quickly and safely through her fourteenth and fifteenth under treatment on these lines; labour was terminated by the forceps directly dilatation was sufficient, and ergot was given twenty minutes before delivery.

But, alas! it has to be confessed that there seem to be bloods which fail to respond to the clotting influence of calcium, and uteri which laugh at pituitary and at ergot, and these will occasionally give us a crowded hour of mouth-drying anxiety. Fortunately, there is probably no uterine haemorrhage that cannot be controlled by bimanual compression, which cannot be arrested by the hot douche. One curious condition ought to be noted here, which I have observed several times. The uterus feels hard, and is obviously well contracted, and yet the bleeding goes on. Vaginal examination shows, however, that the lowest part of the uterus is still quite flabby, and sometimes distended with clot. If the placenta has had some attachment to this area bleeding takes place, and the usual stimulants seem powerless to stop it; it ceases at once under the hot douche.

I am still an obdurate sceptic, despite the eloquence of our Regius, in regard to the educational value of the M.B. thesis. If, however, we still must suffer such things, then I would modestly suggest the investigation of the reaction of different bloods or blood groups to calcium chloride, with a view to placing our clinical use of this sometimes potent agent on a sound and scientific basis, and to determining the proper dosage. To Dr. Grove is due the credit of introducing it for the treatment of haemorrhages, but I certainly think his dose of 1 grain too small. I usually give 2 grains, dissolved—I keep the solution ready made—in 20 minims of 2 per cent. carbolic lotion. Another subject for investigation is the factors which in some cases seem to inhibit the action of pituitary extract on the uterus.

A further word about pituitary must be added before quitting this part of our subject. Practitioners of much greater experience than myself agree that it is one of our most powerful weapons, terminating in a few minutes what would often otherwise be interminable cases in multiparae, and preventing or arresting haemorrhage. It acts at once or not at all, and I do not believe the tales about it causing rupture of the uterus an hour after injection; the fact of rupture occurring then would to my mind prove that the rupture was not due to the drug. There were brave men before Agamemnon, and there were ruptured uteri before pituitary extract. Of course, if a practitioner asks for trouble by giving it in obstructed labour he has only himself to thank, but I decline to believe that there is any risk at all in giving this drug to multiparae in cases where the head is in the pelvis and there is room for easy natural delivery.

Our third division is concerned with puerperal conditions and their treatment. The aseptic accoucheur, if any such there be in actual existence, gowned and gloved and gas-masked, who shaves the vulva and gives a bath of picric acid, will naturally douche the uterus in all cases and pursue a consonant post-operative routine; the ordinary general practitioner will, like Galileo, care for none of these things, and his patients will get along equally well. Cases of sepsis will occur, just as cases of embolism and white leg and mammitis and puerperal insanity, in which one will not be able to trace a cause, in which also there may have been no vaginal or other interference and no ascertainable history of exposure to infection. In view of this fact, the pursuit of a technique which experience has shown to be adequate is enough. As a last word on this I would like to ask two questions: "Ought retained membranes always to be removed at once, or may they be left awhile?" also, "Should a torn cervix be sutured?"

Two other deadly complications of the early puerperium may be mentioned. The first is reactionary, or late *post-partum* haemorrhage. A friend of mine died of it some years ago, and I have had one narrow shave in my own practice. One stays with the patient a reasonable time, all seems well, and then after an hour or two one is urgently summoned, to find the uterus full of clot, the woman blanched, bleeding, and in pain. Fortunately this trouble is rare, or our practice would be a nightmare.

The other trouble is *post-partum* vomiting, of which I have had a fatal case. I suppose that it must be due to some form of toxæmia where it is not hysterical. It certainly constitutes a very formidable complication, and is very refractory to treatment.

Though there of course remain a large number of points of great interest and importance, I think that I have gone on quite long enough, so will close without flourish or peroration.

OBSERVATIONS ON CASES OF RICKETS IN AN OUT-PATIENT DEPARTMENT.

BY

HELEN M. M. MACKAY, M.D.LOND., M.R.C.P.,

BEIT MEMORIAL RESEARCH FELLOW; ASSISTANT PHYSICIAN, QUEEN'S HOSPITAL FOR CHILDREN.

