Examination of the urine for albumin (Anning *et al.*, 1948) is an unreliable indication of renal impairment, being inconstant or absent in some cases.

Treatment consists in forcing fluids by mouth. Herrmann, Kirsten, and Krakauer (1949) have suggested the use of 250 ml. of sodium citrate 2.5% given intravenously four-hourly.

In view of the necessity for laboratory control the question arises whether the results of treatment of rheumatoid arthritis with massive doses of vitamin D are justified. In 1935 Dreyer and Reed reported improvement in the arthritic condition of two patients receiving massive dosage of vitamin D for hay-fever. This was followed by numerous reports, principally in the United States, of its use in rheumatoid arthritis. Though many claims for its curative value have been made, most observers have doubted its efficacy. The Council on Pharmacy and Chemistry of the American Medical Association (1939) concluded that "clinical evidence does not warrant the claim that massive doses of vitamin D are of benefit in chronic arthritis, in allergic conditions, or in psoriasis."

Summary

Two cases of toxicity due to massive dosage of vitamin D are described. The dangers of this form of therapy, particularly in rheumatoid arthritis, are pointed out, and the necessity for laboratory control is stressed.

We would like to thank Dr. J. H. Kellgren for permission to publish these cases and for his constant help and encouragement. Our thanks are also due to Professor R. Platt for allowing us to quote some of his findings in Case 2, and to Dr. M. D. Milne for helpful criticism.

REFERENCES

- Anning, S. T., Dawson, J., Dolby, D. E., and Ingram, J. T. (1948). *Quart. J. Med.*, n.s., **17**, 203.
 Council on Pharmacy and Chemistry and Council on Foods (1939). *J. Amer. med. Ass.*, **113**, 589.
 Dreyer, I., and Reed, C. I. (1935). *Arch. phys. Ther.*, **16**, 537.
 Duncan, G. G. (1947). *Diseases of Metabolism*, p. 208. Saunders, Philadelphia.
 Herrmann, J. B., Kirsten, E., and Krakauer, J. S. (1949). *J. clin. Endocrinol.*, **9**, 1.
 Hess, A. F., and Lewis, J. M. (1928). *J. Amer. med. Ass.*, **91**, 783.
 McCance, R. A. (1947). *Quart. J. Med.*, n.s., **16**, 33.
 — and Widdowson, E. M. (1942-3). *J. Physiol.*, **101**, 44.
 — (1943-4). *Ibid.*, **102**, 42.
 Reed, A. M., Struck, H. C., and Steck, I. E. (1939). *Vitamin D*. Chicago. Quoted by Anning *et al.* (1948).
 Reed, C. I. (1934). *J. Amer. med. Ass.*, **102**, 1745.
 Reifstein, E. C., jun., and Albright, F. (1944). *New Engl. J. Med.*, **231**, 343.
 Slocumb, C. H. (1942). *Ann. intern. Med.*, **16**, 241.

The Staff Side of the Nurses and Midwives Whitley Council states that the Council is referring to the Ministry of Labour and National Service, for consideration by the Industrial Court, the question of revised salaries for public health and domiciliary district nurses and midwives, the Staff and Management Sides having failed to agree on the matter. In June last year increased salaries were agreed for the lower grades of hospital nurses, and in July the Staff Side put forward proposals for public health and domiciliary nurses which would have had the effect of maintaining the existing relationship between the salaries of the public health nurses and those of the hospital nurses, on which those of the public health nurses had previously been based. Similar proposals on behalf of domiciliary midwives were submitted in September, 1949. In February this year the Staff Side was informed by the Management Side that it was unable to agree to any revision of the salaries of public health and domiciliary nurses and midwives. In view of the serious anomalies which the Management Side's decision created the Staff Side asked that the matter should be referred to the Industrial Court for arbitration.

POLIOMYELITIS IN CORNWALL IN 1949

BY

E. R. HARGREAVES, M.A., M.D., D.P.H.

Deputy Medical Officer of Health, Cornwall County Council

During 1949, 110 cases of poliomyelitis occurred in Cornwall, giving an incidence of 0.3 per 1,000 of the population, a little less than double the rate for England and Wales in 1947. The age distribution over the county as a whole was normal—namely, approximately one-third under school age, one-third 5 to 14, and one-third 15 and over. Distribution of the first 100 cases is shown in Fig. 1.

