Case Report of 5 Siblings: Malnutrition? Rickets?

DiGeorge Syndrome? Developmental Delay?

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Background: Parents of six children are facing a trial on charges of aggravated manslaughter in the care a 5 ½ month old infant who died suddenly and neglect of their four older children for causing them to be malnourished by feeding them all an exclusively raw foods vegan diet. Both parents declined plea bargains and plan to defend themselves in court.

Case presentation: The fifth child born to a married couple was breast-fed until 2 ½ months. Subsequently, the parents fed the baby an exclusively raw foods diet prepared in a blender at home. The older children, ages 18 months—6 ½ years also ate an exclusively raw foods vegan diet. At autopsy, the infant weighed 3180 mg (6.99 pounds) and appeared emaciated. The thymus gland was absent and parathyroid glands were not located. The lungs were congested. The coroner ruled that "malnutrition" was the sole cause of death. None of the four older children had significant previous injuries or illnesses. Compared with standard growth charts, they fell 2.1-4.1 standard deviations below the mean for North American children in height and weight. The pediatrician diagnosed rickets in the four-year-old based on a "rachitic rosary" on clinical exam. The 18 month old was developmentally delayed to the level of a 15 month old, according to the evaluating psychologist's interpretation of the Battelle Developmental Inventory Screening Test (BDIST). Given the marginal levels sensitivity and specificity of this evaluation instrument and its documented cultural bias, this assessment is questionable. Labs were normal except for low cholesterol levels in all and a mildly low prealbumin level in one of three children tested. A complete malnutrition panel was not ordered.

Chest x-rays were normal in all and long bone x-rays showed minimal changes in 1/3—no signs of rickets.

Conclusions: In the infant who died, DiGeorge Anomaly cannot be ruled out. Malnutrition, according to the World Health Organization's definition, cannot be diagnosed in the infant or older children. The developmental delay diagnosis in the 18 month old is questionable. The clinical diagnosis of rickets in the 4-year-old was not confirmed by the Center for Disease Control's criteria.

Background

The American Dietetic Association (ADA) and Dietitians of Canada position paper on vegetarian diets officially recognizes that, “Well-planned vegan and other types of vegetarian diets are appropriate for all stages of the life cycle, including during pregnancy, lactation, infancy, childhood, and adolescence.”[1] The American Academy of Pediatrics concurs.[2, 3] However, the ADA position paper also said, “Extremely restrictive diets such as fruitarian and raw foods diets have been associated with impaired growth and therefore cannot be recommended for infants and children.” The single reference for this statement is a book by Mark J. Messina and Virginia L. Messina titled The Dietitian’s Guide to Vegetarian Diet: Issues and Applications.[4] Concerning this issue, this book states, "Older studies show that restrictive food patterns among some vegetarian groups, coupled with erroneous ideas about what constitutes an appropriate diet for infancy, have led to nutritional deficiencies in some vegetarian infants ..." No references to the “older studies” were supplied or available from direct correspondence.

Concerning adequacy of caloric intake in vegan diets, the Pediatric Nutrition Handbook published by the American Pediatric Association[2] states,

> Vegan diets are relatively low in caloric density, and while this poses little problem for older individuals, for vegan infants, weanlings, and small

> children, energy intakes may be too low. During infancy and weaning, the amount of food needed to meet energy needs on vegan diets may be beyond gastric capacity, unless the child is fed frequently.

And concerning adequate protein intake on a vegan diet the Handbook states,

> Mixtures of several plant proteins (eg, legumes, cereals, nuts, and seeds, fruits, and other vegetables) promote good nutritional status, especially if small amounts of animal protein are eaten. . . . Therefore, if parents feed diets that are adequate in food energy and select a variety of plant foods with proteins that complement each other, vegetarian children should receive adequate nutrients to grow and thrive.

Concerning the "living foods" diets (another term for raw foods diets), the Pediatric Nutrition Handbook says,

> 'Living foods' diets consist of the foods found in the fruitarian diet along with fresh vegetables and cereals, and special health foods, such as wheat grass or carrot juice. On such regimens, risk of iron deficiency anemia, rickets, megaloblastic anemia due to vitamin B12 deficiency, and protein calorie malnutrition may arise, although, fortunately, these are rare.

No reference is cited in the ADA position paper or the Pediatric Nutrition Handbook of any specific case of an infant or child on a raw foods diet having any diet related nutritional deficiency or deficiency related adverse health problem.

Case Report

A girl was the fifth child born to a married couple of African American ancestry by way of Jamaica and Puerto Rico. The father delivered the baby at home, which the parents did not weight at birth. The mother breast-fed the baby until nipple bleeding forced her to stop at 2 ½ months. Subsequently, they fed the baby about nine ounces, five to six times each day of an exclusively raw foods diet prepared in a blender at home (see Table 1). The couple also fed their older children, ages 18 months—6 ½ years a raw foods diet (Table 1). The two youngest surviving children had an exclusively raw foods diet since weaning from breast milk. The mother stopped breastfeeding both of them at about three months because they developed mucus discharges immediately after nursing. The second oldest child was breastfed for eight months and the oldest for about one year.

Figure 1 compares the infant's nutrient intake (approximately 650 calories based on 50 ounces x 13 kcal/ounce) with the USDA Nutrient Database recommended daily amounts (RDA) of nutrients.[5] For comparison, Figure 2 graphically demonstrates a 650-calorie diet from commercial vegan formulas and Figure 3 shows a 650-calorie diet from breast milk.

