Chapter 5

Summary & Conclusion
SUMMARY AND CONCLUSION

A prospective observational study entitled “Assessment of Nutritional Status and Outcomes of Nutrition Support in Paediatric patients admitted to an Intensive Care Unit” was conducted on 260 subjects admitted to the Paediatric Intensive Care Unit (PICU) of Sri Ramachandra University and teaching hospital, Chennai, India, for a period of sixteen months from January’10 to April 2011 after obtaining approval from the Institutional Ethics Committee. Data was collected from the subjects who met the following inclusion criteria: subjects between the age group > 28 days to six years with stay in the PICU of 72 hours or more, receiving nutrition support (oral and/or oro/nasoenteric feeds).

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

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 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.
- Assess the impact of optimal nutritional support on the nutritional status of 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.

Assessment of nutritional status of the subjects on admission to the PICU was done. The height, body weight, Mid Arm Circumference, Head and Chest Circumference for all subjects were measured. The measured body weight was compared with the expected body weight using reference standards (Agarwal D.K. et.al., 1994) and it was interpreted using IAP Classification for weight for age and Waterlow’s classification for weight for height. Weight for age (W/A) and Weight for height (W/H) indices were used to identify the incidence of acute malnutrition. Similarly, the measured height was compared with the expected height using reference standards (Agarwal D.K. et.al., 1994) and it was interpreted using Waterlow’s classification for height for age identifying the extent of prevalence of stunting.
Nutritional Status of these subjects was also assessed using Subjective Global Assessment (SGA) tool. Body Mass Index (BMI) was calculated among children aged two to six years and interpreted using WHO (2007) standards, to assess their nutritional status (both acute and chronic malnutrition). Mid-arm circumference was measured in children aged one to five years to assess their somatic protein and fat stores. Head and chest circumference was measured in children up to two years of age.

The nutritional requirements were estimated on an individual basis using standards as per Indian Council of Medical Research standards (2009) which was comparable with the international recommendation of critically ill children, with care taken to avoid either overfeeding or underfeeding. Nutritional support was provided orally and/or oro/nasoenteric feeds based on the guidance and the judgement of the physician, independent of the study. The time duration from PICU admission to initiation of nutritional support, day of attainment of goals and day of transition from oro/nasoenteric feeding to oral feeding were recorded. Outcome measures such as changes in weight and in biochemical parameters, length of hospitalization, ventilation support days and any gastrointestinal complication were also recorded.

Statistical analysis was performed with the use of Scientific Package for Social Sciences (SPSS) version 16. The data was interpreted using Mean and Standard deviation, Percentages and analysis using Student’s ‘t’ –test, Chi- Square analysis, Sensitivity and Specificity for validation.
A total of 319 subjects aged one month to six years who were admitted to the multispecialty Pediatric Intensive Care Unit (PICU) of Sri Ramachandra Hospital were initially enrolled in the study. Nutritional assessment was performed and subsequently an individualized nutrition plan with nutrition support was initiated.

During hospitalization, 17 deaths occurred, 12 were discharged Against Medical Advice (AMA) and 30 subjects had missing data in terms of anthropometric measurements, laboratory data, hence their data was excluded during analysis. The total number of subjects whose data was finally analyzed was 260.

Pediatrics comprises of different age groups and each age group has distinct requirements. Hence majority of the analysis in this study have been done and interpreted for children as per their age group.

Sixty two percent of the subjects were less than one year of age. Among 62 percent of the subjects, those between 1-6 months of age comprised around 32 percent (84) and those in 6-12 months age group comprised around 30 percent (78). Twenty two percent (58) of the subjects were toddlers (1-3 year) and the school going age (4-6 year) children comprised around 16 percent (40) of the total study population.
The following were the observations made in the study:

It was observed that boys in the infant age group constituted around 56 percent (1-6 month) and 55 percent (6-12 month) respectively whereas girls were 44 percent (1-6 month) and 45 percent (6-12 month) respectively. Among toddler age group (1-3 year), 65 percent were boys and 35 percent were girls. In the school going age group (4-6 year), 55 percent were boys and 45 percent were girls.

