Negative diagnosis of surgical lesions of the stomach and cap / by Lewis Gregory Cole, M.D. Professor of Roentgenology in Cornell University Medical College.

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Reprinted from the November 1914 Issue of the American Journal of Roentgenology

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The value of a positive diagnosis of cancer or ulcer of the stomach or cap is directly in proportion to the accuracy of the negative diagnosis. A diagnostic method which enables one to state with a reasonable degree of certainty that a patient has or has not a gastric cancer or ulcer, has or has not an ulcer of the cap, occupies a unique position. At the last annual meetings of both the Gastro-enterological Society and the Medical Section of the American Medical Association it was asserted repeatedly that the early diagnosis of gastric cancer is impossible. To this statement I take exception emphatically, referring you to numerous communications* which show the accuracy of the positive diagnosis of ulcer and cancer of the stomach and cap, and especially to a report on twenty-seven consecutive cases examined by serial Roentgenography and operated upon by Dr. Brewer.** Each of the twenty-seven cases presented sufficiently definite clinical symptoms of a lesion of the stomach or cap to justify surgical exploration. In eleven cases, or forty per cent of the number investigated, examination by serial Roentgenography resulted in a negative diagnosis of ulcer or cancer—or of any surgical lesion of the stomach or cap. Nor was a surgical lesion of the stomach or cap found at operation in any one of these cases. A negative diagnosis of gastric carcinoma and indurated ulcer of the stomach and cap has been made in five hundred and sixty-six cases out of the whole number of gastro-intestinal cases examined to date. Thirty-three of these cases presented sufficiently severe symptoms to justify surgical exploration; and it is upon the results in these thirty-three cases, operated upon by twenty-three different surgeons, that the present communication is based. The negative diagnosis of gastric cancer and ulcer of the stomach or cap was made in each case solely on the Roentgenographic findings, and in not a single instance was a lesion of the stomach or cap demonstrated by surgical exploration. In many cases a lesion at some other point in the gastro-intestinal tract was demonstrated Roentgenologically and proven by surgical procedure. As limited space prohibits a full consideration of each of the thirty-three cases, only eight characteristic cases will be described in detail and illustrated. Of the other twenty-five cases only the clinical diagnosis, Roentgenologic diagnosis and surgical findings will be given. In thirty-two out of the thirty-three cases the

*Arch. of the Roent. Ray, Dec., 1911, Apr., 1912, Oct., 1912. Journal of the Am. Med. Assn., Nov. 30, 1912. N. Y. Med. Jour., Feb. 14, 1914, Vol. xcic, No. 7, p. 305. Zeit. f. klin. Med., Berl., 79 . H. 5 u. 6, 1914. The Lancet, Lond., May 2, 1914, No. 4731, Vol. clxxxvi, p. 1230.

**Annals of Surgery (forthcoming issue).

surgical findings corresponded with the Roentgenographic findings in every essential detail, but in one case they differed to such an extent that it was impossible to explain the discrepancy. In most of the cases the incision was made directly over the pyloric end of the stomach, and in all cases the stomach and duodenum were examined through the laparotomy wound.

The technique by means of which our conclusions were reached has been fully described in previous communications.* An examination less complete than the one prescribed may suffice in a great majority of cases, but abbreviated methods lead to erroneous diagnoses in a sufficient number of cases to cast discredit on the Roentgen method and to rob it of the remarkable degree of accuracy which it can attain. Therefore I beg of you as Roentgenologists—do not apply the diagnostic principles described in this and previous communications to anything less than the complete serial examination.

