Pediatrics and Neonatology (2014) 55, 41—47

Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: http://www.pediatr-neonatol.com

ORIGINAL ARTICLE

Improved Weight Gain in Very-low-birth-weight Infants After the Introduction of a Self-created Computer Calculation Program for Individualized Parenteral Nutrition

Maria Gnigler [a], Bernhard Schlenz [a], Ursula Kiechl-Kohlendorfer [a], Mario Rüdiger [b], Salvador Navarro-Psihas [a,*]

[a] Department of Pediatrics II (Neonatology), Innsbruck Medical University, Innsbruck, Austria
[b] Department of Neonatology and Pediatric Intensive Care, University Hospital Carl Gustav Carus, Dresden, Germany

Received Jan 17, 2013; received in revised form May 6, 2013; accepted May 27, 2013

Key Words
growth retardation;
parenteral nutrition;
small for gestational age;
very-low-birth-weight infant;
weight gain

Background: Although 90% of babies <1500 g (very-low-birth-weight or VLBW) are appropriate for gestational age (AGA) at birth, almost all are small for gestational age at 36 weeks of gestation, mainly due to nutritional deficiency in the first weeks of life. A computer calculation program (CCP) to calculate parenteral nutrition (PN) was introduced to improve nutritional intake in preterm infants.
Methods: Somatometric data and composition of PN of VLBW infants were compared with two points of time measured over a period of 4 years.
Results: Data from 56 patients born before the introduction of the CCP (2001—2002) and 59 patients born after the introduction of the CCP (2004—2005) were obtained. Although the number of AGA infants at birth did not differ, the computer-calculated group had significantly more AGA infants at the time of discharge from hospital (44% vs. 14%, $p < 0.05$). In this group, more protein and fat were administered in the first 5 days of life (7.3 g/kg vs. 4.5 g/kg, $p < 0.05$ and 5 g/kg vs. 0.5 g/kg, $p < 0.05$) and the duration of total PN was shorter (16 days vs. 24 days, $p < 0.05$).
Conclusion: Because the CCP contributes to a better weight gain in VLBW infants due to simplification of PN calculation, we suggest its use in the calculation of PN in VLBW infants.

* Corresponding author. Department of Pediatrics II (Neonatology), Innsbruck Medical University, Anichstrasse 35, 6020, Innsbruck, Austria.
E-mail address: Salvador.navarro-Psihas@uki.at (S. Navarro-Psihas).

1875-9572/$36
http://dx.doi.org/10.1016/j.pedneo.2013.05.010

1. Introduction

Extreme preterm birth represents a medical challenge in different aspects, one of which is achieving adequate postnatal growth. Because intrauterine growth is undisturbed, birth weight is mainly appropriate for gestational age (AGA). However, extrauterine growth is disturbed in almost all preterm infants, causing a high number of small for gestational age (SGA) infants at the time of hospital discharge.[1]

Adequate growth is essential for proper neurodevelopmental outcomes.[2,3] However, there is an increasing rate of mortality and morbidity among SGA infants.[4] Latal-Hajnal et al showed that those children who had a normal birth weight and then suffer postnatal growth restriction have the greatest risk for neurodevelopmental impairment.[5]

Postnatal growth restriction in preterm infants is mainly due to a low caloric intake during the first weeks of life.[6,7] Because of cautious recommendation concerning enteral and parenteral nutrition (PN), PN with protein and fat was very restricted. However, recommendations have changed in recent years, suggesting an early start with protein and fat supplementation.[8–11]

Nevertheless, PN for small preterm infants still represents a complex process. Ideally, the nutritional supplementation should be individually adapted and calculated every day, instead of using pre-existing parenteral solutions for all patients.

We hypothesized that the introduction of a computer calculation program (CCP) for the calculation of PN would lead to a better nutrition and weight gain in very-low-birthweight (VLBW) infants. To test this hypothesis, the CCP was developed and introduced in clinical routine. To test its efficacy, data on nutrition and growth were analyzed for all preterm infants taken care of in our unit in the 2 years before and after its introduction.

2. Methods

Our research hypothesis was that a CCP contributes to a better weight gain in VLBW infants due to the simplification of PN calculation. We tested this in a retrospective study and showed that using a CCP led to a better weight gain and reduction in time for PN calculation.

2.1. Computer-based PN program

To facilitate the calculation of PN, we designed a CCP on Microsoft Excel, consisting of a stepwise calculation of the composition of the infusion mixture (Figure 1).

First, the caregiver has to define the total amount of required fluids. Then, the amount of fluid given as enteral feeding and medications is calculated. The CCP subtracts this amount from the total fluid amount. Second, the caregiver defines the desired daily amount of fat, amino acids, and electrolytes per body weight. The CCP calculates the total amount of components and again subtracts the amount of fluid required. The fluid volume left is then available for the administration of glucose. By entering the percentage of the glucose solution that must be added, the program calculates and gives information about the rate of glucose per kilo and minute. Besides the total calories, it also gives information about the glucose concentration of the whole solution and its osmolarity, indicating in red (conditional formatting) an osmolarity of 800 and more, in order to avoid skin damage in the case of infusion through a peripheral vein line. This information allows for maximizing the amount of amino acids without the risk of giving too little glucose or a solution with very high osmolarity.

2.2. Study protocol

To test our hypothesis, a single-center observational method before and after the study was planned. We included all infants with a birth weight $\leq$1500 g who were admitted to our neonatal unit during the study period. The CCP was introduced in June 2003. To allow for an adaptation phase, we compared infants born before the introduction (January 2001 to December 2002) with infants born after its introduction (January 2004 to December 2005). The exclusion criteria were congenital malformations or metabolic diseases. The PN value was calculated by medical professionals in both groups. The nutritional targets were the same in both periods. The recommendation was to initiate amino acids on Day 1 and fat on Day 2 and to increase both by 0.5–0.7 g/kg/day up to a maximum of 3 g/kg/day of fat and 4 g/kg/day of amino acids. The amount of glucose administered was adapted according to the blood glucose of each individual patient. The recommended fluid amount was 70–80 mL/kg/day on Day 1, which was then increased by 10–20 mL/kg/day up to 150–160 mL/kg/day. Oral feedings were to be initiated on Day 1 or Day 2 and increased according to feeding tolerance. In the conventional group, nutrition was calculated by hand using a pocket calculator. In both study periods, PN was prepared by nursing staff at the ward. The primary outcome of our study was somatic growth until hospital discharge, defined as weight, length, and head circumference. Secondary outcome criteria included the following nutritional data: day of life on which the administration of protein and fat was started, total amount of proteins administered, total duration of PN, and the following data on morbidities: respiratory distress syndrome (RDS) and surfactant application, secondary sepsis, necrotizing enterocolitis, intraventricular hemorrhage, bronchopulmonary dysplasia (BPD), and patency of ductus arteriosus. Data were collected retrospectively from individual patient charts.

2.3. Statistical analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS Version 17, Chicago, IL, USA). All parameters were checked using the Shapiro–Wilk test for normal distribution. Tests for differences in the study population were derived using the Wilcoxon test for control samples. The Mann–Whitney *U* test and χ^2 test were used