Boys in the infant age group (1-6 month and 6-12 month) were with the mean age of $3.55 \pm 1.73$ months and $10.23 \pm 1.81$ months respectively whereas girls were with the mean age of $3.16 \pm 1.90$ months and $9.69 \pm 1.95$ months respectively. Among toddler age group (1-3 year), boys were with the mean age of $2.47 \pm 0.50$ years and girls were with the mean age of $2.20 \pm 0.49$ years. Similarly, those in school going age group (4-6 year), boys were with the mean age of $4.72 \pm 1.65$ years and girls were with the mean age of $5.01 \pm 0.96$ years. No significant difference was observed in the mean age among boys and girls in all the age groups.

The subjects in this study were found to be admitted with various complications. Majority of the subjects were admitted with infectious diseases followed by respiratory disorders, neurological impairment and cardiovascular diseases.
Evaluation of the nutritional status of the subjects using W/A, W/H and H/A criteria was done to determine the prevalence of acute and chronic malnutrition and it was observed that the mean weight of 1-6 month old infants was found to be lesser by 26 percent when compared with the expected standards of weight for age indicating that the children in this age group were underweight. Similarly, height for age was found to be deviating by eight percent among the 1-6 month old infants when compared with the expected standard of height for age. Wasting could also be observed across all age groups of the study population, with the highest percentage deviation (9.6%) among the toddlers. Underweight and stunting was predominant among infants in the age group of 1-6 months of age. The toddlers were more wasted than their other counterparts.

According to IAP Criteria for weight for age, 41 percent, 44 percent and 64 percent subjects in the first three age groups were found to be normally nourished. Around 40-60 percent of subjects in each age group were in any one of the three stages of malnutrition. Most of them had either Grade I or Grade II PEM. However, in children aged 4-6 year, 65 percent were normal and only 35 percent had malnutrition of which Grade I PEM was predominant.

Similarly, according to Waterlow’s Criteria for weight for height, around 30-50 percent of subjects in each age group were in any one of the three stages of wasting. Most of them had either Grade I or Grade II wasting.
However, in children aged 4-6 years, 55 percent were normal and only 45 percent had either Grade I or II wasting.

Waterlow’s Criteria for height for age revealed that among infants and toddlers, stunting was found in around 50-60 percent of subjects whereas among school going children only 40 percent were found to be stunted of which both Grade I (17%) and Grade II (17%) stunting were predominant.

Body mass index categorization according to WHO (2007) revealed that in children aged 2-3 years, 45 percent were undernourished, 43 percent were normal and 12 percent were overnourished. Among children aged 4-6 year, 42 percent were undernourished, 51 percent were normal and seven percent were overnourished. In conclusion, a high prevalence of undernutrition among hospitalized subjects admitted to the paediatric intensive care unit in our population necessitates attention.

Measurement of Mid Arm Circumference among children aged one to five years revealed that in toddlers (1-3 year), 65 percent had normal somatic protein and fat stores, around 19 percent had mild to moderate depletion of somatic protein and fat stores and 16 percent had severe depletion in somatic protein and fat stores. Among school going children (4-5 year), 91 percent had normal somatic protein and fat stores and nine percent had mild to moderate depletion of somatic protein and fat stores and none were severely depleted in somatic protein and fat stores. By virtue of poor somatic protein
and fat stores at admission, toddlers in the present study are at predisposed risk of malnutrition.

No abnormality in measurements of head and chest circumference was observed in children aged one month to two years. Overall, according to Subjective Global Assessment, around 50 percent of our subjects were well nourished, 34 percent were moderately undernourished and 16 percent were severely undernourished.