Gastric cases may be divided into two classes with respect to a negative diagnosis of ulcer or carcinoma of the stomach or cap —(1) those which unquestionably present no unusual Roentgenographic findings, and (2) those presenting direct or indirect Roentgenographic evidence of a spasmodic lesion. The best illustrations of the first type of cases are found in symptomatically normal patients examined for experimental purposes. There is no difficulty in making a negative diagnosis of cancer or ulcer of the stomach or cap in cases of this kind, as the entire series of Roentgenograms shows the stomach and cap well distended and both surfaces of the pyloric sphincter clear-cut and well defined. Naturally such diagnoses are not proven by surgical procedure. Most cases however come under Class II. They have or have had more or less symptoms referable to the stomach and cap. Such symptoms, particularly "hunger-pain," are associated with spasmodic contractions of the stomach, pyloric sphincter or cap. These spasms present definite Roentgenographic findings, i. e., either direct evidence of the spasm itself or the results of continuous and repeated spasm, a condition already fully described in an article on the Relation of Lesions of the Small Intestine to Disorders of the Stomach and Cap.** They manifest an appearance simulating organic lesions from which they may and must be differentiated, lest the operative procedure indicated for a surgical lesion be performed at the site of a reflex spasm of unknown cause. The eight cases about to be described exemplify the marked discrepancies so often observed between the clinical and Roentgenographic findings.

*Amer. Jour. of the Med. Scien., July, 1914, Vol. cxlviii, No. 508, p. 92.

**Amer. Jour. of the Med. Scien., July, 1914, Vol. cxlviii, No. 508, p. 92.

Fig. 1—Case XXVII.

For eighteen months this patient had suffered with pressure from gas. In the last six months she had complained of acute epigastric pain, perpetual belching and some regurgitation of bile. Attacks were almost always accompanied by prolonged vomiting, at one time for seventy-two hours. There was an entire loss of appetite and constant diarrhoea. Roentgenologically no gastric or

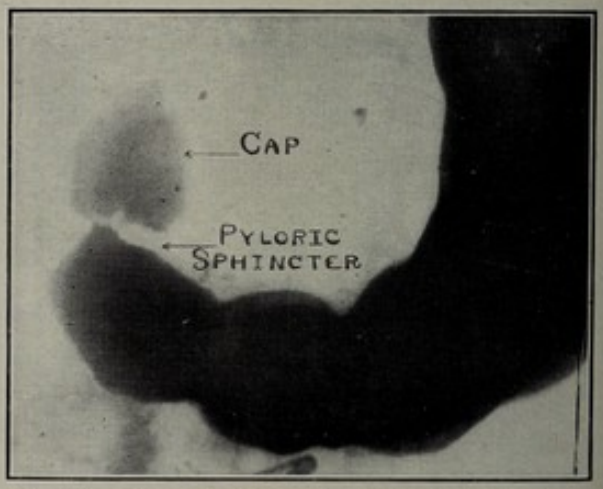

Fig. 1. Stomach Normal—Colonic Adhesions.

duodenal lesion was found. In the Roentgenograms of the colon a loop of sigmoid was observed to lie in close proximity to an extremely prolapsed caecum and ascending

colon in a manner suggestive of adhesions at this point. At operation no lesion of the stomach or cap was found. The entire caecum and ascending colon were removed and the ileum transplanted into the transverse colon.

FIG. 2—CASE XVI.

Fig. II illustrates one of the most extreme spasmodic conditions that we have observed. A negative diagnosis of new growth of the stomach was made. The report reads: "The irregularly shaped cap, the hazy edges of the sphincter, and the lack of

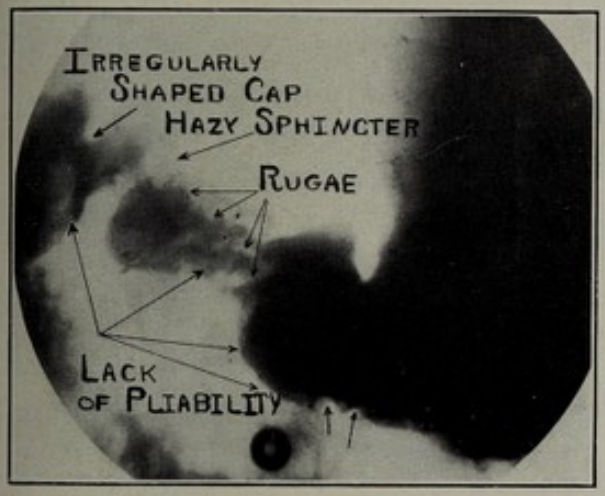

FIG. 2. Stomach Normal—Diseased Appendix.

