REPORT

COMMITTEE ON NUTRITION

On the Feeding of Solid Foods to Infants

Solid foods are being introduced into the infant diet at an increasingly early age. Justification for individual practices appears to rest on opinion rather than on demonstrated proof of benefit or of harm. The Committee on Nutrition deems it desirable to discuss some of the issues involved.

HISTORICAL

Until about 1920, solid foods were seldom offered before 1 year of age. To do so was considered harmful by many pediatricians. In 1924, Jundell, a Swedish pediatrician, followed the growth and development and susceptibility to infections of 2,186 infants in a Stockholm orphanage, fed exclusively on milk for the first year of life. Simultaneously he collected a group of 382 babies to whom he offered a variety of solid foods in the form of minced meat, fish, scrambled eggs and vegetables from 6 months of age on. They received only 300 to 500 ml of milk daily. He reported excellent results compared to the babies fed exclusively milk with respect to resistance to infections, digestibility and weight gain.

Hamburger, a German pediatrician, in 1923 published a paper reporting the successful rearing of 12 infants on a completely milk free diet. The diet consisted of liver, rice, cod liver oil, peanut oil, cane sugar, fruit juice and a salt mixture. All appeared to enjoy their feedings except two who refused to take the offered food after about 2 weeks of age. The infants were debilitated and in poor nutritional condition at the beginning of the study period, but all recovered and developed normally. Hamburger maintained that milk is not essential during the first year of life. He stated that meat, especially liver, was an adequate substitute for milk protein, and that the newborn was capable of digesting the food offered.

By the mid-1930's the earlier fear of solid foods before a year of age had been overcome. The role of one vitamin after another in the prevention of deficiency states had been assessed. Marriott in his textbook on infant feeding suggested 6 months as the proper age to introduce solid foods. The Council on Foods of the American Medical Association in 1937 recognized the usefulness of the early introduction of strained vegetables and fruits into the infant diet for two reasons, (1) because of their content of vitamins, iron and possibly other factors and (2) because of the psychologic benefits on food habits. It was stated that, "The feeding of strained fruits and vegetables... at an age of about 4 to 6 months, is generally favored by pediatricians."

Glazier in 1933 reported a study on 231 infants in which solid-food supplements were made at varying ages. Solids were first introduced between 2 and 3 months of age for 38 of the infants, during the fourth month for 53, during the fifth and sixth months for 97, and during the next 4 months for 43. Mean weight gains by 1 year of age were slightly greater (0.9 lb) in the infants receiving solid-food supplements early, dentition and walking were earlier, and food habits were better with fewer food dislikes.

Stewart in 1943 created a mild sensation by publishing a paper in which he reported the feeding of such foods as sardines in oil, creamed tuna fish, salmon, shrimp, and mashed carrots and peas (skins included) to 51 nursing infants between 4 and 8 weeks of age. A thickened farina or oatmeal feeding was routinely begun on the third day...
Committee on Nutrition

of life and was given by spoon. A variety of other solid foods was added in subsequent months. His purpose in the early feeding of such solid foods was to show that breast feeding could be maintained by this regimen, whereas complemental bottle feedings favored the early discontinuance of maternal nursing. He maintained that, "this liberal diet did not cause important gastrointestinal disturbances."

Brennemann was of the opinion that early introduction of solid food, and change to coarser foods in greater variety, at around 6 months was advantageous because the solids contained vitamins and iron, were easily digested, and prevented difficulties in learning to chew. Reminiscent of the present controversy, he pointed out, "While there may still be considerable divergence of opinion as to what, when and how much to feed babies, there has been a steady tendency to give more and to give it earlier."

Clearly, the swing of the pendulum, as noted by Brennemann when he wrote nearly three decades ago, has continued on with the same divergence of opinion and the same tendencies—the only difference now being that the age period has dropped from 5 or 6 months to 6 weeks and under. In a survey conducted by the Quarterly Review of Pediatrics in 1954, it was ascertained that 88% of some 2,000 pediatricians responding, routinely begin feeding solid foods before 3 months of age, and 66% before 8 weeks of age.

The extreme point of view in the routine early introduction of solid foods is represented by a recent report by Sackett in which the feeding of solid food was begun on the second or third day of life, and on a 6-hour schedule. Cereal, morning and evening, was the first solid food offered. Vegetables were introduced at 10 days of age, strained meats at 14 days and fruits at 17 days. Dropping of the midnight feeding, if possible, was advised at this stage; the infants continuing on three meals a day.

