The Use of Total Parenteral Nutrition in Critically Ill Neonates in Egypt

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List of Abbreviations

AAP	American Academy of Paediatrics
AF	Anterior fontanel
BP	Blood pressure
BPD	Broncho-pulmonary Dysplasia
CHF	Congestive heart failure
CNR	Caloric nitrogen ratio
CNS	Central nervous system
CSF	Cerebrospinal fluid
ECF	Extra cellular fluid
EFA	Essential fatty acids
ELBW	Extremely Low Birth Weight
GIR	Glucose infusion rate
ICF	Intracellular fluid
IVH	Intra ventricular haemorrhage
IWLs	Insensible water losses
MEN	Minimal enteral nutrition
μM	Micro mole
MVI	Multi-vitamin infusion
NEC	Necrotizing enterocolitis
NG	Naso-gastric
NICU	Neonatal intensive care unit
OG	Oro-gastric
PCVCs	Percutaneous central venous catheters
PICCs	Peripherally inserted central catheters
PTE	Pediatric trace element
PUFA	Poly unsaturated fatty acids
RBCs	Red blood cells
RDS	Respiratory distress syndrome
SGA	Small for Gestational Age
SIADH	Syndrome of inappropriate antidiuretic hormone
TBW	Total body water
TPN	Total parenteral nutrition
UAC	Umbilical arterial catheter
UDCA	Ursodeoxycholic acid
UVC	Umbilical venous catheter
VLBW	Very low birth weight

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ABSTRACT

Parenteral Nutrition is intravenous infusion of all nutrients (macronutrients or micronutrients) necessary for metabolic requirements and growth of neonates when their size or clinical condition precludes enteral feeding. *Study design*: The study was designed to cover the literature discussing the standard requirements of all components of nutrition needed by the neonate whether fluids, macronutrients (proteins, lipids and carbohydrates) or micronutrients (electrolytes, trace minerals and vitamins) and how to adjust these nutrients proportions according to the neonatal clinical condition. The study aimed at shedding a light on complication faced during use of Total Parenteral Nutrition (**TPN**) and ways of management. We also aimed at reviewing the availability of the use of **TPN** in Egypt, the current obstacles to its use and how to best overcome these obstacles. *Results*: Parenteral nutrition solutions although still evolving, have improved considerably since early days and complications are now less common especially with meticulous attention to asepsis, good nursing care, and close biochemical monitoring, all are essential for successful parenteral nutrition therapy. Also the current status of the use of **TPN** in Egypt still needs a lot of development in different fields as regard to availability of **TPN** service centers, nursing care and awareness of the medical staff to the importance of its use. *Conclusion*: The ability to provide parenteral nutrition and total parenteral nutrition over the past four decades has significantly improved the overall survival of newborns, when other options of adequate nutrition support are not possible. Also it showed the importance of increasing the awareness to the use of **TPN** in Egypt under scientific basis.

***Keywords*: Neonates, Total Parenteral Nutrition (TPN), premature infants.**

Introduction

The Use of Total Parenteral Nutrition in Critically Ill Neonates in Egypt

Introduction:

In the late 1970s the age of viability in neonates was approximately 28 weeks' gestation. Most infants less than 1,000 grams and some less than 1,500 grams were considered nonviable, therefore, resuscitation attempts were less aggressive. Advancing technology has led to improvements in ventilators, intravenous access materials, and surfactant therapy; have all had an impact on lowering the age of viability. It is not unusual today to resuscitate infants as young as 22 weeks' gestation. One of the major obstacles in the care of babies on the edge of viability is to provide adequate nutritional intake **(Brine and Ernst, 2004).**

Total parenteral nutrition (TPN) is the intravenous infusion of all nutrients necessary for metabolic requirements and growth. Parenteral nutrition (PN) refers to the supplemental intravenous infusion of nutrients by peripheral or central vein. Enteral nutrition (EN) is provided by oral or gavage feedings **(Chaudhari and Kadam. 2006).**