normal expansion and contraction of the pars pylorica indicate that there is some lesion involving this portion of the stomach. The six hour stasis would indicate an organic obstruction at the pylorus, but I believe the stasis is due to some functional disturbance of the stomach and cap rather than to an organic obstruction." The following is an extract from a letter sent at the same time to the surgeon who referred the case: "This case is typical of a group of about twenty cases in which there has been evidence of a definite lesion involving the pars pylorica and cap. I have not felt that I could advocate surgical interference in any of these cases, although I am exceedingly anxious to know what pathological condition causes these Roentgenologic findings. Therefore if the clinical history is sufficiently severe to indicate surgery, I should like if possible to be present at the operation." The surgical diagnosis was "no cancer or ulcer of the stomach or duodenum and no adhesions." A chronically diseased appendix was removed through a second incision.

FIG. 3—CASE III.

A negative diagnosis of new growth, ulcer of the stomach or cap, and adhesions was made in this case. It was even stated that

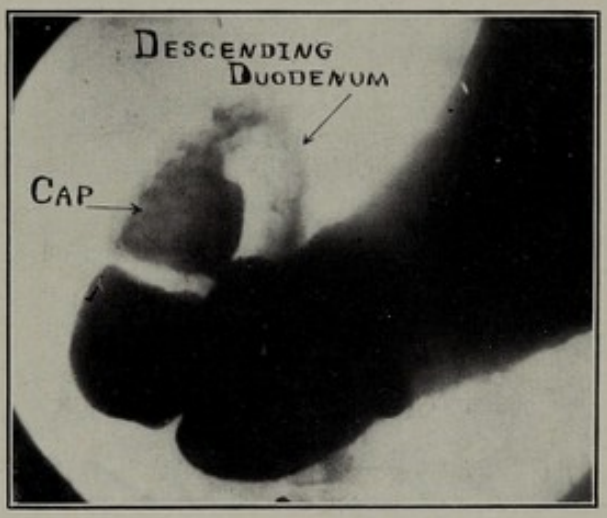

FIG. 3. Stomach and Colon Normal.

"one is justified in making a negative diagnosis of any organic lesion of the stomach or cap." The clinical history however was sufficiently characteristic of an organic lesion of the stomach and cap to justify surgical procedure. No organic lesion was found at operation, after which the surgeon pronounced the case one of "neurasthenia."

FIG. 4—CASE XIII.

The patient gave a history of several attacks of abdominal pain and fever, followed by soreness in the lower abdomen. One of these attacks had been diagnosticated as acute appendicitis by a competent physician. Subsequently the patient had suffered from digestive distress with more or

less epigastric pain, gas and sour eructations after meals. The Roentgenograms

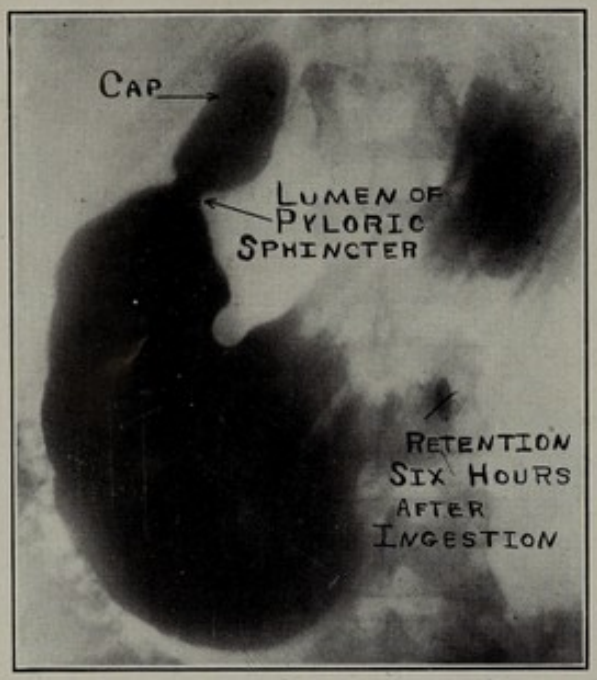

FIG. 4. Stomach Normal—Diseased Appendix.

showed no evidence of new growth, ulcer or adhesions of the stomach or cap. The only unusual finding was a prolonged gastric retention. At operation the stomach, duodenum and gall-bladder were found to be normal. A chronically diseased appendix was removed. The gastric retention observed Roentgenographically was functional.

