# Survival in critically ill pediatric surgical patients with elevated PYMS and caloric deficit

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# Abstract

Introduction: The nutritional counseling of the critical surgical pediatric patient is complex, it requires nutritional monitoring tools to improve their survival. The Pediatric Yorkhill Malnutrition Score (PYMS) is highly valid for determining nutritional risk. In Cuba there are no comparative studies on survival and PYMS.

Objective: To determine survival in pediatric surgical patients with high PYMS and caloric deficit.

Methods: An observational, prospective, cross-sectional and survival study was carried out in the Pediatric Intensive Care Unit of the Octavio de la Concepción de la Pedraja Pediatric Hospital, Holguín, Cuba, in the period from January 2018 to January 2019. analyzed 21 demographic and nutritional variables. Pearson's correlation coefficient was used for the bivariate variables. Kaplan Mier survival curves and ROC curves were created to determine optimal cut-off points for mortality.

Results: All patients who did not survive presented high PYMS (p = 0.001) log Rank: X2 10.5, the patients with better caloric adequacy had better survival (p = 0.513) log Rank: X2 0.428 but without statistical significance. The area under the curve to determine mortality according to the PYMS score was higher (0.891) than caloric deficit (0.468) with a sensitivity of 1 and a specificity of 0.66.

Conclusions: The survival of critical surgical pediatric patients with high PYMS and caloric deficit was determined. The non-survivors of the study had an elevated PYMS. The PYMS score is a better predictor of mortality than the caloric deficit. Demonstrating its excellent utility in advising nutritional risk in pediatric intensive care.


# Introduction

The objective of nutritional support (NS) in critically ill pediatric patients is not only to maintain an adequate nutritional status, but also to modulate said metabolic and inflammatory response, optimize the benefits of the adaptive response to stress and, in the medium-long term, reduce the negative consequences that could arise from this response. (1)

The nutritional management of the child undergoing surgery is not a glamorous subject and rarely receives the attention it deserves, despite the growing evidence of a better postoperative evolution, with a favorable prognosis, associated with better and more specific nutritional support. (2)

The ASPEN 2009 guideline (1) recommended that when a critically ill child is admitted to the PICU, a nutritional risk screening be carried out that allows the early identification of those children who are at risk of malnutrition during the hospital stay and who would benefit from early nutritional interventions. The nutritional risk assessment tools in children include 6 scales:

• Nutritional Risk Score (NRS)

• Pediatric Nutritional Risk Score (PNR)

• Screening tool for the evaluation of malnutrition in Pediatrics (STAMP)

• Subjective Global Nutritional Assessment (SGNA)

• Pediatric Yorkhill Malnutrition Score (PYMS)

• Screening tool for risk of deterioration of nutritional status (STRONGkids). (1.3-8)

Of these tools, PYMS and STRONGKids were the most used in PICUs and were evaluated in multiple centers in Europe. The latest ASPEN guideline from 2017 concludes that none of these nutritional screening tools could be recommended in clinical practice. Currently, there is no consensus on the screening tool upon admission. (9)

The Yorkhill Pediatric Malnutrition Score (PYMS) was developed and used by the Royal Hospital for Sick Children at Yorkhill in Glasgow, Scotland. This screening tool was developed according to the nutritional screening guidelines of the European Society for Clinical Nutrition and Metabolism. The PYMS score measures four parameters that can assess and predict symptoms of malnutrition: (1) body mass index (BMI), (2) history of unintentional weight loss in a short period of time, (3) changes in food intake, and (4) the predictive effect of disease diagnosis on nutritional status. Each parameter is scored separately and the total score shows the level of risk for pediatric malnutrition. (10)

Multiple recent studies have reported a prevalence between 20 and 47% of malnutrition in critically ill children, an incidence of malnutrition in critically ill children that varies between 40 and 70%. (11) To calculate energy requirements, energy expenditure at rest (GER) is used. The GER is defined as the amount of calories required by the body at rest during a 24-hour period and represents 70% of the total energy expenditure; constitutes the sum of basal metabolic rate (BMR) plus endogenous thermogenesis produced by food. (6.12)

