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A REVIEW ON DRUGS USED IN THE MANAGEMENT OF RESPIRATORY DISTRESS DUE TO SURFACTANT DEFICIENCY IN NEONATES FOCUS ON SURFACTANT THERAPY

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ABSTRACT

Respiratory distress syndrome (RDS) presents a significant challenge in neonatal care due to its complex pathophysiology and potential for severe complications. In this comprehensive review, we delve into the intricacies of RDS, focusing on its aetiology, clinical manifestations, and optimal management strategies. It arises from the disruption of the alveolar epithelial-endothelial permeability barrier, leading to the accumulation of protein-rich inflammatory fluid in the alveoli. This process is accompanied by dysregulated inflammation, impaired surfactant production, and compromised lung function, culminating in severe respiratory compromise. Effective management of RDS necessitates a multifaceted approach encompassing meticulous monitoring of oxygenation and ventilation, judicious use of assisted ventilation modalities, and timely administration of exogenous surfactant therapy. Non-invasive respiratory support methods, such as continuous positive airway pressure (CPAP) and nasal intermittent positive pressure ventilation (NIPPV), have emerged as preferred alternatives to invasive ventilation, offering comparable efficacy with fewer associated complications. Surfactant replacement therapy via endotracheal intubation remains a cornerstone of RDS management, with recent advancements in less invasive surfactant administration techniques showing promising results. However, further research is warranted to establish the optimal approach for surfactant delivery in neonates. Effective management of respiratory distress syndrome

(RDS) requires a multifaceted approach encompassing close monitoring, judicious use of assisted ventilation, and timely administration of surfactant therapy. Non-invasive respiratory support methods offer promising alternatives to invasive ventilation, while supportive care measures play critical roles in optimizing outcomes. Collaboration among clinicians and researchers is essential for refining treatment strategies and improving outcomes in neonates with RDS.

KEYWORDS: Respiratory distress syndrome, management, ventilation, neonates.

INTRODUCTION

Respiratory distress is a condition in which the body requires additional oxygen, resulting in rapid breathing, difficulty breathing, and low oxygen levels in the blood. Respiratory distress syndrome (RDS) is a condition primarily affecting neonates, particularly preterm infants, characterized by insufficient surfactant levels in the lungs, resulting in respiratory insufficiency.[1] Clinical manifestations include tachypnoea, retractions, grunting, and cyanosis. Management typically involves providing respiratory support with oxygen therapy, continuous positive airway pressure (CPAP), or mechanical ventilation as needed. Surfactant replacement therapy via endotracheal intubation is often indicated.[2] Complications may include pneumothorax, bronchopulmonary dysplasia, and intraventricular hemorrhage. Close monitoring and timely intervention are crucial in optimizing outcomes for neonates with RDS.[3]

Respiratory distress in noncardiogenic pulmonary edema is primarily caused by damage to the alveolar epithelial-endothelial permeability barrier.[4] This damage leads to an increased movement of proteins and fluid across the lung epithelium and endothelium, resulting in the accumulation of protein-rich inflammatory fluid in the normally fluid-free alveoli. Consequently, this causes increased lung weight and a loss of aerated lung tissue. These changes occur amidst dysregulated inflammation, inappropriate activity of leukocytes and platelets, and uncontrolled activation of coagulation pathways.[5] Additionally, there is a concurrent loss of surfactant and impairment of lymphatic drainage. Collectively, these physiological alterations manifest as the clinical hallmarks of ARDS, which include hypoxemia, bilateral radiographic opacities, increased venous admixture, decreased functional residual capacity, increased physiologic dead space, and decreased lung compliance. These changes may necessitate mechanical ventilation, supplemental oxygen, and increased minute ventilation to support breathing and gas exchange.[6] Respiratory failure

