

RICKETS IN SYDNEY, AUSTRALIA,

BY

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This contribution, originating from an impression of the frequency of minor rachitic manifestations among the children of the public hospital class in Sydney, records the result of an examination conducted towards the end of the winter of 1929. Search was made for evidence of rickets in 218 consecutive infants admitted to the Quay Street out-patients' department of the Renwick Hospital for Infants, Sydney, whose ages fell between six months and two years. The reasons for attendance were, in most cases, minor catarrhal disorders, feeding difficulties, simple ear and skin troubles, or for food relief. No selection of cases was made, and no child was seriously ill.

Enquiry was made into the social condition of the family, including the type of dwelling, location, father's wage, and number of other children in the family. The present and previous health, and progress, of the patient were noted, and details taken of the dietetic history, including the nature, amount and period of administration of anti-rachitic foods and drugs. In the case of breast-fed infants, an attempt was made to assess the satisfactoriness or otherwise of the mother's diet from this standpoint. The child was then specifically examined for evidences of rickets, and in 129 unselected instances, a radiogram of the wrist was taken.

Clinical standards.—It is necessary at once to define the clinical points which were considered as abnormal in the present investigation.

FEEDING. A theoretical deficiency of vitamin D was attributed to infants reared wholly on dried or condensed milk or biscuits, from birth or for a period of four months or more preceding the examination, without the addition of any fresh cow's milk or cod liver oil. Cases where these additions had been made less than two months previously were also included; also, where enquiry showed that the mother had had little or no fresh milk, eggs, or butter, or where breast-feeding for economic reasons had been persisted in for more than 12 months. In older children, a father out of work with two or more other children to be fed, precluded a sufficiency of fresh anti-rachitic foods.

PREVIOUS HEALTH. The occurrence of convulsions was particularly noted. The term 'catarrhal illness' does not here include pertussis, which was very prevalent at the time.

SYMPTOMS. Under this title in the following pages nocturnal restlessness, sweating of the head, and general irritability are meant.

DELAYED PROGRESS. Delay in dentition beyond eight months, and failure to walk by fourteen months, were considered as abnormal.

SKULL CHANGES. Persistence of patency of the fontanelle beyond eighteen months, indubitable bossing or an unusual squareness or disproportion in size to that of the trunk (Fig. 1), persistence of the interfrontal suture, craniotabes or natiform cranium, together or separately, were the standards taken.



FIG. 1.

HARRISON'S SULCUS. This is here taken to include all degrees of splaying and eversion of the lower ribs. Other rarer chest deformities, e.g., parasternal depression, are included for convenience under this heading (Fig. 2).

ENLARGEMENT OF THE COSTO-CHONDRAL JUNCTIONS. This has been almost a matter of individual taste in many cases. For the present purpose, it was termed 'marked' when the knobs were rounded and distinct enough to be either visible, or plainly felt with the flat of the hand. 'Slight'

enlargement required the pulps of the fingers to be rubbed along the ribs for its clear definition. The 'sharp' type, like a knife edge, associated with splaying of the ribs, was also included in the latter category.

LIGAMENOUS LAXITY. This is associated in the majority of instances with muscular hypotonia. The following plan was adopted in order to have a rough standard for comparison. The observer stands to the right of the child, who sits on a table or chair, and firmly presses the child's lower limb against his own with the left hand, so as to secure absolute immobility, while



FIG.2.

the right hand grasps just above the child's ankle and preserves full extension and at the same time rocks the leg laterally. If the ankle moves through a lateral excursion of one inch or more, the result is labelled as 'marked,' and lesser degrees 'slight' or 'moderate.'

POT-BELLY. This was only ascribed to the child when there was an approximate angle of 150° or less at the xiphisternum on viewing the lateral abdominal profile with the child sitting up, associated with diastasis of the recti and sometimes an umbilical hernia. Enlargement of the liver had to be

quite definite, usually about two fingers breadth below the ribs at Murphy's point. Rachitic kyphosis is frequently a factor in the production of abdominal fullness (Fig. 3).

ANÆMIA. Anæmia and abnormalities in body weight were noted when very marked.