Adequate caloric-protein intake is decisive in the morbidity and mortality of critically ill pediatric patients; The caloric-protein debt is very often underestimated, that is, the objective difference between the necessary and real contribution in a day of nutrition. It has been shown in several studies that daily caloric-protein delivery is inadequate by 60–85%, respectively, by day 8 of nutrition in the PICU. (13–14)

The calculation of energy requirements must be carried out individually, according to age, nutritional status and underlying disease. In patients with diseases that carry a high risk of malnutrition, the best method is the calculation of the (GER) corrected by a factor that includes the activity and the degree of stress. The ideal way to know the GER is through indirect calorimetry. However, most clinicians do not

have this technique and, therefore, need to estimate energy needs with guide calculations using prediction equations, the most widely accepted being the Schofield formula. (15)

Mortality in pediatric surgical patients is variable; there are no studies in Cuba that relate mortality to the new PYMS, an important tool in nutritional risk stratification extrapolated to the PICU (pediatric intensive care unit). In our country, the survival of patients with these characteristics is highly variable, and the need for a tool in the PICU for early identification and change in therapy is imperative. Due to its demonstrated ability to show nutritional risk, we wonder if it will be possible to determine the survival of critical surgical pediatric patients with high PYMS score and nutritional deficiency.

Objective: To determine survival in pediatric surgical patients with high PYMS and caloric deficit.

# Methods

An observational, prospective, cross-sectional and survival study was carried out in the Pediatric Intensive Care Unit of the Octavio de la Concepción de la Pedraja Pediatric Hospital in the period from January 2018 to January 2019.

The universe was made up of 396 patients who were admitted in that period, and the sample was made up of 55 patients who met the following inclusion and exclusion criteria.

Inclusion criteria:

Patients older than 28 days to 18 years, 11 months and 29 days, total parenteral nutrition during their stay in the PICU, patients diagnosed with surgical pathologies upon admission.

Exclusion criteria

Patients whose total parenteral nutrition is suspended for any reason. Mixed nutrition, Patients with more than one reoperation, deceased or discharged from another cause in the first 10 days.

The last day for survival was defined as the last death in the PICU, 45 days after the scheduled period.

The database and their statistical processing were carried out and analyzed in the statistical program SPSS 24. (IBM 2016)

Descriptive statistics were used for the collection, presentation and interpretation of the results. Summary measures were used for quantitative data such as arithmetic mean and standard deviation; Inferential statistical methods such as Pearson's correlation coefficient to estimate the linear relationship between quantitative variables given by somatic parameters of patients and nutritional variables. Percentage relationships were used to represent the values of the qualitative variables.

A 95% reliability index was used, with values of $p < 0.05$ being considered significant. A ROC curve was used to define optimal cut-off points in order to predict mortality and survival through high PYMS and

caloric deficit ≥ 25%, the sensitivity and specificity of the test for prediction was determined, the Youden Index was used, defining its area under the curve (AUC).

2 categories of PYMS score were determined, not elevated ≤ 5 points, elevated ≥ 6

The PYMS score was used from its description in Gerasimidis et al (10)

It is noteworthy that although scores of 4 or 5 present moderate risk, in order to determine a greater association with states of higher mortality, they were not included.

The Schofield equations with weight were used to estimate energy expenditure at rest in critically ill pediatric surgical patients, adding stress factors to them. (15)

Kaplan-Meir curves were created to determine survival in those with high PYMS and caloric deficit, the log Rank (Mantel-Cox) was calculated for each one, including the x2 for each analysis.

Ethical considerations: This study was approved by the Scientific Council of the participating Institution. The research was carried out in accordance with the principles of medical ethics, current institutional and national ethical standards and the principles of the Declaration of Helsinki.