PN is commonly indicated in neonates experiencing congenital malformation of the gastrointestinal tract, gastroschisis, meconium and paralytic ileus, short bowel syndrome, necrotizing enterocolitis (NEC), respiratory distress syndrome, extreme prematurity, sepsis, and malabsorption. The ability to provide PN and TPN over the past four decades has significantly improved the overall survival of newborns when other options of adequate nutritional support were not possible **(Duran, 2005).**

The goal of TPN is to initially provide sufficient nutrients to prevent negative energy and nitrogen balance and essential fatty acid deficiency and support normal rates of intrauterine growth of appropriate composition without increased significant morbidity. Fear of toxicity and metabolic imbalance has alerted clinicians to use TPN with caution, especially in the sickest and most premature infants. An increasing number of practitioners appreciate that this cautionary management has resulted in suboptimal nutrition intake of these infants as it has contributed in part to national growth failure outcome statistics published of infants extremely low in birth weight (ELBW; less than 1,000 grams) and appropriate for gestational age (AGA; weight ≥ 10th percentile norm) born from 1995 to 1996 **(Lemons et al, 2001).** When assessed at discharge (~36 weeks' corrected age) 99% of these infants had significant growth failure with weights less than the 10th percentile compared with intrauterine growth standards **(Brine and Ernst, 2004).**

It is now noticed that the earlier the introduction and more aggressive advancement of TPN was shown to be safe and effective, even in the smallest and most immature infants **(Thureen, 1999, and Poindexter and Denne, 2003).**

The use of TPN is suggested to support all ill and premature babies less than 1,500 grams that cannot sustain at least ~60 kcal/kg/d enterally and initiation is recommended during the first 24 hours of life to avoid excessive protein losses and administering it in conjunction with initially small, and then advancing, enteral feedings beginning on the first or second day of life. This way the use of TPN is a mean to achieve rapid, maximal nutrition, and early enteral feeding is designed to prime the gut and stimulate normal hormonal homeostasis **(Thureen, 1999, and Brine and Ernst, 2004).**

TPN is administered either peripherally or centrally while enteral feeding is established. Route of TPN delivery depends on energy needs, venous access, anticipated duration of support, and potential risks **(Yeung et al, 1998).**

Sepsis is the most frequent serious complication during TPN so a meticulous technique is essential when handling the infusion apparatus, particularly upon injecting into the system **(Chaudhari and Kadam. 2006).**

Accurate and routine monitoring of growth measures is necessary to prevent over- or under nutrition from TPN support. Further, routine monitoring of solution compatibility and tolerance is required to prevent morbidity **(Brine and Ernst, 2004).**

Aim of Work:

This text will discuss improvement of the nutritional status of critically ill neonates and its impact on lowering the age of viability.

It will review the current literature on initiation of total parenteral nutrition in critically ill neonates, its components and recommend the evidence based practices in this area and discuss some of the barriers to implement this practice and how to improve its use in Egypt in addition to suggestion concerning initiation of enteral feeding for premature infants.

Chapter 1

History of Pediatric Nutrition and Fluid Therapy

Many of the individual nutrients in the human diet have been recognized for hundreds of years. However, identifying the daily requirements for these nutrients and their role in human metabolism and homeostasis are recent developments. Although, historically, the major focus in pediatric nutrition has been the growth, attention to the relationship between dietary nutrients and other health outcomes, such as host defence, psychomotor development, and long-term health, has occurred only recently and has led to major advances in our understanding of the importance of nutrition in infancy and childhood **(Kleinman et al, 2003).**

Infant Feeding

The early focus of those physicians and basic scientists interested in pediatric nutrition almost exclusively concerned the feeding of infants and the search for alternatives to breast milk. Before the early part of the 20th century, there were no viable alternatives to breast milk for infant feeding. Infants either received breast milk from their mother or a wet-nurse, or they died. It was evident that breast milk was uniquely suited to sustaining the developing infant **(Kleinman et al, 2003).**

The lack of alternative forms of infant feeding had a great impact on infant mortality. In London between 1780 and 1816, seven of eight children less than 2 y of age who died were hand-fed infants. Until the mid-1800s, the prognosis for an infant who was not breast-feeding was grim. One of the most basic impediments to feeding non–breastfed infants was the lack of hygienic feeding vessels. The bottle as we know it was not introduced until 1869 **(Kleinman et al, 2003).**

The development of infant formulas to nourish those infants who did not have the benefit of breast milk advanced concurrently with the increase in knowledge of the composition of human milk.