WRISTS. The distal extremity of the radius was invariably examined for any increase in circumference.

The clinical diagnosis.—In this series a positive clinical diagnosis was made in the presence of two or more of the following features:—Symptoms,



FIG. 3.

history of convulsions, delay in dentition or walking, or both, skull change, definite Harrison's sulcus, marked beading, marked ligamentous laxity, marked pot-belly with enlarged liver, all judged strictly according to the standards above described.

The term 'clinically positive' includes patients with evidences of either past or present disease. As it is impossible to tell with accuracy which phenomena are characteristic of either phase.

The radiographical diagnosis.—The radiograms were snapped with a Phillips's portable Metalix outfit with the wrist held immobile on the plate, palm downwards. No selection whatever was made of the cases for radiography, the only reason that the whole series of patients could not be done was that the machine and operator were not always available or that the mother would not wait for this purpose.

Evidence taken as indicating healed rickets, consisted of a curved zone of sclerosis sometimes surmounted by parallel transverse lines extending into the shaft, but in which the ' wine glass ' ulnar concavity of the active lesion had been filled in. More commonly, a wool-like radio-opaque zone capped the extremities of both bones, for a depth of several millimetres. This was frequently deeper on the inner (ulnar) side of the radial extremity than on the outer aspect, and had a blurred junction with the shaft, which, as the bone grows and the lesion heals, becomes sharper and finer, so that it ultimately appears on the radiogram as if the distal borders of the normal radius and ulna had been outlined in white ink. All grades of these appearances occurred right down to the unquestionable normal, but for the present purpose only those cases have been included which are just as unquestionably abnormal.

The radiograms labelled ' active ' were of the type where definition of the trabeculae disappeared in the last half-centimetre of the ulna, and was replaced by an increasingly blurred but relatively translucent zone. The classical ' wine glass ' or ' florid ' extremity was seen but rarely, and even if it possessed a sclerosed border but was not filled in and square, a certain degree of activity was assumed. Relative shortness of the ulna appeared more frequently in otherwise normal pictures, and an extraordinary degree of ' beaking ' was often unassociated with other noteworthy features. Well-defined changes at the wrist were often reflected by the ends of the metacarpals. No curving or green-stick fracture was observed in any picture.

The number and size of the carpal centres and radial epiphysis were noted, but bore no constant relationship to the above classification. Table 3 gives the average age for the appearance of each centre in the radiographically positive and negative groups. It will be observed that the difference in mean age of appearance of these centres is very slight and therefore of no value either individually or collectively for the purposes of diagnosis, at least as far as this series of cases goes. The only other point which seems worthy of note in this connection is the much earlier time of appearance of the radial epiphyseal centre in the whole series as compared with those set down in the standard anatomical text-books.

Clinical results.—Of 218 patients, 116 (52 per cent.) were adjudged to show unmistakable evidence of rickets, past or present. This was made up of 67 out of 129 radiographed cases (=52 per cent.), and 49 out of 89 unradiographed cases (=53 per cent.) (Table 1).

As regards age distribution, positive clinical findings were noted in 36·7 per cent. of those between six and nine months; in 77 per cent. of those between nine and twelve months; and in 50 per cent. of those between twelve months and two years.

As an example of a typical clinically 'positive' case, the following case notes, selected at random, may be quoted:—

D. H., aged 18 months, male. Two other children in the family; father not working, lives with rest of family in one room in Surry Hills. Breast fed at first for 3 months, then put on to dried milk. Since 12 months old has had 'anything,' but no cod-liver oil. First tooth appeared at 8½ months accompanied by bronchitis. Cannot walk properly yet, but can stand holding on to chair. Child is pallid and flabby, fairly well nourished, has three transparent-looking teeth, slight anæmia of mucous membranes, very soft muscles and moderately lax ligaments; the head appears large and square, fontanelle almost closed. The chest shows a slight Harrison's sulcus and marked beading. There is well marked abdominal enlargement and the liver is plainly enlarged.

This may not be a typical text-book picture, but there is no room for doubt as to the diagnosis. The only uncertain point is whether these signs mean past or present disease.