At the present time, in spite of the large amount of attention which has been focussed upon the etiology of rickets, there appears to be no general agreement as to its cause. Mellanby believes that the ultimate factor determining the occurrence of rickets in puppies of a susceptible age is the absence in the diet of a sufficient quantity of "anti-rachitic factor"¹—a substance which has been held to be identical with fat-soluble A.² Yet Noël Paton and his co-workers, who, in the course of their investigations on rickets, have carried out somewhat similar experiments in dogs, consider that "some other factor than diet is the prime cause of rickets,"³ and that rickets "is directly correlated with overcrowding and confinement in insanitary houses."⁴ Hess, who, like most clinical workers, holds that rickets "is primarily a dietetic disorder," believes that cod-liver oil "is almost a specific" as a prophylactic or curative remedy, but at the same time holds that fat-soluble A is only one among several factors concerned in the pathogenesis of rickets,⁵ and that probably "the danger to infants of a diet deficient in fat-soluble vitamins is slight, provided it includes sufficient calories and is otherwise complete."⁶

Bull, commenting on his clinical and experimental investigations on rickets among foxhound puppies, concludes that "although the faulty nature of the food was closely associated with the production of the disease, it has been shown that it was not capable of producing the disease when other conditions were altered," and that rickets is probably "due to a reaction on the part of the organism to an infection or chronic intoxication."⁷ Erdheim (working in Vienna during the time of shortage and of high prices, when very many among the population were under-nourished) examined pathologically a large number of caged rats which had spontaneously developed rickets at this time. He gives in his published report no particulars of the diet of these animals, but he shows a close relationship to exist between hypertrophic changes in the parathyroids and the presence of rachitic changes in the rats' bones—those rats having rickets had enlarged parathyroids with microscopic appearances indicative of hyperactivity of the glands.⁸ Erdheim also removed the parathyroids in rats, and bone changes similar to rickets followed this operation. This apparent contradiction he explains on the theory that the parathyroids in some way control calcium metabolism, and that in spontaneous rickets the hypertrophy indicates an effort at compensation on the part of the organism. Erdheim's observations are of considerable interest, in view of the following facts: (a) The occurrence of a condition resembling tetany as a result of the experimental removal of the parathyroids;⁹ (b) the extremely frequent association of tetany with rickets and artificial feeding in children; and (c) the fact, as stated for instance by Holt, that in children "the active symptoms of tetany may be controlled by calcium,"¹⁰ the metabolism of which is disturbed in rickets. These facts would suggest that the hypertrophy of the parathyroids may, as Erdheim suggests, be a protective measure against some common cause giving rise to abnormal calcium metabolism, to an increase of guanidin in the blood, and in some way to both rickets and tetany.

Guanidin, a product of decomposition of protein, is, according to Noël Paton, the chemical substance which gives rise to the symptoms of tetany.¹¹ Morpurgo¹² isolated from the organs of white rats which suffered from a spontaneous outbreak of osteomalacia in his laboratory a Gram-negative diplococcus, and succeeded in producing the disease in hundreds of other rats by subcutaneous inoculation of either the pure culture or the organs of animals containing the diplococcus. When adult animals

were the subject of experiment a disease resembling osteomalacia was produced, but with newborn rats the effects were closely similar to the changes observed in rickets in children. Schmorl, who examined Morpurgo's specimens, agrees that the histological changes are identical with those of rickets.

Looser¹³ is of opinion that rickets and osteomalacia are one disease, and supports his views by the results of clinical, radiographic, and pathological examinations of cases coming under his observation during a period of many years. He believes that the cause is most probably an infective one.

The papers heretofore quoted are all recent publications, but Bland-Sutton, working on animals at the Zoological Gardens, described over forty-five years ago how gerbills in captivity developed a condition either of rickets or of osteomalacia according to their age, and concluded that the causes of these two conditions are one and the same.¹⁴ He showed, too, how monkeys frequently developed rickets, and he considers the "rickets of maturity" in monkeys comparable with osteomalacia.¹⁵ His experiments on lion cubs at the Zoo, and the prevention among them of rickets by means of dietetic measures,¹⁶ are well known, and his observations indicate that both osteomalacia and rickets are mainly dietetic diseases, and can be prevented by an adequate diet.

