GASTRIC TETANY.

Thesis

A. Ledger.

I N T R O D U C T O R Y.

Definition,- Tetany is a condition which has been considered by a large number of writers, and various ideas have been propounded as to its nature, and even regarding the essential features of the affection. Osler's definition is characteristically brief and inclusive; he defines tetany as " an affection characterised by peculiar bilateral tonic spasms, either paroxysmal or continued, of the extremities"(1) Risien Russell states the same thing rather more fully and adds "in severe cases the muscles of the trunk, neck, face, eyes and larynx may become involved in the spasm." (2). Dr Russell considers that "there are different gradations --- from mild carpo-pedal contractions associated with rickets to severe general spasms, which may even simulate tetanus". Carpo- pedal spasm in children is not rare, and Professor Osler thinks it a mistake to call these cases true tetany.(3). Henoch (4) writing on tetany in children stated:- " This affection is classed with tetany by many, but, in my opinion, it is well to separate the two diseases entirely. I have never been able to detect the symptoms regarded by Trousseau as distinctive -- in idiopathic contractures of children" But in this relation it must be noted that Trousseau's symptom is sometimes not obtained in undoubted cases of tetany. (5). Probably the affection occurs under

(1) The Principles & Practice of Medicine, 1904, p.1109.
(2) Clifford Allbutt's System of Med., 1901, vol.8, p.47.
(3) Loc. cit., p. 1111. (4) Die Tetanie d. Kind., Berlin.
(5) Gowers. Diseases of the Nervous System, 1893. vol.2 p. 703.

various circumstances, and the spasm can be produced by more than one cause.

Tetany occurs in adults mainly in threeconditions, First, in pregancy, lactation, menstrual disorders and the like.

Secondly, from deprivation of the thyroid gland (or para-thyroid.)

Thirdly, in association with gastro-intestinal disturbances, usually dilatation of the stomach or intestines.

It occurs very rarely in ~~children~~ other conditions and in epidemics, and in children is usually associated with rickets.(1).

This thesis deals especially with the third adult variety, but in the attempt to elucidate the fundamental etiology and pathology it will be necessary t to refer to other varities.

History. Tetany does not seem to have been recognized by ancient or medieval writers. In view of the rarity of rickets in old times our commonest variety must in any case have been extremely rare. Hippocrates (2) refers to a peculiarly fatal form of convulsion from hypercatharsis, but this can hardly be

(1) Roberts. Theory & Practice of Med.1905, Vol.2 p. 1188.
Cheadle, Lancet, 1887, Vol. 2, p.919&p. 967.
Russell, Loc. cit., p.52.

(2) Works, Sydenham Society;Vol. 2, Aphorisms p.737.

construed into an allusion to tetany. Clarke in 1815 re-cognised the association with Laryngismus Stridulus(1). In 1851 Trousseau (2) described it, under t the name Tetanilla in nursing women. In 1852 Corvisart (3) gave it the name "tetanie". Neumann (4) in 1857 described the first case of gastric tetany, and in 1869 Kussmaul (5) described three gastric cases, since when the condition has been well recognized and much written about. The first British work on the subject seems to have been by Macall(6), who in 1871 published a case in which tetany had appeared repeatedly during lactation. The first case of tetany resulting from total extirpation of the thyroid gland was published by N. Weiss (7) in ~~QIIP~~ 1880. During the next ten or fifteen years such cases were not rare, and clinical and experimental work was done on the subject by Victor Horsley (8), Kocher(9), and Schiff(10), with the result that it is now possible to prevent such a sequel to operation, though it is not yet a certainty that one can cure the disease if it should arise from this cause.

---

(1) Commentaries on some of the most Important Diseases of Children, quoted by Dr Russell, Loc. cit. p.47.

(2) Gaz. des hôpitaux 1851, No. 128: lectures trans. by Bazire, New Sydenham Society.

(3) Thèse, 1852, Paris. (4) Deutsche Klinik, 1857.

(5) Deutsche Arch. f. Klin. Med. 1869, 6, p. 455-

(6) Glasgow Med. Jour. 1871, Aug..

(7) Volkmann's Vorträge, 1880, No 189. Innere Med. No 63, 1880, p. 1696.

(8) Brit, Med. Jour., 1885.1. p.111; 1890,1,p.287; 2,p.201.

(9) Arch. f. Klin. Chir., 1883,Bd. 29, S. 254, p. 302

(10) Arch. f. Pathol. u. Pharmakol., 1884 Bd. 18, p. 25.

Etiology

Tetany other than gastric.

In children tetany is commoner than in adults in this country. The writer has searched the records of the Blackburn and East Lancashire Infirmary from 1899 to Sept. 1908: in this period 12,351 cases were admitted, and in this number three cases of tetany were found, all children; two were males, aged eight months, and two years respectively, and the tetany was associated with a mild degree of rickets; the third was a female aged 15 years, the origin of the tetany was unknown. Two of the cases were admitted in May, one in April.

Oddo(1) at Marseilles found four cases in children among 3,500 admitted to hospital. Some authors for instance, Roberts(2) and Leonard Guthrie(3) consider that in infants tetany is almost invariably due to rickets. Cheadle(4) lays stress on the association of tetany with rickets, and states that "laryngismus stridulus', tetany, and general convulsions are the positive, comparative, and superlative of the convulsive state in chlidren."On the other hand Frankl-Hochwart(5) lays stress on the association with diarrhoea, dyspepsia, worms, constipation; of seventy-five cases he states that fifty-one showed such affections, nearly always diarrhoea, often ac-

(1)Rev. de Méd., Paris, 1896,Vol. 16. (2) Theory & Practice of Med., 1905,Vol. 2. p. 1188. (3) Index of Treatment, 1907,p.797. (4) Lancet, Vol. 2., 1887, p.919. (5) Die Tetanie, Berlin, 1891,p.19.

companied by dyspepsia and vomiting. Of thirty - eight cases where the age was known, the youngest was two months old, and twenty-seven were below two years of age. Abercrombie's (1) cases were mostly children with bowel complaints, The writer has observed two cases in young infants where there were no signs of rickets. One was a male child aged four and a half months, a small, moderately thin child, who had from birth a very poor appetite, which had been less still for about ten days before the spasm began, the child only taking three ounces of milk with six of water per diem. There was no diarrhoea, constipation or vomiting, and no rise of temperature. For three days the child had tetanoid spasms of the hands, feet, and muscles of the face lasting from two to three hours, with quiescent intervals of from a few minutes to one hour. There was almost complete sleeplessness. On the third day the child died from exhaustion. Permission for a post-mortem was refused. The other case was a female, aged six weeks at ~~birth~~ death. For three weeks from birth she was perfectly healthy, and was properly fed (milk and water). Then she began to suffer from attacks of tetany: the hands were in the "accoucheur" position, the wrists and elbows flexed, the feet dorsi-flexed, and knees and thighs flexed; the lips became blue during an attack; the child had such attacks two or three times a day, Chvostek's sign was present. There was

---

(1) Thesis, London, 1880.

no sickness, diarrhoea, or constipation, and no fever throughtout the illness. Under treatment the child improved for about a fortnight, when the spasm recurred as before, the muscles of the face being also affected. The child would only take very small amounts of milk and water at a time. On the day before death the spasm was constant nearly all day, and up to the moment of death when the child had been unconscious sometime the hands were clenched, and,if forcibly straightened, immediately contracted again. This cases is recorded in some detail on account of theextreme youth of the patient. A post-mortem examination could not be obtained.

It is evident then,that ~~rickets~~ while either rickets, diarrhoea or both are usually antecedent to tetany, in children, neither is essential. Frankl-Hochwart(1) had one case with peritonitis, twice with infantile cholera, three times habitual constipation, and three times intestinal worms.

In adults tetany occurs in several conditions other than gastric or intestinal disorder. Epidemics have been observed such as one described by Simon(2) in a girl's school in Paris. This outbreak is considered however by Gower's (3) and by Ashby and Wright(4) to be one of hysteria. Aran (5) observed twelve cases

(1)Loc. cit. (2) Thèse, Paris, 1877. (3) Diseases of the Nervous System, 1893, Vol.2,p.701. (4) Diseases of Children, 1905, p.562. (5) L'Union Med.,1855, Vol., 9. p. 341

of tetany after the typhus epidemic in Paris in 1855-
The first attack of tetany may follow a nervous shock. Frankl-Hochwart(1) mentions the case of a suckling woman who had her first attack when she was told her child was dead;another a child who was seized with the spasm when told of the death of his father. Owen reports (2) a marked case of tetany in a female which began when she was ten years old shortly after a caning at school; the attacks recurred at intervals for ten years; Trousseau's phenomenon was present. Tetany may be followed by nervous disease, as general muscular atrophy, local atrophy of the thenar muscles, slight atrophy in the muscles of the legs, by chorea and by epilepsy(3), "the last probably often a coincidence." (4).

A very few cases of tetany are recorded due to various toxins, such as lead(5),albuminuria(6), alcohol(7), spermin(8), ergot(9),congenital syphilis(10), and in a woman who was subject to attacks of tetany at the menstrual periods it was produced by inhalations of nitrous oxide gas (11).

A distinct group of cases is that in which the tetany is associated with or follows various acute fevers. Potain (12) records two cases both females who

(1) Loc. cit.p.42. (2) Brit. Med. Jour., 1892, VOL.1 p.276. (3) Gowers, Diseases of Nervous System, 1893, 2pp.704-705. (4) FRANKL-HOCHWART, Die Tetanie, p.85. (5) Gowers, Loc. cit. (6) Russell, Allbutt's System, Vol. 8,p.50. (7) See appendix, cases by Mortimer and Kussmaul,(Nos 37,74.). (8) Russell, Loc. cit. (9)Russell, Loc. cit. (10) Griffith, Amer. Jour. of Med. Sci., 1895,p. 164. (11) C. Simpson, Practitioner, Sept. 1900,p. 286. (12) Quoted by Frankl-Hochwart, Loc. cit. p. 114

developed tetany during convalescence from cholera; both ended fatally. Cheadle (1) reports one, a female aged seventeen years, with a personal and family tendency to convulsions, who exhibited tetanoid spasm during a mild attack of enteric fever. The case of a boy aged four years who showed contractures of the hands and feet, beginning on the third day of an attack of lobar pneumonia is recorded by Dixon(2). There were mild general convulsions, and the pupils widely dilated during the attack. Loeb(3) saw typical tetany affecting the hands in a child who aged four years who died two days later from tuberculous meningitis; Chvostek's sign was present during life. Loeb (4) also records a cases in a female child six years old with scarlet fever; she became aphasic also; recovery was complete. Tetany may occur as a sequel to smallpox, rheumatic fever, measles, acute tonsillitis, diphtheria (5), influenza and malaria(6). The writer has observed tetany in a case of chronic pulmonary tuberculosis(7).

A most interesting and very important group of cases are those which follow thyroidectomy. As the title

---

(1) Loc. cit. p. 920. (2)Practitioner, 1882, Novr. p.,340. (3) Arch. für Kinderheilkunde, Vol.10, 1889 p.212. (4) Loc. cit. (5) Griffiths, Amer. Jour. of Med. Sci.,1895,Vol.109,p.164. (6) Russell, Allbutt's System, Vol.8,p.50. (7) A male, aged 38; no other cause could be found, Trousseau's sign present .

"tetany parathyreopriva" given by Erdheim(1) to this group indicates, the disease is considered by many observers to be due to the loss of the parathyroid glands. Unfortunately though a large amount of clinical and experimental work has been done on the subject our knowledge of the functions of the thyroid and the parathyroid glands is far from complete. Different observers have obtained contradictory results, which can be only partially explained by their experiments being carried out on different species of animals. And the earlier observers did not recognize the distinction between the thyroid and the parathyroid glands. In man the parathyroids are usually four in number, a superior and an inferior pair, lying close behind the thyroid gland, and often partly imbedded in the thyroid substance; the parathyroids have a distinct capsule each, and each a small special artery, which is however usually short; so that unless particularly looked for and preserved the parathyroids will almost certainly be removed in total thyroidectomy; there is a clear description of the anatomy of these glands, with excellent illustrations in a recent article by Halsted and Evans(2). It was soon found by Kocher(3), Schiff(4), and others that it was only the total removal of the thyroid that carries with it the risk of tetany following.

---

(1) Mitt. aus den Grenzgeb. d. Med. u. Chir, 16, 1906
(2) Annals of Surgery, 1907, Oct. p. ~~499~~ 500.
(3) Arch. f. Klin. Chir., Bd. 29, p.302.
(4) Arch. f. Path. u. Pharmakol., Bd. 18, p.25.

If a portion of the gland were left, this risk was not incurred. Of 115 partial removals of the thyroid at Billroth's clinic, reported by von Eiselsberg (1) no tetany appeared; in 52 total removals tetany appeared 12 times. Eiselburg found after experiments on 100 cats that total thyroidectomy certainly produced tetany with fatal results; if half of the thyroid was transplanted into the subperitoneal tissue some three weeks before removal of the second half, and if the graft healed and grew, no tetany resulted. Horsley (2) found that total thyroidectomy in monkeys produced myxoedema, muscular tremors, and sometimes clonic spasms, which however hardly resemble tetany; death occured in five to seven weeks. In dogs painful tetanic spasms ensued, and death usually at the height of the paroxysm. Frankl-Hochwart (3) produced tetany in dogs by total thyroidectomy, and the animals presented the phenomenon of Trousseau, the altered electrical excitability, tremors, and subnormal or febrile temperature as seen in man. Of modern work on this subject one or two examples will suffice for our present purpose. Pool(4) removed both external parathyroids in seven rabbits; no tetany resulted except in one which had twitching of the head for two days. In three rabbits complete thyro-parathyroidectomy was done; two died with tetany in

---

(1) Ueber Tetanie im Auschluss an Kropf-operationem ~~118~~. Wein, 1890.
(2) Brit. Med. Jour. 1885, Vol. ~~2~~, p. ~~533~~.112.
(3) Die Tetanie, pp.36-37.
(4) Annals of Surgery,1907, Oct. p. ~~599~~

thirty to forty hours; the third died on the ninth day but shewed no positive signs of tetany. In four dogs complete hypo-parathyroidectomy was done; in all tetany resulted and death in two to sixteen days. in four dogs complete parathyroidectomy leaving the thyroid; three developed fatal tetany, one doubtful tetany without death.

Lusena(1), Vassale and Generali(2), & Batty Shaw(2) state that removal of the parathyroids produces tetany, which is more rapidly fatal than when the thyroid is removed also, and checked by parathyroid feeding. On the other hand Swale Vincent(3) finds that removal of all four parathyroids is not necessarily fatal; the functions of thyroid and parathyroid differ in different classes of animals; rats and guinea-pigs do not suffer when both are extirpated; monkeys shew transient nervous symptoms; one monkey died in twenty-four hours with typical symptoms of tetany, but it was found that the recurrent nerve and other structures had been included in the one of the ligatures; dogs and cats frequently- not invariably, suffer severely and die; in foxes symptoms come on with remarkable rapidity and death is early(4). It is then evident that with such variations in different animals it is no longer justifiable to assume that the findings in man must be the same as those in any one animal. But the results of operation

---

(1) Quoted Lancet, 1906, Vol.2, p. 432.
(2) Med. Ann., 1907, p. 229. (3) Lancet,1906,VOL. 2,p.430.
(4) For parathyroidectomy in other animals see also John Hopkins Hospital Bulletin, 1907, pp. 331, 333.

are sufficiently definite to indicate that it is the removal of the parathyroids which causes tetany.

A recent case in man following thyroidectomy is related by Pool(1), A female, aged 35 years, SWiss, a seamstress, had the left lobe of the thyroid removed in 1903. In 1906 a tumour was removed from the thyroid isthmus, and during the operation the right inferior thyroid artery was ligatured. The right lobe was left in place. Four days after operation tetanic contractures began. The symptoms were typical, hands feet, and calves affected, and occasionally the muscles of the face, jaw, neck, and back, with cyanosis, asthmatic breathing, difficulty in articulation and deglutition. For several weeks there was marked oedema of the left wrist and hand, and redness over the knuckles of the hand. The signs of Chvostek and Trousseau were present and, not so typically, the electrical reactions. Symptoms persisted for thirteen months. The patient was treated by thyroid and parathyroid substance given by the mouth, and subcutaneously, and five parathyroids were implanted under the skin. The improvement was coincident with repeated doses of Beebe's(2) nucleo-proteid made from parathyroid glands given hypodermically.

Tetany in pregancy, lactation, and during menstruation must be briefly referred to. In this country such cases seem to be very rare. It appears to be,

(1) Annals of Surgery, 1907, Oct. p. 507.
(2) Proc. of the Soc. for Exper. Biology and Med. 4 1907, p. 64.

at least in many cases,due to the relative thyroid insufficiency. Cases reported by McCarrison(1) in which goitrous mothers suffered from tetany during pregnancy and gave birth to cretins are of interest in this relation. Halsted (2) found that partial removal of the thyroid in bitches only produced tetany if they were pregnant, and that the puppies born under these circumstances had thyroids twenty times larger than normal. Meinert's (3) patient had nine normal pregnancies; during the tenth a goitre was removed and tetany came on immediately after and persisted till the birth of the child; tetany reappeared in the eleventh pregnancy. When tetany does not appear till the puerperium it is possible that the foetus produced sufficient excess of thyroid secretion to supply the extra needs of the mother duting pregnancy, though the writer is not aware of any observations on the chilrren which might support this hypothesis. Maccall(4) reports a cases in which tetany appeared during seven successive lactations. Dr Ranking(5) of Tunbridge Wells saw a patient who suffered from tetany while nursing three successive children; two of the children ~~died~~ suffered from asthma.

---

(1) Lancet, 1908, Vol.2, p.1277.
(2) John HOpkins Hospital Reports, 1896,p.373.
(3) Arch. f. Gynäcologie,Bd.30.
(4) Glasgow Med. Jour. Aug. 1871.
(5) Personal communication.
~~(6) Practitioner, 1900.SEpt.,p. 386.~~

Those cases which occur during menstruation are not so easily susceptible of explanation by thyroid inadequacy, though probably of this nature. Simpson(1) reports an illustrative case; the tetany began at the first menstrual period, and the majority of the periods were accompanied by severe cramps of the hands and feet, followed by vomiting. In later life other causes produced tetany but it is necessary in considering the cause of tetany in all persons who have suffered from it previously to remember that "with people who are much disposed to tetany in the course of life different etiological moments are the opportune occasion of putting it in working order"(2). For instance a woman had her first attack of tetany in the puerperium, the second during a cold winter month, a third while pregnant, and the fourth during an attack of typhus fever(3). Tetany associated with pregnancy, lactation, & menstruation though rare in this country used to be very common in Paris, and Frankl-Hochwart(4) knew fifty-two such cases; of thirty-eight of these thirty occurred between January and April. Medical treatment has as a rule a benificial result, but the termination may be fatal, as in a case of Dakins(5), in which the spasms lasted three days, and the muscles of respiration were involved; there was also however severe vomiting.

---

(1) Practitioner, 1900, Sept., p.286.
(2) Frankl-Hochwart, Die Tetanie, p.42.
(3) Hoffmann, Deutsch. Archiv. f. Klin. Med. Bd. 43, 1888, p.53.
(4) Loc. cit. pp.28-32.
(5) London Obstret. Society, 1891, May 6th.

GASTRIC TETANY.

Tetany associated with ~~and due to~~ various gastric and intestinal disorders is the most important of all groups, and the most fatal. In the appendix, and tabulated from the etiological point of view on pp. 26-29, are recorded the writer's own cases, some obtained by personal communication, and the majority of the cases recorded in the literature to the present time; some of the older cases which have been repeatedly quoted by writers on the subject are not here collected on account of inability to obtain the original papers. A few of these are examples of etiological relationships not seen in subsequent cases, and as such are worthy of reference. Fifty-three cases of which the original reports have been consulted are in the tables.

Riegel's (1) well known case was of tetany which occurred in a shoe-black of forty years of age who suffered from ~~Taenia~~ Taenia Mediocanellata. The spasms ceased the day after the worm was expelled. Frankl-Hochwart(2) in the spring of 1886 when tetany was epidemic in Vienna saw two young workmen suffering from perityphlitis who during the first two or three days of the illness had tetany affecting the hands; they had the typical mechanical and electrical muscular irritability of the disease. Frankl-Hochwart quotes also acase of Müller's (3); a locksmith aged

(1) Deutsch. Arch. f. Klin. Med., 1874,12,p.399, quoted by Russell, Frankl-Hochwart, Nothnagel (Diseases of the Stomach) and others.
(2) Die Tetanie, p. 21.
(3) Charité-Annalen, 13,Jahrgang, 1888,p.273.