The characters and frequency of the clinical features on which a diagnosis was based can now be considered in more detail (Table 1).

1. Symptoms. The usually accepted symptoms of activity such as sweating of the head, restlessness and irritability, are not of much assistance as one is forced to rely on the uncertain grounds of a mother's impressions and her temperamental reaction to her child's behaviour. Generalized tenderness as a symptom is a relict of the days of Barlow's disease. A clear history of recent convulsions or a positive Chvostek sign is much more helpful. In this group the latter was not sought for, and the former is noted seven times. Symptoms of activity such as the above were prominent in 18 cases only.

2. Previous health. Illnesses of a catarrhal character had occurred in 84 instances (39 per cent. of all cases). Bronchitis (especially at teething time), frequent colds, broncho-pneumonia, gastro-enteritis, measles and pertussis appear most frequently. Erythrodema appeared four times, a rather high incidence, and in two cases associated with clinical rickets.

3. Delay in dentition was seen in 45 per cent. of cases in a total of 185 infants old enough to manifest it. Qualitatively, the general average was poor, many teeth being small, irregular and already carious. Departure from the usual order of appearance was common. One tooth would perhaps appear before eight months, followed by a delay in some cases of six months before the next erupted. There were no noteworthy changes in the development of the jaws. Delay in walking was apparent in 40 of 97 infants old enough to show it. As is usual, these children included those with the most hypotonia and looseness of the knee ligaments,

TABLE I.

STATISTICAL SUMMARY OF THE INQUIRY.

| Detail. | Whole series. | | Radio-positive group. | | | Radio-neg. group. | Unradio-graphed group. |
|--|---------------|----------|-----------------------|------------|---------|-------------------|------------------------|
| | Cases. | Percent. | Active. | Doubt-ful. | Healed. | | |
| CASES : | | | | | | | |
| Total | 218 | 100 | 16 | 7 | 40 | 66 | 89 |
| AGE : | | | | | | | |
| 6 to 9 months ... | 52 | 25 | 7 | 2 | 8 | 21 | 14 |
| 9 to 12 ,, ... | 48 | 23 | 7 | 2 | 5 | 13 | 21 |
| 12 to 24 ,, ... | 118 | 52 | 2 | 3 | 27 | 32 | 54 |
| FEEDING : | | | | | | | |
| Breast milk | 104 | 48 | 6 | 3 | 21 | 31 | 43 |
| Dried ,, | 84 | 39 | 8 | 3 | 10 | 26 | 37 |
| Fresh ,, | 75 | 35 | 2 | 3 | 10 | 26 | 34 |
| Cod-liver oil | 67 | 30.7 | 7 | 2 | 17 | 13 | 28 |
| Vitamin D, deficiency in | 94 | 43 | 7 | 2 | 15 | 26 | 44 |
| PREVIOUS HEALTH : | | | | | | | |
| Convulsions | 7 | 3 | 0 | 1 | 2 | 2 | 2 |
| Catarrhal infections ... | 84 | 39 | 6 | 5 | 14 | 31 | 28 |
| SYMPTOMS : | | | | | | | |
| (vide text) | 18 | 8 | 1 | 1 | 4 | 3 | 9 |
| SIGNS : | | | | | | | |
| Delayed dentition ... | 86/185 | 45 | 8/16 | 4/5 | 20/32 | 22/55 | 32/76 |
| ,, walking | 40/97 | 41 | 0 | 1/2 | 6/20 | 15/33 | 18/42 |
| Skull changes | 49 | 22 | 5 | 0 | 2 | 15 | 27 |
| Indefinite wrist enlarge- ment | 54 | 25 | 10 | 5 | 5 | 10 | 24 |
| Harrison's sulcus | 55 | 25 | 4 | 2 | 11 | 21 | 17 |
| Slight beading to moderate | 114 | 52 | 7 | 4 | 30 | 31 | 42 |
| Marked beading | 57 | 26 | 9 | 1 | 8 | 20 | 19 |
| Slight hypotonus | 130 | 60 | 5 | 6 | 21 | 46 | 52 |
| Marked ,, | 39 | 18 | 10 | 1 | 5 | 14 | 9 |
| Pot-belly | 90 | 41 | 8 | 4 | 14 | 34 | 30 |
| Enlarged liver | 26 | 12 | 8 | 1 | 4 | 6 | 7 |
| GENERAL CONDITION : | | | | | | | |
| Much overweight ... | 33 | 14 | 6 | 0 | 5 | 8 | 14 |
| ,, underweight | 18 | 8 | 1 | 0 | 3 | 7 | 7 |
| Marked anæmia... .. | 22 | 10 | 1 | 0 | 5 | 4 | 12 |
| CLINICALLY POSITIVE ... | 116 | 52 | 13 | 5 | 18 | 31 | 49 |

