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Nutritional Management of Very Low Birth Weight Infants

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Abstract: *Background: Normal long-term neurodevelopmental outcome of very low birth weight infants requires adequate nutrition. The latter depends on a precise nutritional protocol and regular checks of adherence to its content. The scope of this study was to reveal factors with potential negative influence on adequate nutritional support of very low birth weight infants in a level IV neonatal intensive care unit. Methods: A detailed chart analysis investigated the adherence to the local protocol for enteral and parenteral nutrition and the resulting growth of very low birth weight infants stratified by predefined criteria in four 250 g strata.*
Results: The median [IQR] birth weight was 1065 (439) g, gestational age was 29.1 (3.4) weeks. Weight gain was 14.8 g/kg/d, which was equivalent to the lower range of intrauterine growth. Hence, z-score of 0.59 at birth dropped to -1.39 at discharge. Chart analysis revealed six reasons for inadequate growth: 1) Delayed postnatal start of parenteral
protein and fat supplementation on day two; 2) Slower than intended advancement of oral feeds by in median 7.8 instead of the proposed 20 mL/kg/d; 3) Failure of using the most current body weight for calculation; 4) Inadequate total protein intake: 7.3 g/kg/d cumulative protein deficit already on day 8, the intended 4 g/kg/d of protein were not reached on 59% of all hospital days; 5) Reduction of milk supplementation ahead of schedule; 6) Interruption of parenteral
nutrition during infusion of antibiotics. Conclusion: To achieve optimal quality of care regular reviews of adherence to internal guidelines are essential. Certain errors in management may only be detected by regular independent detailed analysis of charts and daily practice

Keywords: *neurodevelopmental*

I. INTRODUCTION

Nutrition and growth are important in neonatal care. Especially for Very Low Birth Weight (VLBW) infant's adequate growth has a high impact on long term outcome: Early protein intake, postnatal growth and particularly gain in head circumference corresponding to intrauterine
reference curves are associated with good neurocognitive development [1-4]. Several studies have documented that inadequate nutritional intake may lead to extra-uterine growth retardation [5-7] which to a large extent may be a result of cumulative deficits in caloric and protein intake
starting in the first week of life [6-8]. This postnatal malnutrition is in part due to a slow increase of enteral feeding assuming intolerance of the gut with increased risk of Necrotizing Enterocolitis (NEC). These reasons have been disproven by several studies: An increase of oral feedings by up to 35 mL/kg per day did not result in a higher incidence of NEC [9,10]. In addition, high intake of amino acids of 3.5 g/kg per day from Day of Life (DOL) 1 was well tolerated in preterm infants [11].In order to achieve optimal growth in VLBW infant's nutritional support should be started immediately after birth [12]. Especially a positive nitrogen balance should be achieved as soon as possible and constantly maintained thereafter. For this purpose, a protocol for parenteral and enteral nutrition is required [9]. Our nutritional protocol for neonates was redone in 2009 based on recommendations by ESPGHAN in 2005 [13]. This protocol has been used since without any evaluation concerning the adherence to its content or its effects. Therefore, in this study we assessed (1) The current practice in our NICU regarding parenteral and enteral nutrition, (2)The

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adherence to our protocol and (3) Weight and head circumference gain during the entire hospital stay in a stratified sample of our VLBW infants.

Method

Patients

Eligible were inborns with a birth weight of 500-1499 g treated in our level IIIB intensive care unit. In order to be treated by a constant feeding regimen infants had to be born from January 2010 and discharged home not later than June 2011 (n=56). Exclusion criteria were multiples (n=17) as well as those with severe malformations (n=3), operations involving the gastrointestinal tract (n=1) or NEC grade II or III (n=3) of these eligible 32 infants 20 were selected for detailed chart analysis to have four equally sized 250 g strata of birth weight (500-749 g, 750-999 g, 1000-1249 g, 1250-1499 g) with equal distribution of

Data collection

For retrospective analysis, we extracted all parameters with any relevance to nutrition from our paper charts from admission until discharge from our hospital. Because body weight was measured every second day only, daily values for weight were determined by linear interpolation. The value for head circumference on day 14 was calculated in a similar manner if no value was documented on that specific day. According to the routine clinical practice of written documentation, all parameters were collected in 24 hourly intervals of 6 pm to 6 pm. If patients were born before 6 pm fluids given continuously during this incomplete first day were projected onto 24 hours assuming that the child would have received this calculated amount if born at 6 pm. In contrast, fluid boluses were included into our calculation as given.