# Results

Table 1. Demographic characteristics of the study according to type of nutrition.

| Demographic characteristics | Media ±DE<br>N (55) |
|---|---|
| Age (years) | 6,90±6,51 |
| Sex n (%) | |
| | 33 (60) |
| | 22 (40) |
| Male | 23,64±20,24 |
| Feminine | 1,07±0,36 |
| Weight (kg) | 0,81±0,47 |
| Size M) | 16,97±4,54 |
| Body surface (Mosteller) (SC) (m2) | 18,24±7,25 |
| Body mass index (BMI) (kg / m2) | |
| | 5 (9,1) |
| | 6 (10,9) |
| | 16 (29,1) |
| | 4 (7,3) |
| | 3 (5,5) |
| | 4 (7,3) |
| | 2 (3,6) |
| | 4 (7,3) |
| | 2 (3,6) |
| | 2 (3,6) |
| | 4 (7,3) |
| | 3 (5,5) |
| Duration of nutrition (days) | 8 (14,5) |
| Surgical diagnoses n (%) | 17,80±8,92 |
| Postoperative Bowel Occlusion | 22(40) |
| Postoperative Intestinal Intussusception | |
| | 26(47,3) |
| | 24(43,6) |

| | |
|---|---|
| | 5(9,1) |

N = 55, SD (standard deviation)

After 10 days of parenteral nutrition, the caloric deficit was considerably high, with -42.35 kcal / kg / day, the discharge rising discretely to present a mean difference compared to the 10 day of 14.93 kcal / kg / day, presenting Moderate to strong correlation with somatic parameters, the highest being the one presented by the caloric deficit at 10 days with height (r = 0.690), the nutritional deficit also presented a strong correlation throughout the study with mortality, being the highest that reached by the deficit at 10 days (kcal / kg / day) (r = 787) .The PYMS score and the subclassification of PYMS presented weak correlations with somatic parameters, the lowest with age (r = 0.085), taking into account Note that it really depends mostly on nutritional parameters, but if it reached a weak to moderate correlation with mortality, the PYMS score (0.492) (Table 2.)

Table 2 Caloric deficit and PYMS of study patients, as well as their correlation with somatic variables and mortality.

| | Mean ± SD Age | Mean ± SD Age | Mean ± SD Age | Mean ± SD Age | Mean ± SD Age | Mean ± SD Age | Mean ± SD Age |
|---|---|---|---|---|---|---|---|
| Deficit in caloric intake at 10 days (kcal / kg / day) | -42,35±13,57 | 0,673 | 0,657 | 0,690 | 0,612 | 0,125 | 0,787 |
| Caloric intake deficit at 10 days (%) | -69,78% ±7,24 | 0,514 | 0,498 | 0,432 | 0,423 | 0,202 | 0,690 |
| Deficit in caloric intake on the day of discharge from the PICU (kcal / kg / day) | -27,42±11,27 | 0,598 | 0,527 | 0,590 | 0,600 | 0,148 | 0,612 |
| Deficit in caloric intake on the day of discharge from the PICU (%) | -47,34±8,12 | 0,417 | 0,412 | 0,489 | 0,512 | 0,210 | 0,601 |
| PYMS score | 4,80±1,64 | 0,085 | 0,096 | 0,133 | 0,133 | 0,112 | 0,492 |
| PYMS n (%) | | 0,147 | 0,169 | 0,216 | 0,190 | 0,082 | 0,452 |
| | 25 (45,5) | | | | | | |
| | 30 (54,5) | | | | | | |

N = 55, p <0.05 SD (standard deviation) r: correlation

Optimal cut-off points were determined through an ROC curve to estimate mortality through the PYMS score and caloric deficit ≥ 25% (Figure 1). It was specified that with a cut-off value of 4.5 in the PYMS score, can estimate mortality in the PICU for this sample with a sensitivity of 1 and a specificity of 0.660, with an area under the curve of 0.891. Higher PYMS scores would be associated with higher mortality in

the PICU of critically ill pediatric surgical patients. With a cut-off point of 25% for caloric deficit, mortality can be estimated with an area under the curve of 0.468, with a sensitivity of 0.75 and a specificity of 0.553. The PYMS curve is obviously superior as a predictor of mortality.

The Kaplan Meir curve for survival in PYMS with elevated or non-elevated PYMS is observed (Figure 2A), finding that all those who did not survive had an elevated PYMS Log Rank (Mantel –Cox) X2: 10.53, degrees of freedom : 1, p = 0.001, observing survival with non-elevated PYMS values. In the present study, all the deceased had elevated PYMS.