4. Skull changes, strictly of the type defined above, were observed in 22 per cent. of the children, but a squareness of the head, not exceeding the normal maximal circumference, was far commoner than this. Persistence

of the fontanelle beyond 18 months was the largest factor in these head-positive cases. Natiform cranium was seen once only. Craniotabes though repeatedly searched for was never discovered, perhaps because, as De Buys¹ and other observers have stated, it is more frequently found for a time under the age of six months. The box-like largish head is a familiar sight in the out-patients' waiting room.

5. Epiphyseal enlargement, especially of the wrists, was not encountered in this series. In about 25 per cent. of instances there was a suspicious bulging of the lower radial extremity, on stretching the skin over the dorsum of the wrist, but this occurred almost invariably in the fat overweight child and the soft tissues were probably for the most part responsible for the apparent enlargement. Beading of the fingers, as described by Thomson, was observed in two cases only.

6. Harrison's sulcus was present in various degrees in a quarter of the cases. Rarely, other forms of chest deformity such as pigeon breast, lateral flattening and parasternal depressions were seen.

7. Enlargement of the costo-chondral junctions or rib beading was a definite feature of this series. It was found in a slight to moderate degree in half the children examined and to a definite, marked, or decided degree in a further quarter, though owing to the super-normal thickness of the fat in most of the patients it was visible in three only. One case of spurious beading of the scorbutic type was met with.

8. Ligamentous laxity was also very common, being slight to moderate in 60 per cent. and marked in 18 per cent. of all patients. In practically all cases the laxity was directly proportioned to the degree of muscular hypotonia.

9. Abdominal enlargement was observed to the specified degree in 41 per cent. of patients, usually in association with a mild grade of diastasis of the recti, and in 12 per cent. of the series with a readily palpable enlargement of the liver. Umbilical hernia was not a common feature, nor was splenomegaly found in any child.

10. Anæmia of an indubitable character was only noted in 22 cases. The general state of nutrition was on the whole good. Thirty-three babies were excessively over-weight and many more exceeded the normal for their age, particularly those reared on dried milk according to the directions on the tin. Such children were pale, with a tight but non-pitting type of flesh the firmness of which often contrasted with lax ligaments and muscles, by which the limbs could be placed in all kinds of unnatural postures. Many breast-fed babies were also over-weight but had rosy cheeks and firm ligaments.

Radiographic results.—The whole series can be divided into two groups according to whether or not a picture was taken. Technically unsatisfactory or ruined negatives were rejected, which left 129 pictures to be reviewed. This was done quite independently of the clinical result.

Tables 1 and 2 indicate the gross and detailed results respectively of this examination. In 66 instances (51 per cent.) no alteration was visible. The distal extremities of ulna and radius were square and sharply cut. There was not splaying or osteoporosis. The internal detail of the metaphyses remained clear and sharp. The metacarpals were equally free from change. Definite florid rickets appeared 16 times, i.e., in 12·4 per cent. of the rayed cases. There were 7 borderline cases in which it was impossible to be sure of the activity of the lesion, though one undoubtedly existed. Examples of healed rickets of all grades were noted 40 times, making a total incidence of 49 per cent. among the rayed cases, of all types of positive lesion. All patients with active disease were below the age of fourteen months.