Thus, within the professional life-time of many of the nation's pediatricians, infant feeding has undergone the remarkable change from no solid-food supplementation being recommended in the first year of life to its introduction in the first days of life. No one today would question the nutritional inadequacy of a diet exclusively of milk throughout the first year, nor of the nutritional and other benefits to be derived from a varied diet begun at 4 to 6 months of age. But lacking is proof obtained from controlled observations that feeding of solid foods at ages earlier than 4 to 6 months of life is nutritionally or psychologically beneficial or, on the other hand, is actually harmful. Perhaps a third possibility should be entertained, to wit: The practice produces neither beneficial nor harmful results, but rather attests the adaptability of the baby to the whims of his caretakers.

Nutritional Considerations

Abundant observations over many years have demonstrated clearly that infants thrive when fed at the breast or on properly constructed formulas. Clinical studies have not offered substantial proof of superior nutritional states when solid foods are fed prior to 3 months of age. In view of the well-known normal variation in the time of teething and of walking in normal infants, the correctness of Glazier's contentions already mentioned, that the earlier dentition and walking in the group of infants fed solid foods early represented an improved nutritional status, may properly be questioned. Nor can it be accepted that the larger or heavier infants are necessarily indicative of a superior nutritional state. On the contrary, increased weight may represent merely excessive fat deposition.

Deisher and Goers in 1954 compared a group of 45 infants fed supplemental solid foods during the first 4 weeks of life with a group of 40 in whom the solid food supplements were begun during the 9- to 12-week age period. A variety of solid foods was utilized including cereals, vegetables, fruits and meats. In the course of the study, 419 determinations of hemoglobin and erythrocytes in the peripheral blood were made on
the infants in the early-feeding group, and 382 such determinations were made on the later-feeding group. No significant difference in the two groups was observed. Likewise growth between the two groups was comparable, as were the number of illnesses, character and number of stools, incidence of diarrhea, constipation, colic, excessive regurgitation, and number of food refusals.

Several studies have appeared in the literature in the last decade designed to evaluate the effect of early addition of strained meat to the infant diet. Leverton and Clark in 1947 fed meat supplements to a group of 18 6-week-old infants, and compared the results with a control group of 15 infants. Sufficient meat was fed to increase the protein content of the formula by 25%. Hemoglobin and erythrocyte determinations, made on both groups at the beginning of the study and at 12 and 14 weeks of age, showed a 10 to 13% increase in hemoglobin at these ages in the meat-fed group compared to a loss of 4 to 10% in hemoglobin in the control group. The authors conclude that these results indicate that strained meat added to the formula of bottle-fed infants not only checks the decrease in hemoglobin level characteristic of this age, but actually promotes the formation of hemoglobin and erythrocytes. No attempt was made to speculate upon which factor or factors in the meat was responsible for the improvement.

In a follow-up study in 1952, Leverton et al. confirmed their earlier results with respect to increase in hemoglobin and erythrocytes in meat-fed infants over control groups, but in addition stressed what seemed to be a protective effect against infections observed in infants receiving meat. Colds were fewer in number and of shorter duration in the meat-fed group.

Sanford and Campbell gave desiccated steak to 102 babies at 1 to 3 weeks of age. Weight gain in the test group was not different from that in the control group. However, the authors state that the extra iron provided by the meat supplement maintained the concentrations of erythrocytes and hemoglobin in the blood as well as did iron and ammonium citrate in the usual dosage, but they found no difference in the blood picture of the meat-fed and control full-term infants during the 6- and 12-month period in which they were followed.

Sisson, Emmel and Filer state that, "A comparison of the amino acid composition of whole cow's milk and lean meat demonstrates that they are very much alike, meat being appreciably lower only in leucine and phenyl-alanine. ... both cow's milk and meat do contain all the essential amino acids in high enough concentration to produce adequate growth if protein requirements are met." The authors' study was carried out on premature infants. They concluded that meat protein is as well retained and utilized as milk protein by the premature infant and is therefore as safe and efficient a source of protein as milk. However, strained meats as a sole source do not contain a sufficient quantity of calcium to maintain an adequate intake without further supplementation from other sources. Positive iron balances were obtained in the premature infants whose diets contained meat, but were negative or only slightly positive in the milk-fed controls. The characteristic anemia of prematurity was not prevented in the premature group who received meat, a finding which led to the conclusion that strained meats are an excellent and readily available source of iron for premature infants, and the iron of the meat is absorbed by them, but how well it is stored and utilized requires further investigation.

