Chapter 1
Introduction
"Paediatrics is concerned with the health of infants, children and adolescents, their growth and development and their opportunity to achieve full potential as adults" (Kliegman et al., 2007).

Paediatrics became a medical specialty in the mid-19th century. Before that time the care and treatment of childhood diseases was included within areas such as general medicine, obstetrics and midwifery. Paediatrics unlike the other subjects includes a wide spectrum of age groups. The age groups are foetal period including embryogenesis, perinatal period, prematurity, postnatal period, neonatal period, infancy, toddler group, preschool, school – primary, middle, high and adolescence (Gupte S., 2006).

Each of these age groups have their own physiological, pharmacological, pathological and therapeutic characteristics which need to be remembered while handling different age groups in clinical situations. The pattern of health norms, presentation of diseases, common causes of diseases, type of medical and nutritional treatment required differ at these ages. Hence, age becomes a very important consideration in treating a child (Matarese L.E., 2007).
Childhood is a period of growth and development of almost all systems. Growth and development go hand in hand in a child. A child is not a "miniature adult". Childhood is a totally different physiological state compared to adulthood. They need more nutritious food in proportion to their size than do adults. They may be at a risk for malnutrition when they have a poor appetite for a long period, eat a limited number of foods, or dilute their diets significantly with nutrient poor foods (Elizabeth K.E., 2007).

Malnutrition is a continuum that starts with a nutrient intake inadequate to meet physiological requirements, followed by metabolic and functional alterations and in due course by impairment of body composition. According to a WHO report (1999), the main victims are children under the age of fifteen. The effect of malnutrition is both direct and indirect. The direct effects of malnutrition are the occurrence of frank and subclinical nutritional deficiency diseases such as kwashiorkor and marasmus. High rate of maternal mortality; stillbirth and low birth weight are all associated with malnutrition. Indirectly malnutrition increases morbidity and mortality among young children, retards physical, mental growth and development, lowers vitality of the people leading to lowered productivity and reduced life expectancy. Malnutrition predisposes to infection and infection to malnutrition as shown in figure 1.1 (Gupte S., 2006).
The prevalence of malnutrition is higher in South Asia on an average of 50% compared to rest of the world. Although the prevalence has decreased from 55% in 1985 to 51% in 1997, the total number of malnourished children in South Asia has increased from 88 million to 90 million in the same period (Gupte S., 2006).

**Figure 1.1: Vicious cycle of Malnutrition**

The prevalence of malnutrition among critically ill pediatrics, especially those with a protracted clinical course, has remained largely unchanged over the last two decades (Pollack M.M. *et.al.*, 1982; Hulst J. *et.al.*, 2004) and it is
increasingly being recognized as an important factor in determining outcome of a disease. Malnutrition is common at hospital admission and tends to worsen during hospitalization. In Europe and North America, 40-50% of hospitalized pediatric patients are at risk of malnutrition. Several studies performed in Brazil and in other countries demonstrated that malnutrition can affect 50% of children and adolescents during hospitalization, although the classical kwashiorkor presentation is rare in critically ill infants, children, and adolescents with chronic diseases which varies between 21% to 80% (Dogan Y. et.al., 2005).

In general, little is known about the nutritional status of critically ill children during hospitalization and after discharge from ICUs (Motil K.J. et.al., 1998; Delgado A.F. et.al., 2000; Falbo A.R. et.al., 2002; Ozturk Y. et.al., 2003; Rocha G.A. et.al., 2006). Studies conducted more than 20 years ago had already demonstrated that 15-20% of children admitted to pediatric intensive care units were acutely or chronically malnourished (Merritt R.J. et.al., 1979; Pollack M.M et.al., 1985). Hospital malnutrition constitutes an important risk factor for increases in morbidity, lethality, length of hospital stay and medical costs.