When the second youngest child was four months old, a child protective services worker visited the family at the request of a neighbor concerned about the small sizes of the children and their raw foods diets. This child protective services worker found no indicators of maltreatment and made no recommendation for physician referral. About 13 months later when the new baby was three months old, another neighbor's complaint that the children appeared underfed led to another visit by a representative of the Department of Children and Families. Again the assessment was that no maltreatment or reason for physician referral existed. Three days before the death of the infant, a third complaint led to a child protective services visit. Only the four older children were seen because the infant was out of the house with the father. This time the child protective services worker advised taking the children to a pediatrician but agreed to the mother's preference for a "natural doctor." The infant, who was out with the father during the visit, was scheduled to be seen subsequently, but she died before the visit. At age 5 ½ months after three days of cold-like symptoms, the infant developed difficulty breathing. The parents called paramedics but attempts to resuscitate the infant were unsuccessful.

In the autopsy, (Table 2), the coroner found no evidence of dehydration on the ocular chemistries and ruled that "malnutrition" was the immediate and underlying cause of death.

The older children were examined by a nurse practitioner supervised by a pediatrician. The 18-month-old's findings were the following:

Past medical history: Unknown (ed note: no illnesses by the parents history)

Medications: Unknown (ed note: none by the parents history)

Family history: Unknown (ed note: mother 169 cm [5 feet 6 ½ inches] and 52 ¼ kg [115 pounds], father 168 cm [5 feet 6 inches] and 70.5 kg [155 pounds]. The father weighted 104.5 kg [230 pounds] on the standard American diet about 7 years previously. The paternal grandmother was 152 cm tall [5 feet 0 inches] and the paternal grandfather was 170 cm tall [5 feet 7 inches]).

Immunizations: None

Diet: See Table 1

Physical Exam (relevant positive and negative findings):

General: Small thin female, alert

Length: 68-½ cm (27 inches: 3.68 SD below the mean height/age)

Weight: 16 pounds 8 ounces (7.5 kg: 4.1 SD below the mean weight/age)

Head circumference: 44 cm (17 1/3 inches)

Thorax: Ribcage prominent

Abdomen: Soft, protruding, no masses. Girth: 42 cm. (16 ½ inches)

Labs: See Table 2

Impression: 18-month-old girl with signs of severe malnutrition, including decreased subcutaneous fat tissue. This case represents appropriate food deprivation, severe physical neglect, and failure to thrive, including developmental delay.

Based on a "Denver Developmental" screen,[6] the pediatrician referred the 18-month-old girl to a psychologist for a formal assessment. The consulting psychologist used the Battelle Inventory Screening Test

[7] to evaluate the development of the girl. On adaptive fine motor skills, overall motor skills, expressive language, and communication she scored on average at the level of a 15-month-old. On the cognitive assessment, she scored at about her age. According to the pediatrician, the psychology board does not allow psychologists to release the raw data of their examinations to anyone other than another psychologist. Consequently, the psychologist did not reveal the data supporting the conclusion that the 18-month-old was developmentally delayed to a 15-month-old level.

The 39-month-old boy's findings were the following:

Past medical history: Unknown (ed note: no illnesses by the parents history)

Medications: Unknown (ed note: none by the parents history)

Family history: Unknown (ed note- as above).

Immunizations: None

Diet: See Table 1

Physical Exam (relevant positive and negative findings):

General: Small thin male, alert

Length: 83-1/3 cm (34 inches: 2.9 SD below the mean height/age)

Weight: 11 kg (24 pounds 8 ounces: 2.06 SD below the mean weight/age)

Head circumference: 50 cm (19-2/3 inches with two braids)

Mouth: Dental caries

Thorax: Ribcage prominent

Abdomen: Soft, protruding, no masses. Girth: 49 cm (19 1/3 inches)

Neuro: no deficits

Skin: no rashes

Labs: See Table 2

Impression: 3-year-old boy with signs of severe malnutrition, including decreased subcutaneous fat tissue. This case represents appropriate food deprivation, severe physical neglect.

The 52-month-old's findings were the following:

Past medical history: - (ed. note: He was exclusively breast fed for eight months, was not premature, played outdoors in sunny Southern Florida more than 6 hours per week, and had no hospitalizations or illnesses by the parents history.)

Medications: Unknown (ed. note: none by the parents history)

Family history: - (ed note: as above)

Immunizations: None

Diet: See Table 1

Physical Exam (relevant positive and negative findings):

General: Small thin male, alert

Length: 94 cm (37 inches: 2.82 SD below the mean height/age)

Weight: 13 2/3 kg (30 pounds: 2.48 SD below the mean weight/age)

Head circumference: 52-½ cm (20-2/3 inches)

Mouth: Dental caries

Thorax: Bilateral beading of the ribs (Rachitic rosary)

Abdomen: Soft, protruding, no masses. Girth 49-½ cm (19.5 inches)

Neuro: no deficits

Skin: no rashes

Labs: See Table 2

Photograph of child's chest: Beading of ribs was not seen by the pediatrician or other observers.

Impression: 4-year-old boy with signs of severe malnutrition, including clinical rickets and decreased subcutaneous fat tissue. This case represents appropriate food deprivation, severe physical neglect.