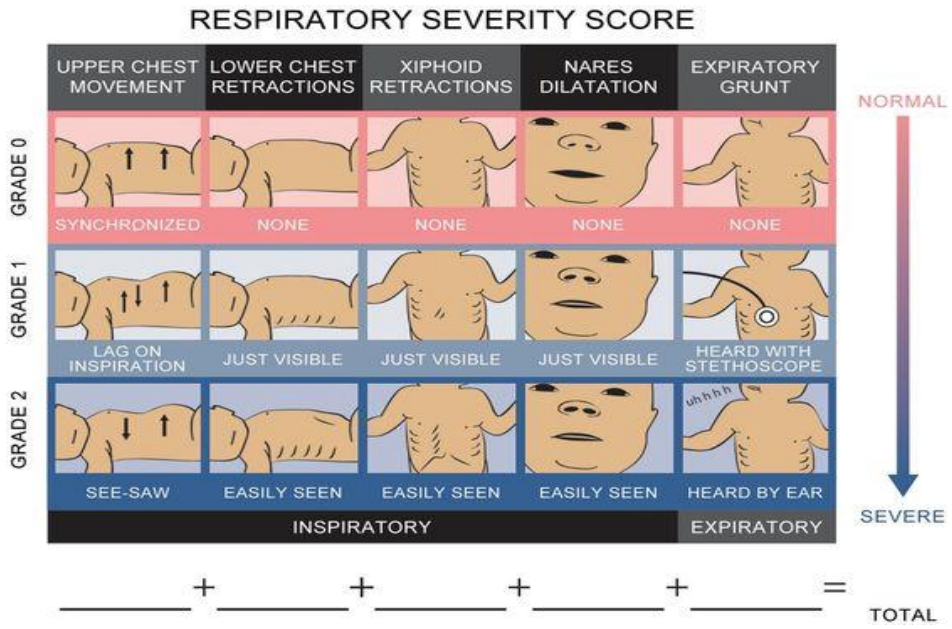
is the leading cause of death among children admitted to paediatric intensive care units (PICUs), with ARDS accounting for 1%–10% of these admissions.[7][8] Children with acute respiratory distress syndrome (ARDS) continue to experience high mortality rates, particularly when associated with specific comorbidities and causes of paediatric ARDS. Conditions such as immunocompromised states significantly increase the risk of mortality.[9]

The risk factors for respiratory distress encompass low birth weight and prematurity. Other contributing factors include being of white race, maternal diabetes, late preterm delivery, perinatal hypoxia, delivery without labor, male gender and ischemia.[10]

Table 1: Evaluating Long-Term Pulmonary Function in Paediatric Survivors of Paediatric Acute Respiratory Distress Syndrome.[2]

OUTCOME	TIME-FRAME	ADVANTAGE	DISADVANTAGE
Mortality	In-hospital	Related to processes of care. Easy to obtain	May be less informative than long- term mortality May be influenced by discharge/ transfer practice patterns
	Fixed time point: short term	Related to processes of care May be easy to obtain Less influenced by practice pattern	May be less informative than long- term mortality Somewhat arbitrary (e.g., death at 27 d is not markedly different than death at 29 d)
	Fixed Time point: Long - term	More relevant because it can capture entire risk period	Can be difficult to obtain Patients may be lost to follow-up
Organ Function	Short term: In hospital or fixed time point	Has biological plausibility Related to processes of care	Relationships between acute organ dysfunction and longer term, patient- centered outcomes not well established Some measures of organ dysfunction influenced by physician practice (e.g. duration of mitral valve, pressor use, duration of renal replacement therapy
	Long term	Has biological plausibility	Depending on the organ system and the evaluation tool, can be difficult and expensive to measure
Overall physical function	Short or long term	Important to patients Substantial Impact on quality of life	Changes markedly with development, and rates of development vary by individual. Thus, comparisons both within and between subjects may be difficult to interpret
Health related quality of life	Short or long term	Important to patients Substantial impact on quality of life	Changes markedly with development, and rates of development vary by individual. Thus, comparisons both within and between subjects may be difficult to interpret.