Critical illness has a major impact on the nutritional status of both children and adults. The nutritional requirement of children becomes very high when they are confronted with any illness resulting in deterioration of their
nutritional status leading to severe malnutrition (Elizabeth K.E., 2007). The situation frequently confronted in the critically ill is not simply that nutrient supply is less than nutrient demand as in starvation. Critically ill patients have a state of hypermetabolism initiated by a variety of causes such as shock, sepsis, thermal injury and trauma. This hypermetabolism is secondary to a number of events initiated in large part by the same mediators seen in the Systemic Inflammatory Response Syndrome (SIRS). Children, similar to adults, rely on the metabolic breakdown and transfer of protein, carbohydrates and lipid to meet the catabolic demands of critical illness. Most critically ill children are in negative nitrogen balance as protein catabolism far exceeds synthesis. Carbohydrate and lipid turnover is also increased several fold during the pediatric metabolic response. There is insuppressible lipolysis and reduced ketogenesis (Mehta N.M. et.al., 2009)

The profound and stereotypic metabolic response to critical illness and failure to provide optimal nutrition support therapy during the intensive care unit (ICU) stay are the principal factors contributing to malnutrition in this cohort. The metabolic response to stress, injury, surgery, or inflammation cannot be accurately predicted and the metabolic alterations may change during the course of illness. Although nutrition support therapy cannot reverse or prevent this response, failure to provide optimal nutrients during this stage will result in exaggeration of existing nutrient deficiencies and in malnutrition, which may affect clinical outcomes. It is troublesome to assess the impact of acute
hospitalization on the nutritional status of critically ill children (Delgado A.F. et al., 2000; Correia M.I. et al., 2003) and associations have been reported between poor nutritional status, decreased respiratory function, impaired wound healing and immune and gastrointestinal dysfunctions (Deitch E.A. et al., 1990; Lyoumis S. et al., 1998; Reid M. et al., 2002). For the prevention and treatment of malnutrition among children, screening for malnutrition should be an integral part of pediatric care universally.

Nutritional assessment should be one of the main aspects of the pediatric intensive care patient and the most important tool to avoid hospital undernutrition. The objective of nutritional assessment should be to identify those patients at risk for complications and create treatment options aimed at decreasing morbidity and mortality. “Appropriate nutritional status” and “malnutrition” are difficult to define and assess because of inappropriate assessment tools and the challenges of separating the impact of malnutrition and the disease state on markers of malnutrition and on outcome (Marshall W.J. et al., 2008). While various nutritional assessment techniques exist, there are still not many gold standards offering high sensitivity and specificity for nutritional assessment in the pediatric intensive care unit. Infact, the ideal nutritional assessment tool has not been defined, possibly due to complexity and variability in body composition associated with the individual response to illness and stress (Marshall W.J. et al., 2008).
Children admitted to the PICU are at risk of longstanding altered nutrition status and anthropometric changes that may be associated with morbidity. Nutrition assessment of children during the course of critical illness is desirable. Hulst J. et.al., (2004) observed a correlation between energy deficits and deterioration in anthropometric parameters such as mid-arm circumference and weight in a mixed population of critically ill children. These anthropometric abnormalities accrued during the PICU admission returned to normal by six months after discharge (Hulst J. et.al., 2004). Using reproducible anthropometric measures, Leite H.P. et.al., (1993) reported a 65% prevalence of malnutrition on admission with increased mortality in this group. On follow up, a significant portion of these children had further deterioration in nutrition status.