The Kaplan Meir curve for survival in PICU with caloric deficit ≥ 25% is also observed (Figure 2B), observing that those who presented adequate caloric intake had a shorter stay in the PICU, and greater survival Log Rank (Mantel-Cox) X2 0.428, degrees of freedom 1, p = 0.513, with a mean PICU survival of 32 days for adequate caloric intake and 35.47 days for inadequate intake.

# Discussion

Counseling the nutritional status of the pediatric surgical patient is very important and should be carried out as precisely as possible, if their nutritional risk is not analyzed upon admission to the PICU, it is likely that it will affect their survival in the PICU, by underestimating the nutritional variables that accompany them.

If the nutritional status is poor, the stay will affect the health costs and may worsen the pathological condition. (16)

An adequate screening tool must have the 4 aspects of the PYMS (unintentional weight loss in a short period of time, decrease in diet, positive effect of disease on nutritional status and antecedents of nutritional status. (17)

The PYMS Score has improved the screening of pediatric patients in the PICU, somewhat reducing the need for expensive methods to assess nutritional risk, the survival analysis of the present study coinciding with that of several authors. (9–11)

The study presented better correlations of PYMS with mortality than that proposed by Gerasimidis et al (10), when reaching AUROC of 0.891 to predict mortality.

Caloric deficit was associated with shorter survival and longer stay in the PICU, consistent with Mehta et al (9), although not statistically significant for the study.

Beser et al (18) determined that the use of anthropometric measures in addition to nutritional screening tools such as STRONGkids and PYMS can prevent the risk that some patients present of being undervalued.

Another important factor with high responsibility for the mortality of pediatric surgical patients is non-compliance with nutritional goals during the administration of parenteral nutrition regardless of their nutritional status, Herman et al (19) describe peri and preoperative nutrition as an associative factor for the favorable prognosis of the surgical pediatric patient.

Adequate preoperative care, as well as nutritional prevention in pediatric patients who are candidates for elective surgery or pre-intervention parenteral nutrition, are associated with higher levels of survival in the postoperative period. (19) According to Weimann et al (20) the fundamental principles include from the integration of nutritional screening and nutritional practices within the general management of the surgical patient, to the elimination of stress factors and the abstention of long periods of preoperative fasting .

The most important finding of the present study was that in the studied population all the deceased had elevated PYMS, something that differs in some investigations, (16–17) but which is an important marker for future investigations due to its possible association with unstudied variables. such as pre-existing diseases or conditions.

Beser et al18 concluded that the PYMS results indicate that patients at high risk of malnutrition have more chronic diseases (75%), an important limitation of the present study.

The present investigation presented as additional limitations the non-inclusion of variables associated with the existing pre-surgical nutrition as well as the pre-hospital nutritional assessments of the patients included in the study.

# Conclusions

Survival of critical surgical pediatric patients with elevated PYMS and caloric deficit was determined. The non-survivors of the study had an elevated PYMS. The PYMS score is a better predictor of mortality than the caloric deficit. Demonstrating its excellent utility in advising nutritional risk in the PICU.