Severity Score [31]



The Silverman Andersen Respiratory Severity Score (RSS) assesses five breathing effort parameters and assigns a score ranging from "0" for a patient breathing comfortably to "10" for a patient experiencing severe respiratory distress.[31]

MANAGEMENT OF RESPIRATORY DISTRESS

Monitoring Oxygenation and Ventilation

To optimize oxygen supply and ventilation, serial blood gas monitoring may be essential. In neonates, it is typically done through an umbilical catheter or a peripheral arterial catheter placed using a sterile technique. The target ranges for partial pressure of arterial oxygen (PaO2) are 50-80 mmHg, partial pressure of arterial carbon dioxide (PaCO2) between 40-55 mmHg, and pH above 7.25.[1][3]

For oxygen saturation monitoring, non-invasive pulse oximetry is commonly used. However, the upper limits can sometimes be vague, impacting its effectiveness, as high SaO2 levels can correspond to significantly higher PaO2 values. Non-invasive capnography and transcutaneous carbon dioxide monitoring serve as additional tools for ventilation monitoring.[11]

Assisted Ventilation of the Neonate

The main goals of assisted ventilation are to decrease atelectasis by providing a constant positive airway pressure. The current preferred approach is the early introduction of

continuous positive airway pressure (CPAP) alongside selective surfactant administration.[12] In most healthcare institutions, non-invasive methods are prioritized over invasive ventilation as they reduce the risk of mortality and bronchopulmonary dysplasia (BPD) compared to invasive ventilation with or without surfactant.[13][14]

Continuous Positive Airway Pressure

Nasal Continuous Positive Airway Pressure is a primary intervention for premature infants with breathing difficulties or at risk of them, even without respiratory failure. Different methods exist for delivering CPAP, like ventilator-based CPAP and a more affordable bubble CPAP device. In the SUPPORT trial, infants on CPAP showed similar outcomes to those on prophylactic surfactant therapy with mechanical ventilation.[15] Infants who received early CPAP also needed less surfactant therapy, and the occurrence of BPD decreased with CPAP use. Treatment objectives include maintaining SpO2 between 90-95% and PaCO2 between 45-65 mmHg.[16]

Non-invasive Respiratory Support

Nasal Intermittent Positive Pressure Ventilation (NIPPV) has been found to be more effective than CPAP alone in reducing extubating failure and the need for intubation in preterm infants, while maintaining comparable cost and safety profiles. The key difference between NIPPV and CPAP is that NIPPV requires a ventilator to provide positive pressure ventilation, whereas CPAP can use a more cost-effective device, such as bubble CPAP, to deliver the necessary pressures.[17]

High Flow Nasal Canula

HFNC are utilized in some centres as a substitute for CPAP to provide positive distending pressure ventilation to neonates with RDS. However, a clinical trial by Roberts et al. indicated that HFNC was found to be less effective than CPAP.[2]

Exogenous Surfactant Therapy

Administering surfactant replacement therapy via an endotracheal tube is the primary treatment for surfactant deficiency. Providing surfactant within 30 to 60 minutes after the birth of a premature neonate has demonstrated positive effects, accelerated recovery and reducing the risks of various complications such as pneumothorax, interstitial emphysema, intraventricular hemorrhage (IVH), bronchopulmonary dysplasia (BPD), and neonatal mortality both during the hospital stay and at one year. However, neonates receiving

surfactant for established RDS are at a higher risk of apnea of prematurity. As per European consensus guidelines, surfactant is administered to premature infants with FiO2 levels surpassing 0.3 and to mature infants with FiO2 levels exceeding 0.4.[18][1]

Surfactant can be administered through the standard method of endotracheal intubation, usually performed by a skilled practitioner, or through less invasive techniques like the Less Invasive Surfactant Administration (LISA) method.[19] LISA offers options such as aerosolized nebulized surfactant, insertion of a laryngeal mask, instillation in the pharynx, and using thin intratracheal catheters.[20] The traditional approach of surfactant delivery via endotracheal intubation and mechanical ventilation can result in temporary airway blockage, lung injury, air leaks in the lungs, and damage to the airways.[21]

