Neonatal Parenteral Nutrition – A Macro-control Approach

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Kwong Wah Hospital
Outline

• Evidence of using standardised parenteral nutrition (SPN)
• Results and outcome of SPN at KWH
• Way forward
Evidence on the use of SPN in neonates

Evaluation of standardized versus individualized total parenteral nutrition regime for neonates less than 33 weeks gestation

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Objective: To evaluate the difference in nutrient intakes and biochemical responses in newborn infants <33 weeks gestation who received standardized versus individualized total parenteral nutrition (TPN) regimes.

Method: Comparison of nutrient intakes and daily biochemical responses in newborn infants <33 weeks gestation who received standardized regime versus those who received individualized TPN regimes from day 2 to day 7 of life.

Results: Twenty-seven infants in the standardized TPN group and 31 infants in the individualized TPN group were compared. There were no statistically significant differences (P > 0.05) between the two groups in gestation, birthweight, Clinical Risk Index for Babies scores, daily TPN volume intake and biochemical responses. Infants in the standardized TPN group received less sodium (P < 0.01) and no potassium on day 2 as required, more protein (P < 0.02) every day, and more calcium and phosphate (P < 0.02 from day 4).

Conclusion: There were no significant clinical and statistical differences in biochemical responses in newborn infants <33 weeks gestation who received standardized versus individualized TPN regimes during the first week of life. The economic cost of TPN provision using standardized TPN formulation was approximately 30% lower.

Key words: individualized total parenteral nutrition; low gestational age; parenteral nutrition; pharmacoeconomic cost; standardized total parenteral nutrition.
Evidence on the use of SPN in neonates

Standardized Parenteral Nutrition in Preterm Infants: Early Impact on Fluid and Electrolyte Balance

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Key Words
Preterm infants · Parenteral nutrition · Fluid balance · Nonoliguric hyperkalemia

Abstract
Background: Parenteral nutrition is commonly given to premature infants. It has previously been suggested that standardized parenteral nutrition (SPN) is associated with a lower water input fluid intake ratio and a lower glomerular renal function than that of parenteral nutrition (IPN). The aim of the present study was to compare the effects of two different nutrition schemes on fluid and electrolyte balance in preterm infants.

Methods: A total of 74 preterm infants (gestational age < 32 weeks) were enrolled in the study. The infants were randomly assigned to two groups: IPN and SPN. The study was conducted over a period of 3 months.

Results: There were no significant differences in urine output/ input fluid intake ratio and glomerular renal function between the two groups. Conclusions: There were no significant differences in water and sodium balance in preterm infants who received IPN versus SPN. The risk of NOHK was higher in IPN. Also, SPN significantly increased amino acid and caloric intakes, and it reduced early weight loss.
Evidence on the use of SPN in neonates

Assessment of implementation of a standardized parenteral formulation for early nutritional support of very preterm infants

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Abstract Introduction: Parenteral nutrition (PN) plays an important role in the nutritional support of very preterm newborns. It has been suggested that a high proportion of PN orders could be standardized. In 2002, we implemented in our unit the preparation of three standardized formulations for PN adapted to the nutritional requirements of premature infants <32 weeks. Following this change of practice, a retrospective observational study was conducted to evaluate the relevance of the implemented standardized PN regime. Twenty premature inborn infants <32 weeks gestation who had received standardized (STD) greater in the STD group (+20% ; p=0.0003). Biochemical parameters were similar in both groups. Insulin infusions were less frequent in the STD group (p<0.06).

Conclusion: Standardized parenteral formulations provided higher early intakes of amino acid and glucose, a better calcium phosphate ratio, and a greater amount of amino-acid intakes during the first week while maintaining the same biochemical parameters. This strategy forms part of an approach concerning quality control and the respect of good professional practice for the preparation of parenteral nutrition solutions.
Evidence on the use of SPN in neonates

Bolisetty et al. BMC Pediatrics 2014, 14:309
http://www.biomedcentral.com/1471-2431/14/309

RESEARCH ARTICLE

Improved nutrient intake following implementation of the consensus standardised parenteral nutrition formulations in preterm neonates: a before-after intervention study

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Abstract

Background: New standardised parenteral nutrition (SPN) formulations were implemented in July 2011 in many neonatal intensive care units in New South Wales following consensus group recommendations. The aim was to evaluate the efficacy and safety profile of new consensus formulations in preterm infants born less than 32 weeks.