TABLE 2.
RELATIONSHIP BETWEEN RADIOGRAPHIC AND CLINICAL RESULTS.

| Series. | Total. | Radiographically positive. | | Clinically positive. | |
|--------------------|--------|----------------------------|-----------|----------------------|-----------|
| | | No. | Per cent. | No. | Per cent. |
| Radiographed ... | 129 | 63 | 50 | 36 | 28 |
| Unradiographed ... | 89 | — | — | 49 | 53 |

Comparison of clinical and radiological results.—It is usually accepted that no one or more clinical signs can be relied upon as indicating the degree of activity or stage of healing of a rachitic process. Only a radiogram or an estimation of blood phosphorus and calcium can determine this with certainty. Nevertheless, clinical signs are held to precede radiographic changes in order of appearance. Again, certain clinical signs such as bossing of the skull, beading of the ribs and laxity of the ligaments, will remain after radiographic cure has occurred, while deformities as bent bones and Harrison's sulcus will remain as land marks throughout life.

A perusal of the literature shows the remarkable difference in significance attached to individual symptoms by authorities in different centres, and this suggests that rickets has a varying symptomatology in different parts of the world. Aidin² holds this view. He also thinks that in different localities the clinical and radiographic signs of rickets can vary in order of appearance as well as frequency. Unanimity exists on some points, e.g., that a slight degree of rib-beading, pot-belly or sweating should not be too much stressed, and that no significance should be attached to slight splaying or osteoporosis in the radiogram, or to slight degree of delay in passing the various milestones in development. Craniotabes and epiphyseal enlargement seem to be among the most variable signs. Hess³, whose experience in this subject is perhaps unique, states that in New York beading of the rib junctions is

positive before the radiogram. In London it is considered that radiographic signs may precede epiphyseal enlargement by three to four weeks. As Pearson¹ says, 'the interpretation of the earliest changes both clinical and radiographic becomes a matter of individual opinion,' and apparently must be worked out for each locality. In any such enquiry as the present, therefore, it is necessary to define the standards used as clearly as possible as has been attempted here.

TABLE 3.

MEAN AGE IN MONTHS AT WHICH CARPAL AND RADIAL EPIPHYSEAL CENTRES WERE OBSERVED.

| Centres present. | Radio-positive (all types) | Radio-negative. | Normal (from Cunningham's Anatomy). |
|--|-------------------------------|-----------------|--|
| None | — | 11 | — |
| 1 for carpus 0 for radial epiphysis } | 9 | 13 | 11-12 |
| 2 for carpus 0 for radial epiphysis } | 12 | 11.5 | 12-14 |
| for carpus 0 for radial epiphysis } | 13 | 13 | 24 |
| 1 for carpus 1 for radial epiphysis } | — | 6 | 24 |
| 2 for carpus 1 for radial epiphysis } | 15 | 14 | 24 |
| 3 for carpus 1 for radial epiphysis } | 16 | 16 | 24 |

PRESENT SERIES. Tables 1 and 2 afford a gross and detailed comparison between clinical and radiographic results in the present series. Though approximately half the whole series were clinically positive, and half the rayed series radiographically positive, only 28 per cent. of the latter could be classed as positive according to clinical standards. This suggests that signs of healed rickets persist in the radiogram longer than clinical signs of a multiple and diagnostic character, or that a positive radiogram is to be frequently found in the absence of adequate clinical signs. The former explanation is the correct one, as of 40 cases with X-ray signs of past disease only 18 would have been suspect on clinical grounds. Of 16 radiographically active cases, 13 were adjudged as clinically positive. The clinical signs in these 16 cases were as follows: Delay in dentition, 8 cases (none were old

enough to show any delay in walking); skull changes, 5 cases; Harrison's sulcus, 4 cases; marked rib beading, 9 cases; slight rib beading, 7 cases; slight muscular and ligamentous laxity, 7 cases, marked in 9 cases; abdominal and hepatic enlargement, 8 cases. Six infants were grossly over weight, and one anæmic and one marasmic.

