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Positive Pressure Ventilation Techniques in Neonatal Resuscitation

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ABSTRACT

Introduction: **Newborns often experience asphyxia; thus they need ventilation support. Neonatal resuscitation has an essential role to reduce the risk of disability.**

***Discussions*: Positive pressure ventilation (PPV) consists of invasive and non-invasive PPV. The tools needed are self-inflating bag, positive end-expiratory pressure, flow-inflating bag, continuous positive airway pressure, T-piece resuscitator, laryngeal mask, and face mask. Indications for PPV are if the baby is not breathing spontaneously/effectively or the baby's heart rate is less than 100 beats per minute. The ventilation speed is 40 to 60 times inflation per minute with an inspiration time of about 0.3 to 0.5 seconds and some studies recommend less than 1 second because it could cause hyperventilation and end up in a condition of lowering blood pressure to the arteries of the brain. The success of PPV if there is dynamic chest movement, heart rate above 100 beats per minute, and oxygenation improvement. Complications that can be caused are lung damage, hemodynamic disorders, pneumonia, and neurochemical changes, and facial injuries.**

Conclusion: **Newborns often experience asphyxia, thus they need ventilation support to save newborns . Positive pressure ventilation is an important part of neonatal resuscitation in infants who are not breathing spontaneously or effectively.**

Keywords: Newborn, non-invasive, positive pressure ventilation.

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I. Introduction

Newborns will experience a transition process from intrauterine to extrauterine life which involves almost all organ systems of the body. A series of physiological events occur after the baby is born that help the baby to adapt to the extrauterine environment. Babies up to the age of one month are the age group that has the highest risk of health problems and various health problems can arise. Therefore, proper treatment is needed so as not to be fatal [1].

One of the health problems that often occurs at the time of the birth of a baby and results in infant death is asphyxia. According to the 2012 World Health Organization (WHO) report that every year, approximately 3% of the 120 million babies born experience asphyxia, almost one million of these babies later die. In the United States, nearly 10% of the 4 million newborns annually require a breathing apparatus at birth, with about 1% requiring extensive resuscitation and about 0.2 to 0.3 percent having moderate or severe hypoxic-ischemic encephalopathy [2].

Meanwhile, in Indonesia in 2017 there was a Neonatal Mortality Rate of 15 per 1000 live births. WHO states that in 2000 – 2010, the Case Fatality Rate (CFR) of asphyxia for infants under 5 years of age in Indonesia reached 11% annually [3].

Neonatal mortality is closely related to the quality of delivery services, and the handling of newborns is less than optimal immediately after birth and the first few days after birth. New normal baby care is a step for medical personnel to provide comprehensive health services in accordance with the findings in the previous step or according to the condition of the baby at that time, so that it becomes a continuous care [1].

Neonatal resuscitation is one of the nursing care for newborns which has an essential role to reduce the risk of disability and death of newborns. Resuscitation steps include initial assessment, airway (opening the airway), breathing (ventilation), circulation (chest compressions), and drugs (administration of drugs and physiological fluids) [1]. Given the importance of neonatal resuscitation procedures, especially those related to positive pressure ventilation, this time we will discuss the indications, techniques, criteria for success and failure, and complications that can arise after positive pressure ventilation.

II. Discussion

A. Positive Pressure Ventilation

Positive pressure ventilation (PPV) in neonates is an act of providing breath support to newborns with respiratory

disorders. This involves the delivery of air, or a mixture of oxygen combined with other gases through positive pressure to the lungs. When air enters the lungs, the intraalveolar pressure increases causing a change in flow or pressure that is detected by the ventilator as a marker of the end of the breath. Expiration of air occurs passively secondary to a buildup of pressure in the alveoli that exits into the conductive airways that are less pressurized [3].

Positive pressure ventilation can be provided in two forms, namely non- invasive positive pressure ventilation (NIPPV) which is given through a special face mask with a tight seal (air flows through anatomical airways), or invasive positive pressure ventilation (IPPV), which involves delivering positive pressure to the lungs via an endotracheal tube or tracheostomy (or other device that delivers oxygen across part of the anatomical airway). Each form of ventilation has its own benefits, risks, indications and contraindications. Non-invasive positive pressure ventilation can be used in acute hypercapnic respiratory failure as long as the patient's condition is responsive to this form of therapy. Conditions that most respond to NIPPV include exacerbations of chronic obstructive pulmonary disease (COPD) and acute cardiogenic pulmonary edema. However, the need for emergency endotracheal intubation is a contraindication to NIPPV and may be required for conditions such as cardiac arrest, hemodynamic instability, inability of the patient to cooperate, or to maintain an open airway protected by reflexes, among other things [3].

B. Apparatus in Positive Pressure Ventilation

Ventilation equipment should always be prepared in all newborns to anticipate the worst. The ventilation equipment includes: Self-inflating bag / Self-inflating balloon (example: 250 ml balloon) and various sizes of face masks, equipped with a positive end-expiratory pressure (PEEP) valve. Flow-inflating bags / non-inflating balloons (example: anesthetic mask, Jackson-Rees) are devices that can provide a constantly measured PEEP, thus providing early Continuous Positive Airway Pressure (CPAP) but are not recommended for positive pressure ventilation. The T-piece resuscitator is a device that can provide a constant positive inspiratory pressure (PIP) and PEEP so that the baby can increase lung volume and achieve functional residual capacity. T-piece resuscitator can provide positive pressure ventilation and early CPAP; Intubation equipment (laryngoscope, endotracheal tube, stylet); Laryngeal Mask Airway (LMA) ; and facemask [4].

