Reprinted from THE PROCEEDINGS OF THE BORDEN CENTENNIAL SYMPOSIUM ON NUTRITION
New York, N. Y., 1958
PRINTED IN U. S. A.

III

"Then the whining school-boy . . ."

THE GROWING CHILD[1]

NEVIN S. SCRIMSHAW, Ph.D., M.D.*

IN a centennial symposium one should look back 100 years. I was unable to find comparable data for the United States, but in the London of 1858, over 40 per cent of all deaths were occurring in children under five years of age. Routh (1863), a London physician, gives these and other similar data in his book *Infant Feeding and Its Influence on Life* and asks (page 3):

> "Now is this mortality a necessary evil? I believe not; and it shall be my endeavour to prove that it arises in great measure from *preventable* causes, and the improper manner in which children, speaking more specifically in reference to food are brought up."

He added what might well be a motto for statesmen as well as nutritionists:

> "Man it is true is born to sorrow as the sparks fly upward; but many of these sorrows are of his own creation."

Another London physician, Pereira (1843) in his treatise on *Food and Diet* states (page 473):

> "Of the ill consequences of defective nutriment we have, unfortunately, too many instances continually presented to our notice . . . Scrofulous and strumous disease, marasmus, rickets, distortions, and pot bellies, so commonly met with among children of the poor, are referrible, in part at least, to food defective either in quantity or quality, or perhaps in both."

He continues (page 474):

> "I think it will be found that more than two-thirds of pauper children are strumous. They derive this condition in part, perhaps, from hereditary tendency; but partly also, as I believe, from defective nutriment. To the same cause also is ascribable their inferior development . . . they will be found, for the most part, smaller and shorter for their age, more

*Regional Advisor in Nutrition, Pan American Sanitary Bureau and Director, Institute of Nutrition of Central America and Panama (INCAP), Guatemala, C. A.

[1] INCAP Publication I-113.

> frequently distorted, and more readily fatigued, than the children of the middling and higher classes."

Whether or not he was adequately breast fed was the major factor determining the survival and early development of the infant in North America and Europe a hundred years ago. As Dr. Darby has indicated in the preceding paper (Darby, 1958), feeding a child "by hand" instead of by breast gave good results in only 10 per cent of the cases in which it was attempted (Reports of the Clinical Hospital for Diseases of Children, First and Second, cited by Routh, pages 25-59, 1863). The reasons for this are not hard to discover. Cow's milk was of extraordinarily poor quality and other products for the feeding of children were inadequate and also frequently contaminated.

Dr. Sanderson (cited by Routh, pages 284-285, 1863), the medical officer of health for the district of Paddington, England in 1858, found that of 32 specimens of milk examined all but one had been adulterated with water. In 12 instances the quantity of solid constituents was only half as great as it ought to have been, and in a few only one-fourth. Routh (1863) asks (page 285):

> "What sort of food can this be for an infant, especially if diluted, as it almost invariably is, by the purchaser, and often afterwards by medical direction? Is it to be wondered at that children fed on such weak milk do not thrive?"

Furthermore, as the same author comments (page 289), the cows were kept in

> "wretched, filthy, and offensive sheds," so that "A common sewer would be in many cases equally pure."

The Report of the Commission on Adulteration (*Lancet*, 1855) contains an account of:

> "30 to 40 cows in a most disgusting condition, full of ulcers, their teats diseased, and their legs full of tumours and abscesses . . . quite horrible to look at; and a fellow was milking them despite all of these abominations."

It adds:

> "This was by no means an exceptional case, a great many dairies being in the same condition. The milk in consequence provided was really *diseased milk*"

and the authors italicized these last two words. One man who kept 50 dairy cows reported losing 200 from disease in 6 years.

These conditions, of course, also existed in the United States at this time, and the dairies supplying New York City were de-

scribed as "ill-managed unkept brewery annexes," to quote the recent Borden Review, *A Century of Milk* (O'Reilly, 1957):

> "Housewives marveled at the richness of the product dispensed from pushcarts along the streets and wondered as their children grew sickly. Ingenious 'processors' it appeared had uncovered the secret of synthesis of milk: water for volume, chalk for whiteness and an occasional egg for creaminess . . . In May, 1857 when Gail Borden began selling his new condensed milk, the daily milk for most of New York's millions or rather for its children was still swill milk."