Jacobs and George evaluated some of the results of feeding a meat supplement to a group of infants under 2 months of age and to another group over 2 months of age. For the group under 2 months of age, improved physical growth was noted, normal physiologic decrease in hemoglobin was lessened with faster return to normal concentrations of hemoglobin, and the physiologic decrease in total serum protein was eliminated with a prompt sustained rise, predominantly in the globulin fraction.
Other than a slight improvement in average weight gain, none of these advantages was observed in the infants fed meat after 2 months of age. Illness rates for the 2 years the study was in progress demonstrated a 40% lower morbidity rate in the meat-fed group compared to the control group. The authors express the opinion that this may be related to the higher values for serum globulin and to the improved protein intake from the meat. A somewhat surprising observation recorded by the authors was that the meat-fed group of children, when given inoculations or restrained for withdrawing blood for counts or chemical analysis, seemed to cry with less intensity and to withstand the procedures with less emotional upset.

Andelman et al. studied the effect of feeding a strained-meat formula to premature-born infants. A total of 144 infants, averaging 2,000 gm in weight at the beginning, were divided into three groups: The first received human milk; the second, Olac® providing 19 calories and 0.95 grams of protein per ounce; and the third received Olac® and a commercial brand of canned meat, increasing the calories to 24 per ounce and protein to 1.7 grams per ounce. The meat formula was well accepted by the premature infants. No significant difference in the symptoms or signs of illness were observed among the infants of any of the three groups. The human-milk group exceeded the other two groups in gain of both weight and length. There was no significant difference in these measurements among the meat-fed and control groups. Hemoglobin concentration and erythrocyte counts were approximately the same at 12 weeks of age in all groups, but at 20 weeks of age the hemoglobin concentration in the meat-fed group exceeded that in the control group by 1 gm/100 ml. This is of interest because both groups received more than adequate amounts of iron added to the diet. The authors speculate that meat may contain some unidentified hemoglobin-producing substance not present in cow's milk. There was no significant difference in erythrocyte counts between the three groups at 20 weeks of age. Serum-protein values did not differ significantly between the meat and control groups at either 12 or 20 weeks, but the human-milk group had 0.4 gm/100 ml less at 12 weeks and 0.35 gm/100 ml less at 20 weeks than did the meat-fed infants. In 41 of the meat-supplemented infants the average daily fluid intake was 23 ounces compared to 28.7 ounces in 30 of the formula-fed infants. The caloric intake was approximately the same, but the daily protein intake of the meat-fed group was 39.1 gm contrasted to 27.3 gm for the babies receiving milk only. Not mentioned by the authors, but appropriate at this point would seem to be the comment that the high protein intake with its considerable contribution to the renal solute load, together with the decreased fluid intake in the meat-fed infants, enhances the potential danger of disturbance of the infant's water and electrolyte balance, especially in instances of excessive extra-renal water losses.

In summing up the evidence contributed by these experimental studies on the use of meat supplements in the diet of young infants, the following conclusions seem justified: (1) Protein derived from meat is comparable, but not superior, to the protein of cow's milk in infant nutrition; (2) strained meat as commercially prepared appears to be well tolerated by most premature and full-term infants at early ages; (3) it is an excellent source of iron, but that it has some unidentified hemoglobin-producing property apart from iron itself must be regarded as purely speculative; (4) that meat exerts a protective influence against infections cannot be accepted without further observation and elucidation of the mechanism involved; (5) further proof is required to conclude that meat supplements are capable of augmenting production of erythrocytes and hemoglobin and thereby preventing the physiologic decrease of these which is characteristic of both premature and full-term infants, but to a different degree.

The generally held view, that no means are available to prevent the usual decrease
in hemoglobin in the peripheral blood which occurs during the neonatal period, would not appear to have been reversed by the data submitted in the meat-feeding studies. Values for hemoglobin, erythrocytes and serum protein were reported by all authors in terms of concentration only. Further evidence may be obtained as to whether more hemoglobin, erythrocytes or protein had actually been produced by measuring the total circulating mass of these substances, not merely their concentrations.