The 78-month-old boy's findings were the following:

Past medical history: - (ed. note: no illnesses by the parents history)

Medications: Unknown (ed. note: none by the parents history)

Family history: Unknown (ed note: as above)

Immunizations: None

Diet: See Table 1

Physical Exam (relevant positive and negative findings):

General: Small thin male, alert cooperative

Length: 104 cm (41 inches: 2.93 SD below the mean height/age)

Weight: 15 2/3 kg (34 ½ pounds: 2.98 SD below the mean weight/age)

Head circumference: 54 cm (21 ¼ inches)

Mouth: Dental caries

Thorax: Ribcage prominent

Abdomen: Soft, protruding, no masses. Girth: 53 cm (21 inches)

Neuro: no deficits

Skin: no rashes

Labs: See Table 2.

Impression: 6-year-old boy with signs of severe malnutrition, including decreased subcutaneous fat tissue. This case represents appropriate food deprivation, severe physical neglect.

After an investigation, including the infant's autopsy, the parents were charged with aggravated manslaughter in the care of the infant and neglect of all their four older children for feeding them an exclusively raw foods vegan diet. The court incarcerated the parents and placed the older children in foster care. Realizing that all four children were small yet appeared quite healthy, the court initially ordered the raw foods vegan diet to be continued in foster care. After about two weeks, the court reversed itself and ordered an omnivore diet for the four older children because of the testimony of the pediatrician who diagnosed severe malnutrition in all four, rickets in the four-year-old based entirely on his clinical finding of a rachitic rosary on the ribs, and developmental delay in the 18-month-old based on the psychologist's report.

Both parents declined plea bargains offering probation, because it did not include the return of their surviving children. They plan to defend themselves in court on October 10, 2005 and face possible 50-year prison sentences for these charges.

Discussion

Some 12 million infants and young children die each year in developing countries from complications of marasmus (protein-calorie deficiency) and kwashiorkor (severe protein deficiency).[8] Diarrhea, dehydration, and infection are generally the immediate causes of death in malnourished children. Kwashiorkor manifests clinically with stunted growth, mental apathy, edema, a desquamating patchy rash, and pigment changes in the hair and skin. Children with marasmus typically retain mental alertness and do not have edema or rash. Autopsies of children dying of kwashiorkor and marasmus show pancreatic atrophy or fibrosis[9, 10] and fatty changes or fibrosis in the liver.[10] Laboratory findings in severely malnourished children include low albumin, protein, prealbumin, BUN, cholesterol, transferrin, ferritin, B12, folate, and lymphocyte count and severe anemia. Notably, the pediatrician did not order most of these tests.

The infant under discussion did not have the typical autopsy findings of either kwashiorkor or marasmus. She had no rash, edema, or pancreatic or hepatic histological changes.

Although the four older siblings were 2.1-4.1 SD below the mean on the USA growth charts, they had none of the clinical or laboratory findings associated with kwashiorkor and marasmus. The World Health Organization describes its standard method of assessing nutritional status as follows:

> The degree of malnutrition is usually measured in terms of weight, expressed in standard deviations from the mean of the relevant reference population. When one or more previous measurements are available, lack of weight gain in children, or evidence of weight loss in children or adults, is usually indicative of malnutrition. When only one measurement is available, the diagnosis is based on probabilities and is not definitive without other clinical or laboratory tests. In the exceptional circumstances that no measurement of weight is available, reliance should be placed on clinical evidence.
>
> There is a high probability of severe malnutrition if there is an observed value situated 3 or more standard deviations below the mean value of the reference population; a high probability of moderate malnutrition for an observed value located between 2 and less than 3 standard deviations below this mean; and a high probability of mild malnutrition for an observed value located between 1 and less than 2 standard deviations below this mean.[11]

The probabilities of various levels of malnutrition for children in developing countries based on local growth charts[11, 12] are completely different from malnutrition risks of North American children based on Center for Disease Control growth charts.[13] Regarding this particular issue of the risk of post neonatal death (aged 1 –12 months) from the

complications of protein-energy malnutrition, we can refer to vital statistics data from the Center for Disease Control/National Center for Health Statistics for 2001 and 2002. Out of approximately 18,000 post neonatal deaths, none were caused by marasmus or kwashiorkor. Only 4 had the underlying cause of "severe malnutrition, not otherwise specified."[14, 15] In those 2 years, there were about 10,000 post neonatal infants who were more than 3 standard deviations below the mean on the CDC growth charts (8 million x .0013 [fraction of any normally distributed population below 3SD]).

Total cholesterol levels of the four children (144, 129, 120, 154 mg/dl) were all below 160 mg/dl, which indicates malnutrition in laboratory assessment panels. While a total cholesterol < 160 mg/dl may be below the normal range because it is less than 2 standard deviations below the mean of the American population, people with total cholesterol levels < 160 mg/dl and no other chronic diseases have lower cardiovascular and overall morbidity and mortality than those with cholesterol levels > 160 mg/dl. No published article documents any health risks of children or adults having total cholesterols <160 mg/dl due to a vegan diet. Reducing risk factors for atherosclerosis is a prime health reason for becoming a vegan and indicates a problem with indiscriminately applying laboratory malnutrition assessment indices to vegans.