Routine monitoring of weight is a valuable index of nutrition status in critically ill children. However, weight changes and other anthropometric measurements during the PICU admission should be interpreted in the context of fluid therapy, other causes of volume overload and diuresis. Nutrition assessment can also be achieved by measuring the nitrogen balance and resting energy expenditure (REE). Because of the diversity of medical conditions and syndromes in hospitalized children assessment of nutritional status and interpretation of anthropometric data need a tailored approach (Mehta N.M. et.al., 2009).
The prevalence of malnutrition in this group of patients and the dynamic effects of critical illness on nutrition status require the ability to accurately measure body composition in hospitalized children. Body composition measurement in children admitted to the PICU has been limited due to the absence of reliable bedside techniques while existing measurement techniques such as the Dual Energy X-ray Absorptiometry (DEXA) scan are impractical in this cohort. Therefore, validation of simple, noninvasive bedside measurement techniques is desirable and will allow monitoring of relevant parameters (Mehta N.M. et.al., 2009).

Owing to the unsatisfactory performance of a single assessment method for the determination of high-risk malnourished patients, attention turned to combinations of measurements to increase sensitivity and specificity (Jones H.J. et.al., 1999). Numerous studies have produced prognostic indexes for different populations, all addressing those patients at increased risk of developing complications. Some nutritional scores are based on mathematical equations, developed by use of stepwise multiple regression analyses of selected nutritional parameters; other nutritional scores are based on clinical and subjective assessment (Schneidner S.M. et.al., 2000). Some of these tools are Nutrition risk index, Nutrition risk screening 2002, Mini nutritional assessment tool, Subjective Global Assessment, Malnutrition Universal Screening Tool.
However, Subjective global assessment is the only screening tool used in general pediatric patients and it has been validated by various authors in different research settings (Rojratsirikul C. et.al., 2004; Dogan Y. et.al., 2005; Secker D.J. et.al., 2007). The Subjective global assessment is a screening tool to determine the nutritional status of patients and was developed by Detsky A.S. et.al., (1987). The SGA is a clinical technique with subjective elements and assesses nutritional status based on features of the patient’s history and physical examination. On the basis of the history and physical examination, patients are ranked into well nourished, mild – moderate malnourished or severely malnourished categories.

Having performed nutritional status assessment a nutritionist’s role in the hospital is to formulate the most appropriate nutritional therapy for each patient based on their nutritional status. The significance of the optimal nutrition for health and human development is well recognized. Nutrition support is an accepted standard of care in Pediatric Intensive Care Units (PICUs) and the provision of nutrients can prevent malnutrition. Nutrition support can result in improved wound healing, a decreased catabolic response to injury, enhanced immune system function, improved gastrointestinal structure and function and improved clinical outcomes. The goal of nutrition support therapies is to augment the short-term benefits of the pediatric stress response while minimizing the long-term harmful consequences. Accurate assessment of energy requirements and provision of
optimal nutrition support therapy through the appropriate route is important in pediatric critical care. The prescription of optimal nutrition support therapy during critical illness requires thorough assessment of the risks and benefits associated with the timing, route and quantity of nutrient intake. Ultimately, an individualized determination of nutrient requirements must be made to provide appropriate amounts of both macro and micronutrients for each patient at various times during the illness course. The delivery of these nutrients requires careful selection of the appropriate mode of feeding and monitoring the success of the feeding strategy (Ista E. et.al., 2005). Both underfeeding and overfeeding are prevalent in the pediatric intensive care unit (PICU) and may result in large energy imbalances (Mehta N.M. et.al., 2009).

Oral nutrition support is considered as the best route for feeding but wherever oral intake is not possible and the gastrointestinal tract is functioning, nutrients can be provided via feeding tubes placed into the alimentary tract. Enteral Nutrition (EN) is the preferred mode because of its lower cost and complication rates when compared with Parenteral Nutrition (PN) (Heyland D.K. et.al., 2003). Early institution of EN is associated with beneficial outcomes in animal models and human studies (Hamaoui E. et.al., 1990; Moore F.A. et.al., 1995) and has been increasingly implemented during critical illness, often using nutrition guidelines or protocols (Moore F.A. et.al, 1992; Chellis M.J. et.al., 1996). However, subsequent maintenance of enteral nutrient delivery remains elusive, as EN is
frequently interrupted in the intensive care setting for a variety of reasons, some of which can be minimized (Adam S. et al., 1997; Rogers E.J. et al., 2003). Frequent interruptions in enteral nutrient delivery may affect clinical outcomes secondary to suboptimal provision of calories and reliance on PN (Rogers E.J. et al., 2003).