38 who had perforation of the caecum, and after a violent fall of temperature tetany in severe form a appeared.

In Berlizheimer's (1) case dilatation of the stomach was due to compression of the duodenum by a cyst of the pancreas.

In attempting a classification of cases on etiological grounds, they may first be divided into two groups; first those associated with dilatation of the ~~first part of the~~ stomach, with sometimes dilatation of the first part of the duodenum also, and s secondly cases due to dilatation of the intestines. In eighty-five cases there is one(No 80) due to dilatation of the small intestine, and five cases(Nos 81 to 85) in which the tetany was due to dilatation of the colon.

These cases are undoubtedly as Dr Langmead (2) considers, analogous to those with dilated stomach, but are conveniently considered as a group by themselves. Case No. 80 was a woman aged 33 years, living under bad hygienic conditions and badly nourished. There was marked constipation. At the autopsy the upper part of the jejunum was found greatly dilated, the coils matted together by old adhesions, but there was was no actual intestinal obstruction; the stomach was not dilated nor ulcerated. No. 85 was aged 24; he had probable dilatation of the colon, and diarhoea. The other four cases with dilatation of the

(1) Berl. Klin. Woch. 1897, p. 773.
(2) Trans. Clin. Soc. London, 1907,p.67.

large intestine were all children, the youngest being two and a half years old. In two (81,82) the stools were pultaceous, and very offensive; in one (83) there was long continued diarrhoea; all were emaciated . In all the anatomical condition present was verified by post-mortem examination or by operation; the states found were, greatly dilated sigmoid (81), distension of the caecum, ascending, transverse and sigmoid portions of the colon (82), dilatation of the transverse colon (83), and general dilatation of the large intestine (84). The last named was the only case that survived, and in this case there is evidence that the tetany was due partly to relative thyroid inadequacy. Of these four children two were boys and two girls. In all there is no evidence of any seasonal influence on the tetany.The average duration of intestinal symptoms from their commencement till death or recovery of the patient was one year and ten months; particulars are not definite as to the duration of intestinal disease previous to the onset of the tetany, except in case (84), in which the intestinal disorder had been present three years and five months before tetany appeared. This is of interest from the fact to be discussed later that in the majority of cases associated with gastric disorder such disorder has been present for a long time before the onset of tetany. All these cases exhibited the marked mal-nutrition which is practically always a concomitant of the gastric type of tetany, and all show evience of excessive putrefactive processes in the in-

testine. In none is it possible to state the exciting cause of tetany other than the intestinal condition. Attention should be drawn to this group which has only been recognized quite recently in view of the possibility that other so-called "idiopathic" cases may be have a similar etiology.

The other main group, more accurately described as "gastric" tetany than the foregoing, consists of seventy-nine cases. There are others in the literature to which brief reference is made by writers on this and other subjects, but these cases are are recorded in sufficient detail to be of value for studying the disease. The classification of these cases presents some difficulty; the division adopted in the appendix into cases treated by operation, and cases treated medically is not scientific, but is convenient for studying the cases. The cases treated by medical means are arranged according to the anatomical condition present. But even this is not altogether satisfactory as sometimes there is reasonable doubt in the absence of post-mortem or operative investigation as to the actual lesion. In practically all cases there is marked or great dilatation of the stomach. The remaining four cases in which there was no dilatation are not very fully reported, but the diagnosis is probably correct. In one there was chronic gastric catarrh, the amount of hydrochloric acid in the stomach diminished, and there was no motor inadequacy of the stomach (73). The other three cases had symptoms of hyperchlorhydria and one had gastric ulcer

also. All these recovered, and need not at present b be considered further, but at this stage it is necessary to enter a plea against considering a fatal issue the almost necessary criterion of the disease. In this the writer has the support of Max Einhorn (1) and Mayo Robson(2).

The dilatation of the stomach is usually due to simple pyloric stenosis. This condition was present thirty-three times, and in five of these cases it was stated that the pylorus was also hypertrophied. Five times adhesions of the stomach or pylorus to other organs was also present, but in none of these were the adhesions the cause of the dilatation. Chronic ulcer of the stomach was present nine times and in six of the cases the pylorus was stenosed as well. Only once was active ulceration present, and in that case the ulceration involved the pylorus, there had been stomach symptoms present for ten years and the pylorus was surrounded by dense adhesions(3).

In one of the writer's cases (32) the stomach was hour-glass in shape; there was stenosis of the pylorus and some perigastric adhesions as well. One of Müller's cases (38) had hour-glass stomach and duodenal obstruction. A remarkable case is that reported by Warbasse(9), in which moderate dilatation of the stomach due to a mass of metallic articles retained in it was the cause of the tetany. Four times there was atonic dilation of the stomach without any obstructive lesion- One was a case of acute paralytic

(1) Diseases of the Stomach. 1902,p .401.
(2) Diseases of the Stomach, 1904,p.408.

distension with gastric ulcer, in theother three there was no ulceration and no lesion is recorded except in 61, where there was a new growth of the body of the pancreas not in a position to produce obstruction, with cirrhosis of both kidneys. In only six cases was the gastric dilatation due to ulcer of the duodemum, once to duodeno-pyloric obstruction from the pressure of a large stone in the gallbladder(Blazicek) and once it was due to carcinoma of the duodenum.(49) Carcinoma of the pylorus was present in seven cases. Five times marked gastroptosis is recorded, but in none of these was ptosis the only lesion causing dilatation of the stomach.

There remain five cases in which the nature of the stomach disease is doubtful. Omitting these there remain seventy-four gastric cases; in these the anatomical lesions are as follows:-

Gastric dilatation.

Simple stenosis of pylorus	33	(44.6%)
Simple stenosis of duodenum	7	(9.4%)
Carcinoma of pylorus	7	(9.4%)
Carcinoma of duodenum	1	(1.3%)
Atony	4	(5.4%)
Foreign bodies	1	(1.3%)
No cause given	17	(22.9%)

No dilatation.

Chronic gastric catarrh	1	(1.3%)
Hyperchlorhydria	2	(2.7%)
Ulcer with hyperchlorhydria	1	(1.3%)

These figures probably represent about the usual relative frequency of serious gastric disease, except under the heading atonic dilatation; this is contrary to Russell's(1) statement that "dilatation from atony is a very rare cause of tetany", but it must be borne in mind that there is always a tendency to report the more rare forms of disease. Still tetany of gastric origin being itself a rare condition this objection has perhaps not much weight. In many of the cases there was a marked increase in the gastric dilatation before or along with the onset of tetany. But twice, the tetany was preceded by marked peristalsis of the stomach. In twelve other cases gastric peristalsis was a prominent symptom. Lavage of the stomach, or passing the stomach tube has long been considered an important exciting cause of tetany; in one or two of the older well-known cases such was the sequence of events, which has resulted in the unfortunate opinion that lavage must not be used in treating the condition. The present series shews how slight a foundation has this opinion. In only seven cases was lavage definitely the exciting cause of tetany, and all of these were examples of advanced gastric disease in which all the conditions necessary to produce tetany were present; and in two of them lavage had been used previously in treating the gastric disease, and had produced a very beneficial result (6,24). In eleven other cases lavage had been used in treating the gastric disease before the occurrence

(1) Allbutt's System of Med., Vol.8, 1901, p.49.

of tetany, but was in no way the means of starting it. The occurrence of tetany from lavage is used as a proof of the reflex origin of the disease, and in this relation it may be noted that, also in case 6, the introduction of a needle for subcutaneous saline injection excited a paroxysm, and in two cases the tetany followed copious drinks of cold water.

It is of more value to consider the important and often preventible causes. And first the writer would call attention to the danger of giving alcohol by the mouth in advanced cases of gastric dilatation. Bouveret and Devic(1) many years ago, and pointed this out on experimental grounds, and other experiments which will be referred to later support the contention. In seven cases tetany of gastric origin definitely followed the administration, medically or otherwise, of alcohol in various forms, but always by the mouth. In other cases mention is made of "stimulant" having been administered, but the nature of the stimation is not recorded. Twice, not including the man who swallowed pen knivesand the like for a living, indiscretions of diet other than alcoholic were followed by tetany.

In the great majority of cases copious vomiting preceded the onset of tetany; this is definitely stated in twenty-five cases, and usually tetany shortly followed. Practically all cases have suffered from vomiting to a greater or less degree for a long time, but vomiting which is particularly frequent and cop-

(1) Revue de Médicine, 1892, Feb., pp. 48, 97.

ious, especially if associated with painful peristalsis of the stomach is apt to be followed bytetany. The amount of the fluid vomited may be enormous, although little or nothing has been taken by the mouth for a considerable time before. In these cases there is a hypersecretion of gastric juice, often apparently a continous secretion of gastric juice. Indeed tetany is considered as a complication of hypersecretion of gastric juice by Bouveret and Devic(1), and by Riegel (2). By these authors it is considered that usually there is also an excess of hydrochloric acid. In this series the quantity of hydrochloric acid in the gastric secretion is not often stated, but in thirteen cases there is proof that it was present in excessive amount, and in others the symptoms point to a probability of such excess. On the other hand in six cases the amount of hydrochloric acid was normal, and seven times it was present in diminished amount.

The nature of the gastric contents will be considered more fully in the section dealing with the Pathology of gastric tetany.

In nearly all the cases it is evident from the anatomical lesion present that there must have been motor inadequacy of the stomach. In only nine, however, is there decisive clinical evidence from test meal or otherwise that such was the case.

---

(1) La Dyspepsie par Hypersécrétion Gastrique; Baillard et Fils, 1892.

(2) Loc. Cit.,p.355.

An etiological relationship of great importance on which previous writers have not laid stress is the state of the bowels. In every case in which this was noted, except two, there was great constipation, and in one of these cases it is only stated that the bowels were moved the day before the attack of tetany, and in the other that they were"regular".

The amount of urine is usually diminished during the attack, and often a diminution in the urinary secretion precedes the tetany. Many of the cases reported are from private practice and no figures on this head are available, and in others admission to hospital was sought on account of the tetany. But in case 7 which was under careful observation in hospital for some time before the onset of tetany there was a marked decrease in the amount of urine for five days before the tetany. And in case 56 already referred to, cirrhosis of the kidneys seems to have been an essential part of the disease.

Practically every case of gastric tetany is markedly emaciated,or at least very thin, and often there has been a rapid loss of weight in the months immediately preceding the onset of tetany. In only two cases in which the state of general nutrition is stated was the patient well nourished, and one of these was the swallower of metallic articles previously referred to. And nearly always the gastric disease has been present some years. The shortest time was six months, and the longest twenty years.

In cases where actual figures are given- thirty-four in number-the average duration of gastric ~~tetany~~ disease previous to the onset of tetany was 7.51 years.

ETIOLOGY TABLE I,

Observer and Case number	Age	Sex	Month	Occupation	Bowels	Urine	General Condition	Duration Gastric Disease (years)	Nature of Gastric Disease,	Exciting cause of Tetany.
Mayo Robson I	34	M,	Jany,		Very costive		Lost 1 stone in weight	5	Marked dilatation; cicatricial stenosis & hypertrophy of pylorus,	
Mayo Robson II	25	M.	Octr,				Lost 2 stones in weight.	Several	Great dilatation; pylorus much stenosed.	Daily vomiting.
Mayo Robson III	29	F.	Decr.				Lost 2 stones in weight.	10	Great dilatation; active ulceration pylorus, and adhesions.	Daily vomiting of large amounts,
Robson and Moynihan IV	50	M.	June	Gentleman		Albumin and bile	Extreme emaciation.	6	Marked dilatation; chronic ulcer of stomach; pyloric stenosis.	Vomiting more frequent.
Mackay and Macdonald V	52	F.	May			Albumin	Very thin	12	Great dilatation; pylorus hypertrophied; HCl increased,	Lavage (?)
Jonnesgo and Grossman VI	40	M.	April			Diminished	Great emaciation.	10	Great dilatation; pylorus thickened; hyperchlorhydria.	Lavage; copious vomiting.
Dickson VII	47	M.	Novr.	Tailor	Constipated	Albumin & casts.	Marked emaciation; emotional.	17	Great dilatation; hypersecretion; pyloric stenosis; adhesions.	Copious vomiting; alcohol.
Brown and Engelbach VIII	48	F.		Housewife		Nucleo albumin	Emaciated	1½	Great dilatation; cicatricial pyloric stenosis.	Indigestible food.
Cunningham X	28	M.			Constipated	Albumin & casts.			Dilatation, pyloric stenosis. HCl normal.	Lavage.
McKendrick XVI	26	M.	June		Constipated	Albumin		12	Marked dilatation; cicatricial pyloric stenosis; dense adhesions.	
Halliburton & McKendrick XVII		M.			Constipated	Albumin & acetone		15	Marked dilatation; cicatricial pyloric stenosis; HCl normal.	
Trimble XVIII	45	M,	Sept,	Commercial Traveller.	Moved day before attack.	No albumin.		Some years.	Great dilatation.	

ETIOLOGY TABLE II.

Observer and Case number		Age	Sex	Month	Occupation	Bowels	Urine	General Condition	Duration Gastric Disease (years)	Nature of Gastric Disease.	Exciting cause of Tetany.
Collier	XIX	36	M.	Aug.		Great constipation		Rapid loss of flesh.	5	Marked dilatation; vomit very acid.	Lavage (?)
Martin	XX	48	M.					Mal-nutrition	7	Marked dilatation; cicatricial stenosis of pylorus.	Lavage
Fenwick	XXI	34	M.	Feb.	Carpenter	Constipated	Albumin and sugar	Well-nourished	½	Dilatation; chronic ulcer at pylorus.	Copious Emesis
Fenwick	XXII	46	M.		Gardener	Very costive	No albumin or sugar	Emaciated	4	Great dilatation; pyloric ulcer (?)	Cold; severe vomiting.
Simpson	XXIII	65	F,	Oct.& April		Constipated	No albumin	Emaciated	20	Dilatation from duodenal ulcer.	
Howard	XXIV	58	M.	Jany.	Merchant	Regular	Albumin	Lost 25 lbs. in weight	5	Great dilatation; pyloric stenosis from scar; adhesions; HCl normal.	Lavage
Sievers	XXV	21	F.	Nov,	Servant	Hard Scybala post mortem		Emaciated		Enormous dilatation; cicatricial pyloric stenosis.	Vomiting
Sievers	XXVI	42	F.	April	Wife of Servant	Constipated	Albumin	Emaciated	15	Enormous dilatation; cicatricial pyloric stenosis.	Fatigue (?)
Kussmaul	XXVII	15	F.						4	Great dilatation	Vomiting
Kussmaul	XXVIII	27	M.						14	Great dilatation; pyloric stenosis.	Vomiting
Kussmaul	XXIX	37	M.							Great dilatation; pyloric stenosis.	Alcohol vomiting.
Dujardin-Beaumetz	XXX	46	M.						5	Dilatation from duodenal ulcer.	
Bouveret and Devic	XXXI	66	F.						1	Great dilatation; chronic ulcer near pylorus. HCl increased.	
Ledger	XXXII	31	F.	April	Wife of a labourer.	Constipated	Albumin	Thin, gaining weight.	3	Great dilatation; hour-glass stomach; pylorus hypertrophied.	

ETIOLOGY TABLE III.

Observer and Case number	Age	Sex	Month	Occupation	Bowels	Urine	General Condition	Duration Gastric Disease (years)	Nature of Gastric Disease.	Exciting cause of Tetany.
Ledger XXXIII	57	F.	All	Housewife; easy circumstances.	Constipated	Albumin, casts, indican, acetone.	Emaciated	12	Great dilatation; gastroptosis; pylorus stenosed; bacteria in stomach.	Brandy; vomiting.
Trevelyan IXL	45	F.	July		Constipated	Albumin	Emaciated	15	Great dilatation; gastroptosis; carcinoma of duodenum.	Copious emesis.
Kuckein L	48	M.	July	Merchant	Constipated	Albumin	Emaciated	4	Great dilatation; cancer of pylorus; HCl absent; many bacilli.	
Moorhead LI	54	F.	Feby.	Married	Constipated	Albumin Indican	Emaciated	6	Great dilatation; cancer of pylorus; HCl +; many bacteria.	Lavage
Bouveret and Devic LII	37	F.						½	Great dilatation; cancer pylorus.	
Trevelyan LVI	60	F.	July			Kidney cirrhotic (P.M.)	Emaciated		Great dilatation of stomach & upper part duodenum; no obstruction.	Incessant vomiting.
Holman LVII									Great dilatation; no ulceration.	Lavage
Fenwick LVIII	30	F.						1 2/12	Ulcer; acute paralytic distension.	Vomiting
De Baurmann LIX	33	M.						Several	Dilatation from atony.	
Nason LX	48	M.	July				Loss of flesh	Some months	Much dilated; excess of acid.	
Howard LXI	24	M.	Nov. & Decr.	Rattanner	Diarrhoea	Albumin	Emaciated	1½	Marked dilatation; HCl normal.	
Howard LXII	52	M,	July	Manager of Foundry	Constipation	Albumin	Emaciated	5	Dilatation; HCL normal	Lavage
Howard LXIII	18	M,	Feb. Dec & Jan.	Janitor	Constipation		Good	1	Slight gastrectasis; HCL +	Vomiting
Howard LXIV	45	M.	March	Plumber	Constipation	Albumin		Several	Gastrectasis; HCL diminished	Alcohol(?)
Howard LXV	46	M.	Nov, & Feby.	Labourer	Constipation	Normal	Lost weight	13	Gastrectasis; HCL +; chronic ulcer.	Vomiting

ETIOLOGY TABLE IV.

Observer and Case number	Age	Sex	Month	Occupation	Bowels	Urine	General Condition	Duration Gastric Disease (years)	Nature of Gastric Disease	Exciting cause of Tetany
Calwell LXVI	26	M.	Jany.		Constipated	Albumin	Lost 3st.10lbs.	3	Great dilatation; HCl +	
Einhorn LXXIII	28	M.	August					Many	Chronic catarrh; no motor insufficiency; HCl diminished.	Ice water. Indiscreet diet.
Mortimer LXXIV LXXV	Adult	M.				Albumin Indican			Hyperchlorhydria; no dilatation.	Alcohol.
Trevelyan LXXVIII	17	F.						6	? Vomiting	Cold weather, vomiting.
Gulland LXXIX	48	M.	June		Constipation	Albumin	Lost 2 stones.	1 4/12	Ulcer; no dilatation; HCl +	
									INTESTINAL	
Greenfield LXXX	33	F.	August	(bad hygiene)	Constipated motions pale.		Mal-nutrition	12 days	Dilatation of upper part of Jejunum; adhesions; stomach not dilated.	
Langmead LXXXI	6	M.	Nov & April		Pultaceous stools.		Mal-nutrition		Greatly dilated sigmoid; renal calculi.	
Langmead LXXXII	3 2/12	M.	May		Pultaceous and offensive stools.		Emaciation		Distended coecum, ascending, transverse, and sigmoid colon.	
Sturges LXXXIII	2½	F.	June		Diarrhoea		Emaciated	1 4/12	Dilated transverse colon.	
Batty Shaw & Mant LXXXIV		F.					Mal-nutrition	4	General dilatation large intestine.	
Howard LXXXV	24	M.	Dec, to March	Lumber Inspector	Chronic diarrhoea	Albumin occasional.	Emaciated	10/12	Probable dilatation of colon; stomach slightly dilated.	
Warbasse IX	23	M.		Tailor "human ostrich"			Well-developed	7	Mass of metallic articles in the stomach; some gastric dilatation.	

Frequency.

Gastric tetany is generally considered a very rare disease, and many practitioners have never seen a case including those with a very large experience of gastric disease. Clifford Allbutt(1) in fifteen years during which cases of gastrectasis were largely treated by lavage had never seen a case. Riegel(2) had only seen three cases in 1903. Boardman Reed(3) and Einhorn(4) consider it an extremely rare condition. Von Sievers(5) in 1898 had only seen two cases, and knew of but two others reported from Finland. Among records of 12,351 medical and surgical cases treated at the Blackburn and East Lancashire Infirmary as inpatients from 1899 to 1908 there was no case of gastric tetany. At the Ancoats Hospital, Manchester, during the past ten years there have been but two cases(6). At the Edinburgh Royal Infirmary from ~~OIO~~ 1891 to 1900 inclusive there occurred but one case of gastric tetany(7). Among 18,150 medical admissions to John Hopkins Hospital were only nine cases of tetany of gastric origin(8). The cases collected for this thesis probably represent the great majority

---

(1) System of Med., Vol. 3, p.502. 1897
(2) Diseases of the Stomach, English edition, 1903, p. 164
(3) Diseases of the Stomach and Intestines, 1905 p.394.
(4) Diseases of the Stomach, 1902, p.400.
(5) Berl. Klin. Woch., Aug. 1898, p.680.
(6) Personal communication from Dr Craven Moore.
(7) Simpson, Practioner, 1900, Sept. p.284.
(8) Howard, Amer. Jour. of Med. Science, 1906, p.315

of those reported; the literature available has been searched carefully in order to obtain a complete series on which to found reliable statistics.