Statistics

For each patient, continuous data were summarized using means. Each strata or the whole group was described by median and interquartile range to account for the limited number of patients. Trends were computed by calculating a mean for each infant and then a median of all means. Categorial data are expressed as frequency and percentage.To calculate calories, 4.1 kcal/g were used for carbohydrates and amino acids, 9.3 kcal/g for fat. To account for their reduced resorption in the intestine, calories for orally provided amino acids and fat were included by 75%. This number takes into consideration an intestinal utilization rate of 50% on average for the different amino acids plus a 25% delayed release into the systemic circulation [14]. For fat, an intestinal non-resorption rate of 10%-40% has been described [15]. If both breast and formula milk were given on the same day but their relative amounts not exactly documented, equal amounts were assumed.Body weight and head circumference were converted into z-scores using the best fitting database published for German newborn infants [16].To analyse the effect of group membership (study group vs. not analysed) a Wilcoxon test was used for (non)-continuous data and a Chi-squared test for dichotome endpoints using STATISTICA 10 (StatSoft, Hamburg, Germany). The level of significance was set to $\alpha=0.05$. All remaining calculations were performed using Microsoft Excel 2007 (Microsoft, Redmond, USA).

Results

The twenty patients selected for analysis had a median birth weight of 1065 g and a median gestational age of 29 weeks. Except for the gender distribution, these 20 patients did not differ in their demographical data from those 12 patients who also fulfilled our study criteria but were not included in the analysis (Table 1). After one week of life, the infants had achieved in median (interquartile range; IQR) 140 mL/kg per day (18) in parenteral plus enteral fluid intake and had regained their birthweight. After 11.5 days, they obtained 120 mL/kg per day in oral feedsb and after 19.5 days 150 mL/kg per day (Table 2). Parenteral nutrition was discontinued when 140 mL/kg per day oral were reached which was on DOL 20 and 9 for stratum I and IV, respectively. In average patients remained 10 mL/kg per day below the intended fluid supply specified in our guideline (data not shown). Caloric intake was 120 kcal/kg (oral plus parenteral)

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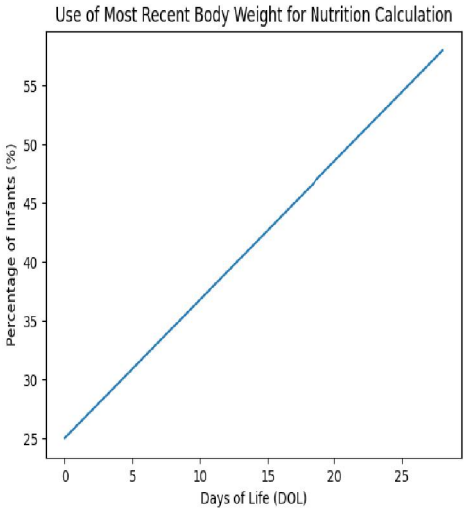
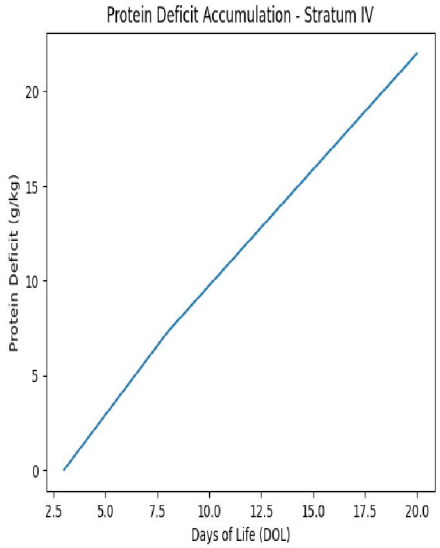
on day 10. From that day on the weight gain was 14.8 g/kg per day which was less than intrauterine growth (Figure 1). Birth weight plus 20% was reached on DOL 20 with little variation between the four strata. Towards the end of the hospital stay the growth curves in all four strata deviated more than before from intrauterine curves, especially those of the lightest infants (stratum I).

Infants' weights started at a median z-score of -0.59 at birth for all groups. The initial weight loss resulted in a drop of weight to a z-score of -0.94 on DOL 14. Except for stratum IV, z-score dropped further during the hospital stay by an additional 0.5 (Table 3). For calculation of weight and head circumference at discharge that of the third infant of each stratum is shown in Table 3.

In order to understand underlying causes of the decline in z-score we compared median values for total caloric and protein intake to recommended intakes. While our guideline aimed for a total protein intake of 4 g/kg/d on day 3 of life, it took 8 days to achieve this value in our study group. This resulted in a protein deficit of 7.3 g/kg/d on DOL 8. The deficit continuously increased to between 57 and 22 g/kg/d at discharge for stratum I and IV, respectively (Figure 2). The study group remained below the protein intake aimed for on 59% of their hospital days. Not receiving the recommended protein intake was seen in all four strata with no correlation to birth weight.

