SHORT COMMUNICATION

Nutritional assessment and risk of malnutrition in hospitalised children in northern Italy

Carlo Agostoni (carlo.agostoni@unimi.it)[1], Emilio Fossali[2], Edoardo Calderini[3], Alberto Edefonti[4], Carla Colombo[5], Alberto Battezzati[6], Simona Bertoli[6], Antonio Pio Mastrangelo[4], Cinzia Montani[3], Arianna Bisogno[5], Valentina De Cosmi[3], Alessandra Mazzocchi[1], Claudia Maffoni[1], Michela Perrone[4], Giorgio Bedogni[7]

1.Pediatric Clinic 2, Department of Clinical Sciences and Community Health, Fondazione IRCCS Ospedale Cà Granda-Ospedale Maggiore Policlinico, University of Milan, Milan, Italy
2.Pediatric Emergency Unit, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, Milan, Italy
3.Pediatric Intensive Care Unit, Department of Anesthesia, Intensive Care and Emergency, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, Milan, Italy
4.Pediatric Nephrology Unit, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, Milan, Italy
5.Cystic Fibrosis Center, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, University of Milan, Milan, Italy
6.International Center for the Assessment of Nutritional Status - DiSTAM, University of Milan, Milan, Italy
7.Clinical Epidemiology Unit, Liver Research Center, Basovizza and Fondazione IRCCS Cà Granda, Ospedale Maggiore Policlinico, Milan, Italy

Correspondence
Carlo Agostoni, Pediatric Clinic 2, Department of
Clinical Sciences and Community Health,
Fondazione IRCCS Ospedale Cà Granda-Ospedale
Maggiore Policlinico, University of Milan, Carlo Via di
Rudinì 8, Milan I-20142, Italy.
Tel: +39-02-891-58-665 |
Fax: +39-02-891-26-846 |
Email: carlo.agostoni@unimi.it

Hospital malnutrition is a state in which a deficiency or imbalance of energy, proteins and other nutrients causes measurable adverse effects on functional and clinical outcomes. The nutritional status of children often declines after admission to the hospital, possibly slowing recovery time and increasing susceptibility to infection.

The reported prevalence of malnutrition in paediatric hospitals ranges from 6% to 30% (1) and may also depend on the operational definition of malnutrition and the study population (2). There are currently no recommendations on nutritional evaluation and risk of hospital malnutrition screening.

The aim of this study was to assess the nutritional status of hospitalised children, as measured by the prevalence of malnutrition, the risk of developing malnutrition and the role of biochemical indices in predicting the length of hospitalisation.

This cohort study was performed between 1 July 2011 and 31 December 2012 in five clinical units at the IRCCS Foundation Cà Granda-Ospedale Maggiore Policlinico in Milan, Italy. We calculated that 300 subjects were needed to estimate a 20% prevalence of malnutrition on admission with a precision of 5% (exact 95% CI, 25% to 35%). Accordingly, 300 (88%) of 340 consecutive patients agreed to participate in the study and were recruited from the paediatric ($n = 111$), short observation and emergency ($n = 70$), nephrology ($n = 53$), intensive care ($n = 50$) and cystic fibrosis ($n = 16$)

units. Children admitted to the study showed the following disorders: lung and heart ($n = 62$), kidney ($n = 52$), rheumatologic ($n = 47$), neurologic ($n = 28$), blood ($n = 30$), gastrointestinal ($n = 14$), liver ($n = 6$) and endocrine ($n = 6$). Patients were included if they were aged between 1 month and 17-year-old and were admitted to the hospital during the study period for more than 24 h and their parents provided informed consent. Infants who were born before 37 weeks of gestation and were under 1-year-old were excluded, as were patients who were hospitalised for more than 60 days. The study was approved by the institutional ethics committee of the Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, Milan, Italy.

Anthropometric parameters included weight, height/length and body mass index (BMI). Weight was measured in all children using calibrated standard equipment on admission and discharge. Supine length was measured in children aged 2 years or less and standing height in children over the age of 2 years. Wasting was defined as BMI of less than – 2 standard deviation scores (SDS). Stunting was defined as length or stature of less than – 2 SDS for the child's age. Obesity was defined as BMI > 2 SDS. Nutritional risk was assessed using the STRONGkids questionnaire (3). At admission and discharge, a fasting blood sample was collected to analyse nutrition-related haematochemical indexes inclusive of insulin-like growth factor 1 (IGF-1), prealbumin, transferrin, albumin, insulin,

total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C) and triglycerides. For the statistical analysis, continuous data were reported as median and interquartile range (IQR) because of skewed distributions. Somers' D was used to evaluate the association between length of stay and selected anthropometric and biochemical indices. Statistical significance was assigned to a value of p < 0.05.

