MORTALITY IN SECOND AND THIRD DEGREE MALNUTRITION *

by

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Malnutrition has been defined as a pathological condition of varying degrees of severity, and diverse clinical manifestations, resulting from the deficient assimilation of the components of the nutrient complex (GÓMEZ, 1955). This disease affects the physico-chemical pattern of the tissues, reduces the defensive capacity to environmental aggressions, lowers both the efficiency and the ability for work, and shortens life (ESCUDERO, 1935 ; TROWELL, 1948 ; DAVIES, 1952 ; ZUBIRÁN, 1953).

The disease attacks with greater intensity certain social groups, and has a considerable clinical importance during critical stages of development of the child, such as infancy and the pre-school age, which are characterized by rapid growth and high nutritional needs.

The causes responsible for malnutrition may be classified as primary — insufficient food supply, or under-nutrition ; and secondary or conditioned — poor absorption, increased excretion, increased requirements (JOLLIFFE, 1950). Most of the patients that come to our Department are children suffering from chronic underfeeding resulting from an insufficient diet, both in quantity and quality, to which they have been submitted for at least three-quarters of their lives.

When underfeeding is moderate, or has acted for only a short time, the " nutritional reserves " of the organism are only partially depleted, and malnutrition exhibits a mild clinical picture, where the body weight ranges between 76-90 per cent. of the theoretical average for the child's age. This, we call *first degree malnutrition.* As the effect of underfeeding becomes more serious, the picture becomes more marked, resulting in *second degree malnutrition.* At this stage, the weight is between 61-75 per cent. of the theoretical average for the age. The clinical picture, the prognosis, and the treatment become much more complicated, and frequently the patient requires hospital care.

In *third degree malnutrition,* when the nutritional reserves are practically exhausted, the maximum weight is never more than 60 per cent. of the average for the age ; while, in addition, there are serious somatic and functional, including psychological, changes. Treatment is very complicated and expensive, and the patient must be hospitalized. At this stage, the disease has a high mortality rate — figures given by several authors ranging from 30 to 60 per cent. (LEVINDER, 1912 ; GILLMAN, 1951 ; DEAN, 1954).

This classification of the disease — according to its varying degrees of severity and its various clinical manifestations — which has been adopted by us since 1946, has oftentimes been criticised. Recently the Guatemalan research workers have introduced the so-called " concept of Incipient Infantile Pluricarential Syndrome (pre-Kwashiorkor) " (SCRIMSHAW, 1955). In other words, they also accept degrees of severity, but use a different terminology.

We have conducted a careful study of both the clinical picture preceding death and of the apparent cause of death in a large group of children suffering from chronic malnutrition due to underfeeding seen between 1949 and 1952, and useful information has thereby been obtained which will assist in assessing the prognosis and the correct form of treatment in this type of case in the future. In due course, we shall also report on a second group studied from 1953 through 1955.

MATERIAL

Our study consisted of 733 children admitted to the Nutrition Department of the Hospital Infantil de México, from 1949 through 1952. These cases had the following characteristics :
(a) *Previous diet.* All the children had been submitted to a severe and prolonged restriction of food (Table I). The sources of protein were corn, beans, and wheat in small amounts. This diet was deficient in lysine, tryptophane, isoleucine, valine, threonine, methionine and cystine. The biological value of the protein mixture, calculated according to MITCHELL and BLOCK's formula (1946), was only 69 per cent. Besides, it was consumed only in small amounts, consisting of 50 per cent. of the essential caloric, and 20-60 per cent. of the normal protein, requirements. (b) *Sex incidence.* 48 per cent. were males and 52 per cent. females. (c) *Average age.* 31 $\pm$ 17 months. (d) *Weight.* 52 $\pm$ 10 per cent. of the normal weight for the age (Table II). (e) *Height.* This was less affected than weight, with maximum variations of 15 per cent. (f) *Clinical oedema.* Present in 71 per cent and absent in 29 per cent. (g) *Skin lesions* The incidence of these is shown in Table III. (h) *Stigmata of malnutrition.* Other signs of malnutrition are shown in Table IV.

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* Studies on the Undernourished Child No. XIV.