As malnutrition rates change in regard to the patient’s age at the moment of their hospitalization, they also vary in terms of the underlying clinical condition. For this reason, it is necessary to evaluate children’s nutritional status at the moment of their hospitalization and to research how both influence each other, so that appropriate, early and effective nutritional support can be meticulously planned for children admitted to an intensive care unit thereby avoiding hospital undernutrition.

The influence of the underlying clinical condition on the nutritional status of our study subjects revealed that prevalence of undernutrition in both forms such as moderate and severe undernutrition (44% and 37% respectively) was predominant among those with cardiovascular disorders when compared to other disease condition. The next clinical condition seemed to affect nutritional status was surgery wherein 39 percent of the subjects were moderately undernourished and 22 percent were severely undernourished. It was further observed that around 40 percent of the study population with
neurological disorders was undernourished. Similarly, 50 percent of the subjects with respiratory disorders were found to be malnourished.

Abnormalities in routine laboratory parameters related to nutritional status in children on admission to the PICU were observed. Anemia was prevalent in our subjects on admission to the pediatric intensive care unit. Severe anemia was found to be highest among subjects aged 6-12 months whereas mild to moderate anemia was predominant among subjects aged 1-6 months.

Total lymphocyte count evaluation revealed that severe immunocompromised state was found highest among subjects aged 1-6 months whereas mild to moderate immunocompromised state was predominant among subjects aged 4-6 years. Evaluation of serum protein levels revealed that severe depletion of protein levels was found highest among subjects aged 4-6 years whereas mild to moderate depletion of protein levels was predominant among subjects aged 1-6 months. Abnormal level of albumin on admission was also found in our subjects. Mild to moderate depletion of albumin levels was found highest among subjects across all age groups.

Having assessed the baseline nutritional status provision of adequate nutrition is an important aspect of management of a critically ill child. The nutritional requirements of our study subjects were estimated using the kilocalorie or protein requirement per kilogram standard equation based on ICMR recommendation, with care taken to avoid either overfeeding or
underfeeding. In our study, infants (1-6 month) were recommended an average of 653.71±140.31 kcal and 13.68±3.09 g of protein per day. For those aged 6-12 month, 909.38±103.67 kcal and 16.39±2.47 g of protein per day was recommended. The average energy and protein recommendation of toddlers (1-3 year) was 1250.95±225.03 kcal and 18.70±5.60 g respectively and among school going children (4-6 year) it was 1579.75±235.74 kcal and 21.00±7.89 g of protein.

Following the estimation of nutrient requirements in the critically ill child, the next challenge was to facilitate the provision of nutritional support.

In our study, 68 percent of subjects aged 1-6 month were fed through oral route and 32 percent were fed through oro/nasoenteric route. Among children aged 6-12 month and 1-3 year, 76 percent were fed orally and 24 percent were fed through oro/nasoenteric route. However, only five percent of subjects were on oro/nasoenteric feeding in the age group of 4-6 year.

For subjects who were in a position to resume oral nutrition support after the initial phase of hemodynamic stabilization, breast milk, nutrient dense formulas and/or progressive hospital diets in terms of consistency starting from clear liquids and progressing to soft solids was suggested, without compromising the nutritional intake. Subsequently, an individualized nutrition care plan was devised. For subjects on oro/nasoenteric feeding, initiation of feeds was done using standard pediatric enteral formulas at fifty percent of the goal rate of feeding. In our study, it was observed that nutrition support
was initiated on an average of 1.20± 0.44 to 2.12± 2.98 days across all the four age groups. Once having started on nutrition support, advancement of feed rate was done to enable early achievement of goal. In this study for subjects on oro/nasoenteric feeding, advancement of feed rate was done as per protocol every second to fourth hourly by 25% of the previously tolerated feeding rate, till the target rate was met. For subjects on oral nutrition support, dietary manipulation, use of dietary supplements and assistance with feeding were adopted depending on the case with care taken to meet the estimated nutrient requirement. The subjects were monitored on a day to day basis until discharge from the hospital. Daily documentation of 24-hour nutrient intake from the day of initiation till the day of discharge was carried out.