TABLE 4.
ILLUSTRATING VARIATION IN SYMPTOMATOLOGY IN CERTAIN CENTRES.

| City. | Approx. sunshine. | Observer. | Year. | Mode of exam. | Incidence (percent.) | Beading. | Epiph. enl. | Cranio-tabes. |
|---------------|-------------------|-----------------|-------|------------------|-----------------------------------|---------------------------------------|------------------|----------------------|
| London ... | + | Still ... | 1908 | Clin. ... | 40 | Unim- portant | Early, common | Freqt. & late |
| | | Paterson ... | 1925 | Clin. & X-ray | 1.2 (active) 32 (healed) | — | — | — |
| | | Mackay ... | 1926 | Clin. & X-ray | 8 (active) | — | — | — |
| Manchester | + | Chisholm ... | 1926 | Clin. & X-ray | 26 | — | — | — |
| Liverpool ... | + | Aidin ... | 1927 | Clin. & X-ray | 95 | Sl. en- largem. diag- nostic | Rare | V. rare |
| Edinburgh | + | Thomson ... | 1900 | Clin. ... | 50 | Marked & constant | Common | Common first sign |
| New York ... | + | Hess & Unger | 1917 | Clin. ... | 60 | Unim- portant | Common | 10 % at 6 mth. |
| New Orleans | ++ | De Buys ... | 1924 | Clin. ... | 54 | Constant | 84 % | 60 % at 4 mth. |
| Vienna ... | ++ | Chick et al. | 1919 | Clin. & X-ray | 50 + | Sl. en- largem diag- nostic | — | 33 % at 6 mth. |
| Cairo ... | +++ | Shawki ... | 1920* | Clin. ... | 45 | — | — | — |

The most prominent clinical signs in the radiographically healed groups were delay in dentition, Harrison's sulcus, pot-belly and slight to moderate degrees of costo-chondral enlargement and ligamentous laxity. Marked beading occurred in 8, and marked looseness of the knees in only 5 cases of this group.

Symptoms of irritability and restlessness were found in one active case and in four healed cases. The unreliability of this feature has already been discussed. Three of the eighteen infants in the whole series to show these symptoms were radiographically negative and were possibly early cases.

The following is quoted as an example of the clinical findings in a patient showing well-marked florid rickets in the X-ray.

Case 56. E. C., female, æt 7 months. One other child in family, father out of work. Fed on dried milk from birth, no cod-liver oil. No previous illness or irritability. Slight nocturnal sweating of head. Sits up quite well. No teeth or signs of same. Head squarish with fontanelle $1\frac{1}{2}$ inches across and parietal bossing. Abdomen negative, knee ligaments moderately lax, and marked costo-chondral beading.

As regards age, all the X-ray positive patients were between 6 and 14 months; and half the clinically positive cases were over this age.

There are many anomalies, however, which are characteristic of the disease and an examination of the radiogram in individual patients frequently produces a surprise. Thus the clinical diagnosis was unsupported by the radiogram in 31 out of 129 cases. Even if one discounts Still's⁵ assertion that a negative radiogram does not exclude rickets, and the probability that some of these cases were too early for bone changes to be seen, the radiogram affords a useful check and commentary on purely clinical findings.

Dietetic factors.—From considerations of diet and social conditions alone a vitamin D deficiency was anticipated in 94 or nearly one-half of the whole series of 218 children, which corresponds fairly closely with the clinical results.

BREAST-FEEDING. Statistics and clinical experience are in accord that breast feeding is not necessarily a protection against the development of rickets. Thus Hess and Unger⁶ found that one-half of the breast-fed negro population of New York in 1917 showed rickets, though this has since decreased. Aidin² states that rickets may occur in the breast-fed as early as the sixth week of life or may be delayed until after the period of breast-feeding is over, even up to four years. There is no doubt, as stated by Pearson and Wyllie, that rickets in the breast-fed provides a high proportion of cases of mild degree. In Manchester, of children weaned before two months, 75 per cent. developed rickets as compared with a general incidence of 26 per cent. in a series of 75 children (Chisholm⁷).