Of the 300 patients, 245 (82%) could be analysed. They had a median (IQR) age of 6 (10), and 117 (44.5%) of them were females. The median (IQR) length of stay was 6 (5) days. Wasting was detected in 25 (10.2%) of the patients at admission and in 19 (8.1%) at discharge. At admission, stunting was present in 16 (6.5%) patients. Nutritional care and support was provided for wasting children. The prevalence of obesity was 7.0% at admission and 6.9% at discharge. When it came to the biochemical indices, length of stay was inversely associated with serum albumin (−10% probability of longer stay, 95% CI −19 to −1%, p = 0.02 for every 1 g/dL increase of albumin). Length of stay was not associated with BMI (p = 0.347) and the STRONGkids questionnaire score (p = 0.08). The questionnaire score was inversely associated with serum albumin (−20% probability of higher SK score, 95% CI −29 to −7%, *p* = 0.001, for every 1 g/dL increase of albumin). Albumin levels ranged from 1.2 to 5.3 g/dL, median 4.1 g/dL in the whole population. Other negative association trends (0.10 > p > 0.05) were found between serum HDL levels and high questionnaire score values.

Children already malnourished on admission may be at risk of further nutritional and clinical deterioration. Our study population showed a lower malnutrition prevalence at admission than another Italian survey (4), while the prevalence of obesity was comparable to that found in northern Italian children (5).

Length of stay was mildly related to the questionnaire score and in agreement with its potential predictive value. The inverse associations found for serum albumin with either length of stay and the questionnaire score suggest that chronic malnutrition may not just relate to, but also be predictive of, the length of hospital stay. Indeed, albumin is the indicator of nitrogen anabolism with the longest half-life – of around 20 days – while other anabolic indicators, such as insulin-like growth factor-1, prealbumin, transferrin, whose half-life ranges from one to 7 days, did not show any type of relationship.

Associations involving serum albumin have already been described in hospitalised adults (6), but there have been few reports in children so far (7). The decrease in serum albumin concentrations only seems to develop late in the course of malnutrition, and as a consequence, it may take place in the most severe cases.

A negative trend between serum HDL-C and LDL-C and clinical risk has been described in adults (3,8) and also in

paediatric patients (9). Nevertheless, the biological bases connecting lower serum albumin and HDL cholesterol with gravity of disease deserve further investigation, because malnutrition may be just a part of the whole picture. In conclusion, assessing nutritional status, nutritional risk and appropriate biochemical indices at admission may help to predict the length of hospital stay and to optimise clinical interventions and follow-up.

CONFLICT OF INTEREST
The authors disclose no conflict of interests.

References

1. Hecht C, Weber M, Grote V, Daskalou E, Dell'Era L, Flynn D, et al. Disease associated malnutrition correlates with length of hospital stay in children. *Clin Nutr* 2014; doi: 10.1016/j.clnu.2014.01.003. [Epub ahead of print].
2. Agostoni C, Axelson I, Colomb V, Goulet O, Koletzko B, Michaelsen KF, et al. The need for nutrition support teams in pediatric units: a commentary by the ESPGHAN committee on nutrition. *J Pediatr Gastroenterol Nutr* 2005; 41: 8–11.
3. Hulst JM, Zwart H, Hop WC, Joosten KFM. Dutch national survey to test the STRONGkids nutritional risk screening tool in hospitalized children. *Clin Nutr* 2010; 29: 106–11.
4. Campanozzi A, Russo M, Catucci A, Rutigliano I, Canestrino G, Giardino I, et al. Hospital-acquired malnutrition in children with mild clinical conditions. *Nutrition* 2009; 25: 540–7.
5. Turchetta F, Gatto G, Saulle R, Romano F, Boccia A, La Torre G. Systematic review and meta-analysis of the prevalence of overweight and obesity among school-age children in Italy. *Epidemiol Prev* 2012; 36: 188–95.
6. Delgado-Rodriguez M, Medina-Cuadros M, Gomez-Ortega A, Martinez-Gallego G, Mariscal-Ortiz M, Martinez-Gonzalez MA, et al. Cholesterol and serum albumin levels as predictors of cross infection, death, and length of hospital stay. *Arch Surg* 2002; 137: 805–12.
7. Leite HP, Fisberg M, de Carvalho WB, de Camargo Carvalho AC. Serum albumin and clinical outcome in pediatric cardiac surgery. *Nutrition* 2005; 21: 553–8.
8. Chien JY, Jerng JS, Yu CJ, Yang PC. Low serum level of high-density lipoprotein cholesterol is a poor prognostic factor for severe sepsis. *Crit Care Med* 2005; 33: 1688–93.
9. Aburawi EH, Grubb A, Raitakari OT, Viikari J, Pesonen EJ. Lowered levels of serum albumin and HDL-cholesterol in children with a recent mild infection. *Ann Med* 2006; 38: 154–60.