# CASE REPORT

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# Infanticide by Starvation: Calculation of Caloric Deficit to Determine Degree of Deprivation

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**ABSTRACT:** A review of medical records and autopsy examination of a six-week-old male revealed the cause of death to be severe malnutrition with dehydration. Weight and caloric deficits were calculated to determine the degree of deprivation, which could be expressed as an interval of days for clear courtroom presentation. These calculations may be useful for quantifying the degree of malnutrition in a variety of child abuse cases.

**KEYWORDS:** pathology and biology, starvation, child abuse

Child abuse and neglect has been recognized as a widespread problem only since the early 1960s [*1*]. Literature is abundant on the overt physical abuse aspect of this problem, but notably sparse in the area of nutritional neglect in children. While others have calculated differences between actual and expected weights, and caloric deficit [*2,3*], we were unable to find reference to allowance for dehydration, or conversion of caloric deficits to an equivalence in days of deprivation, assuming average caloric requirements for growth and development.

This report shows how we calculated degree of deprivation, with the use of standard references, and how we expressed it in terms readily understandable to laymen unfamiliar with caloric measurement.

## Case Report

### *History*

The decedent was the 3010-g product of a 39-week uncomplicated gestation and delivery, to a 20-year-old, unmarried black female. The decedent was a male with a length of 51 cm, and a head circumference of 33.5 cm (Fig. 1).

Early feeding difficulty necessitated placement of an orogastric tube, which was used for a total of twelve feedings, over a one-and-one-half day interval. He was found to have a left choanal stenosis by barium contrast fluoroscopy. This was scheduled to be repaired at age

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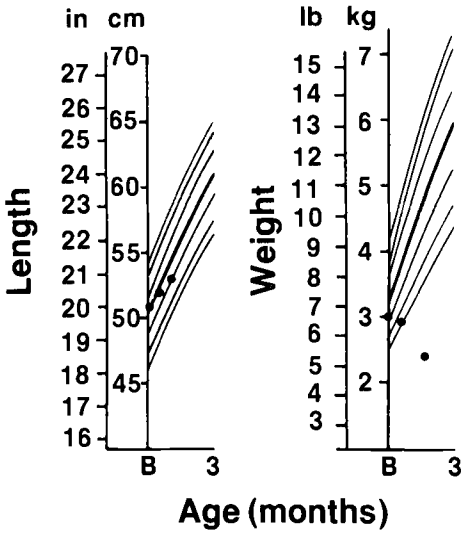


FIG. 1—*This is an enlargement of the first portion of a standard growth curve, adapted from "Boys: Birth to 36 Months; Physical Growth; NCHS Percentiles," Copyright 1980 Ross Laboratories. Notice both length and weight fall off the expected curves, with the weight loss especially dramatic.*

twelve weeks. The orogastric feedings were followed by 24 peroral (PO) feedings, which were received without difficulty over a 3-day interval. The infant was discharged five days post-delivery at a weight of 2990 g.

A follow-up visit at three weeks of age revealed the child to have a weight of 2980 g, a length of 52 cm, and a head circumference of 35 cm (Fig. 1). The mother stated that the child had had no problems since discharge and was feeding well. He was also noted to have a slight inspiratory stridor and monilial diaper dermatitis.

At the age of 43 days, 24 days after the follow-up visit, he was found dead by his mother. He was found at 7:30 a.m. in her bed, where they normally slept. The mother claimed to have fed the child at midnight and again at 2:00 a.m. She stated that the child had had no vomiting, diarrhea, or febrile illness.

### *Autopsy Findings*

At autopsy this six-week-old male was found to weigh 2300 g and have a length of 53 cm (Fig. 1). He was noted to be severely emaciated, essentially marasmic (Figs. 2 and 3). There was a total absence of grossly recognizable fat deposits in the chest and abdominal walls (Fig. 4). Muscle wasting was marked, with approximately 50% of muscle mass remaining. A small amount of fat was seen in the mesentery. The gastrointestinal tract was empty except for 2 mL of mucoid secretions in the colon. The decendent also had depressed fontanelles, 2+/4 skin tenting, and dryness of pleural, pericardial, and serosal surfaces.

### *Determination of Caloric Deficit*

Quantitation of caloric deficit is made by computing expected weight, subtracting actual weight, discounting dehydration (mild = 5%, moderate = 10%, severe = 15%), and then determining the conversion into calories.

An infant normally loses up to 10% of his body weight within the first three to four days of postnatal life. This loss is usually regained within ten days of delivery [*4,5*]. After the initial


FIG. 2—*This view shows the wizened face, well-demarcated ribs, and leathery folds of the skin. The scaphoid abdomen is another feature not expected in a six-week-old child.*

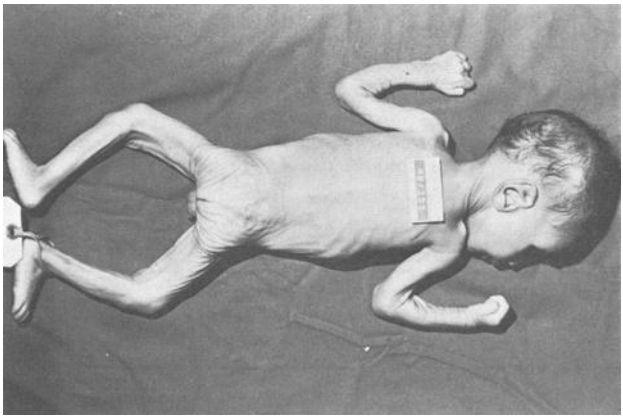

FIG. 3—*Especially apparent in this view is the shriveled, prune-like appearance of the buttocks. This is due to the near complete lack of the gluteal fat pad.*

period of weight loss and recovery ($\leq$ ten days), a normal full-term infant should gain 30 g/d [*6*]. The caloric requirements for normal growth and development are 50 to 100 kcal/kg/d during the first week, and 110 to 150 kcal/kg/d in the subsequent several months of life [*6*].