It was observed that using the RDA as the value for optimal energy, protein, carbohydrate and fat intake, there was an overall improvement between the mean initial and final nutrient intake in all the four age groups. Fifty percent of the estimated requirements across all age groups were achieved on an average 1.37±0.28 to 2.13±0.55 days and 75 percent goal was achieved on an average of and 2.54±0.29 to 3.12±0.38 days. Hundred percent, energy and protein requirement was achieved at an average of 3.08±2.09 to 4.60±1.34 days, which was in par with the reported literatures. Transition from tube feeding to oral soft solids was done within 0.37±1.94 to 2.42±4.29 days.

Early initiation of nutrition is vital to minimize the effects of hypermetabolism and hypercatabolism. Additionally, early nutritional support has been shown
to improve clinical outcomes in a variety of critically ill populations by reducing septic morbidity, decreasing ICU and hospital length of stay, improving wound healing and preserving gastrointestinal mass, structure and function. Therefore, in our study, we intended to evaluate the number of subjects being fed early (≤ 2 days) and late (> 2 days) and its effect on outcomes.

In the present study, it was observed that nutrition support was found to have initiated early among 78 percent to 89 percent i.e. within two days (48 hours) after patient admission. However, critical illness such as respiratory disorder, head injury, seizure disorder, post operative conditions and cardiology related complications precluded the early initiation of nutrition support in around 11 percent to 22 percent of the subjects because most of these subjects had hemodynamic or respiratory instability, blood pressure changes requiring fluid resuscitation or frequent vasopressor manipulation, or airway management. Initial fluid management was carried out in patients with congestive heart failure, renal failure, brain swelling resulting from trauma, status epilepticus, cardiopulmonary resuscitation event and acute respiratory distress syndrome. Nutrition support was initiated in consultation with the physician after the subjects’ attained hemodynamic stability.

Nutrition support was initiated among 78 to 89 percent of the population on an average within 1.15±0.38 to 1.57±0.17 days of admission and for the rest 11 to 22 percent of the population it was initiated only after 3.32±0.52 to
4.72±2.25 days of admission. The difference in between the days of initiation was significant (p<0.001) among the two groups.

In the present study, subjects receiving early nutritional support were able to meet 50 percent of their estimated requirements on an average of 1.45±0.56 to 1.91±0.49 days while those receiving late nutritional support were able to meet 50 percent of their estimated requirements on an average of 1.59±0.19 to 1.97±0.21 days. Though there was a difference observed in the time taken to achieve 50 percent goal in both the feeding groups, the results were not statistically significant. For those on late nutritional support taking food orally, routine hospital prepared nutrient dense diet was provided and for those on tube feeding either isocaloric enteral formula with increased volume or modulated nutrient dense feeds, pertaining to the severity of the underlying clinical condition was provided. These modifications were done to achieve early attainment of goals.

However, when the time taken to meet 75 percent of the estimated requirements was evaluated, it was observed that subjects receiving early nutritional support were able to meet 75 percent of their estimated requirements on an average of 2.29±0.69 to 2.78±0.32 days while those receiving late nutritional support were able to meet 75 percent of their estimated requirements on an average of 2.65±0.34 to 2.91±0.26 days. A significant difference (p<0.05; p<0.001) was found in the time taken to achieve
75 percent goals in both the feeding groups across all the age groups except in infants in the age group of 6-12 month.

Finally, when the time taken to meet 100 percent goal was evaluated in both the feeding groups, it was observed that subjects receiving early nutritional support were able to meet 100 percent of their estimated requirements on an average of 3.55±0.20 to 4.34±0.98 days while those receiving late nutritional support were able to meet 100 percent of their estimated requirements on an average of 3.68±0.14 to 5.79±1.03 days and the results were statistically significant across all the age groups (p<0.05).