Thus it will be seen that there are at present in our possession no facts conclusively proving the cause or causes of rickets, though it would appear to be at least in part a dietetic disease, and that its occurrence in rats is associated with changes in the parathyroid glands.

INVESTIGATION OF 51 RACHITIC OUT-PATIENTS.

In 1920 I carried out some clinical investigations on rickets among children attending the out-patient department of the Queen's Hospital for Children and the infant clinic at University College Hospital. In all I collected 51 cases of rickets in children between 5 months and 4 years of age, of whom 46 were under 3 years of age. I limited myself to cases in which the condition was, so far as I could tell, still active. The majority were heretofore untreated, and a few were cases growing worse, in spite of previous treatment.

I began with the belief that rickets was mainly, perhaps entirely, a dietetic disease, and it seemed reasonable to start from the hypothesis that it is due, in part at least, to a want of fat-soluble A and to investigate the cases from this point of view.

My results go to prove the impossibility of obtaining data of sufficient accuracy from out-patient work to give any conclusive results. There was a very wide margin of error in the histories given me; irregular attendances, intercurrent diseases, and radical changes made by the mother in the food (which, perhaps, in spite of careful questioning, I only discovered by chance weeks later), also invalidated very many of my records. These sources of error point to the absolute necessity that an investigation in clinical work undertaken with a view to elucidating the cause of a supposed dietetic disorder should be institutional. Nevertheless, some points of interest appear worth recording.

The Diet of Rachitic Cases.

The history revealed that in 35 out of 51 rachitic children (that is, nearly 69 per cent.) artificial feeding was begun before six months of age. Allowing for the uncertainties of the history, there seems no doubt that in at least 29 of these 35 cases the diet would have been markedly deficient in fat, as compared with human milk, for a period of anything between one and a half to seven and a half months before the age of 8 months. The degree of deficiency it was quite impossible to estimate. But, as against this, it must of course be remembered that, unless fed on a dried milk (which is very usually given in a strength roughly equivalent to undiluted cow's milk), the vast majority of artificially-fed infants of the poorer classes in London receive a diet containing a considerably smaller percentage of fat than human milk, and I think there can be no question that the majority of these do not develop rickets.

Twenty-two of the 35 bottle-fed children, and probably a considerably larger number, received for a period of six weeks or more before the age of 6 months a food containing a large percentage of carbohydrate—for example,

sweetened condensed milk, or a food with added starch. The older children on mixed diets appeared to receive a large quantity of carbohydrate food, but I did not come to any conclusion as to whether it was more than that consumed by the majority of children of corresponding age of the same social class.

In at least two children under nine months of age rickets developed on a diet of breast-milk only, and it is interesting to note the particulars obtained of the diet of one of the two mothers in question (the husband was a casual labourer at the docks, and sometimes only able to get one day's work in the week):

Breakfast: A cup of tea with milk.

Dinner: Potatoes daily, suet or batter pudding (about four days a week), or meat or fish (about three days a week), greens once or twice in the week, bread sometimes.

Tea or Supper: Generally none, occasionally bread and margarine.

It seems that under these circumstances the milk secreted might well have been poor in quality (*cf.* Dalyell, *BRITISH MEDICAL JOURNAL*, July 31st, 1920). Unfortunately it was not possible to obtain a specimen for examination. In the second case I was not able to get details of the mother's diet.

A communication made to me by a medical woman working in India has some bearing on the association of rickets with diet. She informed me that, except among the "mission" children, she rarely saw a case of rickets in a native. Among the "mission" children it was not uncommon. She attributed this to the fact that many of these children were bottle-fed, whereas a child reared on the bottle was comparatively rare among the general population.

Antiscorbutic in the Diet.

I was interested in the question of whether an antiscorbutic deficiency could play any part in the production of rickets. It is obvious that if fat-soluble A is often deficient in an infant's food as a result, for instance, of dilution, the proportion of the less stable antiscorbutic vitamin may be correspondingly even further reduced in the same food, and even fresh cow's milk is not rich in antiscorbutic. Hess and Unger calculate that an infant probably requires the antiscorbutic equivalent of 1 pint of fresh cow's milk per day.¹⁷ It was impossible to ascertain from the data available whether there was any antiscorbutic deficiency in the diets as a whole. However, in view of Hess's suggestion that a condition of subacute scurvy is not infrequently mistaken for rickets,¹⁸ it is of some interest to note the following two cases which were sent to me as rickets: Rose M., aged 9 months, had been fed on proprietary foods since 2 weeks old, but had had "an orange quarter to suck twice a day since 6 months old." She was brought to the hospital because "she screamed when the ankles were touched." When seen there was beading of the ribs, and enlargement of the epiphyses of the wrists and ankles, the limbs appeared very tender, the gums were swollen and bluish-red round the erupted teeth, and the capillary resistance test of Hess and Unger¹⁹ was strongly positive, a test which, though probably not pathognomonic, yet I think clinches the diagnosis of scurvy in this case. Unfortunately this child was seen once only.