Using the minimum daily caloric requirement per kilogram for this child to grow and develop normally, one may calculate the average minimum daily caloric requirement. The growth curve of an infant is almost linear for the first two months of postnatal life [*7*]. Therefore, the mean of the two points (birth and death) will yield a figure remarkably close to the arithmetic average of daily needs (see Table 1). This child's average total daily caloric needs were at least 385 kcal/d.

In this 43-day-old child, we allow 10 days to regain birthweight, leaving 33 days of 30-g/d growth. This yields 990-g growth, or an expected weight at death of 4000 g. This conforms well with accepted growth curves.

The actual death weight was 2300 g. Adding in the moderate dehydration (10%) yields a hydrated death weight of 2556 g (2300 g = 0.9 $X$). This reveals a weigh deficit of 1444 g.

Adipose tissue is approximately 50% lipid [*8*], and fat contains 9 kcal/g. Muscle mass is

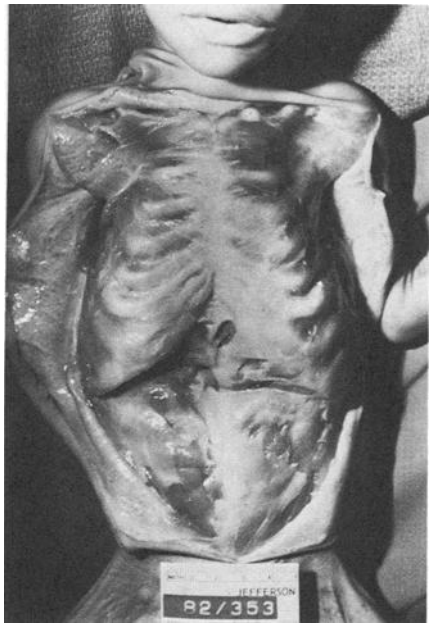


FIG. 4—*Notice the complete lack of subcutaneous fat, as well as the intercostal and abdominal wasting. There was an estimated 50% loss of muscle tissue.*

TABLE 1—*Arithmetic average of daily needs.*

| | |
|---|---|
| Birth: | (110 kcal/kg/d) (3.01 kg) = 331 kcal/d |
| Death: | (110 kcal/kg/d) (4.00 kg) = 440 kcal/d |
| (331 + 440 kcal/d)/2 = 385 kcal/d average daily caloric requirement | |

20% protein, and protein contains 4 kcal/g. Assuming 50% of the weight deficit is from adipose tissue and 50% from muscle mass, one figures caloric deficit from the fat compartment of 3249 kcal and from the protein compartment of 578 kcal (see Table 2). The total caloric deficit at time of death was calculated to be at least 3827 kcal. By dividing total caloric deficit by average daily caloric requirement, one sees this infant was deprived of at least 9.9 days of nutrition.

## Discussion

Conversion of grams to calories must entail a few assumptions: (1) failure to put on mass is qualitatively equivalent to the body's self-reabsorption, (2) the self-digestion is 100% efficient and (3) 50% of the deficit will be from the fat compartment, and 50% from the protein compartment.

TABLE 2—*Calculating days of starvation.*

| | |
|---|---|
| Fat: | (1444 g/2) (9 kcal/g) (0.50) = 3249 kcal |
| Protein: | (1444 g/2) (4 kcal/g) (0.20) = 578 kcal |
| Total caloric deficit = 3827 kcal | |
| Equivalent number of days starvation: (3827 kcal)/(385 kcal/d) = 9.9 days | |

The first assumption states that if a child is expected to gain a kilogram, but in actuality loses a kilogram, then the net weight deficit is 2 kg. This premise should be self-evident.

If the second assumption is false, the caloric deficit would be even higher than calculated. Since utilization of the body's stores as energy would most assuredly not be 100% efficient, this is another factor to ensure conservative estimates.

If the third assumption is incorrect, it is in underestimating the contribution of the fat compartment. A 3000-g infant is 12% by weight fat (equivalent to 24% adipose tissue), and 12% by weight protein (equivalent to 60% wet muscle mass) [*3, 9*]. This percentage of fat increases quickly after birth to as much as 28% [*9*]. This would be equivalent to 56% adipose tissue, by weight. This yields an adipose : muscle ratio of approximately 1 : 1. Cahill states that there is a "preferential and almost exclusive utilization of fat and fat-derived fuels during starvation" [*10*]. The body's metabolic machinery adapts during starvation to conserve protein. In a starving patient, the supply of as little as 150 g of dextrose per day avoids the necessity of turning to protein for gluconeogenesis [*11*].

This child lacked almost all body fat, and his muscle mass was approximately 50% depleted. This indicates a period of minimal caloric support which prevented proteolysis, followed by a period of absolute starvation and fluid restriction.

## Conclusion

The daily caloric requirement may be used with the total caloric deficit to give an approximation of number of days of starvation. This does not indicate a given child received nothing for *X* days, but it does allow the public, that is, a jury, to consider degree of deprivation in terms they may be more familiar with than calories.

Since the metabolic machinery adapts to starvation by decreasing both caloric and water requirements [*10*], it is likely that the actual number of days of total food and liquid deprivation was substantially greater than the number calculated. The computed number is, however, indicative of a minimum. It is felt that any caloric intake below that needed for normal growth and development results in both physical and mental retardation [*12, 13*]. This, in itself, would be child abuse.

On the basis of our calculations, it was our opinion that this child was moderately dehydrated, as well as deprived of at least ten "days worth" of food.

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