In this decade, the death rate of children one to four years of age in the United States has fallen to only 1.4 per 1,000 and deaths of children under five account for less than 12 per cent of total deaths (Verhoestraete, 1956). Deaths from malnutrition are almost unheard of and the quality of our milk and milk products and the nature of our feeding practices make good growth and development of the infant and child almost a foregone conclusion. How satisfying it would be to congratulate ourselves on having thus put the past behind and proceed now to discuss the intricacies of modern biochemical and clinical knowledge of nutritional factors in the growth and health of infants and children. But I am sure that all of you have realized, especially after the talks of the preceding speakers, that I have not only been talking about the past but also describing the present for much of the world's population.

It is a matter of fact and conscience that the same killers of children which have so largely disappeared from the so-called developed countries are daily taking a frightful toll among children of the rest of the world. In countries as near to us as Mexico and those of Central America, infant mortality ranges from 90 to 150 per 1,000 live births and 25 to 40 more children per 1,000 per year die each additional year between the ages of one and four. The percentage of children dying before five years of age is the same or larger in these countries (Verhoestraete, 1956) than in the United States and England of a hundred years ago. To a greater or lesser degree these figures apply to much of Latin America, India, Africa and the Middle and Far East. The descriptions of contaminated milk which Dr. Darby (1958) and I have quoted are applicable to conditions still prevalent in many areas today and help to explain the distrust of cow's milk for infant and child feeding in some of these areas.

Severe protein malnutrition or kwashiorkor is a major public health problem among children in many underdeveloped countries today and usually appears after weaning when the diet consists mainly of starchy foods. Furthermore, the tendency to give starch gruels and stop all protein containing foods when diarrhea develops has particularly unfortunate consequences. To describe the situation today in these countries, I can conveniently use the statements of 1863. Routh (1863) laments the tendency when diarrhea develops (pages 324-325):

> "to substitute for the milk some farinaceous substance, made fluid by boiling arrowroot, gum and rice water, or a thickened preparation of rice and other preparations of a similar kind . . ."

He notes (page 326):

> "Yet how frequently, and even by medical men, is arrowroot ordered in the cases of diarrhea as the exclusive diet!"

and continues (pages 326-328):

> "I cannot conceive anything more injurious than this popular arrowroot feeding. I believe it is a cause of death of many infants. The following example, one out of many, . . . will suffice to prove this. A poor woman had had five children; all had been brought up artificially on arrowroot, and all had died. A sixth in due time was born, and she was strongly urged by a kind friend to try nourishing food, such as milk, beef-tea, etc. instead of the arrowroot. Meeting her accidentally some time afterwards, this friend inquired about the infant. The reply was: 'Oh!, it is dead; but it is no fault of mine as I fed it on the best arrowroot that could be procured.' So strongly rooted is the popular prejudice in favor of this starchy ingredient, which contains only 10 parts of plastic matter in 260 of combustible matter, instead of 10 in 40, as in human milk and therefore can never suffice to nourish a child, especially a weakly one."
>
> "A favorite substitute also . . . is what is known as patent barley. Here again, we have a flour comparatively poor in nitrogenous material . . . Next in esteem with the public is pap . . . I have seen it given to a child from birth . . . in about a month's time the child which was of enormous size, sickened and recovered only after much difficulty."

In Jamaica a form of kwashiorkor occurs in which the child receives abundant calories in his diet but insufficient protein and as a consequence becomes obese and edematous at the same time.