It must therefore be conceded that gastric tetany is undoubtedly a rare condition. But the writer is inclined to agree with Mayo Robson's contention that it "is not so rare as generally supposed"(1). In many cases the condition of tetany may be overshadowed by urgent gastric symptoms, especially in cases where the spasms are markedly intermittent. And in others unless the spasm is actually seen an erroneous diagnosis may be made. These considerations cannot apply to the observers mentioned above, but the writer has seen one case of gastric origin in which the presence of tetany had been unrecognized.

Other varieties of tetany are much more common. Thus Frankl-Hochwart(2) in his study of tetany has in the main groups the following numbers of cases:- chlidren 75, idiopathic workmen's tetany 314, pregnancy and lactation 47, thyroidectomy 31, gastric dilatation 15.

In Howard's(3) series there are ten with dilated stomach in a total of thirty adult cases of tetany, and forty-seven cases of tetany in children. It is probable that in this country the proportion of cases in children, with rickets, gastro-intestinal disorders, and acute fevers is much higher than in either

(1) Lancet,1898,Vol2,p.1333.
(2) Die Tetanie, Berlin,1891,pp.19,12,29,32,and21.
(3) Amer. Jour. of Med. Science,1906,pp.330-337.

of theseseries but there are no statistics on the s. subject.

Gastric tetany probably occurs with about equal frequency among European races, except those of Latin origin, among whom it seems to be more rare.

Of eighty-five cases the race distribution is as follows :-

(1) Great Britain and Ireland	30
Germany and Austria	22
France	10
Finland	4
Russia	1
American (nearly all from the United States)	17
Negro	1

The greater number in this country is partly due to the inclusion of five cases with intestinal dilatation, but is also probably due in part to the more ready availability of English literature; for the latter reason also the proportion of American cases may be too great. Such an explanation does not wholly account for the small number from France. The countries which have the most severe cold in winter namely Finland and Russia show a very small proportion of cases, a matter of interest in view of the old explanation of the origin of tetany from cold. As regards other varieties of tetany however it appears to be especially frequent in Germany and Austria.

---

(1) This includes two cases communicated by Dr Craven Moore.

Thus Frankl-Hochwart(1) writing in 1891 founded his monograph on 482 cases, of which 314 were idiopathic workman's tetany. Gower's(2) in 1893 considered 150 cases of tetany, the great majority of these being in children and young people. Griffiths(3) was only able to collect in 1895 a total of 77 American cases after a careful review of the literature, and in these many cases of comparatively mild carpo-pedal spasm are included. Indeed Osler(4) in 1904 stated that in America tetany is an extremely rare disease. Frankl-Hochwart states that from 1880-1889 the admissions of tetany to the Vienna General Hospital were equal to 0.75% of all nervous cases, and at the Berlin Hospital 0-1% during the same period.

Season.

Practically all writers on Tetany lay stress on its more frequent occurrence in the early months of the year and Frankl-Hochwart went so far as to write that this was the only certain fact applicable to all varieties on which to base a theory of the etiology of tetany. Grumpecht(5) gives nearly 75% of cases occurring between January and March. Frankl-Hochwart(6)

(1) Die Tetanie, Berlin.
(2) Diseases of the Nervous Sysrem, Vol.2, p.699.
(3) Amer. Jour. Med. SCi., 1895, p.158.
(4) Principles and Practice of Med., p. 1110.
(5) Centralbl.f. inn. Med., 1897, p.569.
(6) Loc. cit. see especially pp. 11, 19, 39.

gives February, March and April as typical tetany months; of ten gastric cases he found that five occurred in these months, and only one altogether between May and September. He gave a chart of 360 cases of all varieties, and very few of these are in the months June to December. The highest number-92- occurred in March, the next largest in April and February. It is undoubtedly a fact that some chronic cases have their attacks of tetany in the colder months, but in the present series there is no month with a marked preponderance of cases. There are thirty-nine in which the month when the attack occurred is stated, and they are distrubeted as follows:- January 4, February5, March3, April 5, May 2, June 3, July 5, August 3, September 1, October 2, November 4, December2. February March and April have thirteen cases. Taking the coldest half of the year as being generally Nov. to April we have in this period twenty-three cases, as against sixteen for the other six months. This is certainly a markedly larger number in the colder wearher, but nothing like the high proportion given by other observers. Reduced to percentages for comparison with previous figures we have January to March 30.7%, February to April 33.3 %, November to April 58.9 %.

Occupation.

Gastric tetany seems to have no special incidence on any one trade or profession. Unfortunately among the male cases of the present series the occupation is given in only thirteen. One of these is described

as a gentleman, and the remaining twelve can be separated into two groups, working men and business men; the occupations represented are as follows:-

Working men. 7.		Business men. 5.	
Tailor	2.	Merchant	2
Carpenter	1.	Commercial traveller	1.
Gardener	1	Lumber Inspector	1.
Janitor	1	Manager of foundry	1-
Plumber	1.		
Rattanner	1.		

These numbers are very small but, as far as they go, are in striking constrast to Frankl-Hochwart's figures (1). He found tetany particulary common among cobblers and tailors (but not seamstresses). Among 314 male cases only eight are private or professional men, one being a doctor of medicine. Of theremaimder 141 are cobblers, and 72 tailors; nearly all belong to the artisan class, only two being described as labourers, and two as vagabonds. There are no particulars as to the trade of his gastric cases.

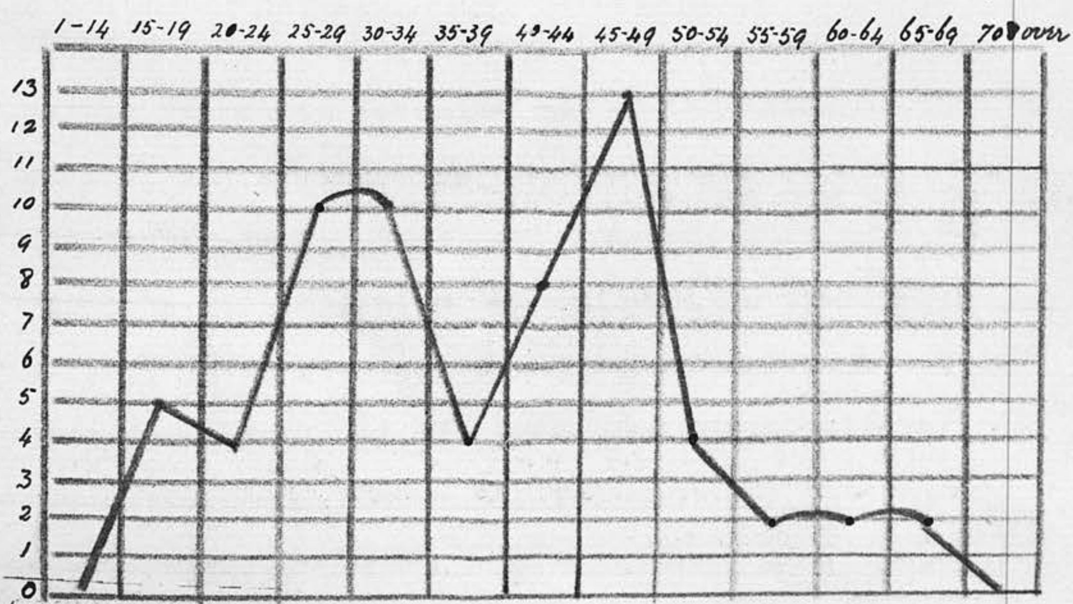
Age.

Gastric tetany is a disease of adult life, but other varieties occur at all ages; tetany is in this country and America most common among children. The youngest cases recorded are one at two days old(2) and one six days old(3). From about four months to

(1) Die TEtanie, see esp. pp. 12,13. Similar figures in Nothnagel's Specielle Path. u. Therap., B. 11, T.2 p. 81, 1897.
(2)Howard, Amer. Jour. Med. Sci.,p. 336. 1906
(3) Griffith, Amer. Jour. Med. SCi., 1895,p. 173.

two years of age is the period during which tetany is the most common. Of seventy-two cases collected by Griffiths forty-five are under two years. In Howards seventy-seven cases forty-seven are under six years old. British statistics shew a less striking preponderance in young children; Gowers(1) gave the age gre grouping of 142 cases; of these 23.9 % were between one and four years, 85.9 % under twenty years. Tetany does not occur in the very old.

In this series of cases the age is given in sixty-nine. Of the gastric cases the youngest is aged fifteen and the oldest sixty-six. Five of the cases are of tetany with intestinal dilatation, the ages of these being 2½, 3, 6, 24 and 33 years. There remain sixty-four typical gastric cases. All are over the a age of puberty. The chart following shews the distribution of these in various quinquennial periods. There are three periods when gastric tetany is most common, namely from twenty-five to twenty-nine and from thirty to thirty-four (ten cases in each) and again from forty-five to forty-nine (thirteen cases).



(1) Diseases of the Nervous System. 1893 Vol. 2) 62

This chart presents features of considerable interest. It would appear at first glance that the ages when the curve rises highest namely from twenty-five to thirty-four, and again from forty-five to forty-nine are the periods when gastric diseases from ulcer and carcinoma respectively are most prevalent. As a fact this is not so in this series. From forty-five to forty-nine are only three cases of carcinoma, one above this period, two below it, and two in which the age is not stated. Most of the thirteen casesin this period are of gastric dilatation due to pyloric stenosis from chronic ulcer. It must be remembered that gastric tetany usually appears in persons with gastric dilatation who have suffered from gastric disease for some years.

The opinion is general that gastric tetany is a disease of middle age. Fenwick(1) gives the average age of twenty-three cases as forty-eight. According to thepresent larger series half the cases occur under forty years of age.

Sex.

Males are ~~generally~~ greatly in excess of the females. The sex is stated in seventy-four of the cases of this series, and of these forty-eight(64.86 %) are males, and twenty-six(35.14 %) are females. This agrees with the findings of other writers. In twenty-six gastric cases Fenwick(2) had twenty males. Males indeed predominate at all ages, and taking all varieties of tetany together the influence of maternity

(1) Transactions of Clinical Society, London,1895,p16.
(2)Loc. cit,p. 18.

is not sufficient to make the number of female equal the male cases. Gowers(1) for instance in ~~forty~~ 142 cases at ages from one to sixty-one years had seventy-six males. Among children males are in marked excess; the following are typical series to illustrate this fact:-

Author.	Number of children.	Boys.	Girls.
Frankl-Hochwart(2)	37	20	17
Howard (3)	47	33	14

In Vienna there are about as many male as female tailors, but in nine years at hospital there were 72 of the former to only 2 of the latter with tetany (4).

Heredity.

There is no evidence of any hereditary influence in gastric tetany. Two cases give a history of nervous disease in the family, and a few of gastric disease; but these cases are not in greater proportion than such histories would be among the general healthy population. Among children on the other hand there is more often some evidence, but not very strong of hereditary influence. A fatal case which has been already mentioned(p.5) was a child of four

(1) Loc. cit. p. 699
(2) Die Tetanie, p. 19.
(3) Amer. Jour. Med. Sci. 1906, p. 315.
(4) Frank -Hochwart, Loc. cit, p. 39.

and a half months who was, with his twin sister, the youngest of a family of seventeen children; the parents were healthy and there was no nervous disease among the grandparents; six of the children had died in infancy, three of these between the ages of four and four and a half months with symptoms which the mother considered identical with those of the present case. Abercrombie(1) mentions two families in each of which four children had suffered from tetany, one in which three children had tetany, and one in which two children had tetany and another had died from laryngismus. Griffiths(2) reports five cases in one family, and Cheadle (3) a family of five children of whom one had tetany, one died at six months with laryngismus, one had "croup" at four months and died at one year and ten months in general convulsions, and one died at six months with diarrhoea but no convulsions. Of chronic tetany in adults two cases in a family are reported by Simpson(4), and in another by Emerson(5).

---

(1) Thesis, London, 1880.
(2) Amer. Jour. Med. SCi.1895,p.173
(3)Lancet, Vol. 1887, p.920.
(4) Practitioner,1900, Sept.,p. 286
(5) John Hopkins Hosp. Bull., 1906,p.38.

PATHOLOGY.

Morbid Anatomy. In the present series there are records of thirty-nine autopsies on cases of gastric tetany. Unfortunately the attention of observers in most of these cases has been devoted only to the gastric condition present. Thus in only ten cases was the central nervous system examined. The associated gastric diseases have already been described (pp. 19-23), and the condition found at autopsy in these cases need only be summarised here as far as relates to the anatomical condition of the stomach. Five autopsies were on purely intestinal cases, the remaining thity-four disclosed the following conditions, the stomach being dilated in all:-

Cicatricial stenosis of pylorus	20
Cicatricial stenosis of duodenum	4
Cancerous stenosis of pylorus	4
Cancerous stenosis of duodenum	1
No ulceration or obstruction	4
Perforation of the cardiac end	1

In one case of pyloric stenosis, and in one of duodenal obstruction from kinking, the stomach was hour-glass shaped. Of eleven cases treated by operation in which the condition found is clearly described ten had cicatricial pyloric stenosis, and one foreign bodies in the stomach.

Of the cases in which the central nervous system was examined most show no definite abnormality . The meninges; In one of Siever's cases (25) and in Kuckein's (50) the pia mater was injected with

blood;in Siever's second case(26) the pia mater was suffused with blood and oedemic, and in one of Kussmaul's (28) the pia was markedly oedematous, and a large quantity of fluid was found on the surface of the brain, and the lateral ventricles were distended with fluid. A similar condition was present in the case of Dujardin-Beaumetz (30). On the other hand in one of the writer's cases (32) there was a remarkable diminution in the amount of cerebro-spinal fluid and but for some slight adhesions the meninges were, as in the remaining cases examined, normal. The brain substance in case 25 was suffused with blood, but in Kuckein's and in case 32 it was pale and somewhat dry, and in the other cases is merely described as normal. The brain was examined microscopically, including cerebrum, the crura, pons, and medulla oblongata in case 32 and no abnormality or disease was found (1).

The spinal cord was examined microscopically in Müller's case (38) and slight softening of the anterior commissure and of the anterior horns of grey matter in the cervical enlargement was found; this case was reported in 1889.

~~The~~ But in Moorhead's case (51) and in case 32 the spinal cord was examined microscopically and the ~~ne~~ nerve cells and nerve fibres were found to be normal

In other varieties of ~~te~~tetany somewhat more definite changes have been observed in the central nervous

(1) Dr Craven Moore informs the writer that he has examined the brain in two other cases of gastric tetany microscopically; in neither was there any abnorm-

system; most of these observations are old, and the cases are children in whom a greater vulnerability of the nervous system might be expected, or the lesions found are such as might have been pre-existent without symptoms, or may be rather the result than necessarily the cause of the disease. Nathan ~~Wise~~ Weiss examined (1) four fatal cases after total thyroidectomy. In one he obtained no positive result, but in the others changes in the spinal cord were more definite the longer the patient had presented symptoms of tetany. In a case which died in two days there was in the cervical region swelling of isolated ganglion cells and distinct hyperaemia of the grey matter in the anterior root zone. In another who died three months after operation there was swelling of many cells in the posterior horns of grey matter, lateral position of the nucleus, vacuolation and atrophy of cells, and swelling of the axis cylinders of the anterior root fibres, and their continuation into the grey substance; these changes were most marked in the fifth and sixth cervical segments.

The third case died in fourteen days and similar but less distinct changes were found, but there was no atrophy of cells.

In two children atrophy of cells and increase of neuroglia in the grey matter of the cervical and lumbar enlargements were found by Benoxne and Cervesato (2). Hyperaemia of the meninges, brain, and

(1) Volkmann's Vorträge, 1880, p. 189.
(2) Révue des Maladies de l'enfance, Feb. 1896.

cord is described in children by Tonnelé(1), De la Berge(2), Baginsky(3),and others. Some have noted oedema of the brain and spimal cord. On the other hand there are many instances of normal findings in the central nervous system; Tonnelé and De la Berge report such cases, as also Abercrombie(4), Bücher(5) and Loos(6) and many others. In tetany produced in animals by thyroidectomy the central nervous system has been found normal by Frankl-Hochwart(7). The cerebro-spinal fluid has been examined in children during the progress of the disease and found normal(8) No good object can be served by giving details of many post-mortem examinations; the findings if abnormal at all, are contradictory, and inconclusive. The peripheral nerves have been found to be normal. Peters(9) has described interstitial neuritis of the extra-dural portion of both motor and sensory nerves.

The thyroid and para-thyroid glands- In the present series of cases there is some description of the condition of one or both of these glands nine times. In four of these cases the thyroid appeared clinically to be normal and in two enlarged. Only in three cases was a careful post-mortem examination undertaken, and in all of these marked abnormalities

(1) Gaz. Méd. de Paris,Vol.3, 1832.
(2) Jour. hebdom. des progrés de méd.1835, no,45,48, 49.
(3) Arch.f. Kind. 1886,p. 321.
(4) Thesis, London, 1880.
(5) Volkmann's Vortäge,no. 357
(6) Wein. Klin. Woch., 1891,no. 49.
(7) Die Tetanie, 1891,p. 116.
(8) Ann. Méd. et Chir. Inf., June 1, 1904.
(9) Deutsch. Arch. f. Klin. Med., Vol. 76.

were discovered. In one the thyroid was enlarged and there was a marked increase of colloid substance (50) in the second (51) there was a very great increase in the colloid substance and some calcareous deposits in the thyroid gland. Case 24 was the only one in which the parathyroid bodies were microscopically examined, and it is of especial value in that the investigation was made by MacCallum of John Hopkins University.(1) In this case was seen great increase in number of the karyo-kinetic figures throughout the parathyroids, evidence of the great activity of these glands. MacCallum has found similar appearances in a woman of sixty-five with acidity and no dilatation of the stomach. He does not mention any negative results. In another case of this series(84) though no mention is made of the condition of the thyroid, treatment by thyroid substance proved curative when other methods failed. In this relation Poole's case previously referred to (p.12) is of especial interest; after other methods had failed cures followed the hypodermic injection of nucleo-proteids prepared from the para-thyroid glands.

The kidneys at autopsy were dideased in seven cases, healthy in four. Of the seven, six were examples of cirrhotic nephritis, in one with acute nephritis superadded, and in one case the kidneys were the seat of cancerous metastases. In one case although the stomach was dilated, there was no ulceration or obstruction to the passage of gastric contents, the

(1) John Hopkins Hospital Bulletin, 1906, p. 38.

only lesion being marked cirrhosis of the kidneys. The state of the urine is reported in twenty-nine cases. Of these it was normal in five, diminished in amount in nine cases, contained albumen in twenty-one though rarely in more than slight amounts, acetone twice, sugar once, indican four times, and casts five times. Bile was present once. In one case toxins were sought for in the urine with negative results. Peptotoxins have been found in the urine by Ewald and Jacobsen in one instance(1). Nearly all the cases with albuminuria were of a very severe character. The urine often was found to be healthy before the onset of the tetany, and in most there was no evidence of structural disease of the kidneys.

In reviewing the post-mortem reports the absence of any gross anatomical lesion as a cause of death is remarkable. In nearly all the heart, lungs and blood vessels are healthy; the nervous system generally normal to the naked eye and on microscopic examination; in all cases examined there was evidence of increased activity of the thyroid and parathyroid glands; in about one-sixth of gastric cases there is Bright's disease.