It will be noted that there are four main centres of infection in the county, Camborne-Redruth, Penzance, Fowey, and Truro. It is interesting to compare this distribution with that of 1947 and to note that areas most affected in that year were relatively free of the disease in 1949.

The Camborne-Redruth outbreak was the first in the county; indeed, other than Newhaven, it was the first group of cases in the country. On June 21 three cases of paralysis were notified in Illogan, a village some four miles from Redruth. During the subsequent two months 21 further cases occurred in the Camborne-Redruth Urban District, and one at Truro School. An interesting feature of this small outbreak was the age group affected, 56% being under 5 years old.

The outbreak was for some time confined to the village of Illogan, and it seemed certain that the source of infection was close at hand. Of the three initial cases, two were pupils at the Illogan Infants' School, and the other, a child of 3, had an elder sister there. Careful investigation of the food supply and hygiene of the school together with the movements of staff and pupils failed to uncover any possible origin of the outbreak.

Consideration was given to the possibility of the importation of the virus from outside, but no visitors had stayed in any of the affected houses during the previous six weeks, nor had the occupants been away on holiday. Two old cases of poliomyelitis were known to be present in the district, but as it was two years since they contracted the disease the possibility of their still carrying the virus seemed remote.

Five more cases occurred in Illogan, all intimately connected with the school, four being pupils; the fifth, a child of 2½, had a brother at the school.

From Illogan the disease spread to Camborne and Redruth, Truro, and St. Day. When peripheral spreading occurs it is usually fairly easy to trace the origin of the first case. In Redruth, for instance, a case was notified on June 29, and on June 30 two boys in an adjoining house developed paralysis. The two families had gone by bus to Portreath beach on June 20 and again on June 21. The bus route is through Illogan, and many children from the village had joined the bus.

The first case in Camborne was admitted to the Isolation Hospital on July 8. The patient was a cousin of an Illogan case, and his aunt, in spite of warnings, had visited his home on two occasions, the last being eight days previously.

One solitary case was reported from Truro School; the boy developed paralysis on July 12, the infection being possibly contracted on June 25, when he went to a large religious meeting at Gwennap Pit, near St. Day, and subsequently spent the evening in Redruth.

Two cases occurred in St. Day; both had had indirect contact with Illogan.

At Fowey the outbreak started with a burst at the beginning of August, when five children developed paralytic poliomyelitis within 48 hours of one another. Again it was the pre-school children that suffered, four of the five cases being under 5 years of age. The area M.O.H. investigated this outbreak in great detail but could find no common factor. The water supply was extremely low at the time, but reports proved satisfactory. The boiling of water and milk was advocated.

The stage seemed set for a serious outbreak, but only three more cases occurred in the town, all developing paralysis two weeks later. One was an indirect contact through her sister with a previous case. The interval was 16 days, which allowed time for the virus to become established in the sister although she developed no symptoms

Polruan, the "Penpoodle" of Sir Arthur Quiller-Couch's *Troy Town*, is in reality a part of Fowey, being separated from the main portion of the town by the River Fowey.

A visit unearthed the history of two further visitors to Polruan who developed poliomyelitis after returning home, the earliest date being June 27, six weeks before the onset of the Fowey cases and approximately the same date as the beginning of the Illogan outbreak, some 40 miles away.

A violent focus of infection appeared in the city of Truro (population 12,950) at the beginning of September. Two cases of paralysis were reported on September 11, and in the subsequent 10 days 12 more patients were admitted to the County Isolation Hospital.

FIG. 1.—Distribution of cases of poliomyelitis occurring in Cornwall in 1947 and 1949.

suggestive of abortive poliomyelitis. The other two cases were close contacts, both working in the local chemist's shop.