In the present investigation 48 per cent. of the whole number were breast-fed for at least three months immediately prior to the examination. These included over a third of the radiologically active cases, and half the healed cases. Of the 116 clinically positive cases, 43 had been fed at the breast as above described, in 22 instances for a period exceeding 12 months. From an inquiry into the mother's diet and the social condition of the family a deficiency in the vitamin-D content of her food seemed apparent in 41 of 96 nursing mothers. It is to be doubted whether this diet, which was frequently largely composed of vegetables, would be lacking in calcium or phosphorus. Mellanby's⁸ work, however, suggests that a vitamin-D deficiency of the mother's diet during pregnancy also, may predispose to rickets in the offspring, a tendency which may not be dispelled by a period of satisfactory diet, and this was probably so in this case. He further holds that a shortage of vitamin A or B facilitates the development of bronchitis

and broncho-pneumonia. The frequency of the former infection among these children at dentition suggests that their diets were further deficient in this factor also.

DRIED MILKS. This diet was exclusive to 39 per cent. of the series, with or without the addition of cod-liver oil, and half the radiologically active cases are in this group. Lactogen was the usual milk taken. Forty-seven of this group were radiographed with 21 positive results. These children formed the majority of the heavy-weight class.

Cases complementarily fed with breast or cow's milk are not considered under this section.

FRESH COW'S MILK. Only 15 of 75 cases receiving adequate amounts of cow's milk showed radiographic evidence of rickets, ten of which were healed; and 21 showed clinical rickets within the present definitions. The contrast between these figures and those for other diets is referred to below.

Anti-rachitic factors.—COD-LIVER OIL. Sixty-seven of the complete series received cod-liver oil for three months or more preceding the day of examination, in some cases (according to the mother) since birth. Thirty of these cases showed clinical, and twenty-six radiographic, signs of rickets. Two reasons may explain these figures. First, it was usually administered in the form of an emulsion containing only approximately 50 per cent. cod-liver oil of B.P. strength, in doses of one drachm thrice daily; and secondly, the necessity for regular administration is neither impressed on nor appreciated by the working-class mother. Some such explanation is necessary since the specific effect of adequate doses of cod-liver oil is beyond all doubt. There is no danger of over-dosage, only of under-dosage, and under its influence the radiogram should begin to show signs of cure in three weeks.

FRESH COW'S MILK. The figures quoted above indicate that, as far as this series is concerned, fresh cow's milk had a greater protective effect than cod-liver oil.

The numbers, and information from the mother only, do not allow of dogmatism, but the contrast is sufficiently marked to be arresting. The vitamin A and D content of cow's milk in Sydney, which mostly comes from animals fed on constantly sunlit pastures, is probably considerably higher than that in most other cities of the world.

SUNSHINE. It is impossible to form a true estimate of the amount of direct sun rays to which these children have been exposed. This point is discussed in the following paragraph.

Discussion.

Sydney is supplied on an average with over 2,000 hours of sunshine annually and the presence of frank rickets to any material degree has been frequently denied by many practitioners of experience. Cases of well-marked natiform cranium or bone deformity have occurred sporadically and have

earned the soft impeachment, but the total number of children with this diagnosis admitted to the Royal Alexandra Hospital for Children during the seven year period 1922-1928 was 51, or approximately 1 in every 1,000 admissions. All were marked to severe cases. Many others, however, are included under diagnoses constituting the catarrhal disorders. Bones X-rayed for other reasons frequently show unequivocal signs of rickets.

Further, osteotomy is not a common surgical procedure at this institution. Harvey Sutton⁹ stated in 1920 that 25 per cent. of more than 500 school children in an industrial suburb of Sydney showed slight but definite signs of rickets. This probably refers to evidences of past rickets, but may include some examples of late or continued rickets, as knock-knee of a moderate degree is relatively common in this city, accompanied by considerable sclerosis of the epiphyseal line in the radiogram. The same observer found that in a series of 26 children, 38·7 per cent. of the artificially fed showed clinical rickets as opposed to 10 per cent. among the breast-fed of the series. Craniotabes was noted as being rare. These seem to be the only previous statistics available for Sydney.