# Declarations

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Interest conflict

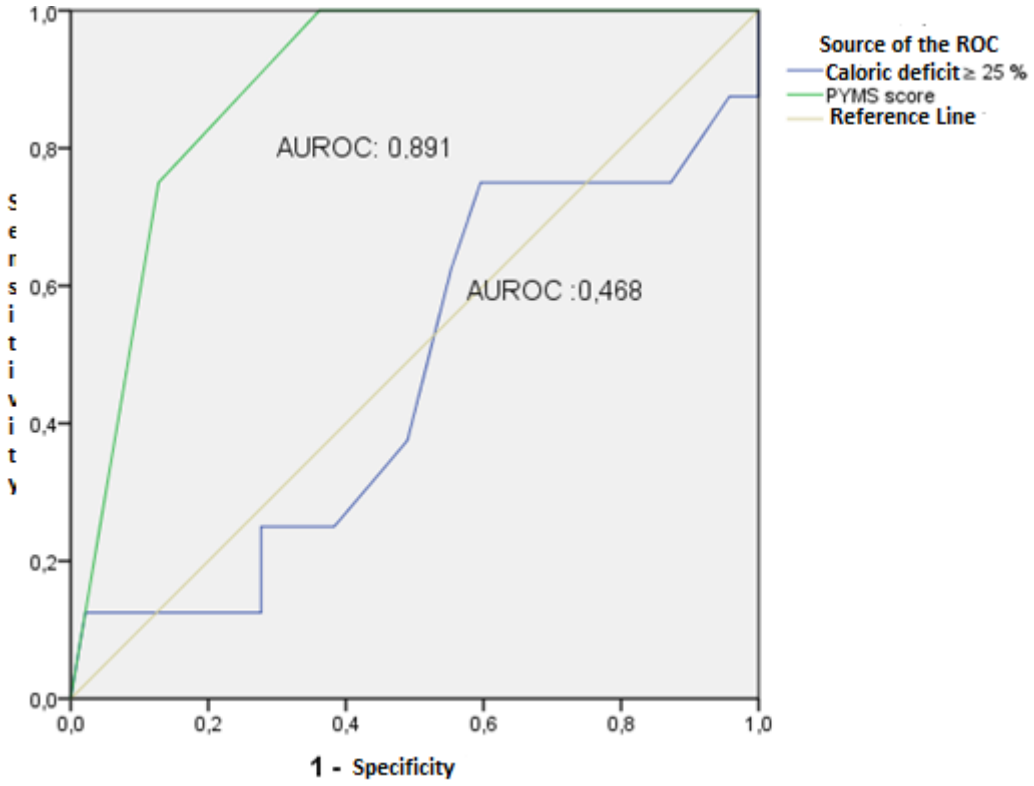
The authors declare that they have no conflicts of interest.

# References

1. - Mehta NM, Compher C. A.S.P.E.N. Clinical Guidelines: nutrition support of the critically ill child. JPEN J Parenter Enteral Nutr [Internet]. junio de 2009 [citado 21 de junio de 2019];33(3):260–76. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/19398612#
2. -Beltrà Pico R, Peña Quintana L, Santana Salguero B. Nutrición en el niño intervenido quirúrgicamente. Can Pediatr [Internet]. 2011 [citado 21 de junio de 2019];35(1):41–8. Disponible en: https://dialnet.unirioja.es/servlet/articulo?codigo=3719470
3. -Tatucu-Babet OA, Ridley EJ, Tierney AC. Prevalence of Underprescription or Overprescription of Energy Needs in Critically Ill Mechanically Ventilated Adults as Determined by Indirect Calorimetry: A Systematic Literature Review. JPEN J Parenter Enteral Nutr [Internet]. febrero de 2016 [citado 21 de septiembre de 2019];40(2):212 – 25. Disponible en: https://pubmed.ncbi.nlm.nih.gov/25605706/
4. -Rinninella E, Ruggiero A, Maurizi P, Triarico S, Cintoni M, Mele MC. Clinical tools to assess nutritional risk and malnutrition in hospitalized children and adolescents. Eur Rev Med Pharmacol Sci [Internet]. junio de 2017 [citado 21 de agosto de 2019];21(11):2690–701. Disponible en: https://pubmed.ncbi.nlm.nih.gov/28678315/
5. -Joosten KFM, Hulst JM. Nutritional screening tools for hospitalized children: methodological considerations. Clin Nutr [Internet]. febrero de 2014 [citado 23 de junio de 2019];33(1):1–5. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/24050847.
6. -De Cosmi V, Milani GP, Mazzocchi A, D'Oria V, Silano M, Calderini E, et al. The Metabolic Response to Stress and Infection in Critically Ill Children: The Opportunity of an Individualized Approach. Nutrients [Internet]. 18 de septiembre de 2017 [citado 22 de junio de 2019];9(9):1032. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/28926994
7. - Joosten KFM, Kerklaan D, Verbruggen SCAT. Nutritional support and the role of the stress response in critically ill children. Curr Opin Clin Nutr Metab Care [Internet]. mayo de 2016 [citado 21 de abril de 2019];19(3):226–33. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/26963579
8. -Ramírez S, Gutiérrez, I, Domínguez A, Barba C. Respuesta Metabólica al Trauma. Medicrit [Internet]. 2008 [citado 17 de junio de 2019];5(4):130–3. Disponible en: http://www.medicrit.com/a/54130.php
9. - Mehta NM, Skillman HE, Irving SY, Coss-Bu JA, Vermilyea S, Farrington EA, et al. Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Pediatric Critically Ill Patient: Society of Critical Care Medicine and American Society for Parenteral and Enteral Nutrition. JPEN J Parenter Enteral Nutr [Internet]. julio de 2017 [citado 18 de junio de 2019];41(5):706–42. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/28686844
10. -Gerasimidis K, Macleod I, Maclean A, Buchanan E, McGrogan P, Swinbank I, et al. Performance of the novel Paediatric Yorkhill Malnutrition Score (PYMS) in hospital practice. Clin Nutr [Internet]. agosto de 2011 [citado 21 de mayo de 2019];30(4):430–5. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/21388725
11. - Martinez EE, Mehta NM. The science and art of pediatric critical care nutrition. Curr Opin Crit Care [Internet]. agosto de 2016 [citado 18 de junio de 2019];22(4):316–24. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/27309970