The gastric contents- Bouveret and Devie(2) though not the first to examine accurately the contents of the stomach in gastric tetany have by their work focussed a condiderable amount of attention on this aspect of the subject. By these authors tetany is con-

(1) Berl. Klin. Woch., 1894,no.2.
(2) Rev. de Méd. 1892, Feb. pp.48,97; La Dyspepsie par Hypersécrétion Gastrique. 1892

sidered as a complication of hypersecretion of gastric juice. They believe that hyperchlorhydria is always present; this opinion however is not founded solely on the results of gastric analysis but they have taken the presence of scars of ulcers found post-mortem in the stomach as indicating the pre-existence of excessive hydrochloric acid. There is certainly very often evidence of hypersecretion of gastric juice, enormous quantities were ~~found to be~~ poured out in some cases, and occasionally there appears to have been continuous secretion of gastric juice. But the amount of hydrochloric acid is by no means always excessive. Some authors of case reports state that hyperchlorhydria was present without giving an analysis of the gastric juice because clinically the gastric contents were very sour. But in other cases where the vomit was very sour analysis shewed absence or marked decrease in the amount of hydrochloric acid. In the present series there is a more or less complete report on the chemical and physical characters of the stomach contents in twenty-seven cases, In very many cases the vomit was copious often foul-smelling, in colour sometimes dark-brown, yellowish, green or even bright-green. Often but not always a marked froth formed on the surface of the vomit, and a considerable sediment settled to the bottom of the vessel in which it was placed. In twenty-six cases the presence or absence of hydrochloric acid is stated. One of these was of intestinal origin and in this there was no free HCl in the

gastric juice. The remaining twenty-five are distributed as follows:-

Hydrochloric acid increased--------8------(32 %)
" " present amount not stated 4 (16%)
" " normal in amount -- 6-----(24 %)
" " diminished ---------4-----(16 %)
" " absent-------------3 ----(12 %)

In one of the cases in which hydrochloric acid was absent during the attack of tetany it had been present in increased amount previously. There are cases of carcimoma of the stomach or duodenum with tetany in which free hydrochloric acid was probably absent but no analysis is reported. But these figures are sufficient to shew that hyperchlorhydria is not essential; in about one third of cases HCl is present in excess, and in almost as many is diminished in amount or absent. In many of these analyses the total acidity is given in terms of HCl; and the normal limits have been taken as being from 30 to 70 or in terms of HCl 0.18 to 0.2 %. Further details are scantily given. Lactic or butyric acids were present in three cases; acetone in one; peptones in four. There is often an excess of mucus.

The microscopic characters of the sediment are of great interest, but reports unfortunately few. Particles of undigested food such as muscle fibres and starch cells are commonly found. Sarcinae are reported as present in six cases and torulae in seven. In two cases where torulae were present and two with sarcinae these disappeared with or before the onset

of tetany and bacteria in large numbers were seen in their place. In the matter of bacteria in the sto stomach works on bacteriology give very little help, but as they are found in all those cases when the most careful examination was made thewriter has attempted to investigate the matter a little further. In text books on bacteriology the presence of bacteria in the stomach is hardly or not at all mentioned. In Hunter's work (1) dealing especially with the flora of the digestive tract there is some slight account but practically only in nurslings, though in other sites from the mouth to the anus the normal and pathogenic bacteria are considered at some lenghts. Dickson's case (7) is one which is fully reported. It was a very severe case of tetany with gastrectasis and pyloric stenosis. Nearly a month before the onset of tetany the stomach contained sarcinae but no bacteria. During the attack there were large numbers of bacteria but no sarcinae. The bacteria were bacilli, and considered to belong to the "coli" group though attempts to isolate them in pure cultures were unsucessful. Injection of the cultures obtained produced negative results. The patient recovered and was operated on five months later; there were numerous sarcinae and torulae in the gastric secretion before operation; in a portion of stomach wall removed were seen many micro-organisms mostly cocci situated in the mucus covering the surface and in the mouths of the glands. In the case of

---

(1) Bacterial Infections of the Digestive Tract, 1907.

Brown and Engelbach (8) no sarcinae were found in the stomach contents but ~~numbers of long bacilli~~ many short-rod gram-negative bacilli. In Hutchinson's case (50) there was gastrectasis with carcinoma of the pylorus; no sarcinæ were present in the stomach contents, but there were numbers of long bacilli.

Moorheads case (51) showed a similar anatomical lesion. Two days before the attack of tetany numerous sarcinae were seen in the vomit. During the attack there were few sarcinae but many motile and non-motile bacilli; in a vomit ejected immediately before death were no sarcinae but bacilli were very numerous The writer has been able to examine one case for bacteria. The patient had suffered from tetany at intervals for some years, the last attack proving fatal. There was great gastrecasis and undoubted pyloric stenosis, though no autopsy was obtainable. The stomach contents showed a large excess of mucus and undigested food; yeasts and sarcinae were present. Bacteria in large numbers amongst which bacillary forms, both long and short, greatly predominated, were seen. Further examination was made by the Clinical Research Association and their report is appended. Three bacilli and a diplococcus were isolated; their cultural characters and carbohydrate reactions(1) do not agree with any previous description with which the writer is acquainted.

---

(1) For the carbohydrate re-action of various bacteria see especially the following, among which are descriptions of many cocci, and of the ~~cocci of~~ bacilli of coli and typhosus groups.
Lancet 1905,2,p.1400; 1906,2,pp.708, 775 852,1498; 1907,1, p.167; 1908,2,p.1663; Muir and Ritchie, Manual of Bacteriology, 1907, pp. 74, 326, 335, 347.

The Clinical Research Association reported on the bacteriology of the deposit from the stomach washings as follows:-

The deposit contains in abundance common mouth organisms, staphylococci, etc. In addition there are Gram positive and Gram negative rods, and some subtilis like filaments, and possibly other air organisms. The following four organisms were isolated:-

1. A Gram negative rod, in longer and shorter filaments, non-sporing, growing readily at 37° on Agar as a thick white streak without discrete colonies. On plates the colonies are white raised opaque, and under low powers appear yellow and coarsely granular. On gelatine at room temperature 20° liquefaction occurs, but in no characteristic manner.

2. Has the same characteristics on Agar and Gelatine, but see table.

3. Is a diplococcus with a decided tendancy to a Gram negative staining, grows very like staphylococcus on Agar, does not liquefy gelatine, grows as a thin spreading film.

4. Gram negative rod, grows as a very heavy paint-like white smear on Agar, colonies indistinguishable from Coli, on gelatine liquefies at 20°.

The following is a table of the carbohydrate reactions:-

Sugar	No 1.	No 2.	No 3.	No 4.
Glucose	Acid	Acid & gas.	Acid & gas	Acid.
Lactose	Acid	Acid & gas.	Acid & gas	?
Mannite	Acid	Acid & gas.	Acid & gas	Acid
Saccharose	Acid	Acid	No acid	Acid
Maltose	Acid	Acid	Acid & gas	Acid
Raffinose	Acid	No acid	No acid	No acid
Glycerine	slight acid	Acid	?	Acid
Salicin	Acid	Acid	?	Acid & gas
Galactose	Acid	Acid & gas	Acid & gas	Acid & gas
Dextrin	Acid	Acid & gas	Acid & gas?	Acid & gas
Indol	Positive	Positive	Positive	Positive
Milk	No clot No acid	Acid & clot	Acid clot	Acid only

The bacilli behave very similarly as regards their cultural and bio-chemical characters. Morphologically and in the formation of indol and the production of acid and clot in milk they resemble Bacillus coli communis, but no strain of this organism described gives the same carbohydrate re- actions. These re-actions are fairly constant for any one organism. For these bacilli the differences are perhaps hardly pronounced enough to seperate them into three species, but the re-actions are sufficiently definite to seperate them as varieties of one species, allied perhaps to the coli group; bacillus coli communis does not liquefy gelatine; investigation of other cases from this point of view is certainly necessary before reaching a positive conclusion; but evidence can only accumulate slowly with a rare disease. As to the diplococcus a conclusion is difficult to reach. Although all the same tests have not been used it seems to correspond closely in fermentative powers to the streptococcus faecalis of Andrewes and Horder (1); these observers have seen this organism as a diplococcus, resembling in one case the pneumococcus and in another the diplococcus rheumaticus; it is they say the commonest intestinal streptococcus. Streptococcus salivarius is the organism most likely to contaminate stomach washings, but it gives no acid with mannite, while producing acid with raffinose; streptococcus too is markedly Gram positive. The question must for the present be

(1)Lancet, 1906, 2,p.775.

left open.

Cocci were found at operation in Dickson's case but are not described in the others. When looked for bacilli have been found in at least a large proportion of cases of gastric tetany; the writer believes them to be of definite importance; their presence and action will be considered in discussing the pathogenesis of the disease.

Various experimental investigations have been made with a view to proving the presence of a toxin in the gastric contents as the cause of the tetany. The writer knows of fifteen such investigations. Müller (1) was the first to use this method. The stomach contents of two cases of tetany were extracted partly with ether and partly by Brieger's method and the resulting product injected subcutaneously into animals; the effects were negative. Bouveret and Devic (2) in three cases isolated a toxic substance, syntonin, a pepto-toxin. There was excessive free hydrochloric acid in these cases; the stomach contents were extracted with alcohol and injected intravenously in dogs and produced general convulsions. These observers consider that free hydrochloric acid acts on ~~animals~~ amines in the stomach, and alcohol on the resulting compound to produce a toxic and convulsant substance. They produced this substance artificially from the three components, and it produced general convulsions on intravenous in-

(1) Charité-Annalen, Jahrg. 13,1888,p.273.
(2) Rev. de Méd., 1892,pp. 48,97.

jection. Halliburton and McKendrick (1) also used the method of extraction with alcohol; the fluid obtained was evaporated to dryness and taken up with n normal salt solution; intravenous injection produced in the cat a great fall of blood pressure, and some transitory slowing of the heart beats, but no spasms or convulsions; the fluid when neutralised produced only a very slight fall of blood pressure. D'Amato (2) claims to have produced convulsions in animals by injection of the vomit. Ewald and Jacobson (3) and Alby (4) have obtained alkaloids from the urine during attacks of tetany, but results of intravenous injection were negative. Cassaët and Féré (5) have obtained a convulsant product from the stomach in cases of ectasy without tetany. On the other hand negative results have been obtained in cases of tetany with gastrectasis by Von Jaksch (6), Blazicek (7), Berlizheimer (8), Grumpecht (9), Moorhead, (10), and Carnegie Dickson (11). Various methods were used in these cases including extraction by ether, by alcohol, and injection of untreated filtered gastric contents; precipitation by the ammonium sulphate method for bacterial toxins has not been attempted.

---

(1) Brit. Med. Jour., 1901, Vol.1, pp. 1608.
(2) Centralbl. f. Inn. Med., 1903, p. 968. (qtd. f. Moorhead)
(3) Berl. Klin. Woch., 1894, No2.
(4) Volkmann's Vorträge, 1897-1900, p. 1499.
(5) Comptes Rend. Soc. de Biol. Paris, 1894, 23 June
(6) Zeitsch. f. Klin. Med. 1890, Bd. 17, p.144.
(7) Wein. Klin. Woch. 1894, p. 3261.
(8) Berl. Klin. Woch., 1897, p. 773.
(9) Centr. f. Klin. Med. 1897.
(10) Practitioner, 1904, 2, p. 171.
(11) Practitioner, 1903, 1, p.72.

Moorhead treated the gastric contents in his case by the method of Baumann and Udransky for the seperation of alkaloids, and obtained a diamine which was crystalline, but non-toxic on intravenous injection. The experiments of Jonnesgo and Grossman(1) explain to a large extent these discordant results. They used the gastric contents from a severe case of tetany with great dilatation of the stomach and pyloric stenosis(case 6). The contents were evaporated to dryness at 37°C and the residue divided into three equal parts; one part was macerated for twenty-four hours in each of alcohol, ether and glycerine. Each was then filtered, evaporated to dryness, and the residue dissolved in 20c.c. of distilled water. The injection of the ether and glycerine extracts into the peritoneal cavity of mice produced no results, though very much larger doses per kilogramme of body weight were used than Bouveret and Devic found necessary. When, however, 1c.c. of the alcoholic extract was injected into the peritoneal cavity of a mouse the effect was "foudroyant". In less than two minutes the animal presented dyspnoea, exopthalmos, and tetaniform convulsions of the limbs; this was repeated several times with the same result. The same dose injected subcutaneously produced first paresis, then complete paralysis of the limbs. The injection of 5 c.c. into the veins of a guinea-pig produced no result. These doses are enormous compared to those used by Bouveret and Devie; 1c.c. was equal to 5

(1) La Presse Médicale, 1905, July 1, p. 409.

grammes of extract perkilogramme for the mice used. It is evidently impossible to say that the toxic substances which have been found were produced in the patient's stomach. "A convulsant substance can be obtained from the gastric contents in some cases but it is not the cause of Tetany" (Jounesgo and Grossman). It is of interest in this relation that nearly all enzymes when injected into the veins are extremely toxic(1). To the rabbit the lethal dose of pepsin, invertase, and diastase is 0.1 gramme; symptoms are trembling, uneasiness, muscular paresis, and finally coma; condiderable fever is produced. This fact renders the results of injection of gastric juice of still less value. As regards the lowering of blood pressure observed by Professor Halliburton it is stated that extracts of many tissues lower blood pressure to a greater or less extent on intravenous injection.(2)

Though largely based on clinical findings it is necessary to consider here the state of the blood in Tetany. Some experimental work has been done on the subject. Von Jaksch(3) investigated the blood bacteriologically, and injected blood of tetany cases into dogs with negative results in both cases. McCallum and Vaegtlin~~KRL~~ ~~KRL~~(4) state that the blood

(1) Wells, Chemical Pathology, 1907, p. 71
(2) Swale Vincent, Lancet, 1906, Vol.2, pp.349, 434.
(3) Zeitschrift f. Klin. Med., 1890, Bd. 17, p. 144.
(4) John Hopkins Hospital Bulletin, 1908, March p.91.

of a dog during tetany from parathyroidectomy shows a calcium content of only half that of a normal dog. Of more immediate interest because the same is often obderved in man is Horsley's (1) statement that leucocytosis occurs in dogs when tetany is produced by total thyroidectomy. In the present series the blood condition is described with more or less completeness in twelve cases. In one (Blazicek,53) the specific gravity alone is stated; of the serum the sp. gr. was 1030. The sp. gr. is also given in Kuckein's case(50); that of the blood was 1061, of the serum 1033; the serum contained 88.9 % of water, 11.1 % of dry substances. The remaining observations are given in the following table:-

Observer &case no.	Haemoglobin.	Erythrocytes.	Leucocytes.	Remarks
Dickson (7) 5 Nov.		3,900,000	22.500	Three days after commencement: Severe attack.
7 Nov.	70 %	4,025,000.	17,500.	
12 Nov.	75 %	4,200,000.	40.000	Condition critical
27 Nov.	58 %	2,900,000.	9,500	Convalescent
Cunningham (10)	60 %	4,900,000.	9,000	Severe attack; cured.
Howard (24)	70 %	4,056,000.	17,480	Severe attak died
Müller (37)		6,000,000.		" "
" (38)		5,697,000.		" "
Kuckein (50)	80 %	4,970,000.	24,000	" "
Moorhead (51) 14FEb,		2,663,000.	18,620.	After first attack
20 "		3,200,000.	14,000.	Improved
22 "		4,603,000.	31,000.	Died next day Stomach more dilated
Howard (61)	50 %	2,460,000.	3,600.	Repeated attacks, not severe, recovered.

(1) Brit. Med. Jour.1, 1885,p.114.

Observer & case no.		Haemoglobin.	Erythrocytes.	Leucocytes.	Remarks.
Howard (64)		83 %	4,536,999.	5,140.	Moderately severe recovered
" (65)		95 %	5,516,999.	9.000.	Moderately severe spasms nine days before, severe attack day after count.
" (85)	7 March	78 %	4,604,000	8,900	Chronic diarrhoea, attacks at intervals for 3 months past.
	13 April	94 %	5,165,000.	9.000	Diarrhoea ceased April 1st. Severe attack tetany on the 9th, recovered.

In three of these cases a differential count of the leucocytes was made; the following figures give the percentage of the polymorphs.

Dickson, 5 Nov. 83.2 % Kuckein 90.4 %

12 Nov. 92.6 % Moorhead, 14 Feb. 80 %.

30 May (before operation) " 76.7 % & 20 & 22 " in excess, no figures.

Other varieties of leucocytes are diminished in proportion to the increase in polymorphonuclears; no abnormal cells have been seen.

These blood counts show a remarkably large number of red blood corpuscles in the most serious cases, especially in view of the fact that the patients were suffering from long continued mal-nutrition. It is unfortunate that in none was the blood counted before the onset of tetany. The series of counts in the cases of Dickson and Moorhead are of especial interest; each of these patients suffered from tetany for some days, and in each the number of erythrocytes per cubic mm. progressively increased. Dickson's patient had the most severe attack of any that recovered, and he when convalescent nearly four weeks

Observer & case no.		Haemoglobin.	Erythrocytes.	Leucocytes.	Remarks.
Howard (64)		83 %	4,536,999.	5,140.	Moderately severe recovere
" (65)		95 %	5,516,999.	9.000.	Moderately severe spasms nine days before, severe attack day after count.
" (85)	7 March	78 %	4,604,000	8,900	Chronic diarrhoea, attacks at intervals for 3 months past.
	13 April	94 %	5,165,000.	9.000	Diarrhoea ceased April 1st. Severe attack tetany on the 9th, recovered.

In three of these cases a differential count of the leucocytes was made; the following figures give the percentage of the polymorphs.

Dickson, 5 Nov. 83.2 % Kuckein 90.4 %

12 Nov. 92.6 % Moorhead, 14 Feb. 80 %.

30 May (before operation) " 76.7 % & 20 & 22 " in excess, no figures.

Other varieties of leucocytes are diminished in proportion to the increase in polymorphonuclears; no abnormal cells have been seen.

These blood counts show a remarkably large number of red blood corpuscles in the most serious cases, especially in view of the fact that the patients were suffering from long continued mal-nutrition. It is unfortunate that in none was the blood counted before the onset of tetany. The series of counts in the cases of Dickson and Moorhead are of especial interest; each of these patients suffered from tetany for some days, and in each the number of erythrocytes per cubic mm. progressively increased. Dickson's patient had the most severe attack of any that recovered, and he when convalescent nearly four weeks after the onset of tetany had only 69 % of the high

est count of red corpuscles per cubic mm. There is then some evidence though not entirely conclusive of loss of fluid from the blood in gastric tetany; there is only one record of increase in the sp. gr. of the blood, and that not great, as against one case with the sp. gr. normal. There is a marked leucocytosis in the most severe cases of tetany, the increase being almost entirely in the polymorphonuclear cells. The highest count is 40.000 per c. mm. from Dickson's patient. Cunnungham's case had severe attacks of tetany, but recovered; in this the number of leucocytes is not above the normal limits. In the less serious cases the number of leucocytes is normal. Howard(1) has made blood counts in two cases of tetany in the infant; each had slight rickets; in one the number of leucocytes varied between 11,600 and 6,000, and in the second, which had also diarrhoea, the leucocytes were 8,600, red blood corpuscles 4.700.000.

The nature of the disease, and seat of the lesion.

Trousseau at first, because of its occurrence in the winter months and the joint swellings sometimes seen, considered that tetany was of rheumatic origin; further experience gave no support to this idea and it is now held by none. It was then thought by some earlier writers to be a manifestation of hysteria; but in view of its occurrence in definite case groups, the bi-lateral character of the symptoms, the general absence of other hysterical manifestations

(1) Amer. Jour. of Med. Sci. 1906, p.337.

in the patients, and the frequently fatal issue in gastric tetany and tetany parathyreopriva this hypothesis does not need more fully refuting. Many authorities, for instance, Sir W. Gowers(1), Weiss(2), Albu(3), Frankl-Hochwart(4) consider that tetany is a disease of the central nervous system; either an affection of the nerve cells of the medulla oblongata and spinal cord(Gowers), a spasm of the vessels supplying the grey matter produced through the sympathetic nerves(Weiss), the whole nervous system (Frankl-Hochwart), or the peripheral nerves(Albu).