Abundantly supplied with sunshine and surf beaches, it is difficult to believe that a deficiency in ultra-violet rays could ever be a factor in the production of rickets in Sydney. With regard to the present series however, it must be remembered that the rickets in the first place is of a mild order, and in the second that only a few could walk sufficiently well to play out of doors in the streets and parks, exposed to the direct rays of the sun. They were usually over-dressed and well covered when taken out of doors, following their first attack of bronchitis or coryza, and spent most of their time in a sole room of a tenement house in a narrow street. No amount of dispersed sunlight or that which has passed through ordinary glass contains many therapeutic rays. Thus Shawki¹⁰ found that 45 per cent. of 500 breast-fed Egyptian children, exposed daily to the bright rays of the Cairo sun, yet swathed in many clothes, showed bony evidences of rickets, and 23 per cent. of apparently healthy infants showed radiological changes. The working-class mother has so far not realized the importance of an adequate daily exposure of her partly undressed child to the direct rays of the sun, which is one of the good teachings of the baby clinics.

Prophylaxis.—The following measures, which are practicable in varying degrees, would help to reduce the ill-results of vitamin-D deficiencies among the children of the poor in Sydney.

1. Public education in the dangers to the child of an ill-balanced diet in the mother as regards vitamin content, during pregnancy and lactation. This could be partly done through the agency of the ante-natal clinics.

2. A stronger insistence on a daily exposure of the half-naked child to the direct rays of the morning sun.

3. The routine provision to all out-patients of a stronger preparation of cod-liver oil in larger doses, and continual instruction of the mother of the need for regular administration.

4. For cases with established rickets, the administration forthwith of irradiated ergosterol which should be made available locally at a suitable price. A portable X-ray machine in the out-patient department should be used for exact diagnosis and control of treatment. A mercury-vapour lamp in a small annexe of the out-patient waiting room would satisfy the physician that he would not have to rely solely on the mother's disposition towards the virtues of natural sunlight. It could also be used continuously for short exposures to waiting infants, as a preventive measure.

5. All dried milk supplied to such infants could be already irradiated. Better still, scalded fresh milk should be supplied and encouraged as the best substitute for human milk in normal infants.

Conclusion.—In reviewing the results reported here it must be remembered that these infants do not represent the child population of the city as a whole. They are selected in so far as they were for various reasons already hospital out-patients. They were nurtured in poor homes during times of industrial distress and this enquiry was conducted towards the end of a rather cloudy winter. The better supervision of diet and conduct exercised on the majority of infants in better class suburbs by means of the baby clinics would undoubtedly bring the general incidence of rickets to a much lower figure, yet 'rickets is probably more often over-looked than any other common disorder of childhood. The number of cases undiagnosed is greater than that of those diagnosed' (Hess).

Summary.

1. In a series of 218 out-patient children of Sydney between the ages of six months and two years, examined for signs of rickets, sufficient clinical evidence, according to a specified standard, for a diagnosis of past or present disease was found in 52 per cent., the higher incidence falling between the ages of nine to twelve months.

2. Of these children 129 were examined radiologically. Signs of active rickets were found in 12.4 per cent., and of healed rickets in 31 per cent. With 7 doubtful cases, the whole radiographic incidence amounted to 50 per cent.

3. On the whole the infants were well nourished and the disorder of a mild to moderate degree and of an occult character. Correlation between the clinical and radiographic findings showed that marked rib beading and ligamentous laxity with abdominal and hepatic enlargement were the most frequent clinical signs in a small series of radiologically active patients. Symptoms of irritability and spasmophilia were rare; craniotabes and epiphyseal enlargement were notably absent. Apparently only a cautious reliance should be placed on alterations in size of the fontanelle and delay in teething or walking. Dentitional bronchitis is very common.

4. Examination of the diets of these children showed that on theoretical grounds evidences of vitamin A and D deficiency could be anticipated in

43 per cent. In 41 of 96 nursing mother's diet was deemed unsatisfactory from this standpoint. Breast-fed infants provided over a third of the radiologically active and a half of the healed cases of rickets.

5. Fresh Sydney milk which is mostly from the country seems to have a good protective effect, better at least than insufficient amounts of cod-liver oil.

6. The cause of this high incidence among the hospital class is possibly partly attributable to insufficient ultra-violet irradiation, which should correct a dietetic vitamin shortage.

7. Certain suggestions are made towards prophylaxis mainly based on the principle of making positively sure that each infant receives an adequate daily amount of direct sunlight or of ingested vitamin D.

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