METHODS

Mortality was studied taking into consideration the time that elapsed between admission and death of the patient. Through the information obtained from the clinical history and the physical examination, attempts were made to determine the cause of death

TABLE I. Composition of the diet previous to hospitalization (GOMEZ, 1952).

	Daily intake	Percentage of normal
Calories	700 — 800	40 — 50
Protein	10 — 30 gm.	20 — 60
Fat	5 — 15 gm.	10 — 33
Carbohydrate	80 — 140 gm.	60 — 85
Calcium	100 — 400 mgm.	10 — 40
Phosphorus	200 — 500 mgm.	20 — 50
Iron	4 — 8 mg.	50 — 80
Vitamin A*	2000 I.U.	—
Thiamine*	400 — 1200 gamma	Sufficient
Riboflavin*	500 — 1500 mgm.	Low
Nicotine acid*	1 — 2.5 mgm.	Low
Ascorbic acid*	Less than 50 mgm.	Low

* Vitamins calculated in raw foods.

TABLE II. Distribution of body weights in terms of percentage of the theoretical weight for the age.

Weight	No. of cases	Percentage
31 to 40% of the normal	75	10.50
41 to 50% „ „ „	241	33.75
51 to 60% „ „ „	268	37.53
61 to 70% „ „ „	105	14.70
71 to 80% „ „ „	20	2.80
81 to 90% „ „ „	3	0.42
91 to 100 „ „ „	2	0.28

in each case. The significance of some positive or negative signs due to malnutrition or to other causes was also determined.

The data obtained were submitted to routine statistical analysis (MAINLAND, 1952) ; a variant of the usual formula to calculate " X^2 " was used to estimate the possible influence of certain clinical situations on mortality.

TABLE III. Incidence of skin lesions.

Type of skin lesion	Without clinical oedema (Percentage)	With clinical oedema (Percentage)	" t "*
Dry hyperchromic skin	90	94	
Very dry hyperchromic with mosaic appearance	38	46	
Follicular hyperkeratosis	20	26	
Hyperkeratosis palmaris et plantaris	48	37	
Fissures	3	8	
Seborrhoea	42	49	
Pellagrous erythema	13	47	4.94
Acute pellagrous dermatitis	18	40	2.94
Dyskeratotic hyperchromic lesions	50	83	3.00
Desquamating lesions in large flaps	8	21	2.48
Desquamating lesions in small flaps	13	37	3.81
Postdesquamation hypochromia	15	26	
Hyperchromia along capillary circulation	1.4	8	3.26
Crusty lesions suggesting post-purpuric lesions	6	11	
Purpuric lesions	24	28	
Perifolliculosis	1.4	11	3.07
Coldness and cyanosis of hands and feet	62	82	
Marblization	11	18	
Telangiectasis	1.4	6	
Gangrenous lesions and eschars	11	18	
Hypertrichosis	24	20	
" Wet cloth " sign	27	11	
Abdominal superficial circulation	6	7	

* " t " shows the significant degree of difference between children with and without clinical oedema. " t " values below 2 were not reported, as they are not significant.

TABLE IV. Certain clinical features and laboratory investigations.

	Percentage positive
Diarrhoea	70
Dehydration	56
Parental infection	51
Vomiting	39
Fever	32
Hypothermia	31
Intestinal parasites	28
Stool cultures	28
Shigellae	14.3
Salmonellae	9.4
Other agents	4.5
Mantoux test	4
Serological test for syphilis	3

RESULTS

(1) *Mortality.*

There were 234 deaths in the 733 cases studied, which gives a mortality of 31 per cent. Fig. 1 shows the number of deaths that occurred during the first 14 days.

During the first 48 hours, there were 105 deaths (44 per cent.). There was a definite difference between the mortality rate on the first day (29 per cent.), and on the second day (15 per cent.). Eliminating the deaths which occurred during the first 48 hours, the mortality is reduced to 129 deaths out of 629 cases (20 per cent.).