Subjects on late nutritional support reported a slow tolerance to feeds due to the severity of the underlying critical illness. Moreover, repeated interruptions due to aspiration risk, respiratory distress, radiologic procedures, bedside procedures, frequent electrolyte imbalance, fluid overload etc lead to slow delivery of nutrients and thereby the time taken to achieve 100 percent goals was prolonged in this group.

Further analyses were done to understand the actual energy and protein intake of the subjects receiving early nutritional support and late nutritional support.

It could be inferred that from the day of initiation of feeding till the day of discharge, there was an improvement seen in the mean intake of energy and
protein by the subjects in all the age groups either receiving early nutritional support or late nutritional support and the results were statistically significant (p<0.01; p<0.001) irrespective of early/late initiation.

In the present study chances of overfeeding and underfeeding was prevented by attentive and thorough estimation of requirements, careful progression of macronutrients and close monitoring of daily laboratory data and weight. A comparison of final nutrient intake for subjects receiving early or delayed nutritional support was done with their recommended intake to understand if any overfeeding and underfeeding was prevalent among them.

It was found that there was no significant difference in the final energy and protein intake when compared to the recommended nutrient intake in all the age groups. Therefore, it could be inferred that neither overfeeding nor underfeeding was prevalent in our study subjects.

It was seen that subjects receiving early enteral nutritional support were able to make a transition from tube feeding to oral soft solids within 6.36±3.87 to 8.00±0.50 days and those on late enteral nutritional support within 3.00±1.25 to 9.00±2.90 days of initiation of enteral nutrition support. A significant difference (p<0.01, p<0.05) was observed while evaluating the time taken to make a transition from Oro/nasoenteric feeding to oral feeds among subjects on early nutritional support when compared to those who were initiated on late nutritional support.
Hence, from the above discussion it can be observed that there was a significant difference in the day of initiation, attainment and transition of feeds among subjects receiving early or late enteral nutritional support in all the age groups. Therefore, it is strongly recommended to improve feeding practices by implementing feeding protocols for optimal nutritional management in paediatric children admitted in a critical care unit.

Once nutritional support is started accurate assessment of body weight changes is necessary for planning ongoing nutritional intake and assessing the adequacy of nutritional supportive regimens during critical illness. In our study, the subjects were weighed on admission and at discharge using a weighing scale/pan. Overall there was an improvement in weight of the subjects between admission and discharge. Among children aged 1-6 month there was a weight gain of 200 g, in children aged 6-12 month there was a weight gain of 130 g and among subjects aged 1-3 year and 4-6 year there was a weight gain of 160 g and 70 g respectively.

Further analyses were conducted to determine the changes in weight between admission and discharge among subjects receiving early or late nutritional support. It was observed that irrespective of the timing of feeding, subjects in all the age groups had no weight loss and there was weight maintenance or an insignificant gain in weight.

Laboratory investigations such as serum hemoglobin, protein and albumin levels are also generally used as markers to determine adequacy of
nutritional support being provided to the subjects. While early nutritional support helps in the improvement of these parameters no significant difference in the initial and final hemoglobin values was observed when analyzed collectively in all the age groups which can be attributed to adequacy of nutritional support in maintaining the levels rather than deterioration. Moreover, the timing of feeding (early versus late nutritional support) seemed to less influence the hemoglobin values. Therefore, nutritional support should be provided as a supportive care in critically ill pediatrics to prevent development of further nutritional deficiencies.

Similarly, the serum level of protein and albumin were within the normal range and was stable during hospitalization when analyzed collectively in all the age groups. There was no significant difference between the initial and final serum protein values in all the age groups irrespective of the timing of feeding.