Of the prealbumin tests obtained on the three older children (i.e., 11, 14, and 15 mg/dl), one was slightly below the "normal" range (14-30 mg/dl). According to the Family Practice Notebook:

- Prealbumin < 5 indicates severe protein malnutrition and predicts a poor prognosis
- Prealbumin <11 mg/dl: indicates a high risk for complications of malnutrition and requires aggressive nutritional supplementation
- Prealbumin <14: Increased risk of malnutrition and requires monitoring twice weekly with repeated prealbumin levels and other nutritional laboratory tests.[16]

Using prealbumin as an indicator for malnutrition has the same problem as using serum cholesterol. There is no published range of prealbumin for healthy vegan children who would typically consume adequate amounts of protein but significantly less than healthy omnivore children.

The nutrient analysis of this infant's diet (Figure 1) shows that it meets the USDA certified recommended daily requirements (RDA) for all nutrients except vitamin B12, calcium, and zinc. Unlike folate for which we have stores for only days or a few weeks, vitamin B12 stores in the liver may be gradually used over months and years. Breast milk of vegan mothers generally has less vitamin B12 than that of omnivore mothers. We do not have the serum vitamin B12 amount of this mother during breast feeding. It may have been low although she had no symptoms of anemia. During the 2 ½ months of breast feeding, the infant accumulated an unknown amount of vitamin B12. The infant and older children were all at risk for B12 deficiency, however, B12 deficiency was unlikely to have triggered the apparent pulmonary infection that caused her death.

Growth and Development of Children on Vegan Diets

One study of preschool vegetarian (mostly vegan) children found that the, "type and amount of carbohydrate, fat, protein, and amount of sodium and cholesterol provided by their diets were more like intakes suggested in the proposed Dietary Goals for the United States than the levels in usual diets of non vegetarian children."[17] However, vegan preschool children are leaner than non vegetarian preschool children.[18-20]A report in 1980 from a vegetarian (primarily vegan) community in Tennessee called "The Farm" showed that only 3/28 boys 1-4 years old were above the 50th percentile in weight while 7/28 were below the 5th percentile. A larger study of 404 vegetarian children from The Farm published in 1989 again showed that children 1 to 3 years of age had significantly lower heights and weights. However, by age 10, the children averaged 0.7 cm and 1.1 kg less than other children (only 0.1 and 0.3 SD below the USA reference means).[211]

Rickets Diagnosed in the 4-year-old.

The Center for Disease Control (CDC) defines vitamin D deficient rickets (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] [*1*] codes of 268.0 [active rickets], 268.9 [unspecified vitamin D deficiency], or 268.2 [unspecified osteomalacia]) as having a low serum 25-hydroxy-vitamin-D level (below laboratory reference range) combined with one or more of the following radiographic changes: osteopenia, widening of growth plates, fraying and cupping of the metaphysis, or craniomalacia.[22] Low phosphorus, normal or low calcium, markedly high alkaline

phosphatase, and high parathyroid hormone levels are also typically seen but not part of the CDC's criteria for the diagnosis.[23] None of the children had any of these findings.

Developmental Delay in the 18-month-old Girl

A licensed psychologist, using the Battelle Developmental Inventory Screening Test (BDIST), made the diagnosis of developmental delay in the 18-month-old girl. An analysis of the BDIST in 104 children 7 to 83 months old compared with a battery of other psychological tests showed both poor sensitivity (failing to detect 25% of the children with developmental problems, such as mental retardation, borderline intelligence, language delays, and learning disabilities) and poor specificity (27% of the non developmentally delayed children failed the BDIST).[24] Children failing the BDIST but determined to have no developmental delay (false positive BDIST) are much more likely to be non-white and to have parents with limited formal education.[25] Correlations of the BDIST with other instruments to assess developmental delay in children (Functional Independence Measure for Children and the Vineland Adaptive Behavior Scales) are fair at best (r ranging from .42 to .92).[26] Vanderbilt University School of Medicine psychological examiners compared the Denver-II and the BDIST with a screening evaluation based on parents' concerns about children's development, using long-term benefits to the child as the outcome measure (impact of early intervention on adult functioning as inferred from longitudinal studies by other researchers). They found that both the BDIST and the Denver-II evaluation instruments cost much more but were not statistically significantly more accurate in determining developmental delay than

asking the parents if they have concerns about the development of their children.[27] Data on the inter-observer variability in the scoring of the BDIST have not been published.

Accuracy of the BDIST in diagnosing developmental delay in this 18-month-old toddler may have also been compromised by the trauma due to the recent separation from her parents.

DiGeorge Anomaly in the Infant

The differential diagnosis of an infant with no thymus gland and "inconspicuous parathyroid glands" includes only one thing: DiGeorge Syndrome. Normally, an infant's thymus should be about 8 times the size of the thyroid gland. Involution of the thymus gland is frequently found in infants and children with malnutrition.[8] However, no case of the complete absence of a thymus gland has ever been reported in the medical literature.

DiGeorge Syndrome is a misnomer and should instead be called "DiGeorge Anomaly" because the constellation of defects results from a failure of an embryological field (third and fourth pharyngeal pouches) to develop normally rather than a single cause.[28]

Patients with DiGeorge Anomaly may have velocardiofacial syndrome ([VCFS] or Shprintzen syndrome), conotruncal anomaly face syndrome, Caylor syndrome, Opitz-GBBB syndrome, or CHARGE (coloboma, heart anomalies, atresia of choanae, retardation [mental and somatic], genital hypoplasia, and ear anomalies) syndrome. Absence or hypoplasia of thymus and parathyroid glands is consistently found.