Methods: A before-after intervention study conducted at a tertiary neonatal intensive care unit. Data from the post-consensus cohort (2011 to 2012) were prospectively collected and compared retrospectively with a pre-consensus cohort of neonates (2010).

Results: Post-consensus group commenced parenteral nutrition (PN) significantly earlier (6 v 11 hours of age, p = 0.005). In comparison to the pre-consensus cohort, there was a higher protein intake from day 1 (1.34 v 0.49 g/kg, p = 0.000) to day 7 (3.55 v 2.35 g/kg, p = 0.000), higher caloric intake from day 1 (30 v 26 kcal/kg, p = 0.004) to day 3 (64 v 62 kcal/kg, p = 0.026), and less daily fluid intake from day 3 (105.8 v 113.8 mL/kg, p = 0.011) to day 7 (148.8 v 156.2 mL/kg, p = 0.025), and reduced duration of lipid therapy (253 v 475 hr, p = 0.011). This group also had a significantly greater weight gain in the first 4 weeks (285 v 220 g, p = 0.003).

Conclusions: New consensus SPN solutions provided better protein intake in the first 7 days and were associated with greater weight gain in the first 4 weeks. However, protein intake on day 1 was below the consensus goal of 2 g/kg/day.
### Standardised neonatal parenteral nutrition formulations – an Australasian group consensus 2012

<table>
<thead>
<tr>
<th></th>
<th>Starter</th>
<th>Standard Preterm PN</th>
<th>7.5% dextrose Preterm PN</th>
<th>High Na Preterm PN</th>
<th>Term PN</th>
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<td>% chloride replaced with acetate</td>
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<td>Osmolarity (mOsm/L)</td>
<td>813</td>
<td>790</td>
<td>651</td>
<td>790</td>
<td>841</td>
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**Bolisetti et al. BMC Pediatrics 2014, 14:48**
## KWH SPN Formulations

<table>
<thead>
<tr>
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<th>Starter PN</th>
<th>Standard preterm PN</th>
<th>Restricted Fluid preterm PN</th>
<th>Peripheral preterm PN</th>
<th>7.5% dextrose preterm PN</th>
<th>Term PN</th>
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<tbody>
<tr>
<td></td>
<td>At 120ml/kg/day</td>
<td>At 135ml/kg/Day</td>
<td>At 105ml/kg/Day</td>
<td>At 135ml/kg/Day</td>
<td>At 135ml/kg/Day</td>
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<td>% chloride replaced with acetate</td>
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<td>IV line access</td>
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<td>Central</td>
<td>Central/Peripheral</td>
<td>Central</td>
<td>Central/Peripheral</td>
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</tbody>
</table>
Results and outcome
Number of cases
(period: 16 Nov 2016 to 16 Jan 2017)

Successful: Used SPN throughout the course of PN

Failed: Switched to IPN or used IPN from start

n=19

Successful: n=16 (84%)
*GA: 32.8wk (3.75), BW 1.7kg (0.8)

Failed: n=3 (16%)
*GA: 25.3wk (1.79), BW 0.6kg (0.25)

*all values are median (IQR)
Percentage Weight Difference from Birth Weight for cases started SPN on 1st 2 days of Life

S.Lacobelli et al. Neonatology 2010;98:84-90

KWH n=11
GA32.8wk
(3.75)
median...

KWH n=7
(GA <33wks
median
values)

Daily weight loss (% of birth weight)

Day of PN

Day of PN
**Calories intake vs SPN +/- EN**

- **Preterm SPN +/- EN**
- **Term SPN +/- EN**

**KWH vs Australian Study (GA<32weeks)**

- **KWH, GA 27.4wk (4.18), BW 1.1kg (0.48)**
- **Australian, GA 29wk (2), BW 1.24kg (0.614)**

**References**

- Bolisetty et al. BMC Pediatrics 2014, 14:309
Protein intake vs SPN +/- EN

Target for PRETERM
- Preterm SPN
- Term SPN

Target for TERM

Protein intake (g/kg/day) vs Day of TPN

KWH vs Australian Study (GA<32weeks)
- KWH, GA 27.4wk (4.18), BW 1.1kg (0.48)
- Australian, GA 29wk (2), BW 1.24kg (0.614)