The adequacy of nutritional support can also be assessed by determining its influence on the length of stay of the patients in the pediatric intensive care unit. In our study, the length of hospitalization for infants (1-6 month) was $11.94\pm8.39$ days, for those aged 6-12month length of hospitalization was $9.95\pm3.24$ days. Among toddlers (1-3 year) and school going children (4-6 year), length of hospitalization was $10.02\pm4.64$ days and $10.95\pm5.17$ days respectively. The acceptable number of days of hospital including ICU stay among pediatric population is <25 days as reported by different authors and the subjects in this study were found to stay on an average of ten days
which is within the acceptable norms. Timely and monitored nutritional support helps to achieve this target.

Recently, malnutrition at admission and critical illness have been found to be a strong risk factor for many complications such as infection, longer stay at the hospital, reintubation and death, among others. However, studies reporting the impact of malnutrition and underlying illness on length of hospitalization in our population were minimal. Such information is needed to design nutritional interventions for these children. Therefore, an attempt was made to report the relationship of these variables on length of hospitalization of critically ill children in our population. In our study, it was observed that severely malnourished subjects had longer length of hospitalization (13.29±10.17 days) when compared with well nourished (9.88±3.98 days) and malnourished subjects (10.87±5.33 days) and the results were statistically significant (p<0.01). On the basis of length of hospitalization in our study, a severely malnourished child on an average stayed for 2.42 days longer when compared to a moderately malnourished child and 3.41 days longer when compared to a well nourished child.

Further analyses were performed to understand the impact of clinical condition on length of hospitalization. It was seen that subjects who came with infectious diseases, cardiology, neurology related complications and those who came for emergency surgery did not significantly influence the
length of hospitalization across the different status of malnutrition. The length of hospitalization of these subjects was comparatively shorter than that defined in the literature (≥25 days) (Carson SS, 2007).

However, a significant (p<0.01) influence was observed among subjects with nephrology related complications. Severely malnourished subjects with nephrology related complications had a longer period of hospitalization. Since, the number of nephrology subjects studied was very less; no concrete conclusions could be arrived at. Closer observation and nutritional support are required in the cases of severely malnourished patients diagnosed with chronic kidney insufficiency. Severe malnutrition among subjects with respiratory related complications was also found to be significantly (p<0.01) influencing the length of hospitalization but was comparatively shorter than that defined in the literature (≥25 days).

Nutritional support seemed to have an impact on the length of hospitalization of our study subjects. It was seen that the length of hospitalization was relatively shorter for subjects who were on early nutritional support when compared to subjects on delayed nutritional support and the results were statistically significant (p<0.001;p<0.01;p<0.05) in all the age groups.

Adequacy of nutritional support can also be determined by feeding tolerance and the ability to advance the rate of feeding delivery until the goal is achieved. In our study population, most of the subjects tolerated feeds and
low frequency of gastrointestinal tract complications was observed. In our study, diarrhea was observed among four percentage of subjects aged 1-6 month. Among subjects aged 6-12 month, two percentages each had either vomiting or abdominal pain. In children aged 1-3 year, five percentages had diarrhea and two percentages had abdominal pain and among children aged 4-6 year, three percentages had diarrhea and 15 percent had vomiting.

Adequate nutrition is a necessary prerequisite for successful weaning. Both overfeeding and underfeeding has been linked with the ability to wean patients from mechanical ventilation. Therefore, in our study, subjects on ventilation were provided 35 percent to 55 percent of total kilocalories from carbohydrates to prevent overfeeding or underfeeding and help in expediting the weaning process. Overall, it was observed that infants (1-6 month) were weaned off the ventilation by 3.15±1.06 days, those among 6-12 month were weaned off the ventilation by 3.75±2.37 days and toddlers (1-3 year) on an average of 3.88±2.47 days. One subject in the school going age group (4-6 year) was weaned off the ventilation within five days.