An additional factor in the early feeding of solid foods merits consideration. It has long been established that the caloric requirement for optimum growth for normal infants is approximately 110 to 120 calories/kg/day. This requirement is readily met when human milk and properly constructed cows’-milk formulas, each supplying 20 calories to the ounce, are fed. Furthermore, the caloric intake for any given infant can readily be calculated from the number of ounces of formula consumed. The addition of solid food in the first few weeks of life may well have the effect, through satiety, of lessening the volume intake of milk. Although the total caloric requirement might be adequately met, the feeding of solid foods nutritionally inferior to milk, at the expense of milk, could result in worsening the nutritional state of the infant rather than bettering it. Knowledge of the caloric content of solid foods commonly used permits an accurate calculation of the total caloric consumption by the baby per day and the portion contributed by the solids and by the milk. Commercial, ready-to-serve cereals have approximately 8 calories per level tablespoon of dry cereal, strained meats have 15, vegetables 3.5 to 10, fruits 10 and strained egg yolks 30 calories per level tablespoon.

Thus on nutritional grounds alone, it is difficult to marshal convincing evidence in support of the present trend to begin solid foods in the first few days or weeks of life. Our present nutritional knowledge is incomplete and it may well be that nutritional substances now unknown are in existence. If so, it is reasonable to believe that they are more likely to be obtained from a mixed diet than from one restricted to a single food. Some support for this concept may be provided by the recent description of what appears to be a new deficiency syndrome occurring in infancy, as reported by Lahey and Schubert\textsuperscript{17} and by Sturgeon.\textsuperscript{18} Clinically the syndrome is characterized by anemia, generalized edema, hypocupremia, hypoferremia and hypoproteinemia. It was postulated that a deficiency of copper in the diet could be an important etiologic factor. The syndrome has not been seen in infants consuming an adequate varied diet, and those afflicted respond promptly to treatment by such a diet. The age period in which the syndrome has been encountered is between 6 and 15 months; hence the occurrence of this new syndrome does not necessarily constitute an argument for the feeding of solid foods in the first few weeks of life. If the etiology of this syndrome is determined as dietary, a compelling reason may be found for supplementing the milk diet of infants at 3 to 4 months of age with foods which are natural sources of suitable essential factors.

If it is difficult to demonstrate specific nutritional advantages in the early feeding of solid foods, it is likewise difficult to cite evidences of specific harm. While ill effects of early feeding of solid food have not been demonstrated, the possibility of later undesirable effects cannot be excluded. Already mentioned is the potential danger that solid foods may lower the volume intake of milk, and that meat supplements providing a high protein content accompanied by a lowered fluid volume intake may compromise the young infant's fluid and electrolyte balance. Another possible harm, stressed more in European than in American literature, is related to the effects of feeding rye and wheat to infants intolerant of these foods. It is the opinion of some of those working in the field that the syndrome of celiac disease may be the result of intolerance to the protein, specifi-
cally the gluten fraction, contained in these grains. However, steatorrhea or questionable examples of the celiac syndrome are of relatively uncommon occurrence among American infants in spite of the widespread use of wheat.

**ALLERGY**

The question of food allergy has been raised by all who have tried to evaluate the merits or disadvantages of early or late introduction of solids. In the poll conducted by the *Quarterly Review of Pediatrics*, 72% of the responding physicians thought there had been no increase in allergy to food as a result of the early feeding of solids; 22% believed the opposite. While practically all foods have been incriminated as potentially allergenic, cow's milk, wheat and eggs, especially egg white, are generally considered to be the most common offenders. For families in which one or more siblings had manifested allergic symptoms, Glaser and Johnston\(^5\) claimed that the incidence in subsequent siblings could be sharply reduced by withholding common allergenic foods from the maternal diet and by using a cow's-milk substitute from the beginning in infants not fed at the breast. Highly allergenic foods, such as wheat and egg white, were postponed until the latter months of the first year when the likelihood of absorbing whole protein is demonstrably decreased.

Reports of studies of normal full-term infants receiving solid foods in addition to cow's milk in the first weeks of life have not thus far indicated an increase in allergic manifestations over infants fed cow's milk alone. Further controlled observations are needed to determine whether it is justified to caution against the inclusion of the more allergenic foods, such as wheat and egg white, at an early age.\(^6\)

**PHYSIOLOGIC CONSIDERATIONS**

Infants a few weeks of age are able to digest, assimilate and utilize many solid foods made available in a finely divided state, but this does not prove their full readiness for solid foods until a later age. The rooting and sucking reflex exhibited in the newborn, and persisting for many months, would indicate that this is the normal method by which the infant obtains food. Not until 3 or 4 months of age, as pointed out by Bakwin,\(^2\) is the infant capable of voluntarily transferring food placed in the front of the mouth to the back through tongue action. "Young infants," he states, "push vigorously with the tongue against a spoon or solid foods placed between the lips. At about 3 to 4 months a change takes place. When food is brought to the child's mouth, the lips part, the tongue carries the food to the back of the mouth and swallowing follows. This is the optimal time to introduce solid food, and nothing is to be gained by earlier administration." Prior to this, the feeding of solid food requires that it be placed well back on the tongue.