Recent research suggests that the LISA technique is associated with a reduced occurrence of bronchopulmonary dysplasia (BPD), lower mortality rates, and decreased need for mechanical ventilation compared to administering surfactant through endotracheal intubation.[22] However, further studies are required to determine if the LISA technique should be favoured over endotracheal intubation as the standard surfactant administration method.[23]

In cases where newborns maintain sufficient respiratory function with FiO2 levels below 0.3, it might be appropriate to contemplate discontinuing surfactant therapy and transitioning to continuous positive airway pressure (CPAP).[24] It is essential to monitor oxygen saturation levels (keeping them above 90%), ensure proper regulation of body temperature (within 36.5 to 37.5 degrees Celsius), and carefully observe fluid and nutrition intake.[25]

Administering surfactant slowly to minimize acute physiological changes during treatment can lead to suboptimal distribution. A slow administration rate may result in non-uniform surfactant distribution, which is not the desired outcome.

CRITERIA FOR SURFACTANT ADMINISTRATION

<24 weeks' gestational age: Right after birth, babies need to have a tube inserted into their airway, and a substance called surfactant should be given preventively within the first 15 to 30 minutes of being born. During the time between inserting the tube and giving surfactant, it's crucial to provide gentle breathing support with small amounts of air and low pressures.[27][32]

≥24 weeks' gestational age: Babies who are intubated right after birth should get surfactant treatment early (within 2 hours of birth), unless they are breathing well on their own with minimal support when they reach the neonatal intensive care unit. These babies should then be extubated immediately and transitioned to nasal ventilation or nasal continuous positive airway pressure.[27][28]

When infants are initially managed with non-invasive ventilation, they should undergo endotracheal intubation and receive surfactant in the following circumstances.

a) If the fraction of inspired oxygen (FiO2) is greater than 0.5 to maintain oxygen saturation (SpO2) above 88% or if the partial pressure of arterial oxygen (PaO2) exceeds 45 mmHg.

b) If the partial pressure of arterial carbon dioxide (PaCO2) is higher than 55 mmHg to 60 mmHg with a pH below 7.25.

c) If there is apnea necessitating bag and mask ventilation.

d) If there are more than 6 apneic episodes within a 6-hour period.

e) If there are indications of significant respiratory effort, such as retractions, grunting, and chest wall distortion in infants with increased oxygen requirements.[26][29][33]

Procedure

The physician will assess if the patient can receive surfactant treatment and will order it. The doctor should be present during the surfactant administration. The respiratory therapist will inform the nurse about the surfactant. They will perform a baseline check including:

- Breathing check: respiratory rate, pressures, volumes, and TcPCO2.
- Chest exam: air entry, sounds, chest expansion, and secretions.
- Vital signs: heart rate, SpO2, and BP.
- Patient status: awake, asleep, or sedated.
- Chest X-ray review: to check ETT position and lung volume.[30][29][33]

Equipment Set-Up

The respiratory therapist (RRT) should prepare the equipment according to the following steps.

1. Retrieve the surfactant from the freezer and allow it to reach room temperature for a maximum of 30 minutes before usage. Gently roll the vial, avoiding shaking.
2. Determine the necessary amount of surfactant.
3. Sterilize the vial's rubber cap with an alcohol swab before inserting the needle. Load the syringe with surfactant.

4. Connect the luer lock syringe containing the surfactant to the luer fitting.

5. Attach the trach care mac cartridge to the Y-connector.

6. Flush the catheter's internal volume with surfactant before connecting the trach care mac to the patient.

7. Establish a connection between the trach care mac adapter, the ventilator circuit, and the endotracheal tube (ETT).[28][30][34]

- **To ensure a professional and effective pre-surfactant delivery procedure, the Respiratory Therapist (RRT) should implement the following interventions**

1. Pre-oxygenation: Elevate the oxygen concentration to achieve an SpO2 level exceeding 95% before the surfactant administration.

2. Suctioning: Perform ETT suctioning and auscultate for adequate air entry.

3. Lung Recruitment Maneuver: Execute five to ten inflations at pressures ranging from 1 cmH2O to 2 cmH2O above the current ventilatory settings to optimize lung recruitment. This step enhances the distribution of the surfactant within the pulmonary airways.