The directions given by these authors for the test are briefly as follows: The blood-pressure band of the sphygmomanometer—Tyco's apparatus was used by them—is put round the arm and the pressure raised and kept at, say, 90 mm. of mercury for three minutes. The object is to obliterate the flow of blood and so produce cyanosis without obliterating the pulse. They claim that, after removal of the band, infantile scurvy cases show very numerous points of bleeding, normal cases none, or perhaps one or two—petechiae just below the pressure band are to be ignored. Obviously there is more probability of obtaining petechial haemorrhages, other conditions being equal, in a child which has raised its blood pressure by crying than in one which is quiet—a point, I think, to be borne in mind in doubtful cases.

The second child, Bertram S., aged 1 year 3½ months, would have appeared from his history to be receiving a sufficiency of antiscorbutic, but the teeth were decayed, the mouth in a condition of stomatitis, the capillary resistance test positive, and in sixteen weeks he had lost ½ lb. in weight. Therefore he was put on large doses of orange juice (about 5 iiij daily), besides local treatment for the mouth, and he rapidly improved, and gained an average

of over 8 oz. a week for five weeks—facts which suggest that the condition may have been subacute scurvy. This child also showed beading of the ribs and enlargement of the epiphyses at the wrists as well as tuberculous dactylitis. I presume that clinically the enlargement of the epiphyses in both these cases would be held to justify a diagnosis of rickets whatever other conditions were also present.

Result of Treatment with Single Additions to the Diet.

I pass now to the results of treatment. I divided the cases as I saw them into five groups, endeavouring to keep all the groups as equal as possible with regard to age and types of case composing them. To the previous diet of the children of each of these groups I made one of the following additions:

1. An animal fat presumably rich in fat-soluble A, namely, cod-liver oil 3 ij daily.
2. An animal fat also presumably rich in fat-soluble A, namely, butter 3 ij daily.
3. An animal fat plus a substance rich in antiscorbutic, namely, butter 3 ij plus orange juice 3 ij daily.
4. An animal fat plus a substance rich in water-soluble B, namely, butter 3 ij plus marmite 3 ss daily.
5. A vegetable oil presumably much lower in fat-soluble A than the foregoing animal fats—namely, cottonseed oil 3 ij daily.

The fats were given as emulsions, and all the substances, including the orange juice, were dispensed at the hospital. Of course any outstanding symptoms, such as constipation, diarrhoea, or cough, had to be treated, but I avoided, as far as possible, giving the mother any directions as to feeding or hygiene in the home, with a view to keeping those factors unaltered. The results were disappointing. Owing to the small number of cases which attended with any regularity I have grouped under the one head of "butter" in the following table all the cases receiving butter, butter and orange juice, or butter and marmite.

Period March to July, 1920. Results of Treatment.

	Addition to Diet.		
	Butter 3 ij daily.	Cod-liver oil 3 ij daily.	Cottonseed oil 3 ij daily.
Number of cases	9	4	6
Average age	25½ mos.	18½ mos.	21½ mos.
Average deficiency of weight (compared to normal child) at beginning of treatment	75 oz.	40 oz.	71 oz.
Average deficiency of weight at end of treatment	79 oz.	32½ oz.	59 oz.
Total period of treatment of all cases	58 wks.	34 wks.	45 wks.
Average duration of treatment for each case	6½ wks.	7½ wks.	8½ wks.
Average change in deficiency of weight	Deficiency increased by 4 oz. 2 oz. nearly.	Deficiency decreased by 7½ oz. 2½ oz.	Deficiency decreased by 12 oz. 2½ oz.
Average weekly gain of each child			

Obviously the numbers are extremely small, and to my knowledge the general diet was modified in several cases during the period of observation, so that I do not think that any deductions can be drawn from differences between the groups. It, however, is noteworthy that no group showed any striking improvement. Some of the cases included, however, had only two consecutive weeks of treatment. About half of the 19 cases showed definite improvement in their general condition, but none could be said to show any definite improvement in the bone lesions, and the sweating persisted in those cases in which it had been present at the beginning of the period. These observations extended from March to the middle of July.

