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Original article

Higher Calorie Diets Increase Rate of Weight Gain and Shorten Hospital Stay in Hospitalized Adolescents With Anorexia Nervosa

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A B S T R A C T

Purpose: Current recommendations for refeeding in anorexia nervosa (AN) are conservative, beginning around 1,200 calories to avoid refeeding syndrome. We previously showed poor weight gain and long hospital stay using this approach and hypothesized that a higher calorie approach would improve outcomes.

Methods: Adolescents hospitalized for malnutrition due to AN were included in this quasi-experimental study comparing lower and higher calories during refeeding. Participants enrolled between 2002 and 2012; higher calories were prescribed starting around 2008. Daily prospective measures included weight, heart rate, temperature, hydration markers and serum phosphorus. Participants received formula only to replace refused food. Percent Median Body Mass Index (% MBMI) was calculated using 50th percentile body mass index for age and sex. Unpaired t-tests compared two groups split at 1,200 calories.

Results: Fifty-six adolescents with mean (±SEM) age 16.2 (±.3) years and admit %MBMI 79.2% (±1.5%) were hospitalized for 14.9 (±.9) days. The only significant difference between groups (N = 28 each) at baseline was starting calories (1,764 [±60] vs. 1,093 [±28], $p < .001$). Participants on higher calories had faster weight gain (.46 [±.04] vs. .26 [±.03] %MBMI/day, $p < .001$), greater daily calorie advances (122 [±8] vs. 98 [±6], $p = .024$), shorter hospital stay (11.9 [±1.0] vs. 17.6 [±1.2] days, $p < .001$), and a greater tendency to receive phosphate supplementation (12 vs. 8 participants, $p = .273$).

Conclusions: Higher calorie diets produced faster weight gain in hospitalized adolescents with AN as compared with the currently recommended lower calorie diets. No cases of the refeeding syndrome were seen using phosphate supplementation. These findings lend further support to the move toward more aggressive refeeding in AN.

IMPLICATIONS AND CONTRIBUTION

Rate of weight gain was almost double on higher versus lower calorie diets for refeeding hospitalized adolescents with AN. There was no increased incidence of low serum phosphate using prophylactic supplementation. Our findings support more aggressive refeeding using a meal-based plan in moderately malnourished subjects with AN.

Current recommendations for refeeding hospitalized patients with anorexia nervosa (AN) are conservative. The American Psychiatric Association [1,2] and the Academy of Nutrition and Dietetics [3] recommend starting with a range of 1,200 calories

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per day and advancing by approximately 200 calories every other day. This cautious approach is intended to avoid the refeeding syndrome, the potentially fatal shifts in electrolytes that can occur when insulin is released in response to an influx of nutrients (particularly carbohydrate) [4–7]. Despite evidence to show that refeeding risk is highest in severely malnourished patients [4–6,8,9], these lower calorie diets have been implemented widely to ensure safety.

Unfortunately, this approach is likely too conservative to maximize nutritional recovery in a large proportion of the adolescents hospitalized with AN in the United States who are only moderately malnourished, with body mass index (BMI) around 75%–85% of expected [8,10–12]. We recently reported significant initial weight loss and slow weight gain among 35 adolescents with a mean BMI of 80.1% of expected who were started on a range of calories averaging 1,200 per day and followed prospectively in our pediatric clinical research center (PCRC) [11]. This was the first study to demonstrate that the longstanding clinical observation of weight loss during early refeeding in AN was associated with the currently recommended lower calorie diets (in addition to fluid losses). These findings have contributed to recognition of the "underfeeding syndrome" [13].