4. Vital Signs Monitoring: Document essential vital signs, including heart rate, blood pressure, SpO2 levels, and TcPCO2 measurements, to ensure comprehensive patient assessment and monitoring throughout the procedure.[26][29][31]

SURFACTANT ADMINISTRATION

Surfactant needs to be administered using an in-line catheter positioned at the mid trachea level. The surfactant available is bovine lipid extract surfactant, with a required dose of 5 mL/kg (135 mg phospholipids/kg), split into one or a maximum of two portions.

Administration Method

- Inject the surfactant as a rapid infusion over 10 to 20 seconds.
- Disconnect the baby from the ventilator and utilize a flow inflating bag or T-piece device to bag the baby at a rate of 60 inflations per minute.
- Apply adequate pressure to ensure effective surfactant delivery into the pulmonary airways.
- Start bagging around 5 seconds after beginning surfactant administration to allow time for a fluid plug or surfactant column to form in the ETT.
- Use the minimum flow rate required to achieve proper pressures.
- Maintain the baby in a horizontal position during the entire procedure.
- If administering more than one portion, wait 30 to 60 seconds between portions, as long as the baby remains stable.

- Monitor vital signs and ventilator parameters continuously throughout the administration process.[28][30][31]

Post-Administration

- Record surfactant administration details in the medical records, including the time, number of portions, PIP and PEEP levels used, vital signs, and any complications.
- Refrain from suctioning the ETT for the next 2 hours unless there are indications of significant airway obstruction.

After administering the surfactant, the nurse should document vital signs immediately post-administration and then at 10-minute intervals for the subsequent hour. Simultaneously, the RRT should record ventilator parameters every 15 minutes during the following hour. This meticulous monitoring is crucial for assessing the patient's condition and response to the treatment.[25][28][30]

Methods of Surfactant Administration

1. Endotracheal Intubation and Surfactant Administration (ETSA)

It is a procedure where surfactant is directly instilled into the trachea through an endotracheal tube. It is typically done in infants with severe respiratory distress syndrome (RDS) who need mechanical ventilation. This method is often chosen for infants with high oxygen needs or significant respiratory acidosis.[32]

During the technique, the infant is intubated using an endotracheal tube, and the surfactant is given in divided doses, usually 2-4 doses. After each dose, manual ventilation is provided briefly to ensure even distribution of the surfactant in the alveoli. This process requires careful timing and coordination to prevent desaturation and bradycardia.[33]

The advantages of ETSA include the rapid delivery of surfactant directly to the lungs, which is effective for severe RDS cases.[34]

Disadvantage is that it is an invasive procedure with potential risks such as trauma, infection, the need for sedation, and the possibility of ventilator-associated lung injury.[35]

2. Less Invasive Surfactant Administration (LISA)

LISA is a method where surfactant is administered through a thin catheter inserted into the trachea while the infant is receiving non-invasive ventilation, such as CPAP. It is typically

used for infants with moderately severe respiratory distress syndrome (RDS) who can maintain adequate breathing and aims to avoid the need for mechanical ventilation.[36][37]

During the procedure, a thin catheter is carefully placed through the vocal cords into the trachea, and surfactant is slowly given while the infant continues to breathe spontaneously with the support of CPAP. It requires precise handling to minimize stress on the infant.[37]

The advantages of LISA include reducing the requirement for mechanical ventilation and its associated risks. This technique can be carried out while the infant remains on non-invasive ventilation.[38]

However, performing LISA necessitates skill and experience to decrease trauma and ensure effective delivery. It may not be suitable for infants with very severe RDS who urgently need intubation and ventilation.[38][39]

3. Aerosolized Surfactant Administration

Aerosolized Surfactant Administration is a technique where surfactant is aerosolized and delivered through inhalation using a nebulizer.[39][40]

This method is primarily experimental and is designed to treat respiratory distress syndrome (RDS) non-invasively, with potential applications for mild to moderate cases of RDS.

