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Nutritional Management of Very Low Birth Infant (VLBW) Throught Human Milk Fortification, Formula Milk, and Breast Milk

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ABSTRACT
A very low birth weight infant (VLBW) with a birth weight of <1500 grams has extremely low nutrient reserves, such as calcium, phosphate, iron, zinc, and vitamins, with little to no subcutaneous fat and glycogen stores. The management of VLBW infants focuses on providing nutrition through fortification, formula milk, or breast milk if lactation is sufficient. This study aims to examine the impact of weight management in VLBW infants through the administration of fortification, formula milk, and breast milk.This research employs a case study method by administering fortified breast milk, formula milk, and breast milk over ten days to a VLBW infant treated in the PICU-NICU of Temanggung Regional Hospital. The results show that after receiving fortified breast milk, the infant's weight increased by 70 grams. When given formula milk, there was no weight gain, while breast milk administration resulted in a weight gain of 75 grams. These findings indicate that breast milk provides the most significant weight gain without causing weight loss, although the increase occurs gradually.It is recommended that parents of VLBW infants optimize weight gain by providing exclusive breastfeeding, either directly or indirectly, if the infant has difficulty nursing.

BACKGROUND

Very low birth weight infants (VLBW) with a birth weight of <1500 grams have extremely low reserves of essential nutrients such as calcium, phosphate, iron, zinc, and vitamins, with little to no subcutaneous fat and glycogen stores (1). According to data from the World Health Organization (WHO), the percentage of low birth weight (LBW) infants in Indonesia was 3.4% in 2019, decreasing to 3.1% in 2020, and further declining to 2.5% in 2021 out of a total of 3,632,252 births. This indicates that over the past three years, the number of LBW infants in Indonesia has been decreasing (2). Meanwhile, according to the United Nations Children's Fund (UNICEF), in 2020, approximately 19.8 million newborns globally, or about 14.7% of all births that year, were classified as LBW (3)

The mother's condition during pregnancy significantly influences birth outcomes. Depression during pregnancy can have direct or indirect effects, such as disrupting the hypothalamic-pituitary-adrenal (HPA) axis and triggering the release of stress hormones like cortisol. Increased cortisol levels can hinder oxygen and nutrient flow to the fetus, as maternal appetite decreases, affecting nutritional status and fetal development, thereby increasing the risk of VLBW and intrauterine growth restriction (IUGR) (4). VLBW can also occur due to premature birth, where fetal development is disrupted, leading to inadequate nutrient intake from the mother or placental disorders that affect fetal growth (5). A history of preeclampsia is another risk factor for VLBW, as it disrupts oxygen and nutrient supply to the fetus via the placenta due to blood vessel vasoconstriction caused by hypertension. This condition results in uteroplacental insufficiency, causing intrauterine growth retardation (IUGR) and ultimately increasing the risk of VLBW (6).

The management of VLBW infants focuses on providing adequate nutrition to support weight gain. Nutrition can be administered through fortification, specialized formula milk, or direct breastfeeding if the mother's milk supply is sufficient. Breast milk is the primary choice for premature infants due to its numerous benefits. Breast milk is the best source of nutrition in early life, particularly during the first six months. Short-term benefits of breastfeeding for VLBW infants include a reduced risk of infections, necrotizing enterocolitis (NEC), and bronchopulmonary dysplasia, while long-term benefits include improved neurocognitive development, higher IQ scores, and enhanced mental and motor development (7).

However, if the mother's breast milk is unavailable, fortification serves as the best alternative. Nonetheless, fortification has limitations in meeting the nutritional needs of premature infants, particularly protein, calcium, and phosphorus, which are crucial for VLBW infants. Human milk fortification aims to enhance its nutrient content to meet optimal growth requirements. Fortification involves two different methods: adjusted fortification based on blood urea nitrogen (BUN) concentration as a protein nutrition marker and targeted fortification based on regular breast milk analysis, with adjustments made according to its actual macronutrient composition (8) . In addition to fortification, formula milk can be used as a substitute or supplement if the mother's breast milk is insufficient. Formula milk helps VLBW infants obtain essential nutrients such as calories, protein, and minerals necessary for growth and development. However, while formula milk provides these benefits, it also poses a higher risk of health issues, such as necrotizing enterocolitis (NEC), compared to breastfed infants (9).