FIG. 5—CASE XIV.

One of the cases which showed a glaring inconsistency between the clinical history and Roentgenographic findings was referred to me with a definite history of duodenal ulcer. The clinical history was so characteristic that there seemed to be no doubt of the diagnosis, and the patient was sent to me for the purpose of increasing my number of duodenal ulcers. This was a hospital case, and I economized on the plates, making only about one-half the usual number of exposures. The patient was to be operated on the next day for duodenal ulcer. My diagnosis was "spasm of the cap, negative diagnosis of new growth or indurated ulcer of the stomach or cap." This negative report delayed the operation temporarily. The following day the symptoms localized in the right iliac fossa and an emergency operation for an appendix was performed in the middle of the night.

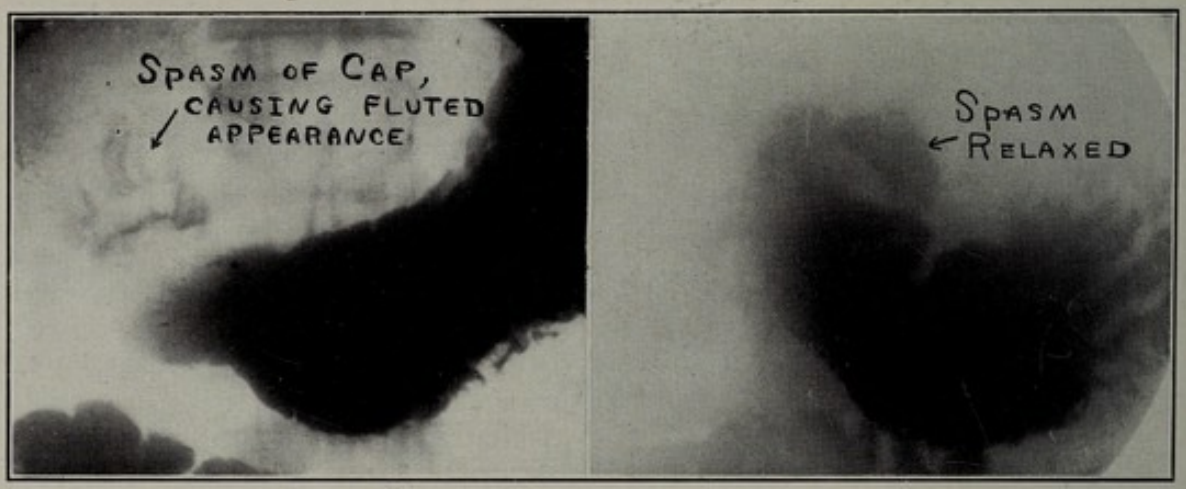

FIG. 5. Stomach Normal—Acute Appendicitis.

FIG. 6—CASE XV.

This patient had been under observation in the hospital for seven weeks with a typical history of gastric ulcer, including even vomiting of blood, as we were informed later, although she appeared for Roentgenographic examination without giving a clinical his-