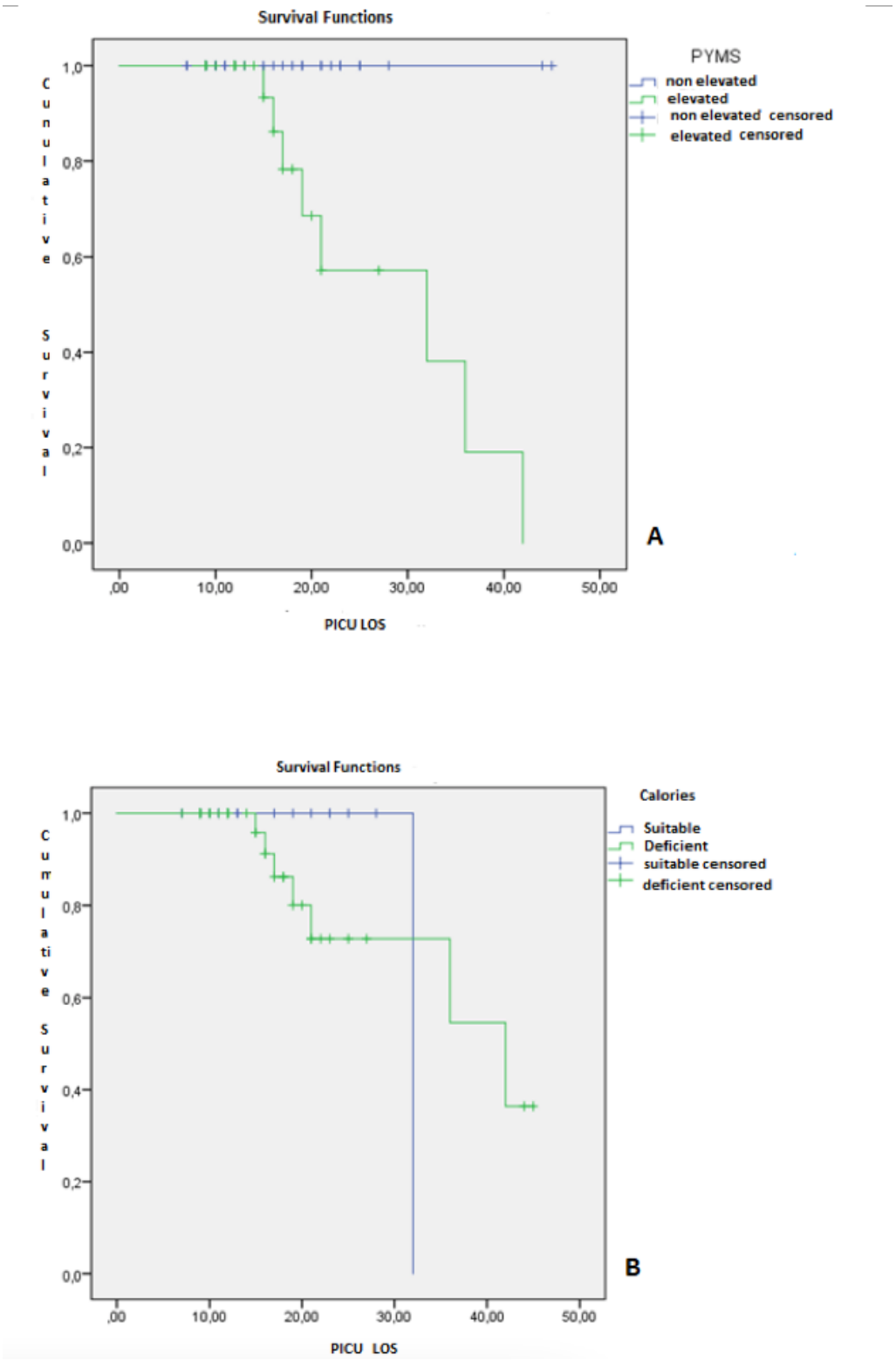
12. - Beggs MR, Garcia Guerra G, Larsen BMK. Do PICU patients meet technical criteria for performing indirect calorimetry? Clin Nutr ESPEN [Internet]. octubre de 2016 [citado 21 de junio de 2019];15:80 – 4. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/28531789
13. - Kyle UG, Jaimon N, Coss-Bu JA. Nutrition support in critically ill children: underdelivery of energy and protein compared with current recommendations. J Acad Nutr Diet [Internet]. diciembre de 2012 [citado 16 de junio de 2019];112(12):1987–92. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/23063414
14. - Mehta NM, McAleer D, Hamilton S, Naples E, Leavitt K, Mitchell P, et al. Challenges to optimal enteral nutrition in a multidisciplinary pediatric intensive care unit. JPEN J Parenter Enteral Nutr [Internet]. 2010 [citado 11 de junio de 2019];34(1):38–45. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/19903872
15. - Jotterand Chaparro C, Moullet C, Taffe P, Laure Depeyre J, Perez M-H, Longchamp D, et al. Estimation of Resting Energy Expenditure Using Predictive Equations in Critically Ill Children: Results of a Systematic Review. JPEN J Parenter Enteral Nutr [Internet]. agosto de 2018 [citado 20 de junio de 2019];42(6):976–86. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/29603276
16. - Lestari NE, Nurhaeni N, Wanda D. The Pediatric Yorkhill Malnutrition Score Is a Reliable Malnutrition Screening Tool. Compr Child Adolesc Nurs [Internet]. 2017 [citado 14 de junio de 2019];40(sup1):62–8. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/29166191