It has been shewn that post-mortem observations give very slight support to these hypotheses. Not much stress can be laid on finding vacuolation of cells, lateral position of the nucleus, or even atrophy of cells considering the state of histological technique.when these observations were made, and the fact that later observers have found no abnormality. And when muscles have been spasmodically contracted for a considerable time vacuolation and even more marked changes in the nerve cells which govern them is not unexpected. There are however facts which indicate that the nervous system is affected in tetany, symptoms which are hardly explicable except through the action of the nervous system. Of theses are the sensory disturbances such as loss of sight, the fundus oculi being normal whenever examined in cases of this series; loss of consciousness

(1) Diseases of the nervous system, 1893, 2,p. 707.
(3) Volkmann's Vorträge, 1897-1900,p.1499.
(2) Volkman's Vorträge, 1880, p. 189.
(4) Die Tetanie, 1891,p. 118.

sometimes coma occurs. The bi-lateral nature of the cramps, the heightened electrical and mechanical irritability of the peripheral nerves often present, the alterations in reflexes and trophic disturbances occasionally seen, these facts speak in favour of a nervous origin. It must be conceded that the nervous system is affected in tetany, the more profoundly the more severe the symptoms are, but it does not follow that the causative lesion is in the central or peripheral nerve tissues. To take only two examples, pneumonia and uraemia, the pronounced nervous symptoms in these diseases do not indicate that the nervous system is the seat of the lesion. The epileptiform convulsions are possibly the result of fatigue, the decomposition of lecithin producing the toxic substance cholin(1). Fatigue of the muscles may be the cause of some of the symptoms in cases with severe long continued spasm. Wells (loc. cit.) states that the amount of acid produced in active muscle is quite considerable; the alkalinity of the blood is decreased in fatigued animals; in extreme exhaustion the condition produced may resemble an acute febrile disease and last several days. In man coma has followed prolonged muscular exertion (2). It is obvious that in tetany poisons produced by excessive muscular action would only be the cause of late symptoms; they may be at least a factor in producing the coma and hyperpyrexia which occasionally

(1) See Donath, Jour. of Phys. 1905,p.211; Wells, Chem. Path. 1907,p.460; Halliburton, Lancet, 1907,1. pp. 1297-1211.
(2) Osler, Practice of Medicine,1904, p.869.

occurs.

There ~~there~~ are three important theories which seek to explain the genesis of gastric tetany. Kussmaul's theory of dehydration, which has been recently advanced by Fleiner(1), was the first. This theory states that the loss of fluid in gastrectasis leads to drying of the tissues of the body, including the nervous tissues, and that this drying produces an ~~ir~~ irritable and unstable state of the nervous system, so that a slight afferent stimulus suffices to evoke spasm. The state of the blood in some cases gives slight support to this theory, as does the frequent diminution in the amount of urine. But tetany is uncommon in cholera, a disease which causes as much loss of fluid from the body as gastrectasis. There is too the fatal objection to the theory that it does not at all explain the other varieties of tetany. Germain Sée(2) next advanced the theory of reflex origin; this is supported by Müller, Berlizheimer, and lately (tetany in chikdhood) by Ashby and Wright(3); according to it the abnormal contents of the stomach (or some other irritation) excite the vagus nerve terminals in the stomach and so reflexly produce the spasm. There are obvious objections to this theory; the spasm may be and often is evoked by afferent stimulation but such stimulus can hardly cause the disease; spasms are evoked reflexly in strychine poisoning and in tetanus, and much more

(1) Munch. Med. Woch. 1903, March 10.
(2) Bull. de l'Acad. de Méd. 1888.
(3) Diseases of children, 1905, p. 561.

readily than in tetany. The theory of auto-intoxication is that which at present has the greatest a amount of support; it is in fact endorsed by nearly all recent writers. For some time after the publication of the work of Bouveret and Devic this theory gained ground rapidly; then negative results of experimental investigations of the gastric juice accumulated, and the support gained now by this theory is given hesitatingly. It supposes that some organic poison is formed in the stomach which is absorbed, acts on the nervous system and so causes the tetany spasms. The experimental investigations made into this theory have been described, and it has been shewn that the foundation is not sure. There is none the less a great deal in its favour. The frequency of albumin in the urine during an attack of tetany, though the urine may be normal before and after, and the kidney healthy on post-mortem examination is the strongest fact pointing to toxic action. The poison may be due to bacterial action, at least in the most serious cases, and the presence of marked leucocytosis points to bacterial action. Von Jaksch suggested that tetany may be an infectious disease, and Frankl-Hochwart inclines, without giving a definite opinion to the same idea. But can a ~~poison~~ the same poison be produced in the intestine among such different chemical surroundings? And how does the intoxication theory explain other varieties of tetany? Why is tetany so rare even in advanced gastrectasis?

These questions must be answered, and the attempt made to correlate the divergent results of investigation. We have one certain fact known about tetany, that removal of the thyroid and parathyroid glandspr produces the disease. Nearly all observers consider that parathyroidectomy is the essential, and the removal of the thyroid not necessary (cf. pp 9 to 12). Though this question is not absolutely settledthere are some suggestive facts knownbearing on the relationship of the two glands. The parathyroids develope in entire independence of the thyroid (1). The histological structure of these organs is entirely different (2). The thyroid gland is remarkable for the amount of iodine it contains; Estes and Cecil have examined the parathyroids for iodine (3); in the dog, cow, horse, sheep and man they found that iodine was always absent or present in infinitesimal quantities; in man iodine was always absent. Notkin (4) isolated from the thyroid a substance thyreo-protein which injected into animals produced phenomena like tetany; this observation has not been confirmed. Baumann (5) separated a substance which he called thyro-iodine, an organic compound unique in the amount of iodine contained in its molecule which cures myxoedema but not tetany. Gottlieb (6) and Notkin (7) failed to con-

(1) Pool, Annals of Surgery, 1907, Oct. pp. 522, 523.
(2) Schäfer, Essentials of Histology, 1903, pp. 183. 184.
(3) John Hopkins Hospital Bulletin, 1907, p. 331.
(4) Wein. Med. Woch. 1895, Vol. 45, pp. 824, 872.
(5) Zeitsch. f. Phys. Chemie, 1895, Bd. 21, p. 319.
1896, Bd. 21, p. 481.
(6) Deutsch. Med. Woch., 1896, pp. 235, 271.
(7) ~~Annals of Surgery, 1907, Oct. p. 498.~~
Wein. klin. Woch. 1896, p. 980

firm this result. These considerations and clinical experience in man point, though not perhaps conclusively, to the thyroid as related to myxoedema (this is universally admitted) and the parathyroids to tetany. Halsted (1) points out that in thyroidectomy unless especial care is exercised the blood supply to the parathyroids is apt to be cut off and these bodies rendered useless functionally, although the operator has not removed them; if then tetany occurs it is likely to be attributed, without real justification to loss of thyroid substance. As already stated the parathyroids when examined post-mortem in cases of tetany showed markedly increased activity.

No theory of the origin of tetany can be accepted w which does not seek to explain all the varieties of the disease. Pinéles (2) considers that all forms are due to the same "tetany poison". Thomas (3) was of opinion that tetany other than that in pregnancy was due in most cases to absolute or relative insufficiency of the thyroid gland or like structures. Chvostek (4) has lately attributed all varieties to a functional disturbance of the parathyroid glands. This idea does not seem to have been worked out in detail; it remains to attempt to do so now.

The parathyroids are necessary to normal metabolism; either they neutralise some poison or poisons formed during metabolic processes, or they regulate nutrition especially perhaps of the nervous system; it is not

(1) Annals of Surgery, 1907, Oct. p. 498.
(2) Deutsch. Arch. Klin. Med., 1906, p. 625.
(3) John Hopkins Hospital Bulletin, 1895, Vol. 6
(4) Wein. Klin. Woch., 1907, p. 625.

finally settled whether they are independent organs, or with the thyroid gland form one system. Normally the parathyroid bodies on the analogy of ~~these~~ other organs such as heart and kidneys, have a very considerable reserve power beyond ordinary needs. This reserve may be diminished either congenitally or by disease; that is to say a disease or condition of nutrition which throws a long continued strain on the glands; again the analogy of the heart or kidneys is illustrative. If this be conceded it explaims the infrequency of tetany in all the conditions with which it is associated, and the less rare occurrence in children in whom the greater metabolic activity makes the more liability to relative inadequacy of function. It also explains why in a person liable to tetany various conditions are able to evoke the spasm (cf p14). Some poison then acts on these glands so as to reduce further their activity below that necessary for normal existence. It is not necessary to consider the poison specific to tetany; for many toxins produce changes in heart, kidneys, spleen and other organs that are indistinguisable post-mortem or in clinical results. In rickets there is evidence of intoxication; not only the bones are affected, but also the bronchial and gastro-intestinal mucous membrane, often the spleen, liver and lymphatic glands are enlarged and slight fever is common.

But the poison is produced gradually, and the disease readily curable by appropiate treatment with concurrent cure of symptoms of parathyroid insuffic-

iency if present. In gastrectasis there is abundant opportunity for pathological chemical processes to take place, and we know they do occur. The poison may be produced by chemical combinations in the stomach or by bacterial action; perhaps in the worst cases bacteria pass into the circulation and act more directly. Except when the amount of poison absorbed is enormous, tetany is not likely to occur unless the reserve power of the parathyroid glands is diminished. If the necessary substances are present (peptone, free hydrochloric acid and alcohol) a toxic body may be formed which itself, acting through the nervous system, causes spasm. In the most advanced cases of gastric dilatation tetany is most apt to occur and to be severe; in such cases the normal protective power of the mucous membrane must be diminished, the formation and absorption of toxins being thereby facilitated, and their removal by vomiting or by passing on through the intestinal tract cannot be complete. If there be also diminution of elimination by constipation and kidney disease all tha factors necessary to cause severe tetany are present. When the gastric disease with which tetany occurs is slight, recovery follows as in the tetany of childhood or pregnancy. Similar considerations apply to tetany with intestinal dilatation. It is not the dilatation whether of stomach or intestine that causes tetany; in the great majority of such cases, though toxins are probably often present, there is no tetany, it is necessary that the funct-

ional activity of the ~~glands~~ parathyroids be diminished or the amount of poison greater than they can neutralise. The toxins of fevers act in the same way. In pregnancy and lactation, the powers of the parathyroids being lessened, the increased metabolic demands made on these glands may be ~~applied~~ sufficient to provoke the onset of tetany without there being any intoxication.

This theory has not been proved, but a considerable amount of evidence- which has been given- is in its favour; and this explanation is adaptable to every case. There is no wish to deny that other factors are of importance; for instance the dehydration of the tissues may be a factor in causing the very serious character of gastric tetany. The claim made is that in tetany the functional powers of the parathyroid glands (possibly of the thyroid also) are relatively insufficient to the demands made upon them; and in consequence either some metabolic poison acts upon the nerve cells or the nutrition of the nervous system is so altered that the various muscular, sensory and other symptoms of tetany are produced. The writer is inclined to adopt the second alternative, that of disturbance of nutrition, which results in disordered function of the nerve cells; the parts affected being the anterior horn cells in the cervical (sometimes lumbar) enlargements of the cord, and in many cases the centres in the medulla oblongata and higher sensory centres also; the higher motor centres are probably affected in many cases as indicated by the occurrence of exaggerated tendon reflexes and

of epileptiform convulsions.

Symptoms.

The onset of tetany is often sudden, frequently soon after copious emesis. There are some premonitory signs in a considerable number of cases; these are tingling or pricking sensations in the extremities, formication, occasionally some redness or lividity of the hands and feet, headache, malaise, and sometimes a condition of collapse in which the patient may appear very ill with eyes sunken, face drawn, and lips livid.

The site, severity, and character of the muscular spasm vary considerably; attempts have been made to form groups of cases according to the nature of the spasm, but with no great success; such groups cannot be distinctly defined, and one case may at different times show characters of more than one variety. The spasm is tonic and cramp-like; the muscles rigid; the affected part is fixed. In the upper extremity the hand is usually fixed in the "accoucheur" position; the fingers are closely pressed together, flexed at the meta-carpo-phalangeal joints and extended at the inter-phalangeal joints; the thumb is pressed firmly into the palm, the wrist is strongly flexed, the muscles of the fore-arm and upper arm rigid and boardlike; the elbow is flexed, and the upper arm pressed against the chest wall, sometimes rotated so that the hand is over the sternum. In slighter cases only the hand is affected. The hand is not always in the typical position. The fingers may be spread apart and extended (one case). In one case the hand was

claw-like -"main-en-griffe". Slow movements of the hand and arm are not uncommon, such as gradual pronation and supination, or slow flexion and extension In one case there were deliberate athetoid movements. Very rarely the fist is tightly closed, there is no example of this position in the present series of cases. The spasm is usually extremely painful, but in two cases there was no pain. The lower extremities are affected in a similar manner; the toes are flexed the great toe being flexed and adducted under the other toes; the ankles are extended and adducted, so that the foot is in the "equino-varus" position; the calves are rigid, and feel on palpation as if gathered into a ball; the knees are extended usually but sometimes flexed, and the thighs extended on the trunk. The spasm as a rule affects the limbs symmetrically, but often one side is more affected than the other, and occasionally one limb alone is affected. Very rarely the upper extremity on one side is affected, and the lower extremity on the other side; there is no such case in this series. Twitching of muscles, especially of the face occurs occasionally and fibrillary contractions are not uncommon. The muscular spasm affects the trunk in some cases. The abdominal muscles may be rigid, and the muscles of respiration are affected not uncommonly to a degree sufficient to embarrass respiration, but only in one case did respiratory failure ensue. In five cases there was opisthotonos. Russell(1) states

(1) Allbutt's System, 1901, Vol. 8, p.69.

that emprosthotonos is more frequent, but there is no example of its occurrence in this series. In one case there was marked head retraction. The laryngeal muscles are occasionally affected, causing loss of speech and dyspnoea; these symptoms commonly occur in severe cases. Deglutition may be rendered difficult by spasm of the pharynx or oesophagus. The face may be immobile, but is not frequently involved in the spasm; two cases had the "risus sardonicus", and three trismus. Occasionally the eyelids are spasmodically closed; once there was strabismus.

The tables on pages 94-96 show the most important symptoms of forty-six cases which are recorded with sufficient detail for facts to be tabulated regarding them. It will be seen that of these the upper extremities were affected alone in seven, upper and lower extremities in nine, upper and lower extremities and head and neck in twelve; all these parts and the trunk of the body in ten, upper and lower extremities and the trunk in four, upper limbs and head in two, and the lower limbs alone in two. In every case one or more of the limbs is affected, and it is in these parts that the spasm first appears.

The duration of the spasm varies greatly; it may pass away in a few minutes or continue without obvious relaxation for days; in case 32 the spasm was continous for five days. In other cases there are intermissions of variable length and the spasm recurs during weeks, months or even years; in some cases there is only some remission, some relaxation

of the spasm but not complete freedom. As a rule the ~~tetany~~ spasm lasts from one to five hours. The least duration from the commencement of tetany in a severe case is six hours; this was a fatal case (67); in another fatal case the duration was six and a half hours, and in another seven hours. In many cases on the other hand the duration is several days and occasionally the attacks have recurred during s some months or years. In tetany other than gastric it is common for the attacks to recur during a long period. The spasm does not cease during sleep.

General convulsions of an epileptiform, or ~~rarely~~ less often of tetanic character are not rare, and their occurrence is of the gravest import. In eighty-five cases such convulsions are recorded nine times, and only two of these cases recovered. Cases which suffered from generalised spasm with or without opisthotonos are not included in these nine. Convulsions are as a rule a late feature, but rarely they alternate with tetany spasms; they never precede the spasm. In tetany other than of gastric origin convulsions are very rare. Retention of urine is common in gastric tetany if at all severe; in the final stages when unconsciousness supervenes there may be incontinence of urine.

The character of the reflexes is not constant. The pupil reflex to light is never lost even when the patient is unable to see, but it may be sluggish and slightly marked. The superficial reflexes are most often exaggerated but not rarely absent; still the

patients are often advanced in years, at an age when the skin reflexes are not constantly present in health. The tendon reflexes are also exaggerated frequently, by no means always. The character of the knee-jerks is recorded in sixteen cases; of these it was exaggerated in seven, normal in four, diminished in three, lost in two. Ankle clonus and even patellar clonus occurs occasionally. Any abnormality of the reflexes rapidly disappears when the patient improves. In tetany of all varieties Frankl-Hochwart found the knee-jerks usually normal, but observed ankle-clonus and increased knee-jerk several times(1). The severity of symptoms and the gravity of the case varies with the duration and intensity of the spasm. The intensity may be so great that death occurs in a few hours but in several cases the spasm was of comparatively moderate degree but so long continued that death followed. Very occasionally the spasm is only slight as in case 50, but soon followed by coma and death. In a severe case the common sequence of events is tonic spasm of the extremities, which may spread to the trunk and head, convulsions, delirium, coma then death with or without rise of temperature; all these symptoms may be seen in a few hours, but usually during a few days.

Sensory phenomena. Some disturbance of sensibility occurs nearly always in tetany; these symptoms are very interesting, a whole work has been devoted to

---

(1)Die Tetanie.p. 85.

their consideration(1), but are almost entirely subjective; any objective signs in the examination of t the sensation are very rarely met with. Various paraesthesiæ are most common; these may appear and pass off again without any spasm occuring, and at another time be followed by typical tetany. The sensations vary from a slight itching, numbness or tingling, to most intense formication; feelings of heat and cold are common; in other cases there is intense pain, stabbing, shooting or cramp-like. These symptoms frequently precede the spasm and cease when it commences, but the pain usually continues and increases till it may be most intense, agonising in degree. The pains are felt in the muscles affected by the cramp, sometimes in the skin of the part affected, rarely in the joints. The pain may be severe in slight cases; it may persist to a slight degree after the spasm has ceased, and sensations of tingling, formication, and the like often re-appear when the spasm ceases; one patient complained that he felt as if he was "getting the electric battery all up and down his limbs". Very rarely there is no paraesthesia and no pain. Objective examination of cutaneous sensibility has usually negative results; areas of hyperaesthesia are occasionally found, not necessarily in a part

(1) Manouvriez, Recherches sur les troubles de la sensibilite dans la contracture idiopathique des extrémités; Paris, Delahaye, 1877.

affected by tetanic spasms. Anaesthesia is very rare; Frankl-Hochwart(1) states that there are two cases in the literature with a high degree of analgesia; in three of his own cases there was some diminution of sensation and delay in localisation. A feeling of numbness is common. Very interesting is the occasional disturbance of special senses. The pupils are often dilated especially when there is coma, but in other cases contracted, even occasionally pin-point, and occasionally of vision in two of these cases, unequal. Of the forty-six cases which are tabulated vision was dim in four, lost entirely in two; these patients had normal vision before they were attacked by tetany, and the sight became again normal in those that recovered. No alteration in the fundus oculi was observed in these cases, and in other varieties the fundus is normal as a rule when vision is affected. Kunn(2) has reported the case of a workman who had suffered from tetany to a moderate degree without disturbance of vision for two years; this patient had a very severe attack with rise of temperature, associated with a profuse cutaneous eruption; after some days vision became dim; the pupils were dilated; the papilla swollen and its outlines indistinct, and about the macula were bright isolated stripes; later there was some atrophy. Von Jaksch (3) had a case

(1) Die Tetanie, p. 77.
(2) Wien. Klin. Woch., 1890, no.12.
(3) Zeitsch. f. Klin. Med. 1890, Vol.17, p. 144.

a young shoemaker who had suffered from tetany for about six months; vision was dim, the optic papilla swollen on both sides; the patient left hospital unimproved, and his further history is unknown. Smell and taste do not appear to be altered in tetany. One of the writers cases(33) is unique in that with tetany there was not only dimness of vision, but also extreme deafness; this patient had suffered from tetany of gastric origin at intervals for years! between the attacks there was slight deafness only; the last attack which was the only one the writer saw was a severe one, with great dilatation of the stomach and general prostration; there was also greatly increased knee-jerks and ankle clonus- which disappeared during a temporary improvement; the plantar reflex was normal. The writer knows of no other case in which deafness occurred with, and apparently due to tetany, and Frankl-Hochwart knows of none though he points out that a sensation of sound can be frequently produced by very small electric currents. Some mental disturbance is common. The patient is often drowsy, unintelligent, or somewhat excited or incoherent. More severe mental symptoms occur. Of eighty-five gastric and intestinal cases there was delirium in eight, coma in thirteen, stupor in two, and in ten the record is merely loss of consciousness. When such symptoms are present recovery is extremely rare unless the patient undergoes operative treatment. The patients are usually sleepless, and in some cases no sleep was obtained even

with the use of considerable doses of various hypnotic drugs.