Bolisetty et al. BMC Pediatrics 2014, 14:309
Serum Potassium vs SPN +/- EN

Preterm SPN +/- EN

Term SPN +/- EN

Mild Hypokalemia

Moderate Hypokalemia

Normal

Serum K with Starter PN on D1-2

3 out of 8 cases on Starter PN on D1-2 were given K
Blood gases vs SPN +/- EN

**pH**

- Preterm SPN +/- EN
- Term PN +/- EN

**pCO₂**

- Preterm SPN +/- EN
- Term PN +/- EN

**HCO₃⁻**

- Preterm SPN +/- EN
- Term PN +/- EN

**Base Excess**

- Preterm SPN +/- EN
- Term PN +/- EN

*Changed to Term SPN*
Blood Gases during the 1st 7 days of Life: KWH vs Australian study (GA <32 weeks)

- **pH**
- **pCO₂**
- **HCO₃⁻**
- **Base Excess**

KWH, GA27.4wk (4.18), BW1.1kg (0.48)
Australian GA29wk (2), BW1.24kg (0.614)

Bolisetty et al. BMC Pediatrics 2014, 14: 309
Failed cases
# Reasons for switching to IPN

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<tr>
<th>Case no.</th>
<th>GA (weeks)</th>
<th>Birth Weight (kg)</th>
<th>Reasons</th>
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<td>1.</td>
<td>23.9</td>
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<td>high serum sodium and dehydration</td>
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<td>2.</td>
<td>27.4</td>
<td>1.12</td>
<td>Low serum sodium (131mmol/L)</td>
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<td>(switched on D10)</td>
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<td>3.</td>
<td>25.3</td>
<td>0.61</td>
<td>inadequate calories</td>
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<td>(switched on D8)</td>
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</table>
Case 4: IPN vs SPN Comparison

**Protein (g/kg/day)**

**Calories (kcal/kg/day)**

**Day of PN**

<table>
<thead>
<tr>
<th>Day of PN</th>
<th>SPN Calories</th>
<th>IPN Calories</th>
<th>Projected SPN Calories</th>
<th>SPN Protein</th>
<th>IPN Protein</th>
<th>Projected SPN Protein</th>
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<td>1</td>
<td>34.9</td>
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<td>102.1</td>
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Time reduction in ordering PN
Process of ordering IPN at KWH

Dr prescribes TPN solution and/or enteral feeds

Paed pharmacist review order

Dispenser enters order to TPN compounding program

TPN pharmacist verifies order

TPN pharmacist checks and releases final product

Compound TPN solution

Review nutrition and clinical status
Calculate total energy, macro/micronutrients and volume

Review nutritional needs
Calculate total energy, macro/micronutrients and volume

Transcribe order to TPN compounding program, manually calculate the requirements of some ingredients

Verify order entered by dispenser

~10mins

~5-20mins

~10-20mins

~5-10mins
Process of ordering **SPN** at KWH

- **Dr** prescribes TPN solution and/or enteral feeds
- **Paed pharmacist** reviews order
- **Dispenser** enters order to TPN compounding program
- **TPN pharmacist** verifies order
- **TPN pharmacist** checks and releases final product
- **Compound TPN solution**

**Cumulative time reduction ~18-34mins**

- Review nutrition and clinical status
- Calculate total energy, macro/micronutrients and volume
- Verify order entered by dispenser

**~10mins ➔ ~3-4mins**

**~5-20mins ➔ ~3mins**

**~10-20mins ➔ Up to 10mins**

**~5-10mins ➔ No change**
Way Forward

• Modify current formulas
  – Adjust acetate
  – Add high Na formulation
  – Add K⁺ to starter

• Web based order program for SPN
  – Minimise transcription error
  – Reduce calculation error
  – Improve monitoring of nutrition
In development – Web based order program for SPN

Dr initiates and generate order through computer

Paediatric pharmacist review order

Dispenser retrieve order from record and generate labels

Scan barcode and compound AA/Dex solution

Order verifies by TPN pharmacist

Final check and release product by TPN pharmacist

Estimated further reduction of time ~15mins
Way Forward

• Batch production of SPN
  – Readily available
  – Better workload management
  – Reduced cost

• Increased in-use PN time (24hrs to 48hrs?)
  – Decrease infection risk
  – Decrease workload
  – Decrease cost
Way Forward

• Can pharmacist take up the role of TPN ordering?
  – Protocol driven
    • Selected cases
    • Within an agreed biochemical parameters
Summary

• SPN was successfully used in majority (84%) of neonates.
• SPN can be safely administered and delivered adequate nutrition to the majority.
• Enhancement programs are in progress at Kwong Wah Hospital to improve the formulations, monitoring nutritional parameters and logistics in ordering and preparation of SPN.
• We believe SPN is the future direction in PN for neonates.
THANK YOU