During the procedure, surfactant is converted into a fine mist using a nebulizer. The infant then inhales the aerosolized surfactant, ideally while receiving non-invasive respiratory support. Ongoing research is focused on determining the most effective nebulizers and protocols for this administration.[40][41]

The advantages of Aerosolized Surfactant Administration include being a non-invasive method that causes minimal discomfort and the potential to address RDS without the need for intubation.

However, there are limitations to this approach. It is currently less effective than direct instillation methods, faces challenges in ensuring uniform and adequate delivery to the alveoli, and is still in the clinical investigation phase, making it not widely accessible.[42][43]

4. Pharyngeal Surfactant Administration

It involves placing surfactant in the oropharynx right after birth, typically before the first breath.

This method is indicated for prophylactic use in extremely preterm infants to prevent the development of respiratory distress syndrome (RDS).[44]

In this technique, surfactant is instilled into the oropharynx immediately after birth, before the infant takes their first breath. The baby's initial breaths help distribute the surfactant into the lungs, and this procedure is usually performed in the delivery room for high-risk preterm infants.

The benefits of Pharyngeal Surfactant Administration include its simplicity and quick execution, as it can be done promptly after birth to prevent RDS.[45]

However, drawbacks of this approach include having less control over the distribution of surfactant and ongoing research to determine its effectiveness compared to other methods.[46]

5. Laryngeal Mask Airway (LMA)

Administering Surfactant via Laryngeal Mask Airway (LMA) involves delivering surfactant through an LMA, which is a device placed above the vocal cords to manage the airway.

This method is typically used as an alternative to endotracheal intubation for infants who require surfactant but do not need immediate mechanical ventilation.[47]

In the technique, an LMA is inserted into the larynx, creating a seal over the glottis. Surfactant is then administered through the LMA directly into the trachea, and this approach can be combined with non-invasive ventilation methods.[48]

The advantages of Surfactant Administration via LMA include being less invasive than endotracheal intubation, quick to perform, and associated with fewer complications.

Drawbacks of this method include potentially being less effective in distributing surfactant compared to direct intubation and requiring specialized training and expertise.[49][52]

6. INtubation-SURfactant-Extubation (INSURE)

The INSURE technique is a medical procedure primarily used to treat preterm infants with respiratory distress syndrome (RDS).[54] It involves three main steps.

1. Intubation: The infant is intubated with a breathing tube to establish an airway for delivering surfactant directly into the lungs.[54]

2. Surfactant Administration: Surfactant, which reduces surface tension in the lungs and helps keep the airways open, is administered through the breathing tube in a controlled, measured dose.[55][56]

3. Extubation: After the surfactant is delivered, the breathing tube is removed. The infant is then placed on non-invasive ventilation support, such as continuous positive airway pressure (CPAP), to maintain proper lung function and breathing without the need for the tube.[55][56]

The INSURE technique aims to minimize the duration of mechanical ventilation and reduce the risks associated with prolonged intubation, such as ventilator-associated lung injury and infections.[54][57]

During the Surfactant administration phase of the INSURE technique, the process involves several detailed steps.

1. Preparation

- The surfactant is warmed to body temperature if needed.
- The dose of surfactant is calculated based on the infant's weight.
- Equipment like the endotracheal tube (ET tube), laryngoscope, and surfactant vial is prepared and checked.[58][56]

2. Intubation

- The infant is positioned correctly, often with a neutral head position, to aid intubation.
- The laryngoscope is used to see the vocal cords, and the ET tube is gently inserted into the trachea.[58][59]

3. Surfactant Delivery

- The surfactant is given directly into the lungs through the ET tube, either as a single dose or in parts.
- The surfactant is administered slowly, typically over 1-2 minutes, to prevent rapid volume changes in the lungs that could lead to complications.[56][59]

4. Monitoring

- The infant's oxygen saturation, heart rate, and respiratory status are closely monitored during administration.
- The ET tube's position is confirmed, often by listening for breath sounds and, if needed, using a chest X-ray.[58]

5. Extubation

- After surfactant administration, the ET tube is removed.
- The infant is then placed on non-invasive respiratory support like CPAP or NIPPV to maintain proper oxygenation and ventilation.[59]

6. Post-Administration Care

After surfactant administration in the INSURE technique, the medical team closely monitors the infant for improvements in breathing, including higher oxygen levels and easier breathing. They may also check blood gases to evaluate how well the surfactant therapy is working.