In a quarter of the infants, the body weight used for calculation of nutrition was two days old and resulted in a reduced nutritional input for the actual weight. Until DOL 28 the percentage of infants in whom the most recent body weight was used for calculation of intake increased to 58% After transfer from intensive to intermediate care supplementation of human milk and preterm formula was not increased to fit to the current body weight in a quarter of the infants. In preparation for discharge, supplementation was reduced in 9 infants in median eight days prior to discharge and stopped completely in another 5 infants 12 days before the day of discharge.





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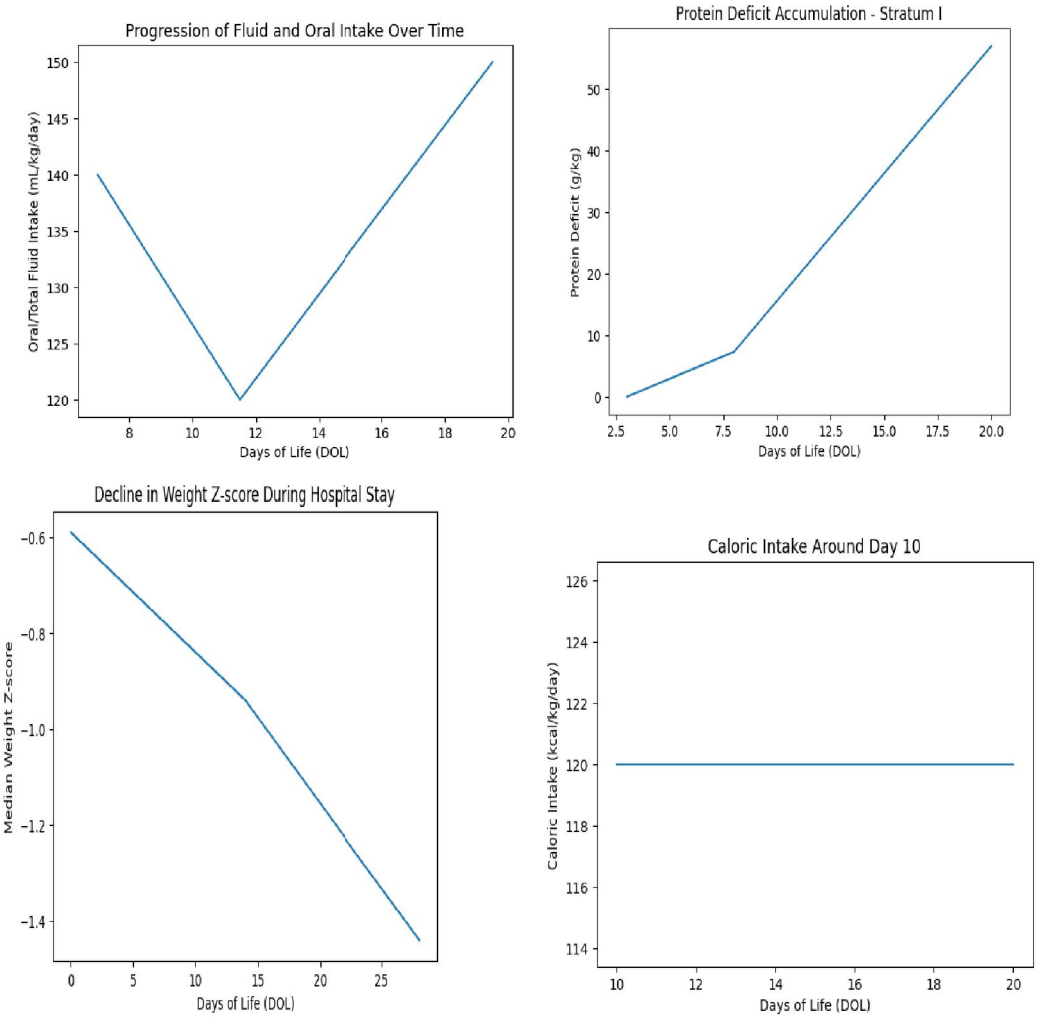

II. CONCLUSION

Certain fundamental shortcomings in the management of preterm infants may only be detected by independent detailed analysis of charts and habits. Electronic tools and documentation of patient care should have detailed definitions and designed to avoid errors. To achieve optimal quality of care regular reviews of internal guidelines are essential and should include defined cornerstones of care.

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