It is fascinating, but often extremely difficult, to trace the origin of outbreaks such as occurred at Fowey. One felt that some connexion with the Camborne-Redruth cases probably existed, and searched accordingly; but in mid-August a letter from Dr. A. M. McFarlan, of Cambridge, told of a clerk from Cambridge and her fiancé who visited Polruan for their holiday on July 24, leaving again on August 9. While there the son of the hotel proprietor was ill for two days with symptoms suggestive of abortive poliomyelitis, and within a few days of returning to their homes—the girl to Cambridge, her fiancé to Scunthorpe—both these visitors developed paralytic poliomyelitis.

In all, some 20 cases occurred in Truro and a further seven in the surrounding villages. Paralysis was severe, particularly in early cases, four of which proved fatal.

Double cases occurred in two families, one of which is extremely interesting. A man aged 27 was taken ill on September 9 and died two days later of respiratory paralysis. He had been working at considerable pressure for several weeks organizing the local shopping week and the R.A.F. "Battle of Britain" activities. There are three other siblings in the family, all grown up, but they happened to be at home at the time of his illness. A brother, a naval officer attached to Plymouth, was in Truro on a week's leave, and assisted in nursing him. He returned to Plymouth and went down with a mild attack of poliomyelitis on September 30. An unmarried sister helped in the clerical

work of the family business and had been in close contact with the brother who had died. She was taken ill on September 25 and developed paralysis of all four limbs with diaphragmatic involvement on September 29. The remaining brother, also in the Navy, was unaffected.

This family illustrates the highly infective properties of poliomyelitis virus and familial susceptibility to the disease.

Two cases in this series are of interest as a study of immunity.

A woman was delivered of her second child on September 1. Apart from slight pyrexia on the 14th the puerperium was uneventful. She was up in the house from September 15 to 19, but did not feel very fit. On the 20th she was feverish, with nausea and headache. Next day she was no better, and as the baby was also off colour and feverish it was decided to begin artificial feeding. The mother remained in bed until September 28, when on getting up she first noticed a weakness in her left leg, which proved to be due to poliomyelitis. As regards the baby, artificial feeding was easily established, but on September 25 and 26 it had four convulsions, and subsequently developed some weakness in the muscles of the shoulder girdle.

The other case, that of a woman expecting her second baby, developed severe paralysis three days before confinement. The baby arrived on the appointed day without undue difficulty. It was normal at birth and has remained perfectly well.

Cases in outlying areas could again be traced to contacts with the main outbreaks.

An isolated case which occurred in a neighbouring town is of interest. A nurse at the Royal Cornwall Infirmary, Truro, was on duty in the children's ward, where there were cases of poliomyelitis transferred after their stay at the Isolation Hospital. Her parents live at Perranporth and she goes there for her day off, staying the night at home, where she shares a bedroom with her stepsister, a girl of 6½. She was at home on September 18, and nine days later her stepsister was kept away from school because of fever, headache, and vomiting. On September 29 the child developed paralysis of all four limbs. The incubation period fits well with the visit of her stepsister on September 18 (11 days before paralysis), and no other possible source of infection came to light. If we accept this we must also accept the possibility that the nurse was a carrier and was presumably infected while nursing cases at the Royal Cornwall Infirmary, all of which had been in the County Isolation Hospital for at least three weeks, and which on present standards are regarded as non-infectious.

During investigations of the Truro cases special attention was given to the possibility that the disease had followed the ingestion of a contaminated aliment. Milk, ice-cream, and food supplies provided no common factor.

Owing to exceptionally dry weather the normal source of the city water supply had proved inadequate, and the local company had been compelled to draw from a heavily polluted stream, the River Allen. At the pumping station the

water is passed through precipitation tanks (aluminium hydroxide) and thence to pressure sand filters. Finally it is chlorinated and allowed to stand in a small service reservoir, but during peak periods the water passes direct to the mains after chlorination. Two samples taken on September 24 from taps in the town showed serious pollution, typical *Bacterium coli* counts being 180 and 50. The chlorination plant in use at the time was abandoned and superchlorination with an electric injector instituted. In addition, the medical officer of health advised the boiling of all drinking-water in the city. Within five days of superchlorination the epidemic ceased. In the subsequent month only one further case occurred—that of a man who

Age Group	Cornwall (110 Cases)	Illogan Area (25 Cases)	Truro Area (27 Cases)
0-4	38%	56%	22%
5-9	25%	28%	19%
10-14	6%	—	7%
15+	31%	16%	52%

developed mild facial paralysis on October 17. The paralysis rapidly receded, but an increase of globulin and protein in the cerebrospinal fluid was suggestive of poliomyelitis.