How better to describe the mechanism of this so-called "sugar-baby type" of kwashiorkor than in these words of Pereira in 1843 (pages 472-473):

> "... I have known children denied animal food, on the mistaken notion that it would be injurious to them, though the digestive functions were active and the appetite for meat most keen. Arrowroot, tapioca, sago, potato starch, sugar . . . are elements of respiration, and if used in greater quantity than necessary for combustion . . . they contribute to the increase of fat; but they do not contain the necessary elements for the growth of bone, cartilage, ligament, muscle, membrane and cellular tissue. For the latter purpose, nitrogenized food is necessary. The casein or curd of milk is an aliment of this kind, supplied by nature for the use of mammals. It is a proteinaceous substance, adapted for the growth of the organized tissues."

Only recently has the significance of the association between diarrheal disease and the subsequent development of kwashiorkor been fully realized. Most of the Guatemalan kwashiorkor cases give a history of an episode of diarrhea of apparently infectious origin shortly before the onset of edema and the other signs of kwashiorkor. It has become apparent that diarrheal disease and infections such as measles and whooping cough often precipitate the development of kwashiorkor in children who are already malnourished. Not only is the child thrown into negative nitrogen balance by them but also the diet is likely to be worsened by the therapeutic removal of milk and solid foods. Some mothers think the diarrhea beneficial in helping the child to get rid of worms and encourage it with purgatives. For a description of these practices today we can employ the phrases of Parker, a New York physician writing a mother's handbook in 1857 (page 87):

> "But with a continuous diarrhoea, there is danger of the child's being prostrated, and that just at the time when he should be increasing in strength and in flesh . . . I dwell upon this point the more, because I know it is . . . the very common opinion that a diarrhoea, at this period not only does no harm, but really does much good, and I am sure that many lives are lost every year in consequence of this belief."

He advises that (page 102):

> "When the child has shown any tendency to diarrhoea, is delicate and puny, it should not be weaned till after its second

> Summer. The reason is, obviously, that it is not fitted to bear the exposure to diarrhoea which it must incur . . ."

This is precisely the present concept of the epidemiology of serious malnutrition in children in many underdeveloped countries — a child delicate and puny is not fitted to bear the exposure to diarrhea which he must incur. For many young children bouts of diarrhea are almost a certainty. For example, figures are available for rural Guatemala which indicate that at least 5 per cent of children under five years of age have clinical diarrhea at any given time and that children one year of age have an average of five episodes of infectious diarrhea per year (Beck et al., 1957). Furthermore, at the time of any single examination by the rectal swab technique, about 6 per cent of all children under ten years of age in rural Guatemala harbour *Shigella,* the causative agent of bacillary dysentery (Beck et al., 1957). Thus in many areas diarrheal disease and malnutrition work synergistically to bring about a high death rate with now one and now the other dominant in the terminal episode.

Even when clinical surveys do not reveal a high frequency of signs and symptoms indicating frank nutritional deficiencies of a specific nature, malnutrition may be affecting a large proportion of the child population. This can be detected because of the sensitivity of growth and maturation to changes in nutritional status. It is well known that in Western countries the average height of the population has been increasing in recent generations due primarily to the improvement in the nutrition of the growing child. Although maximum growth is limited by genetic potential which varies from individual to individual and to some extent from one racial group to another, it is apparent that some differences in stature once thought to be of genetic origin are proving to be largely nutritional. Regardless of the doubtful desirability of greater height *per se* it is a fact, speaking statistically of populations, that a suboptimal diet cannot be improved without a corresponding increase in the rate of growth and maturation. Conversely, poorer nutrition will be quickly reflected in a slowing of these characteristics.

It is extraordinarily revealing that as long as the mother's milk supply is adequate even the economically poorer children of technically underdeveloped areas grow as rapidly or even more so than those of well nourished individuals of comparable age in North America and Europe. After weaning and during the preschool years, growth and maturation are very markedly slowed