To provide optimal resuscitation results, resuscitation equipment must function properly. Therefore, checking resuscitation equipment, especially manual ventilation devices, must be carried out every moment before resuscitation. The stages of checking the manual ventilation device are as follows:

- Self-inflating bag

The stage of checking the tool starts from checking that the tool circuit is installed correctly. Then, make sure the reservoir pipe is available. If an oxygen source is needed, 5-10 L/min of oxygen can be supplied. Although actually this tool can still be used without a gas source. After that, close the open hole leading to the hood and squeeze the balloon until the pressure opens the valve leading to the reservoir. At the end of inflation, check the balloon to see if it can re-inflate quickly [1].

- Flow-inflating bag

The inspection begins with making sure the circuit is arranged correctly and the manometer is installed. The use of this tool requires a gas source, given 5-10 L/min. Then, close the open hole leading to the lid. When partially closing the hole, pay attention to whether the balloon fills with air quickly. Then, continue to close the hole, apply compression to the balloon and note the pressure achieved. Also note whether the balloon can re-inflate quickly at the end of inflation when the balloon is not being compressed. After that, ventilate the newborn by pressing the balloon between the thumb and forefinger, then compressing the balloon to produce positive pressure. Perform 40-60x/minute with an inspiration time of 0.3-0.5 seconds [1].

C. Positive Pressure Ventilation Technique

Positive pressure ventilation is performed when the baby cannot breathe spontaneously and effectively or the baby's heart rate is less than 100 beats per minute. Effective ventilation is characterized by an improved heart rate and remains within the normal range. Ventilation begins with ensuring the baby's airway is unobstructed and open. Position your head or neck like half-smelling to open the airway. If there is meconium and blood, clean it so that there is no obstruction in the airway. If the baby's airway is free, a mask can be placed on the baby's face. Make sure the face mask is firmly attached to the baby's face, the size of the mask is appropriate, and the correct way of holding is according to the type of mask to achieve optimal results. Optimal ventilation is achieved when the baby's chest expansion occurs properly [4].

Peak inflation pressure is the pressure exerted to achieve an increase in heart rate or chest expansion. Giving inflation pressure to the baby can be adjusted to the baby's condition. If the baby is born at term, the initial inflation pressure can be as high as 20 to 30 cm H_2O. In premature infants, excessive chest expansion during ventilation should be avoided. This pressure application should be monitored using a manometer to determine the peak inflation pressure, monitoring the pressure application to be consistent, and to avoid applying excessive pressure. The initial peak inflation pressure that can be given to premature infants is 20 to 25 cm H_2O [4].

The rate of ventilation performed is 40 to 60 times inflation per minute with an inspiration time of about 0.3 to 0.5 seconds and some studies recommend less than 1 second because it can cause hyperventilation and end up in a condition of lowering blood pressure to the arteries of the brain. The success of positive pressure ventilation is indicated by chest expansion. If there is excessive chest expansion, the initial inflation pressure can be lowered, whereas if there is no chest movement evaluate using a manometer to assess whether there is an obstruction or leakage so that airflow is inadequate. Evaluation of the infant's respiratory effort and pulse rate was performed after a 30 second period. Chest compressions are performed if after evaluation the baby is still not breathing and the baby's heart rate is less than 60 beats per minute [5]

D. Positive Pressure Ventilation Effectiveness Assessment

Positive pressure ventilation measures are considered successful and effective if they meet 3 components, namely chest movement, heart rate, and improved oxygenation. PPV can be said to be effective if the movement of the chest wall can occur dynamically up and down during breathing using a ventilation mask. An increase in heart rate above 100 beats per minute is the most reliable indicator of the success of positive pressure ventilation. If the use of the face mask is still not effective, tracheal intubation can be done [6].

E. Evaluation of Positive Pressure Ventilation Measures

The evaluation used to assess the evaluation used to assess the effectiveness of PPV was the heart rate 30 seconds after the procedure with the failure parameter, namely the heart rate of less than 100 beats per minute in spontaneous breathing. There are several points that can be considered in the continuation of the PPV procedure, namely if the heart rate is more than 100 beats per minute with spontaneous breathing then stop PPV and evaluate breathing and signs of cyanosis; if the heart rate is more than 100 beats per minute without spontaneous breathing then continue PPV measures; if the heart rate is between 60 and 100 beats per minute then continue PPV action by increasing the oxygen fraction and evaluating the heart rate 30 seconds after the procedure; if the heart rate is less than 60 beats per minute, cardiac compressions can be performed together with PPV measures with an increased oxygen fraction level; and if PPV is performed incorrectly, chest compressions cannot be continued. Evaluate heart rate 30 seconds after performing the correct PPV procedure [7].

F. Complications of Positive Pressure Ventilation

Complications of positive pressure ventilation were more frequent in invasive PPV and less common in non-invasive PPV. Complications that can be caused are ventilator-associated Lung Injury and Barotrauma due to aveolus damage due to high pressure entering the lungs; Hemodynamic disturbances, namely a decrease in preload due to an increase in intrathoracic pressure, thereby compressing the inferior vena cava and right atrium; Ventilator-associated pneumonia is most often caused by pathogens Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae, Acinetobacter species, and Staphylococcus aureus; Oxygen toxicity which will cause the phenomenon of re-absorption atelectasis; neuromuscular complications such as neurochemical changes in the patient's body; and injuries to the patient's face due to the mask being too tight on invasive ventilation [8].

III. Conclusion

Newborns often experience asphyxia, so they need a breathing apparatus. Neonatal resuscitation has an essential role in reducing the risk of disability. Positive pressure ventilation (PPV) is a part of neonatal resuscitation. PPV consists of non-invasive PPV and invasive PPV. The success of PPV if there is dynamic chest movement, heart rate above 100 beats per minute, and improved oxygenation.

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