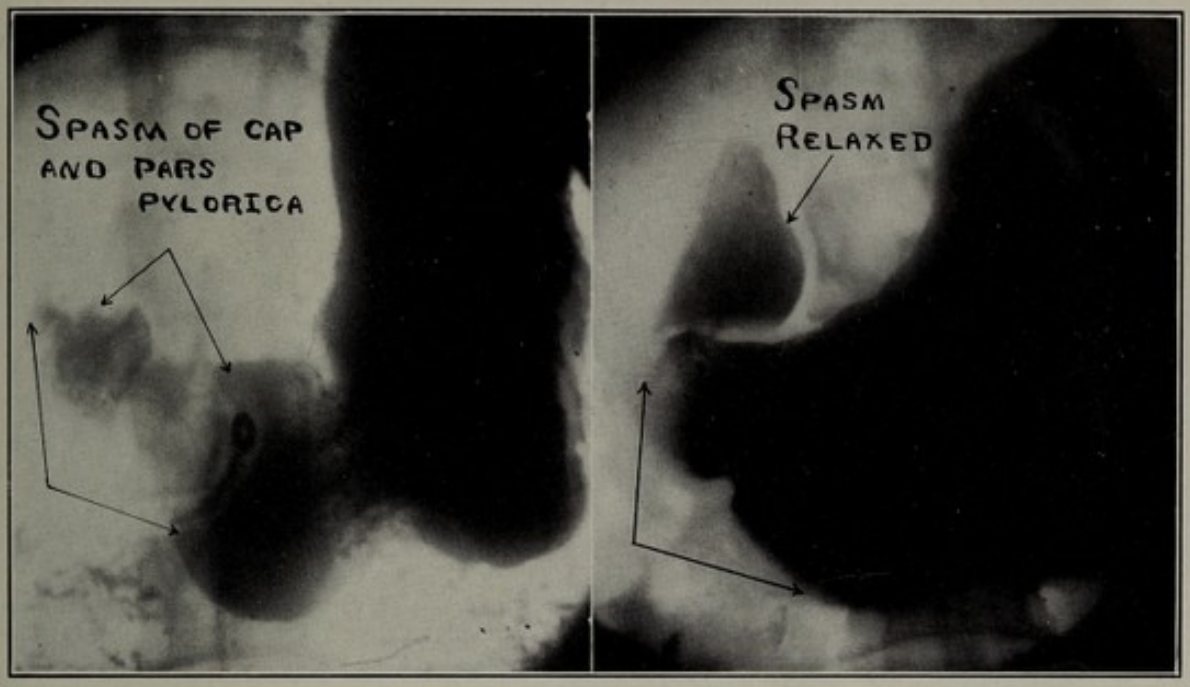

FIG. 6. Stomach Normal—Chronic Appendicitis.

ory. A Roentgenologic diagnosis of negative cancer or ulcer of the stomach or cap was made. An extreme functional derangement of the stomach was observed and the patient was advised to return for an examination of the colon and appendix. Subsequent examination showed a normal colon and bismuth retention in the appendix. We were then told that the clinical history was absolutely typical of gastric ulcer, and were offered an opportunity to hedge; but we "stood pat" on a negative diagnosis, and no surgical lesion of the stomach or cap could be demonstrated surgically. A thickened appendix filled with feces was removed.

FIG. 7—CASE XXVI.

The patient had been admitted to the hospital with a diagnosis of perforated gastric ulcer. His symptoms were acute epigastric pain and severe and protracted vomiting. The vomitus contained blood. Roentgenographically no evidence of new growth, indurated ulcer or adhesions of the stomach or duodenum was found. An acute angula-

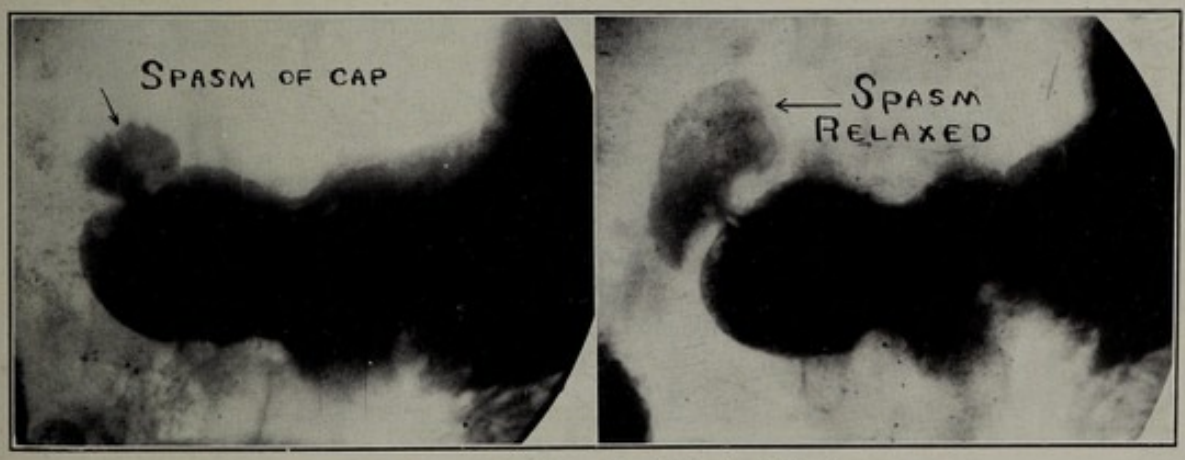

FIG. 7. Stomach Normal—Colonic Adhesions.