in nearly all of the children of many underdeveloped areas; it is during this period that so many are carried off by malnutrition and infection. Once past these crucial pre-school years, when they begin to share the adult diet and are not given a special one adapted to their needs, the child's competitive situation in the family improves and he is frequently able to grow at a rate as rapid or nearly as rapid as that of a well nourished child anywhere — if he has survived to this age. Comparison of Latin American children with the Iowa growth standards has been justified to some extent by the finding that children of upper income and professional families, at least in Central America and Panama, seem to fall well within the limits of the Jackson-Kelly charts based on measurements of Iowa City children from 1920 to 1940 (Jackson and Kelly, 1945). This suggests that the decreased stature of most Central Americans is due primarily to nutritional, rather than genetic factors, although interpretation is complicated by the relative lack of information of well nourished persons of Mayan Indian origin. In the meantime, the standards mentioned are probably no longer entirely satisfactory for children in Iowa. The recent compilation of the United States department of Agriculture on *Heights and Weights of Children and Youth in the United States* (Hathaway, 1957) documents the increase in the mean height of children which has occurred in recent decades. It is important to note, however, that they are not getting healthier because they are taller, but they are taller for their age because they are on the average healthier and better nourished.

In discussing the growth of children it is gratifying to observe that rickets and "distortions" of childhood which figured so prominently among the nutritional problems of the past century have now been largely eliminated. Knowledge of the need for sources of vitamin D in the diet of the child, the appreciation of the role of sunlight in converting ergosterol in the skin to vitamin D, and the practice of supplementing the diets of young children with vitamin A and D concentrates have all contributed to this victory. Fortunately the abundant exposure of children to sunlight in most underdeveloped areas makes rickets much less of a problem for them than would otherwise be the case.

In general the greater variety in the ordinary diet, the enrichment and fortification of food products, the increased consumption of milk and other protective foods, school feeding and surplus food distribution programs and other factors have combined to make frank nutritional deficiencies rare among children in the

United States. This must not blind us, however, to the fact that specific vitamin deficiencies are still of great importance in some areas of the world. In Indonesia, for example, severe vitamin A deficiency is so common that hundreds of children lose their sight because of it and some die from ensuing complications (Report of FAO/WHO Expert Committee on Nutrition, 1958). In the rice-eating areas of Asia, beri-beri has long been a problem. In the Philippines this seemed well on the way to solution through the distribution of enriched rice, but unfortunately this program is seriously lagging at the present time. In Thailand, once relatively free of beri-beri because of the use of hand-milled rice, the introduction of power mills has resulted in infantile beri-beri becoming a very serious public health problem (Report of FAO/WHO, 1958). In Yugoslavia, Egypt and part of Africa, pellagra, common in the United States only a generation ago and now virtually banished by improved diets and cereal enrichment, still strikes both children and adults (Report of FAO/WHO, 1958). Iron deficiency anemia was only recently a problem in those areas of the southern United States in which hook-worm increased the physiological demand for iron beyond the meager amounts supplied in the diet. Today improved sanitation and increased iron intakes have made this condition rare among North American children, but iron deficiency anemia remains an important public health problem in many other parts of the world.

The question may be asked, does the United States now have major nutritional problems among its children? The answer, of course, is *yes,* but they tend to be problems of the individual rather than of population groups. Poor and erratic food habits, harmful food prejudices, food fads, recurrent illness or psychological maladjustment do result in seriously malnourished children. The maintenance and improvement of our many different programs of nutrition education and attention to the nutritive value and advertising claims of food products are essential if present gains are to be maintained and the number of individual malnourished children further reduced. Physicians, health workers, teachers and parents must all be kept aware of the essential elements of a good diet and the fact that malnutrition will occur in any child whose nutritional requirements are not met.

The question concerning the existence of nutrition problems in the United States may be answered affirmatively in another sense. We have very serious gaps in our knowledge of ideal intakes of essential nutrients. In general, we know the amounts of the

common essential nutrients which will prevent clinical deficiency, but we do not necessarily know the optimum intake of these nutrients or even the criteria to employ in determining the optimum. For example, we can measure the amount of any particular kind of protein required to maintain nitrogen balance under a given set of circumstances, but we do not know the validity of nitrogen balance or any other single criterion as a measure of protein requirements. Certainly something more than mere nitrogen balance is required, at least part of the time, to build adequate nitrogen stores, but how much more and what constitutes adequate nitrogen stores?