The outbreak in Truro presents certain interesting features: (1) The high age group attacked: the accompanying table shows the age groups of cases in Cornwall as a whole compared with those of the local outbreaks at Illogan and Truro. It will be noted that 52% of the Truro patients were over 15 years of age. (2) A history of direct or indirect contact with previous cases was

remarkable for its absence. (3) The cases were evenly distributed over the town (see map, Fig. 2). (4) The explosive nature of the outbreak and abrupt cessation after superchlorination of the city's water supply (Fig. 3).

Discussion

Following early work on monkeys, the theory of droplet spread of poliomyelitis virus and entry through olfactory mucous membrane was accepted by most authorities and handed down in medical textbooks for some 20 years. In more recent years (Harmon, 1937; Trask *et al.*, 1938;

FIG. 2.—Map of Truro showing the sporadic distribution of cases of poliomyelitis in the city.

FIG. 3.—Incidence of poliomyelitis in Truro City.

FIG. 4.—Graph of seasonal mortality from poliomyelitis, typhoid, and diarrhoea and enteritis, 1921-5. Deaths per day in each month are expressed as a percentage of deaths per day throughout the year.

Horstmann *et al.*, 1944) the alimentary canal has been regarded as the more probable route of infection.

There is now almost overwhelming experimental evidence that the alimentary canal rather than the olfactory mucous membrane is the common route of infection in man. The monkey can be infected only through the nasal mucosa; it is extremely resistant to poliomyelitis virus, and the olfactory mucous membrane is a weak spot in the armour of both monkey and man against virus infection.

If the nerve endings of the olfactory mucous membrane are blocked the monkey resists infection by all routes. Chimpanzees are more susceptible than monkeys, and in addition to nasal spray can readily be infected by feeding the virus.

In man, although pathological changes in the central nervous system are widespread, lesions in the lumbar enlargement of the cord are by far the most common, next in frequency being those in the cervical enlargement. The pathology is in agreement with the clinical findings, paralysis of the lower limbs being more frequent than that of all other parts of the body by three to one, and impairment of bladder function is a common symptom in the early stages of the disease.

It is true that at necropsy there is usually some degree of meningeal congestion, but if an experimental animal is killed in the pre-paralytic stage, when symptoms of irritation alone are present, there is no meningitis, yet even at this early stage the motor cells in the anterior horn show signs of degeneration (Hurst, 1929).

In droplet infections it is the nasal, not the oropharyngeal, carrier who is of danger to the community (Hamburger and Green, 1946; Cook and Ashman, 1949), yet the virus of poliomyelitis has seldom been recovered from nasal washings; nor was Sabin (1947) able to recover it from the masks of five early severe paralytic patients who for 30 minutes had talked, coughed, and blown into them.

That ample opportunity exists for the infection of man by the alimentary canal is no longer in doubt. The virus is widely scattered among contacts and excreted in the stool (Gordon *et al.*, 1947).

Both in America and in South Africa virus has been isolated from sewage during epidemic periods and for some months after the appearance of the last case (Paul, Trask, and Gard, 1940; Gear and Mundel, 1946). Food and drink can therefore readily become contaminated at times of epidemics. The virus is able to retain its virulence outside the body for considerable periods—for example, in butter for as long as 90 days (Kling *et al.*, 1931) and in milk for some weeks (Landsteiner *et al.*, 1911)—and it can be recovered from water after three months. Nor is the virus readily killed by chlorine. Kempf and Soule (1940) and Kempf *et al.* (1942) found that under laboratory conditions adapted so far as possible to conform with natural methods of water purification the virus was still active after sedimentation and subsequent exposure to 0.5 parts per million free chlorine for four hours.