Based on a previous study conducted by Jain (2023) titled "*Effect of Fortification of Human Milk With HMF Versus Infant Formula Powder on the Growth of VLBW Babies*" it was found that preterm very low birth weight (VLBW) infants who receive only pure breast milk cannot achieve a growth rate comparable to intrauterine growth. Therefore, breast milk fortification is essential to support their growth. The use of infant formula as a fortifier shows comparable growth outcomes to HMF without increasing the risk of morbidity.

Therefore, the weight management of VLBW infants should consider optimal nutritional intake to support significant growth and development. Breast milk remains the primary choice due to its effectiveness in reducing the risk of infections, NEC, and other complications, as well as promoting long-term neurocognitive development. However, when breast milk is insufficient, fortification and formula milk can serve as effective alternative solutions, despite their limitations and certain risks. Based on this discussion, this case report aims to examine the impact of weight management in VLBW infants through the administration of breast milk, fortification, and formula milk.

METHODS

This research employs a case report study method. The sample in this case report study is a very low birth weight infant (VLBW) admitted to the Neonatal Intensive Care Unit (NICU) at Temanggung Regional Hospital. The sample selection was done randomly without any specific criteria. Participants agree and sign informed consent before the study begins. The instruments used in this study include a scale for measuring weight during human milk fortification, as well as materials such as formula milk and breast milk (BM). Nutritional management in this study was conducted over ten consecutive days, from December 23, 2024, to January 1, 2025, at 9:00 AM and 12:00 PM. The amount of fortification, formula milk, and breast milk was determined based on the doctor's recommendations, adjusted to the infant's needs and condition. The nutritional management was carried out in three phases: providing fortified breast milk for the first three days, followed by formula milk for the next three days, and breast milk for the final four days. Nutrition was administered every three hours per day. The intervention was conducted under direct supervision by the ward nurses. Subsequently, the researchers analyzed the nutritional requirements for human milk fortification, formula milk, and breast milk over the ten-day period and evaluated the infant's weight gain over 10x24 hours.

Table 1. Human milk fortification as needed

Day	Breast milk (ml) + Fortification (gram)
1	25 ml + 0.25
2	25 ml + 0.25 + 0.125
3	25 ml + 0.25 + 0.125