Vaso-motor & trophic phenomena. Perspiration is common, and often extreme; it may occur with the attack or at the end of spasm; the onset of profuse sweating seems in many cases to coincide with the relief of symptoms. Redness of the skin of the parts affected, and flushing of the face and ears is frequently observed. Sometimes oedema occurs, as a rule firm and sometimes almost hard; it is seen with or without redness. Swelling of the joints is much more rare in gastric tetany than in other varieties. Cyanosis of the face and extremities is present in the majority of severe cases, even without obvious respiratory embarassment. Disturbance of trophic functions is not so frequent in gastric tetany as in varieties more long continued; there is one example of atrophy of muscles especially the small muscles of the hands(85); a similar case after thyroidectomy has been reported by Weiss(1). Cutaneous eruptions have been referred to (Kunn's case), and Eiselberg reports another, after thyroidectomy, in which intense urticaria came and went with attacks of tetany. There are four or five cases, all of chronic tetany, with falling out of the hair or change in the nails; one of these is Meinert's case already quoted(2) and she had also zonular cataract.

---

(1) Allgem. Wien. Med. Zeitung., 1885, no. 37.

(2) Archiv. f. Gynäcologie, Bd. 30, 1887, p.444.

The temperature varies considerably in different cases and at different times in the same case; there is no characteristic temperature curve. It is not unusual for the temperature to rise considerably before death, but on the other hand it fell remarkably in several cases. The highest temperature recorded is 107.2F, and the lowest 90.5F. other cases have shewn unusually low temperatures, but when raised it is usually only to a moderate degree(99°-101°). Taking those cases only in which temperature variation was not great it was constantly subnormal in six, normal in eight, hyper-normal in eleven. In workman's tetany Jaksch found hypernormal temperature in one-seventh of the cases, Frankl-Hochwart in one-tenth. The pulse is almost always rapid, quickened out of proportion to any rise of temperature which may occur, and the respiration rapid and shallow; if the cramp involve the muscles of the larynx, thorax, or abdomen there may be great dyspnoea, and jerky irregular respirations. The blood pressure is recorded in three cases; in one it was somewhat reduced , (105mm.), in one normal, in one raised(143mm.).

There are four special signs of value which are commonly found in tetany, and almost only in this disease; these signs depend on the increased mechanical and electrical irritability of the nerves. The mechanical irritability has been studied especially by Trousseau, Schultze(1) and Chvostek(2), and the

(1)Deutsch. Med. Woch., 1882,p.21.
(2) Zeitsch. f. Klin. Med., 1891,p. 489.

electrical reactions by Erb(1), Hoffmann (2), and Frankl-Hochwart(3).Some writers have considered these signs pathognomonic of tetany, but it seems hardly rational to do so as other features of the disease are quite characteristic, no change is found in the peripheral nerves post-mortem, and some cases of tetany otherwise characteristic do not exhibit these signs, or do not show all of them. They are more frequently found in chronic varieties of tetany than in gastric cases, and are usually found in slight cases.

1. Trousseau's symptom is the reproduction of spasm at will by compression of the affected part over the nerves or blood-vessels. The compression is made with the fingers and heavy pressure is not needed, but in some cases the paroxysm does not appear until the pressure has been maintained for some minutes; the paroxysm may be preceded by tingling, numbness, or pain, and by cyanosis as in naturally produced spasm; a paroxysm may be induced in some cases by stretching the nerves, for instance by forced abduction in the upper extremity. This sign is most commonly observed in the upper limbs. It may be present when there has been no actual paroxysm but only the prodromal symptoms, and it persists for a variable time after the paroxysm has ceased; on this account it is often of great value in diagnosis. It is doubtful whether this phenomenon occurs in any other ~~direction~~-condition but some authors state that it may be pre-

(1)Arch.f. Physiol., Vol. 4, p. 271.
(2)Deutsch. Arch. f. Klin. Med., 1888,Bd. 43,p.53.
(3)Die Tetanie, 1891,pp.52-66.

sent in hysteria. It does not occur in people liable to common cramps; the writer has attempted to elicit it in many such people, always with negative results.

2. Chvostek's sign is the production of muscular contraction on tapping or gently pressing on the nerve supplying the muscle; this is elicited especially with the facial nerve. The writer has found it positive in rickets and weakly children occasionally when there is no tetany. In gastric tetany there may be great difficulty in observing these phenomena either because the paroxysm is continuous, or because of frequent irregular muscular twitchings.

3. Erb's sign is the increased excitability of motor nerves to the galvanic current; Erb wrote with reserve about the re-action to faradism and this is by no means so regularly increased; in about one half of the cases heightened re-action to faradism is found in an individual muscle or muscle-group. It is the re-action to galvanism that is important; the muscle is stimulated by a much smaller ~~amount~~ current applied through the nerve than in health. The examination is a difficult one to carry out; the electrical apparatus must include a galvanometer and a rheocord besides switches and electrodes, and a large number of motor nerves may have to be examined before obtaining a positive result, as the reaction is by no means often shewn in many nerves; it is usually positive in the ulnar nerve. If the paroxysm of tetany is continuous or only remittent it is difficult to be certain of the result of electrical examination.

For these reasons the majority of cases of gastric tetany are unable to bear the prolonged examination as being too ill, and most of our knowledge on this point is obtained from chronic cases and workman's tetany. The phenomenon is however present in gastric tetany when looked for; not quite constantly but nearly always, and the negative results are in view of the difficulties of examination of less importance than those positive. Another difficulty in the way of electrical examination is to know the strength of current necessary to produce contraction of muscle in health. This varies for different nerves and different persons, but in tetany the re-action is usually elicited with such a small current that it is undoubtedly abnormal; in other cases it is necessary to wait some weeks after recovery and discover then the standard for the individual case. Contraction usually appears first when the cathode is applied over the nerve and the current closed. Anodal closure contracture occurs with the same current or one but slightly increased; anodal closure contracture not uncommonly appears first(Erb, Gowers(1), Russell). Cathodal closure tetanus occurs with slightly increased current; when the current is slowly increased without make or break the cathode being applied, fibrillary contractions are often seen and then- still with a very small current, tetanus. Anodal opening tetanus can be obtained in most cases; tetany is the only

(1)Diseases of the Nervous System, 1893,2,p.703.

condition in which this occurs in man (Gowers). Erb's sign can be obtained in animals with tetany produced experimentally. This phenomenon is the most constant of the special signs of tetany and may persist for weeks after tetany has ceased. Frankl-Hochwart found it positive in all but one of the cases he examined, and in that one he omitted to examine the ulnar nerve. In the present series we have thirteen cases in which the electrical examination was made; of these eight gave a positive result, three negative in two of which the ulnar nerve was examined, and two others were negative but the examination was not made until the tetany had ceased, operation having been performed to cure it. When the tetany is unilateral Erb's phenomenon may be found on both sides, or may be positive only on the side affected. The table following shows a few illustrative results taken from the present series and two of Frankl-Hochwart's cases; the figures indicate milliampères.

	Case & part tested.	C.C.C	ACC	AOC	CCTet	Normal CC.C.
50.	Fatal case					
	Nerv. radialis dexter	1.25				2.0-5.0
	Nerv. peroneus dex.	2.0				1.0-2.0
	Nerv. peroneus sin.	1.25				1.0-2.0
61.	Brachial plexus; spasm of hands resulted	2.0				
	Brachial plexus; spasm of both legs and arms	6.0			Weak current	
63.	Arm muscles	0.5				1.0-5.0
65.	Severe case; Trousseau negative. N.ulnaris	3.0				0.9-3.3
85.	N. ulnaris d. 10th March	0.8	3.0	3.0	1.0+	0.9-3.3
	same nerve; patient still suffering, 23rd March	0.7	1.7	4.0	2.0	0.9-3.3
	Frankl-Hochwart					
A.	N. ulnaris; during the cramps	0.6				0.9-3.3
	same nerve, three months later	0.8				
B.	M. biceps brach.; before the cramps	2.0				1.1-4.0
	same muscle immediately after the cramps	0.5				

Contraction is obtained in some cases with current of only 0.1 milliampère. Gowers states that he has occasionally obtained Erb's phenomenon in rickety chil-dren and weakly nervous adults without tetany.

4. Hoffmann's sign is the increased irritability of sensory nerves to electrical stimulation; it is thus analogous to Erb's phenomenon. It was only test-ed in one case of this series and was negative.

For cutaneous sensibility it is positive in about 75% of cases, and for hearing and taste in about one-third.

The figures following show the number of cases in the present series in which these phenomena were present or not:-

	Positive	Negative.
Trousseau	16	7
Chvostek	11	9
Erb	8	3
Hoffmann	0	1

SYMPTOMATOLOGY TABLES

Observer and Case number	Site of Spasm † Arms	Legs	Trunk	Head & Neck	Intensity	Duration *	Sensory Phenomena	Consciousness	Temperature F° Pulse Respiration	Result
Mayo Robson I	+	+	+	+	Severe	0	0	0	0	Recovered, Operation
Mayo Robson II	+	+	+	-	Moderate	0	Pain	0	0	" "
Mayo Robson III	-	+	-	-	Moderate	Some days	Pain	0	0	" "
Robson and Moynihan IV	+	+	0	0	Severe	Few weeks	Pain	Lost	Almost pulseless	" "
Mackay and Macdonald V	+	+	-	-	Severe	30 hours	Sight dim	Lost	P.110	" "
Jonnesgo and Grossman VI	+	+	-	+	Severe	1 day	Pain; vision dim.	Lost	P.100. R.24.	" "
Dickson VII	+	+	+	+	Severe	3 days	Pain; vision lost.	Preserved; later delirium.	P. impalpable.	" Operation later.
Brown and Engelbach VIII	+	+	+	-	Moderate	14 months	Pain	0	0	Recovered Operation
Warbasse IX	+	+	+	+	Severe	3 years	0	Lost	Dyspnoea	" "
Cunningham X	+	+	-	+	Severe	20 months	Pain, numbness; vision dim.	Lost	T.99° P.126	" "
McKendrick XVI	+	+	-	+	Severe	9 days	Tingling, pain.	Lost	T.98.6° P.rapid Dyspnoea.	Death; autopsy.
Halliburton & McKendrick XVII	+	-	-	-	Severe	36 hours	Headache, tingling.	Coma	0	Recovery
Trimble XVIII	+	-	-	-	Moderate	6 days	Tingling, pain.	Delirium, coma.	T.99° P.88	Death
Collier XIX	+	+	+	-	Severe	7 hours	0	Lost	T.100.6°	Death
Martin XX	+	+	+	+	Severe	6½ hours	0	0	Pulseless, livid T.107.2°	Death
Penwick XXI	+	+	-	+	Moderate	39 days	Hyperaesthesia Headache	Coma at end.	T.102° R.jerky.	Death; autopsy.

† Signs used; + = affected, - = not affected, 0 = not stated.
* From first to end of last spasm.

Observer and Case number		Site of Spasm: Arms	Legs	Trunk	Head & Neck	Intensity	Duration	Sensory Phenomena	Consciousness	Temperature Pulse Respiration	Result
Fenwick	XXII	+	+	-	-	Moderate	Several hours	0	Retained	T. subnormal	Recovery
Simpson	XXIII	+	+	0	0	0	6 months	0	Mental impairments, coma.	0	Death autopsy.
Howard	XXIV	+	+	-	+	Severe	48 hours	Numbness, pain	Stupor	T. 90.5 P.76-104 R. 20-24	Death, autopsy.
Sievers	XXV	+	+	+	+	Severe	1 day	0	Lost	T. 104.6°F. P.144	Death autopsy.
Sievers	XXVI	+	+	+	+	Severe	Some hours	Pain	Retained	T. 100.4 P. 120	Death, autopsy.
Kussmaul	XXVII	+	+	-	-	Moderate	0	0	Retained	0	Recovery.
Kussmaul	XXVIII	+	+	+	+	Severe	Some hours	Pain	Coma	0	Death, autopsy.
Kussmaul	XXIX	+	+	-	-	Severe	0	Pain	Coma	0	Death, Autopsy.
Dujardin-Beaumetz	XXX	+	+	+	+	Severe	1 day	Tingling	0	0	Death autopsy.
Ledger	XXXII	+	+	+	-	Severe	7 days	Pain, vision lost	Retained	T. 99-97.4 P. 120-170	Death, autopsy.
Ledger	XXXIII	-	+	-	-	Moderate	Years	Pain, vision dim, deafness	Retained	T. 98-100.8. P. 84-106. R. 22	Death.
James	XLVIII	+	+	+	+	Severe	48 hours	Pain	0	T. 101-105 P.140 R. 24.	Death, autopsy.
Trevelyan	XLIX	+	+	-	+	Severe	1 day	No tingling	Retained	T. 94.6	Death, autopsy.
Muckin	L	+	+	—	+	Severe	4 days	0	Delirium, Coma	T. 96.5 - 98.6 P. 124	Death, autopsy.
Moorhead	LI	+	-	-	+	Severe	8 days	Pain	Coma	T. 98. P. 84 R. 22.	Death, autopsy.
Trevelyan	LVI	+	-	-	-	0	Few hours	Pain	Retained	T. 100.4	Death, autopsy.
Penwick	LVIII	+	0	-	-	Severe	6 weeks	0	Delirium	T. subnormal	Death,

Observer and Case number	Site of Spasm: Arms	Legs	Trunk	Head & Neck	Intensity	Duration	Sensory Phenomena	Consciousness	Temperature Pulse Respiration	Result
Nason LX	+	+	+	+	Severe	48 hours	Pain	Retained	R, rapid	Recovery
Howard LXI	+	+	-	+	Moderate	20 days	Tickling sensation	Retained	T. normal. P. 88-92	Unimproved
Howard LXII	+	-	-	-	Slight	3 minutes	None	Retained	T. 98.4° P.68-80	Recovery
Howard LXIII	+	+	-	-	Moderate	3 months	Tingling, no pain	Delirium	0	Recovery
Howard LXIV	+	-	-	+	Moderate	3 months	Numbness, pain	Retained	T.101° P.68-96	Unimproved
Howard LXV	+	+	-	+	Severe	3 months	Pain	Retained; excited	T.98-100° P.76-120	Recovery
Calwell LXVI	+	+	-	-	Severe	2 days	0	Lost	T. high	Death.
Einhorn LXXIII	+	+	-	-	Moderate	some weeks	0	Sometimes lost	0	Recovery
Trevelyan LXXVIII	+	+	-	+	Slight	6 years	Pain	Retained	0	Recovery
Gulland LXXIX	+	+	-	+	Severe	9 hours	Pain	Retained	T. 97° P. 84	Recovery
Greenfield LXXX	+	+	-	+	Moderate	6 days	0	Retained, great collapse	T. subnormal P.90	Death, autopsy.
Langmead LXXXII	+	-	-	-	Moderate	2 yrs. and 5 mos.	?	Mental impairment	0	Death, autopsy.
Howard LXXXV	+	+	-	+	Severe	6 months	Tingling	Stupor	Normal	Recovery

DIAGNOSIS.

Some authors have doubted whether tetany is a disease itself or merely a symptom-complex; it has been seen that tetany is usually a complication of other diseases, but it does occur in healthy persons, and the writer has attempted to indicate the probability of a common anatomical foundation for the different varieties. The condition tetany has features as definite and constant as many a state allowed to be a separate disease, and the denying of this status to tetany seems rather an attempt to evade the need for elucidating its pathology than a satisfactory explanation. Other writers distinguish between a true and pseudo-tetany, making the presence of the phenomena of Trouseau, Chvostek, and Erb the essential features of the first. But it has been shewn that there is as a rule no anatomical foundation for these signs; any one or two of them may be negative and the third positive; all may be negative in gastric cases differing in no other respect from cases in which they are positive. The opinion that the presence of these signs is not pathognomic has support from many writers; it will suffice to quote Russell, Gowers, Pfeiffer(1), and the authors of those cases here collected in which the signs were negative. The signs are yet of great value; it is only in gastric tetany that they are negative in any considerable proportion of cases, and even then they are usually positive. They are often positive in slight

(1)Centr. f. Allgem. Path. u. Path. Anat., 1896,p.225

cases, when perhaps only the sensory phenomena are otherwise present, and they persist after the spasm has ceased and indicate the diagnosis when the attack itself has not been observed. Erb's phenomenon persists the longest, even for several weeks, and as long as it is present the paroxysm is liable to return at any time. Trousseau's sign is the most easily observed and most generally useful; it may appear before the paroxysm occurs and give warning of its imminence; this is perhaps its most valuable feature. These signs are of comparatively slight value when the diagnosis is, as usually in gastric cases, at once obvious; when one sees a patient with the face flushed, perspiring, lying motionless in the peculiarly stiff attitude assumed so often, the hands in the "accoucheur" position and fixed, the patient in great pain, but with speech inarticulate, and vomiting at frequent intervals, in such a case the diagnosis is not in doubt. This is a picture of a severe case, but the majority whether of greater or less intensity are equally obvious. The history of long-continued gastric disease with vomiting and constipation indicate the possibility of tetany. Sudden onset with or without various paraesthesiæ shortly after gastric pain and copious emesis is frequent and characteristic. Exaggeration of reflexes, and disturbance of special senses, especially vision, are helpful signs. If the patient is not seen till delirium or coma have set in as in Siever's cases(25,26) and Kuckein's(50) there may be more difficulty, but the spasm will probably

persist perhaps to a slight degree and the presence of the signs of Trousseau, Chvostek and Erb is of great positive value, pathognomonic in such a case. The history of long continued disease and of the mode of onset, and the absence of indications of uraemia or other forms of coma point to tetany; in this relation one notes that the respiration in tetany is not stertorous, but shallow, jerky and rapid, and the limbs are not flaccid but stiff. Latent cases as Kuckein's(50) occur in which the spasm is comparatively slight and coma early; of this variety is probably a case described by Jurgensen(1) though he does not give an absolute diagnosis himself. These same characters will indicate the diagnosis in such cases.

In the matter of differential diagnosis little need be said. Some diseases must be excluded in atypical cases. In tetanus there is often a source of infection found; the spasm begins in the masseters and spreads downwards; in tetany it begins in the extremities and spreads to the trunk and head. In tetanus trismus and risus sardonicus are common but rare in tetany. In both conditions the spasms may be continuous but the widespread spasm of tetanus is of short duration though the contracture of the masseters is persisting. In tetanus there is pyrexia, but in tetany no fever as a rule, and then only in gastric cases. Of the various forms of meningitis that of tuberculous origin is most likely to be confounded

(1) Deutsch. Arch. f. Klin. Med., 1900.

with tetany, and in fact this mistake has been made. With meningitis the patient is usually more obviously ill and the spasms are more of a clonic convulsive character than in tetany; there is a long premonitory stage; the signs of Trousseau, Chvostek, and Erb are negative. The pain is not felt ~~in~~ especially in the muscles affected by spasm. This form of meningitis occurs nearly always in children over one year old and at this age children are rarely seriously ill with tetany. In epilepsy the spasms are convulsive, of short duration but if generalised consciousness is lost. In spastic contracture the result of organic brain disease the spasm is permanent, often unilateral and there is paralysis as well as spasm.

Hysteria is the condition most likely to give rise to difficulties; but in this state the contractures are usually unilateral, and various hysterical stigmata such as emotional outbreaks and ovarian and mammary tenderness are likely to be found. In all conditions a search for the disease associated with tetany, such as gastrectasis, lactation, or rickets is of the first importance.

PROGNOSIS.

As regards tetany in general the outlook is good; attacks are apt to recur but except in long continued spasm in young infants recovery eventually follows. After total thyroidectomy on the other hand tetany is followed by death in about two-thirds of cases(Eiselsburg, Weiss.). Gastric tetany is by all authors considered to be a peculiarly fatal disease. It is cases which have suffered long from gastrectasis in which there is marked motor insufficiency of the stomach that provide the large proportion of fatal results. The first paroxysm of tetany may prove fatal as in the cases of Martin, Trevelyan and Collier, but usually daeth occurs after a series of paroxysms. The occurrence of mental symptoms such as delirium coma or epileptiform convulsions is of the gravest import. Moorhead in reporting his fatal case first pointed out that the leucocytosis is an aid to prognosis; cases with a high leucocyte count which rises or remains high even during apparent improvement are nearly always fatal. Cases with a high or markedly subnormal temperature are usually fatal. Patients who shew signs of renal inadequacy are also unlikely to recover. But the prognosis even in the most severe cases is profoundly modified by the treatment adopted. To quote Robson and Moynihan " the earlier adoption of surgical measures in conditions in which there is grave mechanical impediment to the free working of the stomach, will banish altogether that class of patient which furnishes us with the

last desperate forms of tetany"(1); and it can be added that even though the patient be desperately ill operation holds out a chance of recovery; five of the twelve patients operated on had lost consciousness before operation; one of these was pulseless and almost moribund; operation should be performed even if the stomach is in active peristalsis at the time(case 5). Fifteen gastric cases have been treated by operation and 80 % of these recovered, the three fatal cases were all the result of post-operive complications. Of sixty-three gastric cases treated without operation two were discharged from hospital unimproved and of the others 73.7 % died, to 26.2 % who recovered. Tetany associated with intestinal dilatation has similar prognostic characters but is more chronic and less rapidly fatal; its duration is rather months or years than weeks or days, though this is not a constant feature. Of such six such cases here recorded four (66.6 %) were fatal. Complications of tetany are rare; hysteria or some mental impairment may follow and very rarely muscular atrophy.