Circulating T-cells tend to be decreased but not absent and functionally deficient with poor response to mitogens.[290] Consequently, the presence of CD3+ T-cells in the spleen at post mortem examination does not rule out DiGeorge Anomaly. T-cell function with mitogens or skin tests cannot be measured in post mortem specimens.

Chromosome 22q11 deletions are associated with 88% of cases, which have been recently grouped under the acronym CATCH-22 DiGeorge/ velocardiofacial [VCFS] syndrome (cardiac defects, abnormal facies, thymic hypoplasia, cleft palate, and hypocalcemia).[30] The basis of the striking variability of the 22q11DS phenotype remains unclear, and no phenotype-genotype correlation has been made.[31] Rarely, partial deletion on chromosome 10[32] and partial trisomies of 8q[28] and 1q[33] are found. About 10% of patients have no discernable chromosomal abnormality.

In 2002, the last year for which vital statistics are available, 41 death certificates mentioned DiGeorge Syndrome. Of those, 31 died before age 12 months. Only one survived childhood.[14] If DiGeorge patients survive problems with congenital heart disease and hypocalcemia typically presenting in the first month of life, they generally succumb to infection due to the T-cell immunodeficiency.[34] In an autopsy series of 24 DiGeorge patients from a large specialty hospital, most of the children surviving the first month of life had failure to thrive and developmental delay.[28]

Conclusion

In the infant who died, DiGeorge Anomaly cannot be ruled out and malnutrition, according to WHO criteria, cannot be diagnosed. The 18-month-old's recent separation from her parents and the cultural bias and poor sensitivity and specificity of the Battelle Developmental Inventory Screening Test make the diagnosis of developmental delay highly questionable. The older children were not malnourished by the WHO's definition. The clinical diagnosis of rickets in the 4-year-old was not confirmed by the CDC's criteria. The raw foods vegan diet and possibly inherited small stature from the father's side account for their relatively low heights and weights. Catch-up growth will probably occur on the standard American diet but would have also been expected if they had remained on a vegan diet.

Abbreviations

American Dietetic Association: ADA

Battelle Developmental Inventory Screening Test: BDIST

Blood Urea Nitrogen: BUN

Center for Disease Control: CDC

Cyanocobalamin: Vitamin B12 or B12

Standard Deviation: SD

United States Department of Agriculture:USDA

World Health Organization: WHO

Competing interests

None

Authors' Contributions

DKC conceived of drafting the case report, researched the appropriate medical records, and wrote the text. WH created figures 1-3, using the nutritional intake data supplied by the mother in the case. Both authors read and approved the final manuscript.

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Table 1. Diets of the Children

Infant's diet	Children's diet
24 ounces coconut water	raw fruits, vegetables, and nuts.
8-9 ounces of blended sunflower, pecans, walnuts, brazil nuts, sesame seed, pumpkin seed, hazel nut and or almond/flax/coconut water and burdock root.	Green juice/veggie juice consisting of cucumber, celery, carrot, parsley, dandelion, kale, lemon, garlic, ginger, and other vegetables.
carrot juice, cucumber, celery, spinach, romaine, lettuce, cilantro, kale, radishes, broccoli, tomato – 4-5 of these were included in one puree, blended with ½ avocado. Occasionally, a sliver of garlic or ginger was added. This puree would be placed in a baby bottle with the nipple cut a little larger to allow it to flow.	Nut or curry pate (almonds or sunnies, or brazil, or walnut, or other nuts with onion, garlic, basil, lime juice, dulse, carrots, celery, black pepper) was put on sticks or slices or chunks of celery, carrot, broccoli, cauliflower, or tomato.
	Papaya, strawberry, apple, banana, pear, watermelon, cantaloupe, figs, dates, raisins and other fruits.
	Nut milk several times per week
	Occasional raw pie.
½ ounce of wheat grass with coconut water - 3 times a week.	Coconut water and the coco jelly; three times a week, 1 ounce wheat grass.

8-10 ounces of fruit juice consisting of mango, cantaloupe, papaya, berries, oranges, banana, etc. blended up with a bit of coconut water.	Big green salad with lettuce, cucumbers, tomatoes, arugula, collards, kale, sprouts, carrots, avocado and pate added.
	banana date/strawberry/almond/macadamia ice cream made in food processor or juicer

Table 2. Autopsy Findings

Gross and Microscopic	Laboratory
Weight: 3180 mg (6.99 pounds)	Toxicology studies all negative
Length: 57 cm (22 ½ inches)	Home-made infant formula: no drugs found; not tested for nutrients.
Head circumference: 38 cm (15 inches)	Ocular fluid: Calc ium = 6.0
Emaciated appearance	Ocular fluid: Chloride = 108 mmol/l
The complete absence of the thymus gland	Ocular fluid: Creatinine = 0.2 mg/dl
"Inconspicuous" parathyroid glands	Ocular fluid: Glucose = < 5.0 mg/dl (considered due to post mortem glucose metabolism)
Probe patent ductus arteriosis	
Congested pulmonary parenchyma	
Lungs: postmortem changes and atelectasis	Ocular fluid: Potassium = 10.3 mmol/l
Probe patent ductus arteriosis	Ocular fluid: Sodium = 120 mmol/l
Liver: passive congestion, no fatty changes	Ocular fluid: BUN = 13 mg/dl
Pancreas: normal histology	Blood/CSF/lung post mortem cultures all showed heavy gram-negative rods (Klebsiella pneumoniae, citrobacter freundii, and enterococcus faecium).
Adrenals: spent	
Mediastinal soft tissue: thymus not present	
Parathyroid histology: no tissue submitted	
Spleen: "Immunochemistry for CD3 demonstrates the presence of T-lymphocytes towards the periphery of the Malpighian corpuscles and scattered throughout the red pulp. NOTE: The	