Table 2. Formula milk as needed

Day	Formula milk (ml)
4	14 ml
5	15 ml
6	17 ml

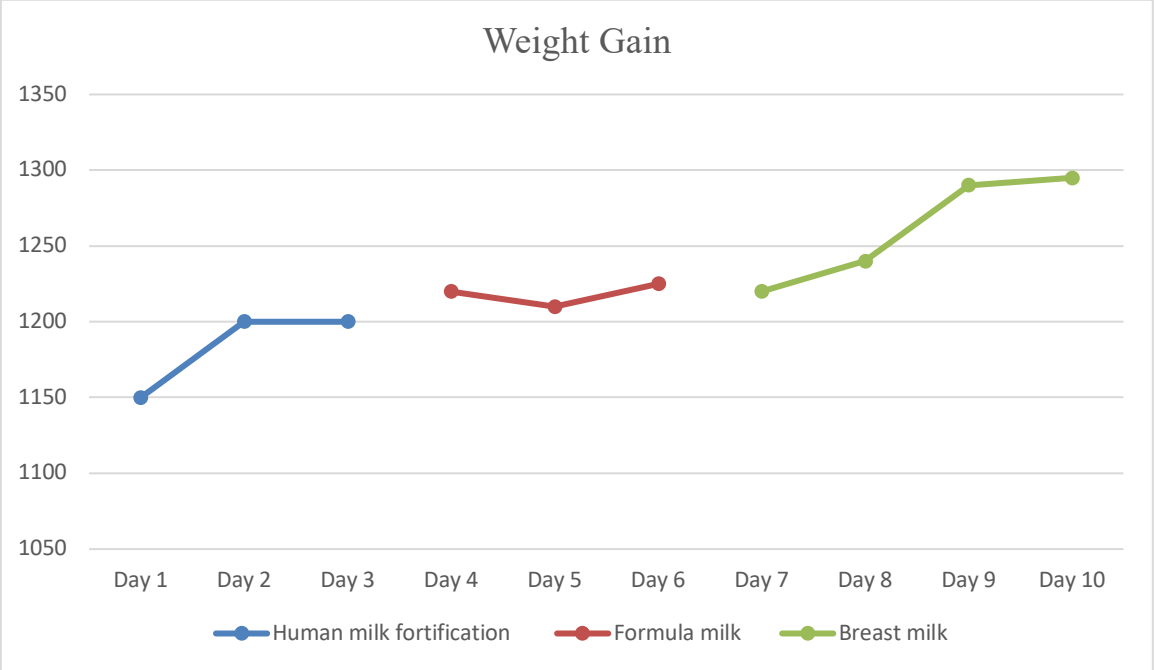
Table 3. Breast milk as needed

Day	Breast milk (ml)
7	20 ml
8	20 ml
9	23 ml
10	24 ml

RESULT AND DISCUSSION

RESULT

This study was conducted on Baby Ny. M, an 8-day-old patient diagnosed with very low birth weight (VLBW). The patient was born prematurely at 33 weeks of gestation via cesarean section on December 15, 2024, at Temanggung Regional Hospital. At birth, the anthropometric measurements were as follows: head circumference 28 cm, upper arm circumference 6 cm, chest circumference 26 cm, abdominal circumference 20 cm, body length 40 cm, and birth weight 1100 grams. The APGAR scores recorded were 7/8/10. During the initial assessment, the patient was found to be conscious (Compos Mentis), less active, and frequently asleep. The baby was on a nasal cannula at 0.1 LPM and had an orogastric tube (OGT) in place. The vital signs were recorded as HR 146 bpm, temperature 36.5°C, and SpO_2 98%. Based on this assessment, the identified nursing diagnoses were Ineffective Breastfeeding (D.0029) and Ineffective Breathing Pattern (D.0005).



Graph 1. Weight Gain

After a ten-day observation, nutrition was administered in phases: human milk fortification from Day 1 to Day 3, formula milk from Day 4 to Day 6, and breast milk (BM) from Day 7 to Day 10, all delivered via an orogastric tube (OGT). During the first three days, fortified breast milk increased the infant's weight from 1150 grams to 1200 grams by Day 2, but weight remained at 1200 grams on Day 3. From Day 4 to Day 6, formula milk led to fluctuating weight changes, with an increase to 1220 grams on Day 4, a decrease to 1210 grams on Day 5, and a rise back to 1225 grams on Day 6. The weight fluctuations were attributed to the baby experiencing diarrhea three times in one shift while on formula milk. From Day 7 to Day 10, breast milk resulted in a consistent weight increase from 1220 grams to 1295 grams. This indicates that breast milk effectively supports weight gain in VLBW infants while also providing essential immune benefits crucial for the baby's health.

DISCUSSION

The 10-day observation results indicate that a combination of nutritional interventions—human milk fortification, formula milk, and breast milk—administered via an orogastric tube (OGT) can support weight gain in VLBW infants. This is evident from the weight measurements taken throughout the study. During the first three days of human milk fortification, the infant's weight increased from 1150 grams on Day 1 to 1200 grams on Day 2, with no further increase on Day 3. Over the next three days, with the administration of formula milk, weight fluctuated: 1220 grams on Day 4, a drop to 1210 grams on Day 5, and an increase to 1225 grams on Day 6. Finally, during the four days of exclusive breast milk feeding, the infant's weight increased consistently, reaching 1220 grams on Day 7, 1240 grams on Day 8, 1290 grams on Day 9, and 1295 grams on Day 10

The implementation of these three nutritional approaches was adapted to the infant's needs, given that maternal breast milk production was insufficient to meet the baby's nutritional demands. As a result, human milk fortification and formula milk supplementation were utilized to support the infant's growth until the mother's milk supply improved sufficiently. VLBW and critically ill infants, particularly those with inadequate breastfeeding, have high metabolic demands but minimal macronutrient reserves, requiring additional energy for growth and development (11).

