Journal of Adolescent Health 50 (2012) 24–29

ELSEVIER

JOURNAL OF ADOLESCENT HEALTH

www.jahonline.org

Original article

A Prospective Examination of Weight Gain in Hospitalized Adolescents With Anorexia Nervosa on a Recommended Refeeding Protocol

Andrea K. Garber, Ph.D., R.D.[a,*], Nobuaki Michihata, M.D.[a,b], Katherine Hetnal [a], Mary-Ann Shafer, M.D.[a], and Anna-Barbara Moscicki, M.D.[a]

[a] *Division of Adolescent Medicine, University of California, San Francisco, California*
[b] *Division of Adolescent Medicine, National Center for Child Health and Development, Tokyo, Japan*

Article history: Received February 17, 2011; Accepted June 21, 2011
Keywords: Anorexia nervosa; Adolescents; Refeeding syndrome; Nutrition; Weight gain; Fluid balance

See Editorial p. 1

A B S T R A C T

Purpose: Current refeeding recommendations for adolescents hospitalized with anorexia nervosa (AN) are conservative, starting with low calories and advancing slowly to avoid refeeding syndrome. The purpose of this study was to examine weight change and clinical outcomes in hospitalized adolescents with AN on a recommended refeeding protocol.
Methods: Adolescents aged 13.1–20.5 years were followed during hospitalization for AN. Weight, vital signs, electrolytes, and 24-hour fluid balance were measured daily. Percent median body mass index (%MBMI) was calculated as 50th percentile BMI for age and gender. Calories were prescribed on admission and were increased every other day.
Results: Thirty-five subjects with a mean (SD) age of 16.2 (1.9) years participated over 16.7 (6.4) days. Calories increased from 1,205 (289) to 2,668 (387). No subjects had refeeding syndrome; 20% had low serum phosphorus. Percent MBMI increased from 80.1 (11.5) to 84.5 (9.6); overall gain was 2.10 (1.98) kg. However, 83% of subjects initially lost weight. Mean %MBMI did not increase significantly until day 8. Higher calories prescribed at baseline were significantly associated with faster weight gain ($p = .003$) and shorter hospital stay ($p = .030$) in multivariate regression models adjusted for %MBMI and lowest heart rate on admission.
Conclusions: Hospitalized adolescents with AN demonstrated initial weight loss and slow weight gain on a recommended refeeding protocol. Higher calorie diets instituted at admission predicted faster weight gain and shorter hospital stay. These findings support the development of more aggressive feeding strategies in adolescents hospitalized with AN. Further research is needed to identify caloric and supplementation regimens to maximize weight gain safely while avoiding refeeding syndrome.
Published by Elsevier Inc. on behalf of Society for Adolescent Health and Medicine.

Studies support the importance of maximizing the rate of weight gain during hospitalization for patients with anorexia nervosa (AN) [1–3]. Low weight at the time of discharge has been shown to increase the risk of rehospitalization [3], whereas higher weight at the time of discharge predicts weight restoration at 1 year [2]. However, weight gain in patients with AN admitted for acute malnutrition is often difficult to achieve. Although patients with AN are hypometabolic in the starved state [4–8], they become hypermetabolic during refeeding [5,6,9,10]. This increase in metabolic rate can slow the rate of weight gain by significantly increasing caloric requirements beyond what can be predicted by the increase in body weight. Van Wymelbeke et al (2004) showed that resting energy expenditure (REE) in-

* Address correspondence to: Andrea K. Garber, Ph.D., R.D., Division of Adolescent Medicine, University of California, Suite 245, California Street, San Francisco, CA 94143.
E-mail address: garbera@peds.ucsf.edu (A. K. Garber).

1054-139X/$ - see front matter Published by Elsevier Inc. on behalf of Society for Adolescent Health and Medicine.
doi:10.1016/j.jadohealth.2011.06.011

creased by 13.6% above baseline after 8 days of refeeding, and by 42.7% after 75 days [9]. In a study using total parenteral nutrition in four malnourished subjects with AN during 63 days in hospital, the mean number of calories required to increase the body weight by 1 kg was 9,768 (or 4,440 per pound) [11]. It is clear that energy requirements per kilogram of body weight in AN patients during refeeding are far higher than in normal weight individuals [10], and cannot be predicted by standard approximation equations for energy expenditure [5,7].