Nutritional reassessment at regular intervals allows the efficiency of metabolic support and intolerance to administration of nutrients to be checked and makes changes in nutritional support possible according to the evolution of the patient. In our study, the subjects were nutritionally assessed using SGA tool on admission to the PICU and at discharge. Out of 42 (16.1%) subjects who were found to be severely malnourished based on SGA initially, 20
(7.6%) subjects improved to the next level of nutritional status, that is, moderately malnourished category. Thereby, reducing the total number of subjects in the severely malnourished group to 22 (8.5%) finally. Further, it was noted that out of 87 (33.5%) subjects in the moderately malnourished category, 33 (12.7%) subjects improved in their nutritional status and were found to be well nourished thereby reducing the total number of subjects in the moderately malnourished group to 74 (28.5%) finally. The subjects in the well nourished category increased from 131 (50.4%) to 164 (63%). The improvement in nutritional status from one category to the other was found to be significant (p<0.001).

The results of this section have demonstrated that provision of meticulously planned and judiciously implemented nutritional support is vital in minimizing the effects of fasting, hyper catabolism and hyper metabolism in pediatric patients admitted in a critical care unit than that commonly used. Early nutritional support was well tolerated, demonstrating that it is a safe and effective method for administration of nutrients.

Despite the known benefits of nutritional support, subsequent maintenance of nutrient delivery remains elusive among PICU patients as nutritional support is frequently interrupted in the intensive care setting for a variety of reasons, some of which can be minimized. In our study, factors affecting adequate delivery of nutritional support were also identified. Overall it was observed that respiratory distress was the most common cause of interrupted delivery
of nutrients in infants and toddlers in our study. Among school going children (4-6 years), majority of the subjects were predisposed to have aspiration risk.

The impact of feeding interruptions on nutrient delivery, time taken to attain 100% goals, weight changes and length of hospitalization of our study subjects was also evaluated. It could be inferred that subjects without feeding interruptions were able to attain 100 percent goals on an average of 2.90±2.37 to 3.70±1.93 days whereas in subjects with feeding interruptions 100 percent goals were achieved on an average of 3.46±1.36 to 5.15±1.51 days following initiation of feeds and the results were statistically significant (p<0.01; p<0.05). Overall, it could be understood that feeding interruptions significantly affected the time taken to reach the prescribed caloric goals as also observed in our study population.

However, irrespective of feeding interruptions or no feeding interruptions all the subjects were able to meet their requirements. There was no statistical difference seen between the recommended intake and the actual nutrient intake at discharge between the two groups.

Moreover, subjects without feeding interruptions had a better weight gain when compared to subjects with feeding interruptions. However, the results show no statistical difference. But, when the length of hospitalization was evaluated, subjects without feeding interruptions had a shorter stay in the hospital when compared to subjects with feeding interruptions and the results were statistically significant in all the age groups (p<0.05;p<0.01).
It was also observed that the mean hemoglobin values in subjects without feeding interruptions were low at admission and it slightly improved at discharge although the results show no statistical significance. But, no further decline in hemoglobin values was observed. In contrary, among subjects with feeding interruptions the mean hemoglobin values was low at admission and it further declined at discharge. However, this difference was also not statistically significant.

Serum protein and albumin values were maintained at normal from admission till discharge in all the age groups irrespective of feeding and no feeding interruptions and the results show no statistical significance. However, serum total protein and albumin concentrations may be affected by albumin infusion, fluid overload, dehydration, sepsis, trauma and liver disease.

Overall, it was inferred that feeding interruptions significantly affected the length of hospitalization. It may also affect the weight to a certain extent in critically ill children.

The usefulness of SGA as a screening tool for malnutrition in these patients has been checked by determining its sensitivity and specificity against IAP Weight for Age (W/A) criteria for malnutrition at admission and at discharge. It was inferred that SGA had a sensitivity of 87 percent and a specificity of 86 percent at admission and at discharge it had a sensitivity of 90 percent and a specificity of 94 percent when compared against IAP Weight for Age (W/A) criteria. The high sensitivity and specificity of SGA indicates that it is strongly
able to predict nutritional status of critically ill children both at admission and at discharge. The positive predictive value at admission was 86 percent and the negative predictive value was 87 percent whereas at discharge it was 89 percent and 95 percent respectively.