Ascorbic acid is another example; it takes relatively little of this vitamin to prevent scurvy but much more of it to produce tissue saturation and bring about high blood levels. There is evidence that the small amounts required to prevent scurvy are not enough to maintain optimum tissue function (Lowry et al., 1946; Vilter, 1954) but the limits are still poorly defined. As another example, there is a large discrepancy between the amounts of calcium presently recommended for daily consumption and the much lower intakes which, in some studies, have been found free of any adverse consequences detectable by present methods (Hegsted et al., 1952).

It is also highly probable that a number of nutrients, largely overlooked because they are supplied in abundance by ordinary diets or are required in only trace amounts, are much more important than now realized and have a great deal to do with health. We know much more about the role of trace minerals in the growth of plants and domestic animals than in the growth of children. Major advances may be expected in the future from research in this field.

Finally the relative freedom from clinically apparent nutritional disorders which has been brought about in the United States and other technically developed countries must be extended to children everywhere. Not only are there humanitarian reasons for this but also compelling political and economic reasons. Improvement of child nutrition in many underdeveloped countries will require more than the transfer of knowledge and techniques and surplus products from the "haves" to the "have-nots". Both action programs and education campaigns must be adapted to the nature and resources of a country and its people. The nutrition efforts of the specialized agencies of the United Nations, WHO, FAO, UNICEF and UNESCO and the direct country-to-country

programs of technical assistance should be continued and expanded.

As preceding papers in this symposium have indicated (Hundley, 1958; Darby, 1958) some countries are not in a position to meet the nutrition needs of their children by the same degree of reliance on products of animal origin as the countries of North America and Europe. While further development of animal industry will make it possible for some to do so eventually, increasing population pressure is likely to make it more difficult for others. There must be better utilization of local plant resources, and recent studies in India (Gopalan and Ramalingaswami, 1955; Phansalkar and Patwardhan, 1955; Phansalkar and Patwardhan, 1956; Subrahmanyan et al., 1955; Venkatachalam et al., 1956) and Central America (Béhar et al., 1957, 1958; Scrimshaw et al., 1957a; 1957b) have made it clear that practical vegetable protein combinations suitable for the supplementary and mixed feeding of infants and children can be developed wherever agricultural and economic conditions require.

In closing I will try to summarize the advances in the study of the growing child which should come about in the next one hundred years.

First, a more precise knowledge of optimum needs for intakes of essential nutrients should lead to diets that are even more conducive to health and longevity. This will probably include the identification of additional growth factors and the assigning of more importance to the trace minerals. It will require a better understanding of the interrelationships among essential nutrients and also those between nutrition and zymotic disease. We will certainly be able to make more specific adjustments in our diets to counter the effects of disease involvement or risk.

Secondly, the revolution in food processing and packaging will most certainly continue with more convenient and nutritious products for feeding children of all ages.

Thirdly, and most significantly, I anticipate low infant mortality and child death rates and sturdy, healthy children in all countries of the world.

REFERENCES

Beck, M., Dorthy, Muñoz, J. A. and Scrimshaw, N. S. 1957 Studies on diarrheal diseases in Central America. I. Preliminary findings on cultural surveys of normal population groups in Guatemala. *Am. J. Trop. Med. and Hygiene 6:* 62-71.

Behar, M., Viteri, F. and Scrimshaw, N. S. 1957 Treatment of severe protein deficiency in children (Kwashiorkor). *Am. J. Clin. Nutrition 5:* 506-515.

BEHAR, M., VITERI, F., BRESSANI, R., ARROYAVE, G., SQUIBB, R. L. and SCRIMSHAW, N. S. 1958 Principles of treatment and prevention of severe protein malnutrition in children (Kwashiorkor). *Ann. New York Acad. Sc. 69:* 954-968.

DARBY, W. J. 1958 The Nutritional "Ages of Man." II. The mother and her baby. *Proceedings of The Borden Centennial Symposium on Nutrition,* New York.

GOPALAN, C. and RAMALINGASWAMI, V. 1955 Kwashiorkor in India. *India J. Med. Research 43:* 751-773.