Result of More Extensive Changes in the Diet.

In July I decided to see if I could obtain any marked improvement in the children by attempting to bring about a greater change in the diet. I gave the mothers instructions as to the general feeding, particularly concerning any obvious errors in the dietary, usually instructing them to increase the quantity of animal fat and protein and cut down the quantity of carbohydrate in the diet. At the same time I endeavoured to push the quantity of cod-liver oil—in some cases I gave as much as 3 vj daily to a child of about one year. The improvement in this set of cases

as compared with the last set of 19 was marked. (This group includes many of the cases already treated in the first group.)

Table showing Results following General Directions as to Diet, with increasing doses of Cod-liver Oil (3 ij to 3 vj daily).

Number of cases	18
Average age (in months)	23
Average deficiency of weight at beginning of treatment	57½ oz.
Average deficiency of weight at end of treatment	41 oz.
Total period of treatment of all cases	115 weeks
Average duration of treatment	6½ weeks
Average change in deficiency of weight: Deficiency decreased by 16½ oz.	
Average weekly gain	4 oz.

Not only did the weight approach the normal, but in nearly every case there was a definite improvement in the child's general condition, and in several cases there was an improvement in the bone lesions—for example, less marked beading of the ribs or reduction in size, of enlarged epiphyses; 9 of the 18 cases had excessive sweating at the beginning of the period, and in 5 of these the condition improved or disappeared. On the other hand, David H., aged 1 year and 3 months, for example, who showed very marked improvement in weight and general condition (his weight increased from 11 lb. 14 oz. to 15 lb. 4 oz. in eight weeks), showed no improvement in the sweating. This child at the end of the period was receiving 3 vj of cod-liver oil daily, and I presume the sweating was evidence that the rachitic condition was still active in spite of the large consumption of cod-liver oil.

Chart showing percentage of cases examined post mortem (386 in all) with active and healing rickets for each month of the year. Compiled after Schnorr. Reproduced from "A Study of Social and Economic Factors in the Causation of Rickets," by M. Ferguson and L. Findlay (Medical Research Committee Report).

In connexion with this group of cases it is of interest to

Victor B.

Elsie B.

Weight charts of two cases in which there was definite improvement from the date at which general dietetic treatment was begun. The arrow indicates the date at which directions as to general diet were given; the numbers against the weight curve indicate the daily dose of cod-liver oil in drachms.

Victor B., aged 1½ years, was the son of a pastrycook, and received large quantities of "pastries." He has attended for seventeen weeks, and shows improvement in the size of the rosary and wrist epiphyses.

Elsie B., aged 2 years, is the child of a widow in extremely poor circumstances.

note the seasonal curve of rickets reproduced herewith. It will be seen that July shows a sharp rise in the incidence of "healing rickets." Whether the contrast between this group of 18 cases as compared with the previous group is merely due to the season at which treatment was carried

out, or whether the dietetic treatment was an important factor, it is impossible to say with certainty, but from the observations of Dalyell²¹ on the effect of small additions of animal fat to the diets of children suffering from arrested development in Vienna, my impression is that the general dietetic treatment played an important part in the improvement which occurred. (See weight charts.)

Summary.

My observations on these cases are, therefore, so far as they go, in accordance with the fairly general belief that rickets is a dietetic disease and commonly develops in children receiving insufficient fat and too much carbohydrate in the food, and that it shows itself most commonly among those who have been bottle-fed. In the case of one child known to have developed rickets while at the breast it is evident that the mother was receiving an inadequate diet, and it is probable that the infant's diet was also inadequate as a result.

The number of cases observed was unfortunately small, but they gave no indication that fat in the form of cod-liver oil, butter, or cottonseed oil exerts any specific curative influence on the disease in doses of 5ij daily. On the other hand, there was a marked improvement in a group of 18 cases treated during July, August, and September with larger doses of cod-liver oil, together with advice as to diet, but it is certain that this improvement was in part due to the season of the year.