Therefore, it was understood that both IAP weight for age (W/A) criteria for malnutrition and SGA are better identifiers of malnutrition in children admitted to PICU. Either of the tools can be used at admission and at discharge to assess the nutritional status in subjects admitted to the PICU as the latter is useful in assessing subjects who are not ambulatory whereas the IAP requires objective data for ascertaining the nutritional status.

CONCLUSION

The prevalence of malnutrition is high among infants and children admitted to the PICU as also inferred from our study. Moreover, it is a well established fact that malnutrition is associated with impaired wound healing, impaired immune response to infections, reduced gastrointestinal function, decreased function of muscles, longer dependency on ventilation, prolonged hospital stay and also an increase in morbidity and mortality. However, the prevalence of malnutrition is seldom recognized by health care professionals of paediatric ICU. As a consequence, nutritional therapy is under prescribed and thus compounding the problem. Therefore, assessment of nutritional status should be one of the main aspects in the management of the pediatric intensive care patient.
Assessment of nutritional status can be done using the routine anthropometric measurements such as height and body weight and their suitable interpretation using IAP W/A criteria or Waterlow’s H/A and W/H criteria which is being used across the nation. Subjective Global Assessment (SGA) tool can be used as a complement of IAP weight for age criteria as it was observed in our study that SGA tool when compared with IAP weight for age criteria, showed a high sensitivity and specificity and was found to predict the nutritional status of children admitted to an intensive care unit as strongly as IAP weight for age criteria.

Hence, from the current study it is suggested that SGA tool can serve as a complimentary tool to IAP W/A criteria for assessment of nutritional status, as the latter is beneficial in assessing the nutritional status of subjects who are non ambulatory when compared to the IAP W/A criteria which requires objective data.

Having assessed the nutritional status provision of adequate nutritional support in order to prevent disease related malnutrition should play an important role in the clinical management of critically ill children both in acute illness and during recovery thereafter. Adequate nutrition is an essential need of all children for survival, mental, motor development and for growth. In our study, provision of early nutritional support showed a significant improvement in physiologic stability and outcomes of PICU patients. The targets of nutritional support in our study population were to 1) Prevent protein
catabolism and loss of lean body mass as much as possible by promoting protein synthesis and/or diminishing protein breakdown 2) preventing under and overfeeding 3) improving clinical outcome and ascertain normal growth and development.

In conclusion, the results of the current study provide multiple evidences for implementation of quality nutrition support administration to the critically ill pediatric population across the healthcare system. Based on the observations of the study, an institution specific nutrition support protocol was developed, including published guidelines considered as the best practices that would help in early initiation, progression and transition of nutrition support and thereby improve the overall clinical outcome of the critically ill pediatric children.
LIMITATIONS OF THE STUDY

- This study is a single centre trial
- Age group was restricted upto six years
- Critical status of the subject's clinical condition was not categorized
- Indirect Calorimetry could not be used in our study subjects for accurate estimation of energy
- Weight and laboratory parameters could not be taken for some patients during follow-up, hence their data had to be excluded during analysis
- Details of vitamin and mineral supplementation and albumin transfusion were not noted during the study period
- Bioavailability of nutrients from the formula feeds and oral soft solids could not be determined
SCOPE FOR FUTURE STUDIES

- Studies on metabolic and nitrogen balance in critically ill children
- Studies using Indirect Calorimetry for accurate estimation of energy in critically ill children
- Randomized control studies on assessment of nutritional status and outcomes of nutrition support based on specific clinical condition of critically ill children
- Implementation of the developed protocol in different centers across the nation and development of a national protocol for critically ill children