In a recent study, Beal\(^2\) of the Child Research Institute in Denver obtained case histories on 57 infants relative to behavior toward feeding. The earliest age of ready acceptance of food from the spoon was 2\(^\frac{1}{2}\) to 3\(^\frac{1}{2}\) months. Salivary secretion, as manifested by drooling, usually does not make its appearance until the third or fourth month. Teeth appear around 6 months of age and chewing motions are a later accomplishment. All of these are indicative of nature's plan for a liquid diet for the first few months of life.

**PSYCHOLOGIC CONSIDERATIONS**

Alleged psychologic benefits from early feeding of solid foods must be viewed with skepticism. So many factors are involved in the emotional behavior of infants that attempts to assign a major role to any single factor are extremely difficult and precarious. Even the causes of crying or "3-month colic" are imperfectly understood. That the emotional requirements of infants in the first 3 to 4 months of life can be better met by solid foods than by adequate quantities of human milk or formula seems unlikely.
Consideration should be given to the possibility that it is the adults responsible for administering the solid food who are emotionally satisfied rather than the baby.

**SUMMARY**

Present knowledge of nutrition is admittedly incomplete. Accumulation of further knowledge by controlled observations is to be encouraged.

The present divergence of opinion regarding the appropriate time for the introduction of solid foods into the diet of the infant is recognized.

No nutritional advantage or disadvantage has as yet been proven for supplementing adequate milk diets with solid foods in the first 3 or 4 months of life. No harmful results have been reported thus far, but potential danger exists that earlier supplementation of the milk diets of infants with solid food of inferior nutritional content may, because of satiety, result in a decreased intake of milk.

High-protein feedings unaccompanied by sufficient water intake, as may occur with a meat supplement, can compromise the young infant's fluid and electrolyte balance.

Strained meat has been shown to be the equivalent of milk as a source of protein, and to be well tolerated by both premature and full-term infants. Claims for the advantages of the early introduction of meat are conflicting and do not permit the drawing of definite conclusions.

An increased incidence of allergy has not been demonstrated from solid foods fed in the early weeks of life.

Digestion, absorption and utilization of solid foods appears to be adequate even in the first days of life. Other physiologic mechanisms indicate nature's provision for their administration at a later date.

No psychologic advantage can be attributed solely to early feeding of solid foods.

Caution should be exercised in attributing any beneficial effect observed while feeding a food to a single constituent of so complex a mixture as a natural food.

**RECOMMENDATIONS**

The Committee on Nutrition believes that some specific recommendation regarding the optimum time for introducing solid foods into the infant's diet might serve a useful purpose, especially for pediatricians who are under pressure to recommend solid foods early. With this in mind, the following statement has been prepared.

Normal full-term infants can be expected to thrive for the first 3 months of life on human milk or a properly constituted cow's-milk formula. Supplements of a minimum of 400 units of vitamin D and 30 mg of ascorbic acid should be provided.

Iron-containing solid foods should be introduced during the third month. The Food and Nutrition Board of the National Research Council recommends a daily allowance of 6 mg of iron. Commerically-prepared, ready-to-serve, infants' cereals in the dry state contain approximately 0.92 mg of iron per tablespoon. Green and yellow vegetables vary from 0.05 mg/tablespoon (spinach) to 0.28 mg (green beans). Strained meats supply from 0.23 mg/tablespoon (pork) to 0.56 mg (liver). An egg yolk supplies approximately 1.0 mg of iron. Peaches are the best source of iron among the fruits, supplying 0.32 mg/tablespoon.

The Committee is in agreement with those who object to the use of age as a rigid standard. It believes the needs of infants are best served on an individual basis. Large, rapidly-growing infants consuming large quantities of milk, yet obviously hungry, may be made contented by reasonable concentration of the formula or by supplementing with cereal or meat at an age earlier than 3 months. On the other hand, small premature infants may not be considered ready for solid-food additions even at 3 months of age. Likewise, ill infants and those with special problems, such as sensitivity to milk, merit individual attention.

On the basis of present knowledge, the Committee is in agreement that no nutritional superiority or psychologic benefit results from introduction of solid foods into
the infant diet prior to 2½ to 3 months of age.

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**REFERENCES**

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