More recent work (Lensen *et al.*, 1946) suggests that the figure of Kempf *et al.* is too high. The present position is well summarized by Professor Maxey (1949), who states: "While further carefully controlled studies are desirable, on the basis of experimental results now available, it appears to the author that the application of chlorine under conditions which will insure the maintenance of 0.2-0.3 p.p.m. free available chlorine residuals after one-half hour of contact may be sufficient to inactivate the quantities of poliomyelitis virus that might be present in a potable water."

The seasonal curve of poliomyelitis is remarkably regular, the incidence beginning to rise in June and reaching its peak in August, September, or October. The disease normally dies out with the advent of colder weather,

FIG. 5.—Graph of seasonal mortality from poliomyelitis, whooping-cough, and measles, 1921-5. Deaths per day in each month are expressed as a percentage of deaths per day throughout the year.

although winter outbreaks are not unknown. The curve is thus similar to that of intestinal diseases such as enteric fever or gastro-enteritis, and is in marked contrast to accepted droplet infection such as measles and whooping-cough (see Figs. 4 and 5).

It has been noted that outbreaks of poliomyelitis often occur during abnormally hot weather: a graph of the incidence of poliomyelitis in Cornwall, 1911-49, plotted against the average mean daily temperature recorded at Falmouth for the third quarter of the year, shows that the incidence of the disease has risen above 0.05 per 1,000 on six occasions. These six epidemic years include four of the five highest mean average temperatures recorded for the third quarter in the span of years under consideration (1911, 1921, 1947, and 1949), and the other two epidemic years (1919 and 1945) show an abnormally high August temperature.

Some will argue that at Illogan the epidemiological findings I have recorded suggest droplet infection, as most of the cases were in close contact at school, but it should be remembered that in such a closed community up to 80% of the pupils will be excreting virus, and it is thus easy for children's hands to become contaminated.

The findings at Truro—namely, the shift to an older age group, the sporadic distribution of cases in the city, the lack of any history of contact, the explosive nature of the outbreak together with its sudden cessation with the adequate superchlorination of the water—are suggestive of water-borne infection. No known abortive cases had been reported in Truro before the outbreak, but as a number of paralytic cases had occurred in the surrounding country—particularly Redruth, which is only nine miles away—it is likely that many carriers existed in the neighbourhood, and contamination of the city's emergency water supply, the intake for which was located in meadows used by children as an unofficial playground, was therefore probable. Unfortunately it was not possible to prove the presence of virus in the water by animal passage, but circumstantial evidence was strong enough to warrant superchlorination and boiling of water for domestic use.

Summary

A description is given of the severe epidemic of poliomyelitis which occurred in Cornwall during 1949 (incidence 0.3 per 1,000 of the population), and it is noted that the areas most heavily attacked in that year are among those which escaped the disease in 1947.

Individual cases of interest are those of two expectant mothers who developed poliomyelitis at or about the date of their confinement. In the one, severe paralysis developed four days before delivery, labour was normal, and the baby was unaffected. In the other, paralysis was first noticed 28 days after confinement. The baby, who was breast-fed, had symptoms suggestive of pre-paralytic poliomyelitis three weeks after birth, followed four days later by convulsions, and now has a slight residual weakness of the muscles of the left shoulder girdle.

An exceptionally severe outbreak occurred in the city of Truro (population 12,950), where 20 cases were notified in the short space of 18 days. The high age group of these patients, their sporadic distribution in the city, the lack of history of contact between cases, together with the sudden cessation of the outbreak after superchlorination of the water supply, known to be contaminated, suggest water dissemination of the virus.

The evidence in favour of intestinal spread of poliomyelitis is briefly discussed; the marked dissimilarity between the seasonal incidence curve of the disease and that of known droplet infections, together with the finding that recorded epidemics of poliomyelitis in Cornwall have been associated with exceptionally hot

weather in the third quarter of the year, lends support to this mode of spread.