To realize the potential benefits of Nutritional support in the pediatric intensive care unit (PICU), both early initiation and maintenance of feeding must be ensured.

**NEED FOR THE STUDY**

In 2009, American Society of Parenteral and Enteral Nutrition Support published Grade B nutrition support guideline recommendations for critically Ill children. However, the lack of systematic research and clinical trials on various aspects of nutritional assessment and nutrition support in the PICU is striking and makes it challenging to compile evidence based practice guidelines. There is an urgent need to conduct well-designed, multicenter trials in this area of clinical practice. The extrapolation of data from adult critical care literature is not desirable and many of the interventions proposed in adults will have to undergo systematic examination and careful study in critically ill children prior to their application in this population (Mehta N.M. et al., 2009).
Therefore, based on the above, the need to carry out a prospective study to assess the usefulness of a simple nutritional assessment tool which could serve as a complimentary tool to the existing conventional tools, and still could be performed when certain objective measurements of nutritional status are not available and to determine the influence of early nutritional support on outcomes, identify factors which interfere with nutrient intake and its effect on outcomes in this cohort was perceived. This necessitates a multi-disciplinary approach involving the Paediatrician, Nutritionists, Nurses, the child, their parents and any other support services (where appropriate) involved in the child’s care. The paediatric ICU in our teaching hospital provided an adequate platform to conduct such a study.
**AIM**

The aim of the study was “To assess the nutritional status, implement a protocolized nutrition support and evaluate its effect on the nutritional outcome of subjects admitted to a paediatric intensive care unit”.

**OBJECTIVES**

The objectives of the study were to:

- Determine the prevalence of malnutrition among paediatric subjects admitted to a paediatric intensive care unit.
- Assess the impact of optimal nutritional support on the nutritional status of paediatric subjects admitted to a paediatric intensive care unit.
- Assess the impact of early nutritional support on nutrient intake, timeliness of nutritional support, weight changes, biochemical parameters and length of hospitalization among paediatric subjects admitted to a paediatric intensive care unit.
- Evaluate the impact of feeding interruptions on nutrient delivery, timeliness of nutritional support, weight changes, biochemical parameters and length of hospitalization among paediatric subjects admitted to a paediatric intensive care unit.
- Evaluate the usefulness of Subjective Global Assessment as a nutritional assessment tool against conventional IAP weight for age (W/A) criteria among paediatric subjects admitted to a paediatric intensive care unit.
HYPOTHESIS

- H1: There is no significant impact of early nutritional support on nutrient intake among paediatric subjects admitted to a paediatric intensive care unit.

- H2: There is no significant impact of early nutritional support on the timeliness of nutritional support among paediatric subjects admitted to a paediatric intensive care unit.

- H3: There is no significant impact of early nutritional support on weight changes among paediatric subjects admitted to a paediatric intensive care unit.

- H4: There is no significant impact of early nutritional support on length of hospitalization among paediatric subjects admitted to a paediatric intensive care unit.

- H5: There is no significant impact of feeding interruptions on nutrient intake among paediatric subjects admitted to a paediatric intensive care unit.

- H6: There is no significant impact of feeding interruptions on time taken to attain goals among paediatric subjects admitted to a paediatric intensive care unit.
• H7: There is no significant impact of feeding interruptions on weight changes among paediatric subjects admitted to a paediatric intensive care unit.

• H8: There is no significant impact of feeding interruptions on length of hospitalization among paediatric subjects admitted to a paediatric intensive care unit.

• H9: There is no significant impact of optimal nutrition support on nutritional status of paediatric subjects admitted to a paediatric intensive care unit.