HATHAWAY, M. L. 1957 Heights and weights of children and youth in the United States. Home Economics Report No. 2, U.S.D.A., Washington, U.S.A.

HEGSTED, D. M., MOSCOSO, I. and COLLAZOS CH., C. 1952 A study of the minimum calcium requirements of adult men. *J. Nutrition 46:* 181-201.

HUNDLEY, J. M. 1958 The Nutritional "Ages of Man." I. Nutritional problems associated with food habits and environment. *Proceedings of The Borden Centennial Symposium on Nutrition,* New York.

JACKSON, R. L. and KELLY, H. G. 1945 Growth charts for use in pediatric practice. *J. Pediatrics 27:* 215-229.

Joint FAO/WHO Expert Committee on Nutrition. 1958 Report of the Fifth Meeting. In press.

LOWRY, O. H., BESSEY, O. A., BROCK, M. J. and LÓPEZ, J. A. 1946 The interrelationship of dietary, serum, white cell and total body ascorbic acid. *J. Biol. Chem. 166:* 111-119.

O'REILLY, M. J. 1957 A century of milk. *Borden's Review of Nutrition Research 18:* 46-67.

PARKER, E. H. 1857 *The Mother's Handbook, A Guide in the Care of Young Children.* Edward P. Allen, New York, 250 p.

PEREIRA, J. 1843 *A Treatise on Food and Diet with Observations on the Dietetical Regimen Suited for Disorder States of the Digestive Organs; and an Account of the Dietaries of Some of the Principal Metropolitan and Other Establishments for Paupers, Lunatics, Criminals, Children, the Sick, etc.* Longman, Brown, Green and Longmans, London. 542 p.

PHANSALKAR, S. V. and PATWARDHAN, V. N. 1956 Utilization of animal and vegetable proteins: Urinary nitrogen excretion in absorptive and early post-absorptive phases. *Ind. J. Med. Research 43:* 265-276.

PHANSALKER, S. V. and PATWARDHAN, V. N. 1956 Utilization of animal and vegetable proteins: Nitrogen balance at marginal protein intakes and the determination of minimum protein requirements for maintenance in young Indian men. *Ind. J. Med. Research 44:* 1-10.

Report of the Commission on Adulteration. 1885 *Lancet ii:* 551.

ROUTH, C. H. F. 1863 *Infant Feeding and Its Influence on Life; or, The Causes and Prevention of Infant Mortality.* 2nd ed., J. Churchill and Sons, London. 462 p.

SCRIMSHAW, N. S., BEHAR, M., VITERI, F., ARROYAVE, G., and TEJADA, C. 1957a Epidemiology and prevention of severe protein malnutrition (Kwashiorkor) in Central America. *Am. J. Public Health 47:* 53-62.

SCRIMSHAW, N. S., SQUIBB, R. L., BRESSANI, R., BEHAR, M., VITERI, F. and ARROYAVE, G. 1957b Vegetable protein mixtures for the feeding of infants and young children. In *Amino Acid Malnutrition, XIII Annual Protein Conference,* Rutgers University Press.

SUBRAHMANYAN, V., PATWARDHAN, V. N. and MOORJANI, M. N. 1955 Milk substitutes of vegetable origin. Indian Council of Med. Res., *Special Rept. Series No. 31,* New Delhi.

VENKATACHALAM, P. S., SRIKANTIA, S. G., GEETA, M. and GOPALAN, C. 1956 Treatment of nutritional oedema syndrome (Kwashiorkor) with vegetable protein diets. *Ind. J. Med. Research 44:* 539-545.

VERHOESTRAETE, L. J. 1956 International aspects of maternal and child health. Variation in problems with differences in technical development. *Am. J. Public Health 46:* 19-29.

VILTER, R. W. 1954 Ascorbic acid. Requirements of human beings. In *The Vitamins. Chemistry, Physiology, Pathology,* Volume I. Edited by W. H. Sebrell, Jr. and Robert S. Harris, Academic Press, New York. 388 p.