(1) Diseases of the Stomach, 1904,p.417.

Treatment.

The preceding sections have indicated the basis for t
treatment which is to remove any condition causing strain on the parathyroids, and if possible to improve the function of these glands; during paroxysms of tetany it will be necessary to palliate the spasm. But in practice successful treatment is by no means easy, as may be judged by the large number of remedies recommended and abandoned. For gastric tetany the best treatment is prophylactic; if there be any anatomical condition causing gastrectasis, especially pyloric and duodenal stenosis from cicatrix formation after ulcer, operation is to be advised, either pyloroplasty or gastro-enterostomy; these have both given good results but the benefit from gastro-enterostomy seems to be the more lasting. But if there is no such gross obstructive lesion operation will be valueless, and in view of the still high mortality from gastro-enterostomy is not to be lightly recommended. These cases can be greatly improved and often cured by careful medicinal treatment which may need to be continued for a long time. It is not necessary to consider this treatment in detail here; the diet should be nourishing but given in small quantities at a time, avoiding the use of fluid diet as much as possible, but giving plenty of water either plain or alkaline between meals; constipation should be prevented by diet, drugs, or enemata as necessary; the chemistry of the stomach may need rectifying by the use of either alkalies or acids

and pepsin occasionally; at the beginning of treatment lavage will probably be necessary and perhaps the use of antifermentative drugs such as phenol, ecreosote or sulpho-carbolate of sodium. Rest in bed is necessary at the beginning of treatment if there is any marked degree of dilatation, and is of assistance in improving the patients nutrition; it is a gfeat help in such cases to have the windows wide open while the patient is kept to the house. Alcohol by the mouth should be avoided and if a stimulant is necessary ether, ammonia, or strychnine should be used.

For the paroxysms of tetany treatment should first be directed to the stomach; careful lavage using abundance of hot water to which an alkali may be added should be carried out; it is an advantage as recommended by Professor Greenfield(case 7) to pass into the stomach through the tube warm milk which contains a drachm of sodium phosphate to the pint after lavage. A purgative should be given or the bowels moved ~~after~~ by means of an enema. The patient should be kept warm and elimination aided by maintaining free perspiration and if necessary by the ~~a~~ administration of diuretics; catheterisation may be necessary. If vomiting continues abundant ~~fluid~~ fluid should be supplied per rectum or subcutaneously. Various methods have been used locally to relieve the spasm; the most generally successful is forcible movement of the parts affected and massage; this is very painful at first but generally leads to relief

later; in some cases hot water bathing, in others ice locally is of value; the inhalation of chloroform may produce cessation of the spasm, but not always. A great many drugs have been recommended, all disappointing; but nerve sedatives such as bromides, chloral, valerian may give some relief; sleep should be obtained if possible, but it is often difficult to do so. Cheadle recommended physostigmine in gradually increasing doses but this drug has not shewn itself of especial value. All these methods have been tried and found wanting. Nucleo-proteids from the parathyroid glands have had very limited trial, but so far have been satisfactory; given with through lavage, and the injection of abundant fluid they might be expected to be beneficial. McCallum and Vaegtlin(1) find that in tetany produced by parathyroidectomy cure immediately follows the intravenous injection of calcium acetate or lactate in 5 % solution; the same result follows administration of calcium salts by the mouth but more slowly; tetany might reappear but could be ~~clear~~ cured by the same means.

Though careful treatment by medical means, especially with lavage does produce cures even in apparently desperate cases, surgical treatment by gastroenterostomy is far the most certain; operation should not be postponed, but performed at once, for it is impossible to say when the fatal termination may happen, nor can one feel sure that an improve-

(1) John Hopkins Hospital Bulletin, 1908, March, p. 91

ment is permanent until the cause of tetany is removed Operation may be performed during the continuance of tetany, and the cases of Robson and Moynihan(4) and of Mackay and Macdonald(5) show that any patient, however little hope there may appear to be, should be given the chance of operative treatment. In cases of maligant disease of the stomach partial gastrectomy can be performed at the same time if the condition of the patient allows, and in hour-glass stomach a gastro-gastrostomy may be needed as well as gastro-enterostomy.

In other varieties of tetany it is also necessary to palliate spasm, and to cure the associated disease. In pregnancy and after thyroidectomy the administration of thyroid substance may be beneficial, but is often disappointing; thyroid gland has been given in other cases with variable, but generally unsuccessful results. More benefit is to be expected from the use of parathyroid glands, or nucleo-proteeids prepared from these bodies; removals of parathyroids produces tetany far more constantly in carnivora than in other animals such as sheep; in goats especially young animals the removal of these glands produces tetany(1). Thyroid substance is ordinarily obtained from the sheep, but it would be advisable to use the parathyroids of dogs or kids. Benefit is to be expected- as stated above- from the use of calcium salts, and Netter(2) has administered calcium

(1) MacCallum, Thomson, and Murphy; John Hopkins Hosp. Bull., 1907, p. 333.

(2) Comptes Rend. de la Soc. de Biol. Mar. 15, 1907.

chloride in doses of 20 to 30 grains daily to children with tetany with good results. Along with the use of these special measures the patient should be kept warm and a generous, easily digestible diet given. Tonic drug treatment is to be given during the day and if necessary nerve sedatives such as bromides at night. For nocturnal tetany Gowers(1) recommends digitalis at bed-time. Electrical treatment - faradism and galvanism - has been tried and found useless.

(1) Diseases of Nervous System, Vol. 2, p. 709. 1893

A P P E N D I X.

The following are references to the cases which have been used in preparing this thesis; only the briefest particulars are given of those previously published as most of these are included in the various tables given or otherwise referred to. They are arranged and numbered for reference from corresponding numbers in the text; cases hitherto unpublished are reported in more detail. The author's name is first given after the number, then the reference.

Cases treated by operation.

1. Mayo Robson; Lancet, 1898, Vol. 2, p.1392.
   Severe case; Pyloroplasty, recovery.
2. Mayo Robson; loc. cit.
   Pyloroplasty, recovery.
3. Mayo Robson; loc. cit.
   Severe case of long duration; pyloroplasty, later a gastro-enterostomy was done; recovery.
4. Mayo Robson and Moynihan; Diseases of the Stomach, 1904, p.420.
   Severe case, the patient almost moribund; posterior gastro-enterostomy, tetany persisting for four days afterwards, but followed by complete recovery.
5. Mackay and Macdonald; Lancet, 1905, Vol. 2, p.1470.
   Severe tetany, with convulsions and loss of consciousness; gastro-enterostomy during active gastric peristalsis; recovery.
6. Jonnesgo and Grossman; La Presse Médicale, 1 July 1905, p.409. Generalised tetany; loss of consciousness; gastro-enterostomy; recovery

7. Carnegie Dickson; Practitioner, 1903, Vol.1, p.44.
Very severe paroxysms, some mental impairment, and later delirium; temprorary recovery under medical treatment, but signs of tetany returned; gastro-enterostomy, followed by complete recovery.

8. Brown and Engelbach; Surgery, Gynecology, and Obstetrics; Nov. 1908,p.558
Paroxysms of varying intensity for fifteen months; gastro-enterostomy, recovery.

9. Warbasse; Annals of Surgery, 1904, Dec.,p.911.
For seven years patient had given exhibitions as a "human ostrich"; for four years had suffered at intervals from tetany, four of these attacks being very severe, generalised, with convulsions; gastrostomy had already been performed once, and large numbers of metallic articles removed from the stomach. Gastrostomy was again performed and penknives, keys, watch-chains, nails, a button-hook, spoon, and pin weighing in all sixteen ounces were removed; recovery was complete.

10. Cunningham; Annals of Surgery, 1904, April.
Severe attacks with unconsciousness; gastro-enterostomy, recovery.

11. Grumpecht; Centr. f. Innere Med., 1897.
Typical tetany; gastro-enterostomy, death from peritonitis.

12 to 14. Fleiner; Arch. f. Verdauungskrank., Bd. 1, Heft.3.
Typical tetany; two cases died from postoperative complications, one cured.

15. Boas; Diagn. u. Therapie der Magenkra~~nkh~~. 2Th.,p.126
Typical case; gastro-enterostomy, cured.

15a. Personal communication from Dr Craven Moore, too late for use in the tables.
Female, aged 42, history of gastric ulcer for tweny-four years; gastrectasis, pyloric obstruction; several attacks of tetany which could be elicited by pressure on the epigastrium. Gastro-enterostomy, recovery.

Cases medically treated.

A. Associated with gastrectasis due to simple pyloric or duodenal ~~obstruction~~ stenosis.

16. McKendrick; Lancet, 1898,Vol.2,p.796.
Severe case, cicatricial pyloric stenosis, death, autopsy.

17 Halliburton and McKendrick; Brit. Med. Journ., 1901, Vol. 1, p.1607.
Patient became comatose but recovered; operation later.

18. Trimble; Brit. Med. Journ., 1905, Vol. 1,p.986.
Spasms of moderate severity,followed by persistent hiccough and delirium; Trousseau's sign positive; death, no autopsy.

19. Collier, Lancet, 1891, Vol. 1,p.1251.
Severe paroxysms five hours after lavage; death in seven hours from the beginning of tetany.

20. Martin; Lancet, 1887, Vol.1, p. 74.
Severe attack two hours after passing stom-

ach tube, the stomach was not washed out; temperature rose to 107.2°F; death in six and a half hours from passing the tube.

21. Soltau Fenwick; Trans. Clin. Soc. Lon., 1895,p. 13; Lancet, 1894, Vol.2, p.914.
Spasms recurred during over six weeks, the last attack was generalised, and caused death in twelve hours; autopsy.

22. Soltau Fenwick; Trans Clin. Soc. Lon., 1895,p.18.
Treatment by lavage was followed by recovery.

23. Christian Simpson; Practitioner, 1900, Sept.p.287.
Tetany at intervals for some months, some mental impairment during the illness, fatal attack associated with violent convulsions and coma; autopsy showed cicatricial stenosis of the duodenum.

24. Howard; Amer. Journ. Med. Sci., 1906,p.305.
Patient had previous less severe attacks of tetany successfully treated by lavage; present attack very severe, associated with leucocytosis of 17,480 per cm., fatal, autopsy; there was a great number of karyokinetic figures in the parathyroid glands.

25 Sievers; Berl. klin. Woch., 1898,1stAug.,p.680.
Patient was admitted to hospital unconscious with severe generalised tetany, and died three- quarters of an hour later; autopsy.

26 Sievers; Loc. cit.
Severe tetany, generalised; autopsy.

27 Kussmaul; Deutsch. Arch. f. Klin. Med., 6, 1896, p.481
Long continued tetany, attacks of moderate severity; recovery.

28.29 Kussmaul; loc. cit.
Both severe cases with coma; cicatricial pyloric stenosis; autopsy.

30 Dujardin- Beaumetz; Paris Med. Soc., Oct. 1884.
Severe generalised tetany; gastrectasis from cicatrised duodenal ulcers; autopsy.

31 Bouveret and Devie; Revue de Med., 1895, Feb. p.48.
Three attacks of tetany the last followed by coma and death; autopsy.

32 Observer- The writer.
M.C. female, age 31 years (in April 1908) married; 3 children, eldest 10 years, youngest 2½ years old, Pregnancies and labours normal Nothing abnormal in health before stomach trouble began, except that when about twenty years of age she suffered from "bloodlessness". Family history good. No nervous disease in the family and child en are all healthy. In May 1907 patient was attended by the writer while suffering from gastric ulcer; there were vomiting, pain, haematemesis and maloena; at this time the stomach was moderately dilated, the greater curvature just below the umbilicus. Patient had a similar illness in 1905 Since 1905 she had occasional attacks of pain and vomiting, induced by taking any food which was not very simple and easily digested.
After prolonged medical treatment she recovered from

illness of 1907 apparently completely, and from about October 1907 began to increase in weight. She had been extremely emaciated, and though improved she remained thin.

On April 17th 1908, the writer was called in, the message stating that patient had had a stroke. On this day she woke in her usual health, had a good breakfast of bacon and eggs and did her usual housework. Suddenly about 1P.M. vomiting commenced, and the hands were affected by spasm. Patient could not state definitely whether the vomiting preceded or followed the spasm, but thought these symptoms appeared simultaneously. When seen about an hour later she had vomited repeatedly, the vomit consisting of large quantities of viscid, green fluid, not frothy, and containing no solid matter. She complained of great pain in the arms and hands. The fingers were flexed at the meta-carpo-phalangeal joints, extended at the interphalangeal joints, and the thumb strongly flexed and pressed into the palm of the hand. The wrist was markedly flexed. The fingers and wrist could not be straightened, and any attempt to do so gave great pain. The dorsum of the hands, and the face were red, but not swollen. There had been no premonitory symptoms. The bowels had not been moved for three days before the onset of symptoms. The pulse rate was 120, and the temperature 98.8°F.

The vomiting and spasm continued all day, and at night patient did not sleep, although Potassium Bromide(gr.20) and Chloral Hydras(gr.15) were given

at bedtime.

On the 18th April the hands and wrists were in the same position, and the elbows also were flexed, so that the hands were over the manubrium sterni, the upper arms being pressed firmly to the side. Any attempt to move the limbs caused pain; the upper extremities were equally affected. The back was stiff and thepatient could not move herself; to be moved caused her pain. There was no opisthotonus. There was great difficulty in articulation so that patient could hardly be understood. The jaws were stiff but could be moved, and there was no spasm of the masseters corresponding to that of the arm muscles. The lips were not distorted. The toes were not affected by spasm; the feet were extended and stiff and the calves of the legs painful and hard. The knee-jerk was slightly increased. The face and hands were still red, but not swollen. Vomiting continued at short intervals, the vomit being of the same character as before. Vomiting occured spontaneously, and also anything swallowed produced vomiting, even small pieces of ice. There was profuse perspiration. Patient was intensely thirsty. The pulse was 150, temperature 99F. Only a small amount of urine was passed, the exact quantity not being measured; it contained a trace of albumin(having previously been normal), no acetone. The bowels were not moved although a Seidleitz powder had been given. Everything given by the mouth was however rejected immediately. The stomach was greatly dilated, extending from the fourth rib in

the left mid-clavicular line to 2 inches below the umbilicus. On this date till death rectal injections of normal saline were given three times a day through a long tube, from one to one and a half pints being injected at a time. They were not however always retained. During the 19th, 20th, and 21st the condition remained much the same. The spasm of the upper extremities was continuous. During these days patient was wholly unable to speak; she could not pass urine necessitating the use of the catheter, but very small quantities were obtained; the character of the urine was unaltered. The temperature was between 98&99F. the pulse between 150 and 170 per minute. She slept very little and then only for a few minutes at a time. The vomiting continued, but not quite so frequently; the stiffness of the back and pain on moving made nursing difficult. Perspiration was stikl profuse. From the 22nd till death patient was able to speak, and passed urine voluntarily. The temperature fell to 97.4F, and remained at that height with very slight variation till death. Pulse continued about 150 per minute, as arule, occasionally as high as 170. Patient was now very emaciated. The arms could be moved from the side, and the pain was not so severe. Patient said the pain left her sometimes, and during the evening the spasm of the upper limbs relaxed for about two hours. Vomiting continued about every two hours, the vomit was darker in colour, sometimes brownish.

On the 23rd the spasm of the upper extremities was paroxysmal, the spasm lasted about an hour and a half with free intervals of two or three hours. The pain seemed much less, but patient was greatly exhausted. During an interval of relaxation pressure on the brachial artery brought on a spasm of the fingers and thumb lasting about half an hour. Towards evening the spasms became much slighter. Patient complained that she was blind in the evening.

On the 24th the blindness continued, the spasms were not severe. Vomiting continued at intervals. Patient was conscious during her illness. She was greatly emaciated and died from exhaustion at 7.45 p.m.

Througout there was almost absolute sleeplessness. Pot. Brom. and Chloral, Cannabis Indica and Hyoscyamus, Opium and Trional were given both orally and per rectum, but none had more than a very slight effect; hypodermically Morphia, Morphia and Atropine and Hyoscine Hydrobromide were given in full doses, but with no better results. Of other treatment besides the saline injections patient had Bismuth and alkalies, dilute hydrocyanic acid, and Vinum Ipecacuanha, but after the first three days food and medicine by the mouth were stopped, and drugs, food (peptonised milk and eggs) and saline were given per rectum.

Patient's husband was a labouring man; she had always sufficient food and clothing, and a warm, well-built and well-ventilated house. She herself was not of a neurotic or hysterical temperament, habits temperate.

Necropsy:- 25th April, 2.30 p.m.

The body was greatly emaciated; post-mortem rigidity general and marked.

Cranium. On reflecting the scalp the tissues were remarkably dry; there was no bleeding. Bones normal, dura mater normal. There was no free subdural fluid. There were two slight adhesions between pia and dura mater on the left frontal lobe, and one over the right frontal lobe, and at these places the pia was unduly adherent to the cortex cerebri, The brain was pale in colour, firm in consistence; there was no excess of fluid in the ventricles. There was no naked eye evidence of disease in the brain, cerebellum, pons or medulla oblongata. The cervical portion of the cord was removed. The membranes were healthy, there was no excess of fluid and no naked eye evidence of disease in the cord.

Abdomen. Commencing discolouration in right iliac region. The subcutaneous tissues were markedly drier than usual; there was no bleeding. Subcutaneous fat was very scanty.

There was no free fluid in the peritoneal sac. The peritoneum had an extraordinary dry, sticky feel. The stomach presented at once; it was enormously dilated; the greater curvature extended one and a half inches below the umbilicus; the pylorus was two inches to the right of the middle line, high up beneath the liver and adherent to the under surface of that organ. The pylorus was firm and rather thicker than normal. The stomach consisted of a greatly dilated

cardiac portion, filling the whole dome of the diaphragm on the ~~right~~ left side, the left hypochondriac, and epigastric regions, and extending below the umbilicus; this was seperated by a marked constriction from the dilated pyloric canal, which was almost wholly to the right of the middle line, about two and a half inchss long, and two inches in diameter. The fundus had contracted abnormal adhesions to the spleen. The stomach was opened and found to contain gas, and about six ounces of viscid, brownish, foul smelling fluid. This was acid, containimg free hydrochloric acid; total acidity in terms of HCl 0.11 %. The pylorus was contracted, but there was no sign of old or recent ulcer at the pylorus, when divided the thickening appeared muscular. Corresponding to the constriction between the cardiac and pyloric portions of the stomach there was a smooth cicatricial area of mucous membrane, extending round the circumference of the stomach, except for a small area of normal mucous membrame at the lesser curvature. The smooth portion was from 1½ to 2 inches wide. The stomach wall was slightly thickened. The great omentum contained very little fat; there were numerous adhesions between it and the small intestine. The colon was somewhat dilated, the transverse colon especially so. The transverse colon was markedly proptosed, reaching as low as the symphysis pubis; the hepatic and splenic flexures were in their normal position. The liver was normal in size and showed no evidence of disease on section; the gall-bladder contained

a little viscid bile.

The pancreas was normal.

The kidneys were normal in size, and appeared healthy on section; they were not examined microscopically

The heart and lungs were normal; there was no free fluid in the pericardial or pleural sacs.

Dr Craven Moore kindly examined microscopically the brain and the portion of spinal cord removed; he reports that both were ~~healthy.~~ entirely normal.