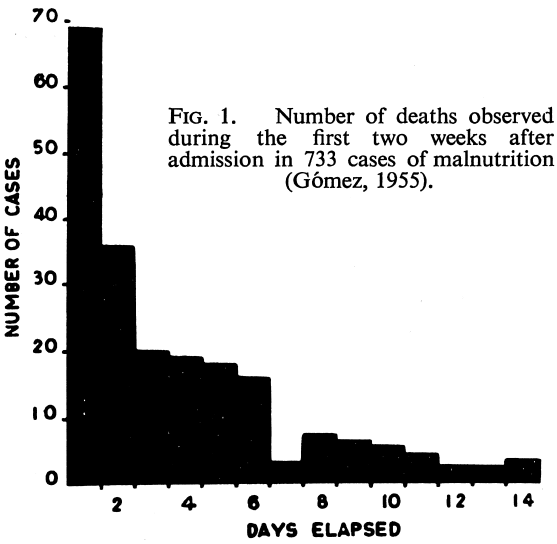

FIG. 1. Number of deaths observed during the first two weeks after admission in 733 cases of malnutrition (Gómez, 1955).

(2) *Probable causes of death.*

Water and electroyte imbalance was evident in 48 children out of 69 who died within the first 24 hours. Acute broncho-pneumonia, either alone or combined with water and electrolyte imbalance, was responsible for death in another group of 35. On the second day, the mortality rate dropped to 36 — out of these, there were 21 with disturbance of water and electrolyte metabolism and 18 with acute bronchopheumonia, or a combination of both.

Between the third and the seventh days, there were 76 deaths, and again electrolyte and fluid imbalance (50 cases) alone or combined with acute bronchopneumonia (35 cases), was considered to be responsible (Table V).

TABLE V. Distribution of mortality by weeks.

Weeks	1st.	2nd	3rd.	4th.	Late cases
Number of cases	181	29	10	7	7
With fluid and electrolyte imbalance	119	20	5	3	0
With bronchopneumonia	88	14	5	6	3
Fluid and electrolyte imbalance alone	47	4	2	0	0
Combined with broncho-pneumonia	52	8	3	2	0
Fluid and electrolyte imbalance with other causes	20	8	0	1	0
Bronchopneumonia with other causes	9	1	2	2	3
Bronchopneumonia alone	27	5	0	2	3
Other causes	26	3	3	0	4

(3) *Effect on mortality of certain clinical features found on admission.*

(a) *Weight.* The death rate in 120 cases of second degree malnutrition was 22.6 per cent.; while in 544 cases of third degree malnitrition, it reached 33.53 per cent. The significant statistical difference is : t = 2.3 (Table VI).

(b) *Clinical Oedema.* The gross mortality in patients with clinical oedema was 29.67 per cent., and in those without this sign it was 35.98 per cent. — the difference was not statistically significant. On further analysis of these cases by the elimination of deaths that occurred within the first 48 hours, the mortality was found to be 20 per cent. and 22.6 per cent. respectively, with " t " = 0.74 (Table VI).

(c) *Skin lesions of " pellagra."* The statistical significance on mortality of cases with lesions of " pellagra," may be seen also in Table VI.

TABLE VI. Effect on mortality of certain signs of malnutrition found on admisiosn.

Clinical groups	No. of cases	Total mortality		Early mortality (1st—48 hrs.)		Late mortality	
		Percentage deaths	" t "*	Percentage deaths	" t "*	Percentage deaths	" t "*
Second degree malnutrition	128	22.65	**2.30**	5.47	**2.80**	18.18	0.80
Third degree malnutrition	584	33.53		14.70		21.50	
With clinical oedema	519	29.67	1.67	12.13	1.85	20.00	0.74
Without clinical oedema	214	35.98		17.29		22.60	
With " Pellagra "	465	31.70	0.09	12.25	1.62	18.60	0.93
Without " Pellagra "	268	31.40		16.05		21.80	

* A value of " t " above 2 shows significant differences.

According to these data, in our clinical material the groups with and without pellagra, and with and without oedema, showed no difference in mortality.

(4) *Effect on mortality of certain clinical features not due to malnutrition found on admission.*

(a) *Fluid and electrolyte imbalance.* Table VII demonstrates the differences in mortality between children suffering from an obviously upset water and electrolyte balance on admission, and those who did not. The presence of this type of disturbance has an obvious effect on the mortality rate.