If the baby continues to have breathing difficulties, additional doses of surfactant might be considered. This method is crucial in helping premature infants with respiratory distress syndrome by reducing lung surface tension, preventing alveolar collapse, and enhancing lung function and gas exchange. It's an effective approach that can decrease the need for mechanical ventilation and its related complications.[58][59][60]

Supportive Care

Preterm babies with apnea of prematurity may require caffeine therapy. Moreover, caffeine might be prescribed for preterm infants born before 28 weeks' gestation or with extremely low birth weight (less than 1000 grams) to boost their respiratory drive and enhance CPAP effectiveness. Studies have demonstrated a reduced incidence of bronchopulmonary dysplasia (BPD) and earlier extubating in preterm infants treated with caffeine compared to those given a placebo.[26][50]

Ensuring proper fluid and electrolyte balance is essential in the initial management of RDS. Some newborns may require fluids and vasopressors to address low blood pressure. Additionally, caring for preterm infants involves optimizing body temperature, providing

adequate nutrition, administering blood transfusions for anaemia, managing a significant PDA, and using antibiotics as required.[1][2][51]

Side effects of Surfactant

Surfactant replacement therapy plays a crucial role in managing neonatal respiratory distress syndrome (RDS), especially in premature infants. Although it is a life-saving treatment, it can come with several side effects.[61] Here are the primary side effects linked to surfactant therapy in neonates.

1. Bradycardia

- A temporary decrease in heart rate that can occur during surfactant administration. This is usually brief and can be addressed with supportive measures like pausing the administration and providing additional oxygen or stimulation.[61][62]

2. Oxygen Desaturation

- Temporary lowering of blood oxygen levels during or shortly after surfactant administration. This typically resolves quickly with appropriate monitoring and oxygen supplementation.[62][63]

3. Apnea

- Temporary cessation of breathing that may occur, requiring careful monitoring and sometimes intervention such as stimulation or mechanical ventilation support.[61][63]

4. Pulmonary Hemorrhage

- A serious but relatively rare side effect involving bleeding into the lungs, more common in very premature infants or those with severe RDS. Immediate medical intervention is necessary to manage this condition.[64]

5. Endotracheal Tube Obstruction

- Surfactant can occasionally block the endotracheal tube used for mechanical ventilation. Ensuring proper administration techniques and monitoring can help reduce this risk.[63][64]

Less common but serious side effects associated with surfactant therapy in newborns[61][62][63][64][65]

1. Infection

- While rare, there is a risk of introducing infections during surfactant administration, especially if proper sterile techniques are not followed diligently.

2. Pneumothorax

- The potential for a collapsed lung due to air leakage into the space between the lung and chest wall, a known complication of both mechanical ventilation and surfactant therapy.

3. Intraventricular Hemorrhage (IVH)

- The risk of bleeding in the brain, particularly in very premature infants, is associated more with the fragility of these infants than directly with the surfactant treatment.

4. Patent Ductus Arteriosus (PDA)

- Surfactant therapy can impact the closure of the ductus arteriosus, a blood vessel in the heart that should close after birth. If it remains open, it can lead to heart issues and may necessitate medical or surgical intervention.

5. Hypotension

- Low blood pressure can occur post-surfactant administration and is typically managed with fluid and medication support.

CONCLUSION

Effective management of respiratory distress syndrome (RDS) requires a multifaceted approach encompassing close monitoring, judicious use of assisted ventilation, and timely administration of surfactant therapy. Non-invasive respiratory support methods offer promising alternatives to invasive ventilation, while supportive care measures play critical roles in optimizing outcomes. Collaboration among clinicians and researchers is essential for refining treatment strategies and improving outcomes in neonates with RDS.

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