33. Observer; The writer.

Female, aged 57 years, November

Patient was a married woman, 6-para, the wife of a brush-maker, in comfortable circumstances; she was a tall, emaciated woman, emotional and of an irritable temper. Two of the daughters suffer from epilepsy; there was no history of other nervous disease in her family. For twelve years patient had been losing weight, and had lost more rapidly the last twelve months. She had never been very strong, but no definite ailment till about twelve years ago, then she began to have attacks of vomiting, with some pain in the epigastrium, soon accompanied or preceded by painful cramps in the legs; since then she has had such attacks at varying intervals; for some years about every fortnight she had an attack of greater or less severity, but for the past twelve months there had been only two, one in July, and one three weeks ago. There had never been any haematemesis; the vomiting was rarely copious except at the begin-

ning of an attack, but during an attack retching and vomiting of small quantities was almost continual; and attacks lasted from a day or two to about a week and were always relieved quickly by medical treatment The cramps never occured without an attack of vomiting, but sometimes the cramps preceded the vomiting; the calves and feet and occasionally the thighs were affected, and the spasm was very painful. The cramps were not worse during cold weather; they had sometimes occured shortly after the patient had taken brandy; as a rule she took no alcohol; they lasted as arule from a few minutes to an hour or more, and recurred frequently as long as the vomiting continued. There were no premonitory sensations. During an attack of tetany the feet were plantar-flexed, the toes strongly flexed and the great toes bent in under the others and the calves became hard and prominent; the attack was very painful; the parts affected could not be moved voluntarily; occasionally the thigh muscles were similarly affected. The muscles of the face, trunk, and upper extremities had never been affected. Both lower extremities were equally affected as a rule, occasionally the left side was worse. During such attacks the vision became so dim that the patient could hardly see, there was great difficulty in articulation, and she became very deaf. The dimness of vision, deafness and difficulty in articulation lasted as a rule about a day after the spasm ceased, but in lessening degree. During an attack of tetany there was no retention of urine, but the

amount was always diminished, and it was passed in frequent small quantities. As long as she could remember patient had been very constipated.

On the 18th November an attack of vomiting began. On that day patient vomited a large quantity, and during the night felt very cold and weak; her daughter then gave her about a teaspoonful of brandy; an hour later an attack of tetany began; the calves amd feet were affected, and the spasm was very painful. The vision became very dim, there was marked deafness and the speech so indistinct that it could not be understood. At intervals during the 19th the spasms recurred, with intermissions varying from one to three hours; during such intermissions the patient could walk about her room though feeling very weak. Retching was almost continuous, but only small quantities of very sour-tasting material were vomited. Nothing was taken by the mouth but small quantities of tea and coffee. During the night patient did not sleep; there was one attack of tetany lasting about two hours. On the 20th the retching continued; there was one attack of tetany in the forenoon. In the evening patient was attended by the writer. She was very thin, worn-looking and pale, not jaundiced; retching violently every few minutes, only small quantities of mucus being brought up. She complained of great dimness of vision; the pupils were contracted; she was very deaf and her speech slurred, and most indistinct. The pulse rate was 100, with occasional intermissions, the wave of medium size, and

moderate tension; the arterial walls were somewhat thickened. Temperature 98, respiration 22. The bowels had not been moved for three days.

Abdomen. There was some hollowing of the epigastrium and marked prominence of the umbilical and hypogastric regions. Peristalsis of indefinite direction was visible in the umbilical region, when occasionally a rounded prominence about the diameter of an orange was seen. The abdominal walls were lax; stomach splash was elicited; one inch above the umbilicus, and one inch to the right of the middle line a firm, rounded, painless, slightly moveable swelling apparently the pylorus, was easily felt; in the left iliac region was a round sausage shaped mass, apparently sigmoid distended with faeces. The lower border of the liver was felt just below the costal margin in the right mammillary line. The spleen, kidneys and pancreas were not palpable. By percussion the stomach was found to extend, in the middle line from three inches above to two inches below the umbilicus, one and a half inches to the right of the middle line, and upwards in the left mamillary line to the fifth interspace.

Nervous System. Vision, hearing, articulation as related. No subjective alteration in taste. Skin sensibility was normal. Superficial reflexes; abdominal absent, plantar normal. Tendon reflexes; in the upper extremity easily obtained, but not exaggerated; the knee jerks were markedly exaggerated and on the right side patellar clonus was obtained; on both sides ankle clonus was easily obtained.

Chvostek's and Trousseau's phenomena were not present; attempts were made to elicit Trousseau's sign in both upper and lower extremities.

The heart was slightly enlarged; left border half an inch external to the left mamillary line, right border half an inch to the right of the mesial plane; there was a faint mitral systolic bruit. The lungs were normal. There was marked prolapsus uteri. Patient stated that the amount of urine had been diminished during the last two days, but could give no figures.

Treatment.

Large quantities of hot water in small doses at a time ordered by the mouth, and hot bottles to be placed in the bed; drugs, Bismuth Carbonate gr. ~~XX~~,24, and Magnesium Carbonate grs. 8 every three hours.

21 Novr.,- Patient had a good night's sleep, no more retching or sickness, and no cramps, and she feels much better, no pain, vision perfect, less deaf, speech distinct. During the night the bowels had been moved. Pulse 84; the intermissions shewn by sphygmographic tracings to be due to the occurence of occasional premature systoles. Blood pressure 105 mm. Hg. Peristalsis was visible as before and stomach borders unaltered. The knee-jerks were moderately exaggerated no ankle clonus obtained. Diet ordered was hot water and albumin water and raw pounded beef(patient stated that she could not take milk).

22 Novr., noon. Yesterday patient felt so much better that she insisted upon getting up, cooking and

eating a mutton-chop. During the night she felt very weak, was extremely restless, and had pain in the epigastrium, but no vomiting and no tetany. All this day(22) she had only taken a small quantity of water by the mouth. The speech was again very indistinct, and deafness worse. The temperature was 100.8F, pulse 106. The lower border of the stomach was four inches below the umbilicus; very slight peristalsis was visible. The knee-jerks were greatly exaggerated, and ankle clonus obtained on both sides; there was no alteration of skin sensibility.

4p.m., Stomach-tube passed; attempts to obtain the gastric contents failed; the stomach was washed out with weak warm solution of sodium bi-carbonate; after about two quarts had been used, before the stomach was clean, the patient suddenly became very irritable and restless, removed the tube and refused to allow further lavage. The fluid removed was clear, pale yellow in colour, containing a large amount of ropy mucous. A pint and a half was taken home for further examination. On standing there settled an abundant deposit of mucous, and some shreds were floating in the fluid. The reaction was alkaline, the biuret test negative, no blood was present.

Microscopic examination of the deposit:- Yeasts and sarcinae were seen in considerable numbers, and some short and long rod-like bacilli; some starch cells were present, and a few muscle fibres(this was more than twenty-four hours after the mutton-chop and no animal food had been taken since); some masses of

brownish pigment looking like melanin were seen. Examination of a stained specimen confirmed these findings. The deposit was sent to the Climical Research Association for further bacteriological examination (report on pp.).

10.30 p.m. The daughter stated that during the evening the patient had been rather restless, tossing about in bed; she had refused to take more than a few tea-spoonfuls of peptonised milk containing sodium citrate one drachm to the pint. The bowels had been moved about 5.30 p.m. There was no pain or sickness. She was very deaf, vision normal, speech slightly slurred. Pulse 100, temprature 98.4, respirations 28. The lower border of the stomach was just below the umbilicus, peristalsis was visible, and definitely gastric. The knee-jerks were distinctly exaggerated; slight ankle-clonus was obtainable on the right side not on the left. Patient was given a hypodermic injection of morphia gr. ¼ with atropine gr 1/150. On this occasion urine was obtained for examination; in colour it was a dark yellowish, on standing an abundant deposit of mucus settled. The reaction was acid, specific gravity 1.018; it contained albumin, the amount was too small to be estimated by Esbach's method, indican and acetone, there was no di-acetic acid, sugar, blood or bile; phosphates were abundant the deposit examined microscopically shewed epithelial cells, some granular casts, urates, and a few uric acid crystals.

23 Novr.:- The daughter stated that soon after 11

p.m. last night patient fell asleep and slept quietly till about 5a.m. when she began to moan in her sleep and her face appeared drawn, sunken and yellow; the daughter made no attempt to waken her. The sunken drawn appearance became more marked, and about 7 a.m. when the patient was alone in her room she quietly died.

Post-mortem. The skin was yellowish in colour; there no contracture. No further examination could be obtained.

34. Neumann; Deutsch. Klinik, 1861,no.3,p.26.
Epileptiform convulsions and coma followed the tetany; autopsy.

35,36. Leven; Maladies de l'estomac, Paris, 1879.
Two severe and fatal cases; autopsy reported in both.

37, 38. Müller; Charité-Annalen, 13, 1889,p.309.
Two fatal cases with duodenal obstruction in both, one by cicatrised ulcer, the other by kinking; hour-glass stomach in the second case; autopsy in both.

39. Hayem and Gaillard;Gaz. des Hôpitaux, Paris, 1883 p. 899.900.
Patient recovered but died two years later from cholera, and there was then found cicatricial stenosis of the duodenum.

40. Renvers; Berl. Klin. Woch., 1884,p.74.
Fatal tetany; at autopsy stenosis of pylorus and duodenum.

41. Loeb; Deutsch. Arch. f. Klin. Med., 1889, p. 95.
Generalised fatal tetany; cicatricial stenosis of pylorus and duodenum.

42. Backman; Dilatation of the Stomach, Helsingfors 1891.
Fatal tetany with pyloric stenosis; autopsy.

43. Bamberger; Allgemeine Weiner Med. Zeit., 1886, p. 376
Fatal case; gastrectasis due to ulcer of duodenum; autopsy.

44. Blazicek; Weiner Klin. Woch., 1894.
Duodenum compressed by the chronically inflamed gall bladder filled with gall-stones; autopsy.

45. Parsons; Proc. Acad. Med. Ireland, 1894.
The first case reported in Ireland; fatal.

46. Thiroloix and Du Pasquin; Bull. de la Soc. Anat. de Paris, March, 1893.
Fatal tetany; cicatricial stenosis of pylorus and duodenum.

47. Holsti; Finsha Läkaresällisk. Handb., Bd. 39, p. 591.
Fatal case aged sixteen years; cicatricial stenosis of pylorus; autopsy.

48. James; Presb. Hosp. Reports, 1896.
The second attack of tetany in six months; generalised; acute nephritis, pyloric stenosis found at autopsy.

B. Associated with carcinoma of the stomach or duodenum.

49. Trevelyan; Lancet, 1898,Vol,2.p 791.

Tetany associated with fall of temperature to 94.6F.; at autopsy there was found a cuboidal-celled carcinoma of the duodenum.

50. Kuckein; Berl. Klin. Woch., 1898,p.989.

Paroxysmal symptoms not severe, but unconsciousness early and persisting nearly four days; the phenomena of Trousseau and Erb were present, carcinoma of the pylorus and secondary growths in the peritoneum, retro-peritoneal glands, liver, kidneys, but the semilunar ganglia were free from growth and from cancerous glands; central nervous system normal.

51. Moorhead; Practitioner, Aug.1904, p.160.

Severe paroxysms followed by coma; carcinoma of the pylorus; autopsy.

52. Bouveret and Devic; Revue de Médecine, 1892,p.58.

Tetany lasted half an hour; death later from the gastric disease; carcinoma of pylorus and secondary growths in peritoneum at autopsy.

53. Blazicek; Wginer Klin. Woch., 1894.

Tetany caused death; scirrhus cancer of pylorus; autopsy.

54,55. Reigel; Diseases of the Stomach(English edition) 1903,p. 164.

Fatal cases with carcinoma of pylorus; no particulars given.

C. Stomach dilated, no obstruction at pylorus or duodenum. These cases in the absence of autopsy or in those that recovered had no signs sufficiently definite to diagnose stenosis.

56 Trevelyan; Lancet, Vol. 2,p.791. 1898

Tetany fatal in a few hours; stomach and first part of duodenum greatly dilated, but there was no lesion of these organs; there a was new growth in the middle of the body of the pancreas, but the head was free from growth; there was cirrhosis of both kidneys; autopsy.

57 Holman; Lancet, 1894,Vol.2,p.915.

Patient died in the second attack of tetany; the stomach was greatly dilated but therewa was no signs of ulceration; autopsy. This case was related in a discussion at the Clin. Soc. London, 1895.

58 Samuel and Soltau Fenwick; Ulcer of Stomach and Duodenum, 1900, p.320.

Two attacks of tetany in six weeks, each associated with increased gastric dilatation, the second attack fatal; gastric ulcer with acute paralytic dilatation of the stomach; no post-mortem examination.

59 De Baurmann; Bull. Soc. Méd. des Hôpitaux de Paris, March, 1889,p.166.

Tetany for thirteen hours and coma towards the end; at autopsy there was found dilatation of the stomach from atony.

60 Nason; Lancet, 1891, Vol. 2, p.44.

Repeated attacks of tetany during forty-eight hours; the stomach was greatly dilated and vomiting copious; recovery.

61 Howard; Amer. Jour. Med. Sciences, 1906,p. 303.

Repeated attacks of tetany; the stomach was greatly dilated and the phenomenon of Trousseau, Chvostek, and Erb present; patient died sixteen months later from the gastric disease; no post-mortem examination.

62 Howard; loc. cit,

Mild attacks of tetany; gastrectasis, recovery.

63 Howard; loc, cit.

Repeated attacks of tetany, signs of Trousseau, Chvostek and Erb present, some mental impairment; moderate degree of gastrectasis; recovery.

64 Howard; loc.cit.

Repeated attacks, Trousseau's sign present moderate degree of gastrectasis; patient recovered but had numerous mild attacks later after drinking bouts.

65 Howard; loc.cit.

A drinker of beer to excess; marked gastrectasis; five attacks of tetany following copious vomiting; recovery.

66 Caldwell; Brit. Med. Jour.,1902,Vol.1,p.1603.

Extreme gastrectasis; great weakness fol-

owed by tetany of moderate severity, w without vomiting; temperature rose rapidly before death; no autopsy.

67 Merlin; La LoireMédicale, 1890, 15th Nov.
Two attacks of tetany with an interval of two months between them; the second attack fatal with coma, in six hours; at autopsy the stomach dilated, and haemorrhage and erosion of mucous membrane of stomach and duodenum.

68 Prebble; Jour. of Amer. Med. Assoc., 1898.
Mild attack of tetany following vomiting ther was gastrectasis and diarrhoea; patient also had pulmonic hypertrophic osteo-arthropathy.

69 Ladd; Med. Council. 1901.
Severe attack of tetany which ended fatally in twenty-four hours; at autopsy there was gastrectasis and perforation of the cardia.

70 Strong; Boston Med. and Surg. Jour., 1902
Two attacks of tetany of moderate severity preceded by vomiting; there was gastrectasis; recovery.

71 Griffith; Amer. Jour, of Med. Sci., 1895,p.171.
Marked gastrectasis; severe tetany and death in twenty-four hours.

72 Griffith; loc. cit.
Gastrectasis; painless tetany affecting the left arm and leg; signs of Trousseau,

Chvesta Chvostek and Erb present; result not stated.

D. Associated with other gastric affections without dilatation.

73 Max Einhorn; Diseases of the Stomach, 1902,p.401.
Patient suffered from chronic gastric catarrh for many years; attack of tetamy alternated with epileptiform convulsions and loss of consciousness; recovery.

74,75 Mortimer, Lancet, 1907, Vol. 1, p. 1088.
In both cases tetany followed the ingestion of alcohol; there were symptoms of hyperchlorhydria; recovery.

76 Trevelyan; Lancet 1898, Vol. 2,p.793.
Attacks of tetany preceded by vomiting during six years; a case of "chronic benign tetany of gastric origin"; recovery.

77 Gulland; Personal communication;from Chalmers Hospital, Edinburgh.

Male aged 48, admitted 25 June, 1906.
Family history; Father died of cancer, Mother and five brothers alive and well.
In Feb.1905 patient began to vomit blood, and he had pain in the stomach after meals; ha was treated for gastric ulcer. The pain and vomiting continued till between October 1905 when he had a severe haematemesis,and was admitted to hospital; his weight then was 9 stone 10 lbs; he was discharged in three weeks feeling much better and weighing 10 stones 10 pounds. Soon after he began to have severe pain though

he kept strictly to milk diet. He had no severe haematemasis though the vomit was occasionally streaked with blood.

The patient was very thin, emaciated, eyes sunken weight 8 stones 10 pounds. The pupils were very contracted; the tongue dry and very white. The bowels were constipated. Patient had pain very soon after taking milk and often vomited at once; the pain was felt chiefly over the region of the stomach. There was no visible peristalsis, no tumour palpable, no pain on palpation; the stomach was not dilated, and the liver not enlarged. The temperature was subnormal, the pulse 84. Urine was acid, sp. gr. 1022, containing albumen. The respiratory and cardiac systems were normal.

About midnight on the day of admission patient had a very severe attack of tetany involving the hands and toes chiefly; the muscles of the face were also involved; there was difficulty in speech and swallowing. The spasm was relieved by morphia gr 1/6 hypodermically, and one pint of saline per rectum, and patient then slept. About 8 a.m. he had another attack of tetany lasting an hour; both hands and feet were firmly clenched, he was able to swallow a and speak slightly; he looked very ill. The spasm was relieved by bromide grs 40, and saline per rectum. Temperature 97F. Patient was given a diet of milk and raw meat juice. On the 28th June he was given a test breakfast which shewed abundant free hydrochloric acid. On the 1st July patient was put

onfarinaceous diet, and on the 2nd July no albumen was found in the urine. Operative treatment was recommended but refused by the patient. He improved greatly and left hospital having gained one stone weight. He had no more attacks of tetany.

78 Personal communication from Dr Craven Moore; too late for use in the tables.

Female aged 23, chronic gastric ulcer for five years, pyloric stenosis, gastrectasis, tonic contractions of the extremities noted on a few occasions; general epileptiform convulsions after the passage of the stomach tube followed by coma and death. Post-mortem there was great gastric dilatation, free HCl 65, no lesion in other organs, nervous system normal

79 Dr Craven Moore.

Male aged 39, history of duodenal ulcer for several years; stomach dilated to the pubis, tetany for two days, then epileptiform convulsions, cutaneous petechiae, semi-coma with ~~unconsciousness~~- incontinence for seven days, death. Post-mortem great emaciation, cicatrising ulcer first part of duodenum, great gastric dilatation, cardiac dilatation, marked passive engorgement of all organs, brain no lesion (microscopically examined). Free HCl 78, total acidity 90.

79a. Dr Craven Moore.

Male aged 32, dilated stomach; recurrent attacks of tetany of hands and legs lasting four to twelve hours with intervals of freedom; last attack followed profuse vomiting; face also affected; pupils pinpoint, the respiratory muscles affected, jerky breathing,

temperature 104 F., death in 14 hours. Post-mortem e cicatrising ulcer just beyond pylorus with adhesions, enormous dilatation of the stomach, free HCl 67, total acidity 75. Brain normal (microscopically examined).

E. Associated with intestinal dilatation.

80 Greenfield; Lancet, 1903, Vol. 2, p. 1019.

Patient had constipation and frequent vomiting; the bowels were moved by purgatives and enemata; attacks of tetany of moderate severity; death followed a recurrence of vomiting; at autopsy the upper part of jejunum was greatly dilated, the coils matted together by adhesions, but there was no actual obstruction; the stomach was not dilated.

81 Langmead; Trans. Clin. Soc. London, 1905.

On five occasions patient had tetany accompanied by the evacuation of porridge-like stools; treatment by lavage of the colon was curative except in the last attack which was complicated by diphtheria and was fatal; at autopsy the sigmoid flexure was greatly dilated; two uric acid calculi in the right kidney.

82 Langmead; Trans. Clin. Soc. London, 1907. L.67

The stools were large, whitish, pultaceous and very offensive, there was typical tetany of the hands, signs of Trousseau, Chvostek a and Erb present; under treatment by dieting and intestinal lavage patient improved and the tetany ceased, a month after admission

diarrhoea began; two days later ~~two~~ ten inches of dilated sigmoid flexure was removed by operation; patient improved for a few days then the pultaceous motions returned, and death followed from exhaustion; at autopsy the whole large intestine was greatly dilated; there was no obstruction.

83 Sturges; reported by Langmead, loc. cit.

At age of 14 months diarrhoea began, the abdomen became distended, and attacks of tetany of variable duration commenced; patient admitted to hospital at the age of 2½ years, when the diarrhoea and tetany were still present; the child had laryngismus stridulus when excited; death followed from exhaustion; at autopsy the transverse colon was dilated.

84 Batty Shaw and Mant; Trans. Clin. Soc. London, 1906.

Attacks of tetany for seven months; the abdomen was distended; treatment by thyroid substance was curative; at laparotomy later a general dilatation of the large intestime was found.

85 Howard; Amer. Jour. of Med. Sci.,,1906,p.309.

After seven months diarrhoea of moderate severity began; there were occasional convulsions; the abdomen was distended; the signs of Trousseau, Chvostek and Erb were present; tetany persisted at intervals for four months; the diarrhoea ceased nine days before the last attack of tetany; recovery.