Still has drawn attention to the fact that children suffering from coeliac disease in which there is failure to absorb fat "show a remarkable freedom from rickets."²⁰ In two experiments recently carried out at the Lister Institute, kittens given a diet deficient in fat-soluble A developed a condition showing a striking resemblance to that of children with coeliac disease: together with arrest of growth and distension of the abdomen there was muscular feebleness and apathy with a "pathetic interest in food." A small liver appears in many cases to be a feature of the disease. All these are points to which Still draws attention in coeliac disease in children.²² These facts would suggest the conclusion that a deficient absorption of fat-soluble A accounts for the picture in coeliac disease. If that be so, some other factor and not a deficiency of fat-soluble A alone must be concerned in the production of rickets.

In conclusion, I should like to express my great indebtedness to Dr. C. J. Martin for his help and for his kindness in arranging that the expense of this investigation should be defrayed by the Lister Institute; to Dr. E. A. Barton, who took much trouble in collecting suitable cases for me at his infant consultations at University College Hospital; to Miss S. E. Jacob, pharmacist to the Queen's Hospital, and to the many others who were kind enough to send me cases and to co-operate in other ways.

REFERENCES.

- ¹ E. Mellanby: Experimental investigation of Rickets, *Lancet*, 1919, i, p. 407.
- ² Report on the Present State of Knowledge concerning Accessory Food Factors (published by the Medical Research Committee, 1919), p. 102.
- ³ D. Noël Paton, S. Findlay, and A. Watson: Observations on the Cause of Rickets, *BRITISH MEDICAL JOURNAL*, 1918, ii, p. 625.
- ⁴ D. Noël Paton: Discussion on the Influence of the Accessory Food Factors in Infant Feeding (Royal Society of Medicine), *Lancet*, 1920, i, p. 604.
- ⁵ (a) A. F. Hess: Discussion on the Present Position of Vitamines in Clinical Medicine (British Medical Association), *BRITISH MEDICAL JOURNAL*, 1920, ii, p. 154. (b) Hess and Unger: Prophylactic Therapy for Rickets in a Negro Community, *Journ. Amer. Med. Assoc.*, vol. 69, 1917, p. 1583.
- ⁶ A. F. Hess: The Clinical Role of the Fat-soluble Vitamine: Its Relation to Rickets, *Journ. Amer. Med. Assoc.*, 1920, vol. 74, p. 217.
- ⁷ L. B. Bull: Rickets in Foxhound Puppies, *Journ. of Comp. Path.*, xxxi, 1918, p. 193.
- ⁸ J. Erdheim: Rachitis und Epithelkörperchen (1914), *Die Denkschriften der Mathematisch-Naturwissenschaftlichen Klasse der Kaiserlichen Akademie der Wissenschaften*, Band xc.
- ⁹ D. Noël Paton and others: The Parathyroids, Tetania Parathyreopriva, *Quart. Journ. Exper. Physiol.*, 1916, p. 203.
- ¹⁰ L. E. Holt: Diseases of Infancy and Childhood, 1919, p. 677.
- ¹¹ D. Noël Paton, S. Findlay, and others: *Journ. Exper. Physiol.*, 1917, x, p. 345.
- ¹² B. Morpurgo: Ueber eine infectiöse Form der Osteomalacie bei weissen Ratten, *Beiträge z. Path. Anat.*, etc., 1900, Bd. 28, p. 620. Durch Infection hervorgerufene malacische und rachitische Skeletveränderungen, etc., *Centralblatt. f. Allgemeine Path.*, 1902, Bd. 13, p. 113. Ueber die infectiöse Osteomalacie u. Rachitis, etc., *Verhandlungen deutsch path. Gesellschaft*, 1907, p. 282.
- ¹³ E. Looser: Über Spätrachitis und Osteomalacia, *Deut. Zeitschrift für Chirurgie*, vol. 152.
- ¹⁴ J. Bland-Sutton: Bone Diseases in Wild Animals, *Trans. Path. Soc. of London*, xxxv, 1884, p. 468.
- ¹⁵ J. Bland-Sutton: Observations on Rickets, etc., in Wild Animals, *Journ. Anat. and Physiol.*, xviii, 1884, p. 362.