17. - Wonoputri N, Djais JTB, Rosalina I. Validity of Nutritional Screening Tools for Hospitalized Children. Journal of Nutrition and Metabolism [Internet]. 2014 [citado 21 de junio de 2019];2014:6. Disponible en: http://dx.doi.org/10.1155/2014/143649
18. - Beser OF, Cokugras FC, Erkan T, Kutlu T, Yagci RV. Evaluation of malnutrition development risk in hospitalized children. Nutrition [Internet]. abril de 2018 [citado 21 de julio de 2019];48:40 – 7. Disponible en: https://www.sciencedirect.com/science/article/pii/S0899900717302502?via%3Dihub
19. - Herman R, Btaiche I, Teitelbaum DH. Nutrition support in the pediatric surgical patient. Surg Clin North Am [Internet]. junio de 2011 [citado 17 de junio de 2019];91(3):511–41. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/21621694
20. -Weimann A, Braga M, Carli F, Higashiguchi T, Hubner M, Klek S, et al. ESPEN guideline: Clinical nutrition in surgery. Clin Nutr [Internet]. junio de 2017 [citado 23 de agosto de 2019];36(3):623–50. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/28385477

# Figures




## Figure 1

ROC curve to determine mortality according to PYMS score and caloric deficit ≥ 25%. Area under the curve (AUROC) Caloric deficit ≥ 25% 0.468, p = 0.035, Area under the curve (AUROC) PYMS 0.891, p = 0.024.




## Figure 2

Kaplan-Meir survival curves for high PYMS and caloric deficit in 45 days. A: survival curve in PICU with elevated or not elevated PYMS. B: survival curve in PICU with caloric deficit ≥ 25%.