Scientists searched for the alternative milk that would most closely approximate the composition of human milk. Various animal milks were examined, and cow's milk was most commonly used as the basis for an artificial "human milk." Unfortunately, contaminated cow's milk was often the cause of diarrhoea and dysentery in the American infant **(Wegman, 2001).**

Pasteurization of animal milk was a major advance in improving milk quality. It was adopted by the American dairy industry around 1890. This process killed tubercle bacilli and *Brucella* organisms, as well as some of the bacteria that produced acid and the souring of milk. The advent of electric refrigeration in the 1920s also contributed to improving the quality of milk **(Anderson et al, 1982, and Kleinman et al, 2003).**

In the last part of the 20th century, biochemical studies of human milk revealed the presence of biologically active non nutritive substances in human milk, such as nucleotides, polyamines, long-chain polyunsaturated fatty acids, prebiotics, trace metal and vitamin-binding proteins, hormones, immunoglobulins, and other unique substances that influence host defence and development as well as contribute to the nutritional adequacy of the milk.

Many modifications of cow's milk were examined for infant feeding. Most formulas were based on mixtures of cow's milk, sugar, and water.

After World War II, there was a surge in formula feeding of infants. The commercially available formulas varied in content and quality. The American Academy of Pediatrics established a new committee in 1954 called the Committee on Nutrition. This committee was established to "concern itself with standards for nutritional requirements, optimal practices, and the interpretation of current knowledge as these affect infants, children, and adolescents." **(Kleinman et al, 2003).**

Feeding the Premature Infant

Major advances have occurred in the nutritional support and feeding of premature and immature newborn infants, contributing to the significantly improved chances of survival seen today for even very low birth weight infants in the developed world. In the 1930s and 1940s, pediatricians, following the advice of Smith, often withheld all food from premature infants for the first 3–4 d of life. Holt in 1961 strongly objected to this concept and advocated feeding all newborns soon after birth. From these primitive beginnings, significant progress in supporting the nutritional needs of premature infants was made by Holt and Snyderman, who studied amino acid absorption in premature infants and developed data for their minimal daily requirements **(Holt and Synderman, 1961, and Kleinman et al, 2003).**

Gordon *et al.* in 1947 established that preterm infants fed unfortified breast milk had reduced growth compared with those fed formulas enriched in specific nutrients compared with breast milk. Between 1960 and 1980, Fomon in 1967, Ziegler *et al* in 1976 and Widdowson in 1984 provided critical reference information on the changes in body composition from fetal life to childhood that permitted more-accurate estimations of daily energy and nutrient requirements for both preterm and term infants. Non invasive body composition analysis has advanced significantly in the past two decades with the use of stable isotope techniques, x-ray imaging, instruments that measure total body electrical conductivity and impedance, and air displacement chambers. Forbes in 1981, Fiorotto and Klish in 1991 and many others have provided body composition analyses of infants, children, and adolescents that are critical to understanding the changes that occur with growth, activity, and illness **(Fiorotto and Klish, 1991).** Raiha and colleagues in 1976 demonstrated the metabolic consequences of the quantity and quality of protein provided preterm infants, leading to further improvements in the composition of defined formulas to support the nutrient needs of these infants.

The development of isotopic tracer techniques has been enormously important in advancing our understanding of the daily requirements and metabolism of nutrients. Picou and Taylor-Roberts in 1969, Young *et al.* in 1975, Bier in 1997, and others used