presence of T-lymphocytes in the spleen excludes the possibility of DiGeorge syndrome.”	
Brain: no abnormalities	
Ova, parasites, and viral inclusions not found in stool specimen	

Table 3. Laboratory Data of the Four Older Children

Labs	18 month old girl	39 month old boy	52 month old boy	78 month old boy	Normal Range
PT	12.9	13.4	12.3	10.6	11.0-13.0 seconds
INR	1.06	1.4	1.3	1.1	0.9 – 1.1
PTT	28.1	27	32	25	< 35 seconds
Vitamin D 25-hydroxy	27.5	-	32	-	10.0 – 60.0
Glucose	76	-	10.1	-	70-110
BUN	10	-	-	-	8.0 – 23.0 mg/dl
Creatinine	0.5	-	-		0.7 – 1.4 mg/dl
Alkaline Phosphatate	351	232	-	351	39 – 117 IU
Calcium	9.4	10.4	-	9.4	8.5 – 10.4 mg/dl
Magnesium	-	1.8	2.0	2.4	1.5 – 2.5 mg/dl
Phosphate			4.0		3.0 – 6.0 mg/dl
Bicarbonate	29	-	-	-	22.0 – 29.0 mg/dl
Sodium	139.3	-	-	-	133.0 – 145.0 mg/dl
Chloride	101.0	-	-	-	96.0 –108.0 mg/dl
Potassium	4.4	-	-	-	3.3 – 5.1 mg/dl
Triglycerides	128	48	-	67	< 200 mg/dl
Cholesterol	144	129	120	124	< 200 mg/dl
VLDL	25.6	-	-	-	5 – 55 mg/dl

LDL	73	82	63	73	
HDL	65	37	43	68	
Prealbumin		15	11	14	14-30 mg/dl
Chest X-ray	Normal	Normal	Normal	Normal	
Long bone X-ray	-	Normal	Normal	Minimal changes*	

* Minimal metaphyseal banding or proximal femora possibly associated with some interruption of growth on a transient basis of the proximal femora.

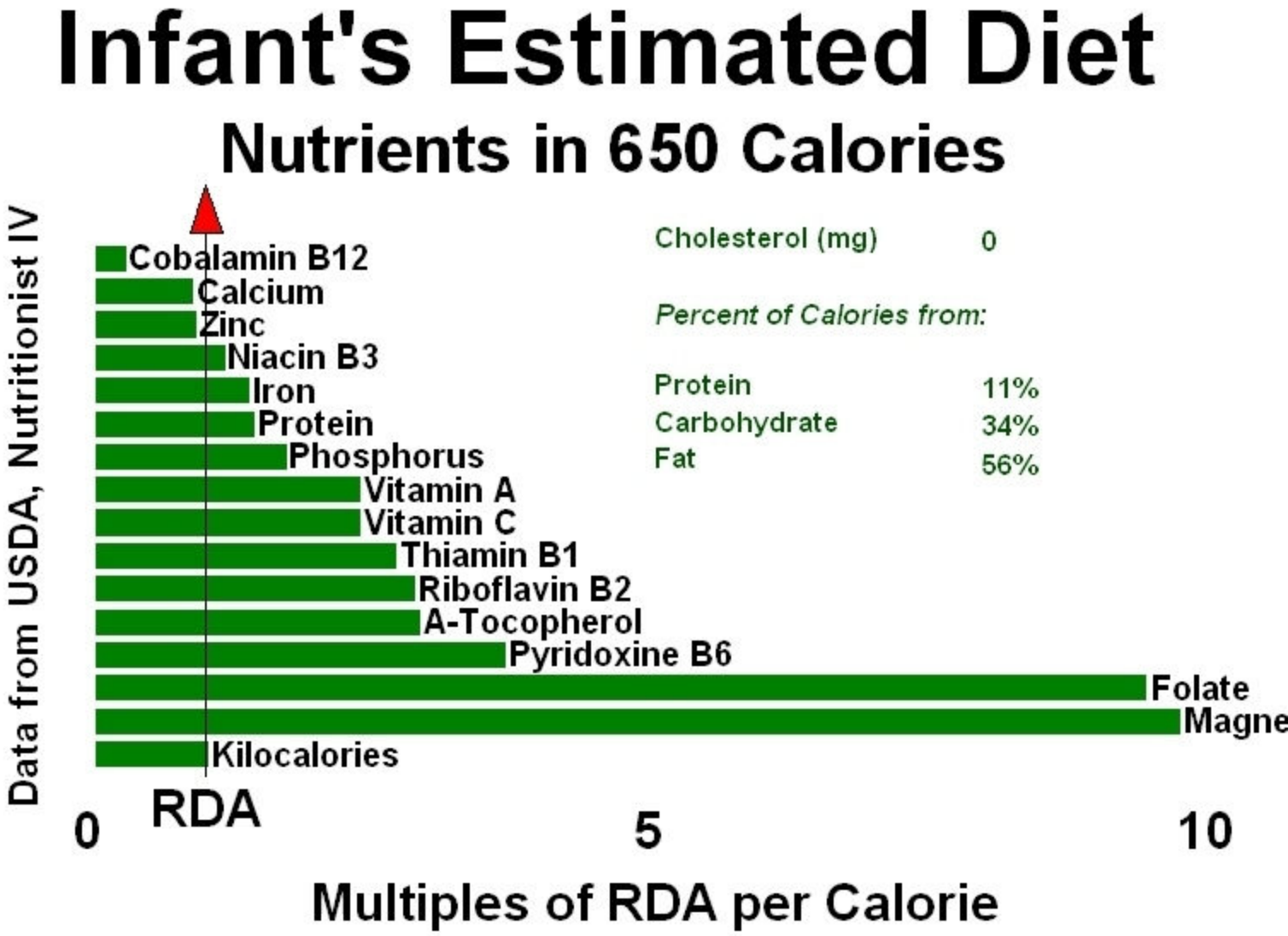
Infant's Estimated Diet
Nutrients in 650 Calories
Data from USDA, Nutritionist IV
Cobalamin B12
Calcium
Zinc
Niacin B3
Iron
Protein
Phosphorus
Vitamin A
Vitamin C
Thiamin B1
Riboflavin B2
A-Tocopherol
Pyridoxine B6
Folate
Magne
Kilocalories
Cholesterol (mg) 0
Percent of Calories from:
Protein 11%
Carbohydrate 34%
Fat 56%
0
RDA
5
10
Multiples of RDA per Calorie