(b) *Diarrhoea.* The possible influence of this symptom was also considered and it was studied in children without fluid and electrolyte imbalance, but with diarrhoea on admission. Table VII shows that the difference in mortality rate between children with and without this symptom is significant, though less so than when comparing the presence and absence of dehydration.

(c) *Broncho-pneumonia.* The differences in mortality were analysed only in those cases where the cause of death was an acute pulmonary process, present since the time of admission, but without a clinically evident fluid and electrolyte imbalance (Table VII). The difference between both groups is significant.

TABLE VII. Effect on mortality of some clinical signs found on admission, not directly due to malnutrition.

Clinical groups	No. of cases	Total mortality		Early mortality (1st. —48 hrs.)		Late mortality	
		Death percentage	" t "*	Death percentage	" t "*	Death percentage	" t "*
With fluid and electrolyte imbalance	411	44.00	**7.98**	19.10	**12.00**	31.53	**12.00**
Without fluid and electric imbalance	322	15.00		7.10		9.36	
With diarrhoea (but without fluid imbalance)	152					21.40	**2.60**
Without diarrhoea or fluid imbalance	168					10.70	
With bronchopneumonia, but without fluid imbalance	39					53.84	**4.86**
Without bronchopneumonia or fluid imbalance	288					11.08	

* A value of " t " above 2 shows significant differences.

DISCUSSION

As pointed out by DEAN (1954) and emphasized by BROCK (1955), the accurate comparison of mortality rates in cases of infantile malnutrition is difficult. Nevertheless, the high mortality found in our department agrees with that reported by GILLMAN and GILLMAN (1951), TROWELL (1954) and many others. The first mentioned authors point out that gross mortality varies from one year to another, fluctuating from 30 to 50 per cent., " without any objective index of the gravity of the acute episode." It is obvious that in our series water and mineral imbalances, and acute pulmonary processes, have a definite influence on gross mortality, and this influence extends throughout the first two weeks of hospital stay.

Independently of the cause of death, differences in weight have a significant effect on mortality. There is a marked difference in mortality during the first 48 hours between children with second degree malnutrition, and those with third degree. With these findings, the classification of malnutrition by degrees acquires, not only a clinical value, but a definite prognostic significance as well.

It has also been ascertained that other pathological disturbances, often found in severe malnutrition, such as oedema and " acute " skin lesions, have no influence on mortality. In view of the tendency other authors still have to consider as different entities cases with or without clinical oedema and " acute " skin lesions, the above findings show that there is probably no sound clinical basis for such classification.

In contra-distinction to the above, it has been shown that the difference in mortality in children with clinically evident water and mineral imbalance, and in those without it, gives a very high " t " (7.98), " p " being > 0.001. Similarly, when diarrhoea was present on admission, it also influenced mortality, possibly through the production of water and mineral imbalance, which becomes established much more easily in children with serious malnutrition than in healthy ones. There is evidence that malnutrition *per se* may be

responsible for a negative potassium balance (HANSEN, 1954), and this could partly explain why diarrhoeal processes, however moderate, can bring about a marked derangement in water and mineral metabolism in these children, and why successful treatment of this situation is so difficult. The possible influence of the severity of undernutrition upon this situation is illustrated by the higher early mortality in third grade malnutrition.

The statistical analysis of the cases of acute bronchopneumonia without clinically evident fluid and water imbalance is especially difficult. The diagnostic signs, as pointed out by TROWELL et al (1954) may be misleading. Moreover, bronchopneumonia by itself may be responsible for the production of acid-base disturbances, which may not be clinically apparent. On the other hand, a process of this type may be the sole cause of death by interfering with respiratory functions.

Malnutrition in itself may be regarded as a predisposing factor, but not as the direct cause of such a high mortality. An answer to this acute problem may perhaps be sought in a better understanding of the patterns of water and electrolyte metabolism in malnutrition, which obviously are different from those described in well-nourished children.

SUMMARY

The mortality rate in 733 malnourished children hospitalized from 1949 to 1952 has been subjected to analysis. The significant influence on mortality of the degree of malnutrition and the presence of water and mineral imbalance, diarrhoea and acute bronchopneumopathy has been demonstrated. The existence of evident oedema or of skin lesions has no influence on mortality. The significance of these findings has been discussed.

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