Although the exact cause of this observed increase in REE in AN subjects during refeeding is not known, it appears to be associated with the caloric level of the diet [5,7,9,10,12–15]. Obarzanek et al demonstrated an increase in REE of 21% over baseline when calorie intake advanced from 1,105 to 2,105 calories, and a further increase of 63% over baseline at an intake of 3,216 calories [10]. Van Wymelbeke et al (2004) showed 13% increase in REE when calories increased from 823 to 2,057 in 1 week, with a total increase of 43% over baseline after 10 weeks of feeding, when subjects reached 2,615 calories [9]. These increases are partly due to increases in the energy required to process, digest, and absorb nutrients, or the thermic effect of feeding (TEF) [7,12,13]. However, increased TEF does not completely explain the dramatically elevated metabolic needs during refeeding in AN patients. More recent studies have shown that psychological factors, including anxiety, depression, and fear of weight gain, may contribute to the hypermetabolic state [9,12,16]. Rigaud et al administered blind loads (such that patients were unaware of the calories ingested) to AN patients through tube feeding and demonstrated a calorie-dependent increase in REE [12]. This study demonstrated unadjusted correlations between TEF and increased calories, plasma cortisol, adrenocorticotropic hormone (ACTH), and catecholamines, decreased beta-endorphin, fear of becoming fat, and feelings of satiety and anxiety. These findings underscore the complexity associated with energy expenditure in AN.

Despite elevated caloric needs to achieve weight gain, most AN refeeding protocols begin at very low levels. Current guidelines recommend starting around 1,200 calories and advancing with caution by approximately 200 calories every other day [17–19]. The goal is to avoid refeeding syndrome, the life-threatening shifts in electrolytes that can occur when nutrition is reintroduced. Hypophosphatemia, the hallmark of refeeding syndrome [20], has been shown to occur in 27.5% of patients undergoing standard oral renutrition [21] and is more likely reported in those who are severely malnourished [21]. Weight loss has been observed during the initial days of refeeding on these hypocaloric diets [22].

Some inpatient programs have currently started refeeding with higher calorie diets [23]. However, the daily weight trajectory of hospitalized adolescents with AN following the refeeding recommendations that are currently in place has not been reported. The purpose of this study was to examine predictors of weight change in hospitalized adolescents with AN on a refeeding protocol starting with a low range of calories.

Methods

Study sample

Subjects were adolescents admitted to the hospital for malnutrition secondary to AN. Criteria for hospital admission were based on the guidelines from the Society for Adolescent Health and Medicine [24] as follows: heart rate <50 beat/minute (bpm), temperature (T) <36.0°C, or orthostasis (assessed with postural changes as described in vital signs section below). Participation was offered to all patients requiring hospitalization who met the inclusion criteria for the study. The inclusion criteria were age 9–20 years and diagnosis of AN according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth edition, Text Revision [25]. Exclusion criteria included previous admission for AN, pregnancy, diagnosis of bulimia nervosa, eating disorder not otherwise specified, or other major mental health diagnoses such as schizophrenia. All eligible subjects and their parents were approached for assent and consent at the time of admission. Forty subjects (39 females) agreed to participate in the study between October 2002 and May 2009. Five patients were excluded: two met exclusion criteria (had previous admissions for AN) and three were transferred to receive care in another hospital or unit. This study was approved by the Human Subjects Protection Committee, University of California, San Francisco.

Study setting and design

All participants were admitted to the Pediatric Clinical Research Center (PCRC), a research unit with specialized staff within a large tertiary care children's hospital. PCRC staff are trained in AN protocols including this study. We observed subjects prospectively over the course of hospital stay, from the time of admission until discharge. Discharge criteria included waking heart >50 bpm and temperature >36.0°C for at least 24 hours. Data collection began when subjects were admitted (D0), generally in the afternoon or evening. Because weight and vital signs are known to vary widely depending on time of day, the first full day in hospital (D1) was established as baseline for this study. Measurements were repeated daily until D14 and on the day of discharge if stay was >14 days. Length of stay was recorded as number of days from D1 until discharge, not including the day of discharge.

AN inpatient refeeding protocol

The following standard oral refeeding protocol was followed: three meals and three snacks were served on trays at the bedside, high-energy liquid supplement drinks were only used orally as needed so as to substitute for calories refused on meals or snacks. Room sitters were assigned by the nursing staff to observe during all meals and snacks, and for 45 minutes later. No subjects in this study received nasogastric tube feedings. Physicians prescribed diets starting around 1,200 calories depending in part on a 24-hour recall; those with lower calorie intake before admission began at lower calorie prescriptions. Prescribed calories were advanced by about 200 calories every other day. Sample menus were analyzed using Computrition Hospitality Suite software v.17.9.5 (Computrition, Inc., Chatsworth, CA) and were found to be quite a bit lower in fat (20%) and higher in protein (21%), as compared with the 2005 Dietary Guideline for Americans [26]. All subjects received the following oral vitamin and mineral supplementation regimen, which is routinely used in our institution: 500 mg calcium carbonate (200 mg elemental calcium) twice per day, zinc sulfate or zinc acetate to provide 36–50 mg elemental zinc once per day, and an adult multivitamin with minerals once per day. Phosphate supplements were not rou-