Figure 1

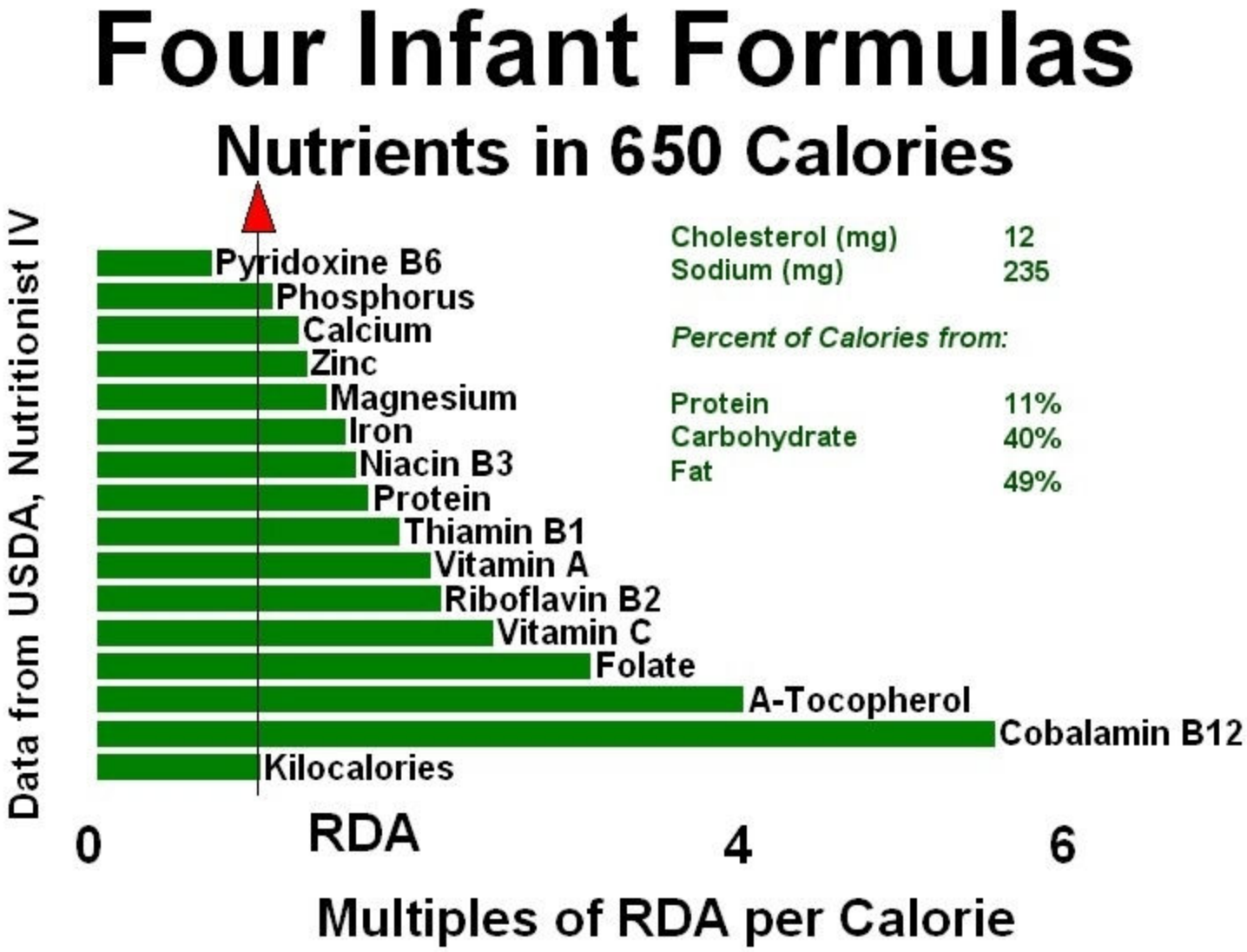
Four Infant Formulas
Nutrients in 650 Calories
Data from USDA, Nutritionist IV
Pyridoxine B6
Phosphorus
Calcium
Zinc
Magnesium
Iron
Niacin B3
Protein
Thiamin B1
Vitamin A
Riboflavin B2
Vitamin C
Folate
A-Tocopherol
Cobalamin B12
Kilocalories
Cholesterol (mg) 12
Sodium (mg) 235
Percent of Calories from:
Protein 11%
Carbohydrate 40%
Fat 49%
0
RDA
4
6
Multiples of RDA per Calorie