¹⁶ J. Bland-Sutton: Quoted by Cheadle and Poynton, *Albutt's System of Medicine*, p. 385.

¹⁷ A. F. Hess and L. J. Unger: Factors Affecting the Antiscorbutic Value of Foods, *Journ. Amer. Med. Assoc.*, 1918, lxxi, p. 941.

¹⁸ A. F. Hess: Discussion on the Position of Vitamines in Clinical Medicine, *BRITISH MEDICAL JOURNAL*, 1920, ii, p. 154.

¹⁹ A. F. Hess and M. Fish: *Infantile Scurvy: The Blood, the Blood Vessels, and the Diet* (1914), p. 11.

²⁰ G. F. Still: Lisleian Lectures on Coeliac Disease, *Lancet*, 1918, ii, p. 227.

²¹ E. Dalyell: The Present Position of Vitamines in Clinical Medicine, *BRITISH MEDICAL JOURNAL*, July 31st, 1920.

²² G. F. Still: Lisleian Lectures on Coeliac Disease, *Lancet*, 1918, ii, p. 164.

THE VALUE OF EXTENSIVE INOCULATION OF A COMMUNITY DURING AN EPIDEMIC OF TYPHOID FEVER.

BY

A. ROMANES,
M.A., M.D.

AND

G. G. JOHNSTONE,
M.A., M.D., D.P.H.

DOUBT can no longer exist concerning the incalculable value of antityphoid inoculation as a means of preventing typhoid fever in military communities. The published figures of the incidence of typhoid fever in all armies during the late war prove this point conclusively. In this case the inoculation has almost invariably been carried out under favourable circumstances and in the absence of an epidemic prevalence of the disease.

The question arises as to the value of inoculation as a means of protection—first, to the individual, and secondly, to the community as a whole—during an actual epidemic. The opportunities for the study of this subject on a scale large enough to give any reliable results have been few. It seems desirable, therefore, to place on record any evidence which will enable an opinion to be formed concerning inoculation under these circumstances.

The opinions hitherto expressed on the matter are of a rather divergent nature. Spooner, speaking of a water-borne epidemic in a Vermont village, remarks that "inoculation in the time of epidemic must be performed with care, since it is inevitable that many must be inoculated during the incubation period. The result of this accident is not serious, however. My experience would indicate that the onset of symptoms was hastened by this step, but that the infection was shorter and of a less severe character." He also notes in another instance the small morbidity among a number of nurses and others intimately exposed to infection before and during inoculation, and points out that this agrees with the observations of Pfeiffer, Leishman, and Russell, that the period following inoculation is one of increased resistance.

Elmer, recording a food epidemic in a hospital at St. Louis, says: "The fact that only 20 out of the 261 who received the vaccine developed typhoid speaks against any marked increase of susceptibility, and the fact that 20 did develop typhoid is against any marked increase of resistance following recently given vaccine."

Basten reports the result of inoculating 245 members of a Sanitäts Kompagnie, in which 15 cases of typhoid fever had occurred, 3 of which died. Three doses, of $\frac{1}{2}$ c.cm., 1 c.cm., and 1 c.cm., of antityphoid vaccine were given at intervals of eight days. After the first inoculation, 13 cases of typhoid occurred, two being fatal; after the second, 9 cases occurred, one being fatal; after the third, one case occurred. In a field hospital 4 cases occurred after one inoculation; one after the second, while after the third, five men had elevation of temperature for five days, one of whom died after a relapse during the third week.

Furth, Pfugbeil and Oertel describe the results of compulsory inoculation of the inhabitants of Ostend in 1915 and 1916. Typhoid fever was endemic, and the number of cases in August, 1915, was 38. The population of the town in 1915 was 32,811, and 27,472 received three doses of vaccine. A similar procedure was repeated the following year. They express their results as follows:

"Consequences injurious to health were observed in no case. Two facts in particular speak for the excellent effect of vaccination: Before inoculation, typhoid fever occurred sporadically over the whole area. Its complete disappearance was afterwards directly proportional to the degree of inoculation in the various districts. It disappeared in the districts in the order in which they were inoculated, and did not show signs of abatement until inoculation had taken place. It ceased entirely with the completion of inoculation.