Observations from Days 1 to 3 indicate that human milk fortification provided an initial weight gain but was insufficient for consistent weight improvement. The baby's weight increased by 50 grams from Day 1 to Day 2 but then remained stagnant on Day 3. On Day 4, the weight increased slightly by 20 grams. Fortification is necessary because exclusive breast milk alone may not meet the protein and micronutrient requirements for the rapid growth of preterm infants, especially those with extreme prematurity. Human Milk Fortifier (HMF) is designed to enhance the nutrient content of breast milk and is recommended for preterm infants weighing below 1800 grams (12). Human milk Fortification supplements breast milk with calcium, phosphorus, protein, essential minerals, and vitamins, contributing to significant weight gain in fortified infants. Additionally, fortification supports immune system development, reducing vulnerability to infections and diseases commonly affecting VLBW infants (13).

Observations from Days 4 to 6 show weight fluctuations and potential side effects such as diarrhea. The baby's weight increased to 1220 grams on Day 4, then dropped to 1210 grams on Day 5, and rose to 1225 grams on Day 6. This variability was linked to the onset of diarrhea, occurring three times in one shift after the administration of formula milk. Studies indicate that breast milk reduces the risk of necrotizing enterocolitis (NEC) and late-onset sepsis, whereas formula feeding has been associated with an increased risk of NEC (14). Formula milk, particularly cow's milk-based formulas, can heighten NEC risk due to its protein composition and other components that trigger excessive inflammatory responses in the immature digestive system of preterm infants. This inflammatory reaction can damage the intestinal walls, increase infection risk, and cause diarrhea (15).

Observations from Days 7 to 10 show that breast milk led to the most stable weight gain and overall health benefits. The baby's weight increased by 20 grams from Day 7 to Day 8, by 50 grams from Day 8 to Day 9, and by 5 grams from Day 9 to Day 10. Breast milk is considered the optimal source of nutrition in early life and is recommended for exclusive feeding as it promotes healthy growth and development (16). Breast milk contains macronutrients, micronutrients, and bioactive components, including immunoglobulins, cytokines, growth factors, hormones, antimicrobial agents, immune cells, stem cells, and prebiotic oligosaccharides (17). These immunological compounds help reduce the risk of gastrointestinal infections, respiratory infections, acute otitis media, allergic reactions, and urinary tract infections (18). Although breast milk is associated with slower weight gain in VLBW preterm infants, it supports better body composition recovery and lower fat mass accumulation. In contrast, preterm infants fed formula milk tend to develop higher fat mass, increasing the risk of metabolic complications. Additionally, exclusive breast milk feeding provides superior metabolic and neurological outcomes compared to formula feeding (19).

CONCLUSION

After a ten-day monitoring period, differences in weight gain were observed in the VLBW infant based on the type of nutrition provided: human milk fortification, formula milk, and breast milk. Human milk fortification resulted in a total weight gain of 70 grams, with an increase of 50 grams from Day 1 to Day 2. However, no weight gain was observed from Day 2 to Day 3, followed by an increase of 20 grams from Day 3 to Day 4. Formula milk

feeding did not lead to consistent weight gain. The infant experienced a weight loss of 10 grams from Day 4 to Day 5, followed by a 15-gram increase from Day 5 to Day 6, and then a 5-gram decrease from Day 6 to Day 7. This fluctuation was attributed to diarrhea, which occurred after formula feeding. Exclusive breast milk feeding resulted in the most significant weight gain, totaling 75 grams. The weight increased by 20 grams from Day 7 to Day 8, 50 grams from Day 8 to Day 9, and 5 grams from Day 9 to Day 10. These findings indicate that among the three types of nutritional intervention human milk fortification, formula milk, and breast milk, exclusive breast milk feeding provided the most consistent weight gain without causing weight loss, despite its gradual effect.

It is recommended that parents of VLBW infants prioritize exclusive breastfeeding to optimize weight gain, either directly or indirectly, if the infant experiences difficulties with latching. For future research, studies with larger sample sizes and extended monitoring periods are suggested to strengthen findings and support decision-making in the care of VLBW infants.

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