Figure 2

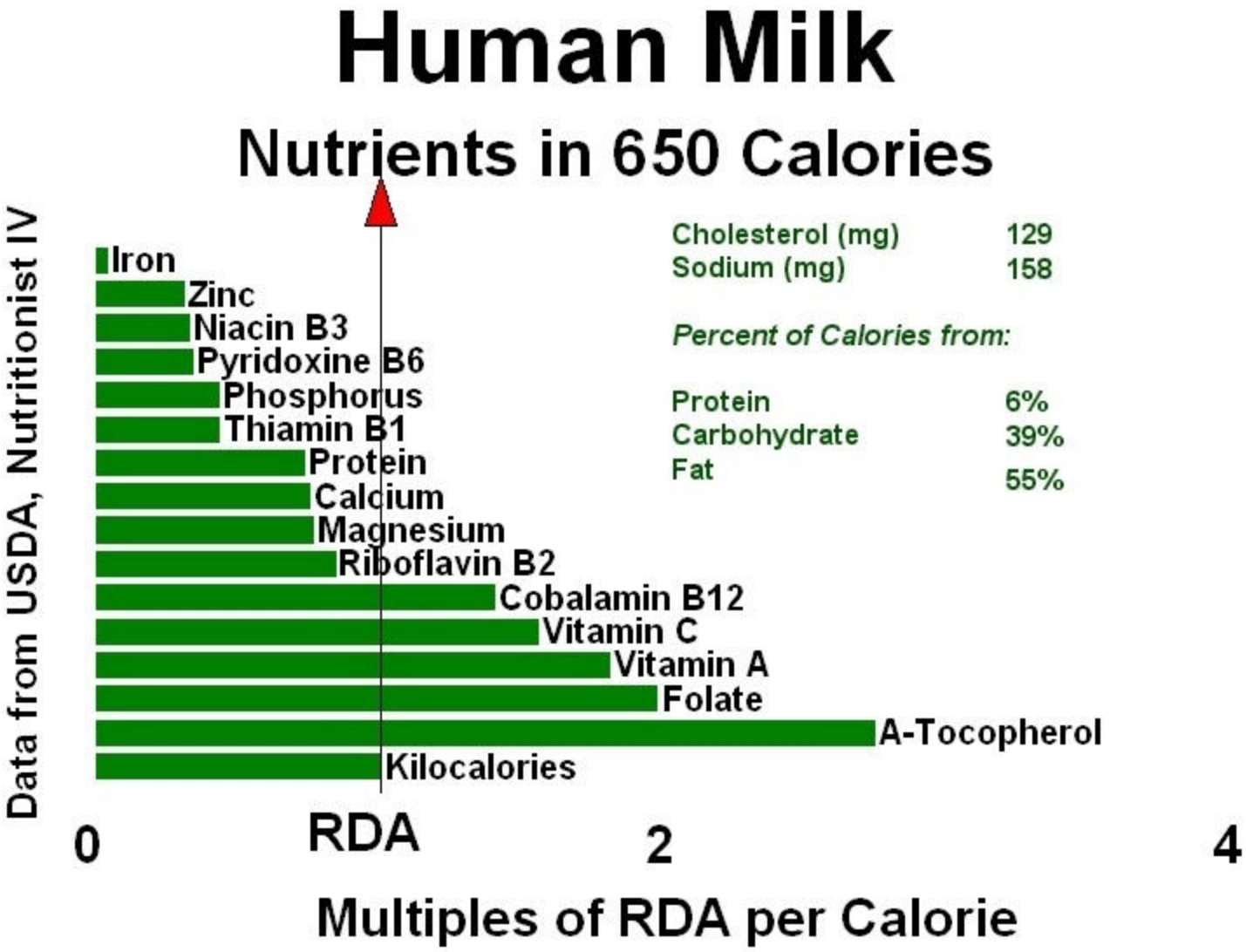
Human Milk
Nutrients in 650 Calories
Data from USDA, Nutritionist IV
Iron
Zinc
Niacin B3
Pyridoxine B6
Phosphorus
Thiamin B1
Protein
Calcium
Magnesium
Riboflavin B2
Cobalamin B12
Vitamin C
Vitamin A
Folate
A-Tocopherol
Kilocalories
Cholesterol (mg) 129
Sodium (mg) 158
Percent of Calories from:
Protein 6%
Carbohydrate 39%
Fat 55%
0
RDA
2
4
Multiples of RDA per Calorie

Figure 3