I wish to thank Dr. R. N. Curnow for his encouragement and for affording me the facilities for carrying out the investigations, the District M.O.H.s for their assistance, Dr. W. H. Bradley for his helpful criticism of this paper, and Dr. F. D. M. Hocking and Sister E. M. Keeling for kindly reproducing many of the diagrams.

BIBLIOGRAPHY

- Cook, G. T., and Munro-Ashman, D. (1949). *British Medical Journal*, **1**, 345.
- Gear, J. H. S., and Mundel, D. (1946). *S. Afr. med. J.*, **20**, 106.
- Gordon, F. B., Schabel, F. M., Casey, A. E., Fishbein, W. I., and Abendrath, M. (1947). *Proc. Inst. Med. Chicago*, **16**, 123.
- Hamburger, M., and Green, M. J. (1946). *J. infect. Dis.*, **79**, 33.
- Harbitz, F., and Schell, O. (1907). *Dtsch. med. Wschr.*, **33**, 1992.
- Harmon, P. H. (1937). *J. Amer. med. Ass.*, **109**, 406.
- Horstmann, D. M., Ward, R., and Melnick, J. L. (1944). *Ibid.*, **126**, 1061.
- Hurst, E. W. (1929). *J. Path. Bact.*, **32**, 457.
- Kempf, J. E., and Soule, M. H. (1940). *Proc. exp. Biol., N.Y.*, **44**, 431.
- Wilson, M. G., et al. (1942). *Amer. J. Publ. Hlth*, **32**, 1366.
- Kling, C., Levaditi, C., and Lépine, P. (1931). *Bull. Acad. Méd., Paris*, **106**, 245.
- Landsteiner, K., Levaditi, C., and Pastia, C. (1911). *Ann. Inst. Pasteur*, **25**, 805.
- Lensen, S. G., Rhian, M., and Stebbins, M. R. (1946). *J. Amer. Water Works Ass.*, **38**, 1069.
- Local Government Board (1912). Special Report No. 61. Epidemic Poliomyelitis. London.
- Macey, F. (1949). *J. Amer. Water Works Ass.*, **41**, 696.
- Paul, J. R., Trask, J. D., and Gard, S. (1940). *J. exp. Med.*, **71**, 765.
- Registrar-General (1925). Statistical Review of England and Wales. London.
- Sabin, A. B. (1947). *J. Amer. med. Ass.*, **134**, 749.
- Trask, J. D., Vignec, A. J., and Paul, J. R. (1938). *Ibid.*, **111**, 6.
- Wickham, I. (1907). *Acute Poliomyelitis*, New York, 1913. (Translated by Moloney.)

Medical Memoranda

Necrosis After Penicillin

In the case described below aseptic necrosis followed intramuscular injections of penicillin; the condition was associated with thrombophlebitis and severe constitutional disturbance. In view of this experience it is suggested that persistent burning pain at the site of penicillin injections may indicate an idiosyncrasy and make it inadvisable to continue injections.

CASE REPORT

A woman aged 33 with moderately severe glandular and pulmonary tuberculosis was admitted to Harefield Hospital for assessment of her fitness to continue pregnancy. A large glandular swelling developed in the right side of the neck, associated with a leucocytosis of 18,700 (87% polymorphs) and pyrexia. Penicillin injections of 500,000 units in 2 ml. of sterile distilled water six-hourly were started. Most injections were made into the front of the thighs and some into the gluteal muscles. Despite the inclusion of a little 1% procaine in each injection, burning pain was experienced, and redness of the skin and induration resulted. The temperature did not fall, and penicillin therapy was abandoned after five days.

Ten days after the beginning of treatment fluctuant swellings developed in the muscles of both thighs and there was a tender indurated swelling in one buttock. The white cell count was then 30,500 per c.mm. (90% polymorphs). Both thighs were incised and pus was obtained from them. Aerobic and anaerobic cultures of the pus were persistently negative. Fluid from the necrotic tissue was injected into two guinea-pigs intraperitoneally and subcutaneously and neither showed post-mortem evidence of tuberculosis.

The legs continued painful; pus oozed from the wounds, and the surrounding soft tissues were hot and tense, with oedema of the skin and of the legs below the knees. Further