In 2008, our program began increasing admission calorie prescriptions in response to our own data [11] and clinical reports of higher calorie approaches [14]. Our feeding approach is meal-based, with calorie prescriptions divided into three meals and three snacks per day with formula only as necessary to replace refused calories. In 2010, Whitelaw et al. published the first report of higher calorie meal-based refeeding showing good outcomes beginning around 1,900 calories and increasing by 500 calories in the first 5 days [9]. Yet, no studies to date have compared this higher calorie approach with the lower calorie diets that are still recommended. This gap represents a significant barrier to revising the current recommendations and moving forward with evidence-based approaches to refeeding in AN. Thus, the purpose of the present study was to compare higher and lower calorie diets during refeeding in moderately malnourished adolescents hospitalized with AN. We used the change in clinical practice in our program around 2008 to compare higher and lower calorie diets using a quasi-experimental design, with our previous study [11] participants as historical controls.

Methods

Study design and participants

This prospective observational study used a quasi-experimental design to compare a lower calorie group (800–1,200 calories) including former study participants as historical controls and higher calorie group (1,400–2,400 calories) including newly enrolled participants. Participants were age 9–20 years old, diagnosed with AN [15], met criteria for hospitalization [16] and had no previous admissions for AN. Exclusion criteria included pregnancy, diagnosis of bulimia nervosa, and/or thought disorders such as schizophrenia or other psychosis. Eligible patients and parents were consented upon hospitalization at University of California San Francisco (UCSF) Benioff Children's Hospital between October 2002 and February 2012 and admitted to the PCRC. Race/ethnicity was self-identified upon registration for admission to hospital. Of 62 patients, three were excluded for previous admissions and three transferred care to another unit. This study was approved by the UCSF Human Subjects Protection Committee.

Refeeding protocol

Participants received three meals and three snacks served on trays at the bedside. Calorie levels were prescribed on admission by the physicians, who generally followed the lower calorie recommendations between 2002 and 2008 and began prescribing higher calorie diets starting in 2008. However, calorie levels were not strictly protocolized or randomly assigned, so it is likely that physicians used clinical judgment when assigning diets. We attempted to control for some degree of variation in clinical practice in our statistical analysis (see the following section). Macronutrient content of the diet was approximately 20% fat, 21% protein and 60% carbohydrate (Computrition, Inc., Software v.17.9.5, Chatsworth, CA). A standard high-calorie liquid supplement ("formula") providing 1.06 calories per mL, 22% fat, 14 % protein, and 64% carbohydrate was used orally to replace refused calories; no participants received enteral feedings. All beverages were weighed and measured before serving; free water was restricted to 1 L per day. Room sitters observed all meals/snacks and 45 minutes afterwards. Daily calorie counts assessed actual calorie intake from food and formula in a subset of participants. Phosphate was supplemented as needed in packets of 250 mg phosphate, 160 mg sodium, and 280 mg potassium. Because patients are assumed to have low micronutrient stores and overall poor nutrition leading up to hospitalization, our program provides a standard supplement regimen including 500 mg calcium carbonate twice per day, zinc sulfate or zinc acetate once per day, and an adult multivitamin with minerals once per day.

Data collection

Daily measures were made from admission on day (D) 0 through D14 and day of discharge (if stay $>$14 days). Discharge criteria included waking heart rate (HR) $>$50 beats/min and temperature $>$36.0°C for at least 24 hours. Detailed methods for vital signs and anthropometric and laboratory measures in this study have been previously described [11]. Briefly, HR and blood pressure were assessed with continuous cardiac monitoring and temperature was measured orally. Weight was measured each morning D1–D14 and on day of discharge; height was measured on D1. Laboratory indicators of hydration status, including blood urea nitrogen (BUN), creatinine (Cr), serum sodium, and urine specific gravity, were measured within 24 hours of admission. Fluid balance was calculated daily as the difference between total intake and output recorded over 24 hours. Intake represents beverages only; output represents urine only using bedside commode. Electrolytes were measured twice per day as needed to monitor refeeding risk; only serum phosphorus is reported here.

Statistical methods

Descriptive statistics were computed for the overall study population; unpaired t-tests compared lower and higher calorie groups. Rate of calorie advancement during the first week in hospital was calculated as absolute increase in calories D1–D7 divided by seven. Discharge calories are reported as percent of energy needs, calculated retrospectively using estimated energy