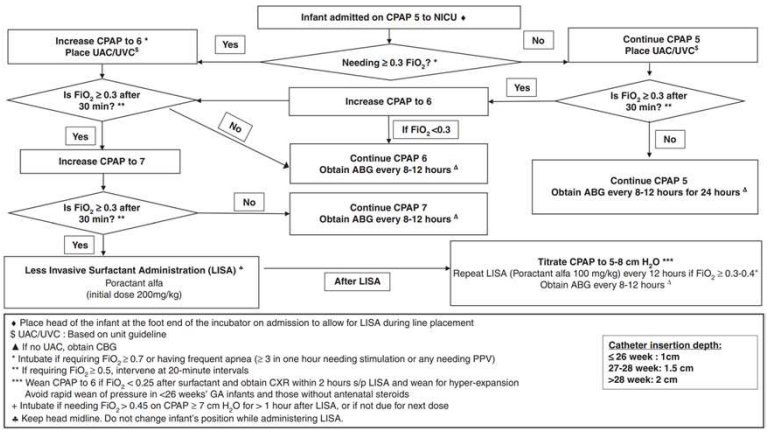
32

Our experience

None! Yet…

Preparation stage

- Synthesis of clinical practice guideline
- Availability of equipment
  - Stiff catheter
  - Video laryngoscope
- Training
  - Physician & APP staff
  - RRT
  - RN



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Kakkilaya V and Gautham KS. Should less invasive surfactant administration (LISA) become routine practice in US neonatal units? *Pediatr Res* **93** (2023): 1188-98.

33

Matt's tips for surfactant success

1. Be prepared for changing lung compliance immediately following surfactant administration. Use a mechanical ventilator (VTV) or T-piece resuscitator to disperse surfactant when delivering via ETT.
2. There is no longer evidence to support position changes while administering divided doses of surfactant.
3. Administer surfactant to intubated preterm babies as early as possible.
4. Premedication strategy should be individualized for each infant's clinical scenario. One size doesn't fit all.
5. Eliminate variations in care based on who is the attending physician of the moment. Use prespecified, unit-specific thresholds to determine candidacy for surfactant replacement therapy.
6. Support a culture of team-based care. Flatten existing hierarchies to allow for optimal communication pathways.

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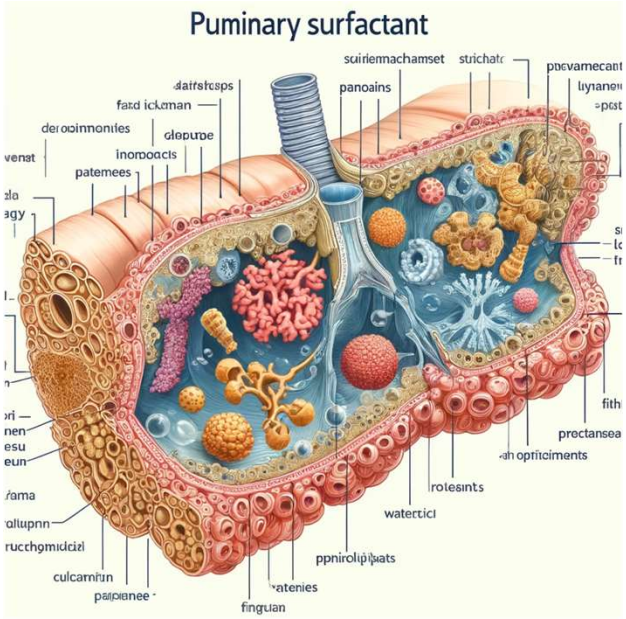
34

34



Here is the diagram illustrating pulmonary surfactant molecules at the air-water interface in an alveolus. The image shows a cross-sectional view of an alveolus with surfactant molecules, including proteins and phospholipids, arranged at the interface. This diagram is educational and suitable for use in a biology or medical textbook. You can view the image above.

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35

35