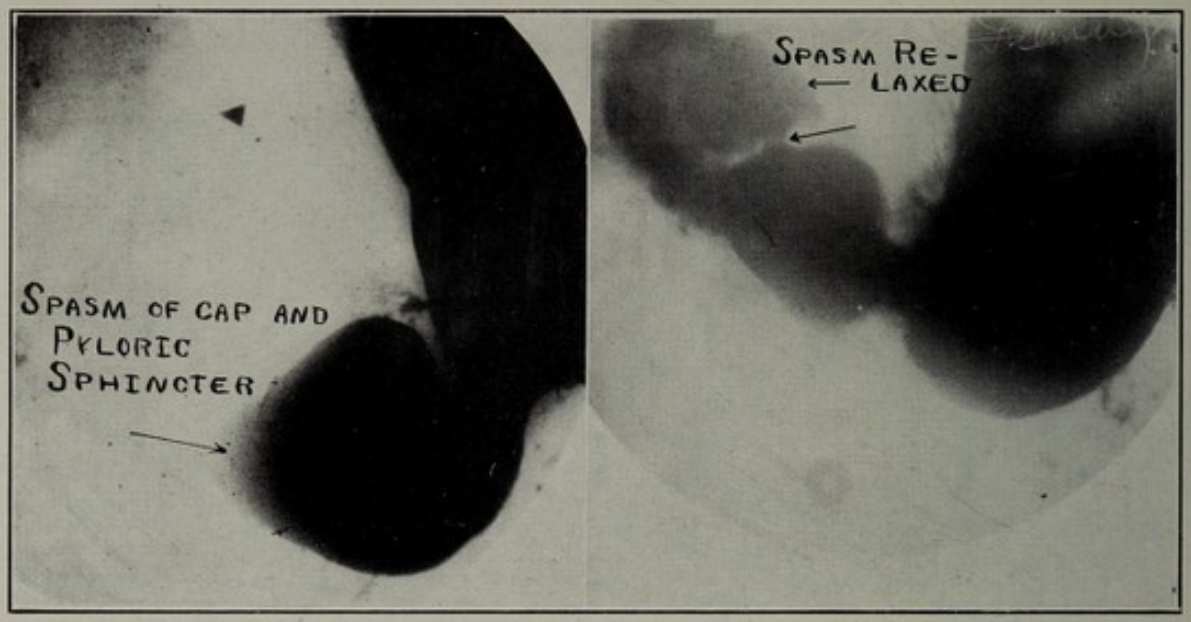

FIG. 8. Stomach Normal—Carcinoma of Colon.

tion in the first portion of the transverse colon was observed. Operation revealed a normal stomach, duodenum and gall-bladder. There was a band of adhesions on the ascending colon causing angulation.

FIG. 8—CASE XXVIII.

Eighteen months previous to the Roentgenographic examination the patient began to have dull pain after eating, sometimes in the epigastrium, at other times in the right or left iliac fossa, lasting from five to fifteen minutes with subsequent prolonged discomfort. There was a great deal of belching, soreness across the lower abdomen and through to the back, and a loss of twenty-five pounds in eighteen months. Roentgenologically the important finding was a marked pylorospasm which at certain stages of digestion completely occluded the pyloric opening. When the spasm relaxed it was evident that there was no organic lesion of the stomach or cap. As a carcinoma of the colon was found at operation, it was unfortunate that the colon was not examined Roentgenographically.

The remaining twenty-five out of our thirty-three cases will simply be enumerated and the diagnoses given in brief. Many of the patients presented such atypical symptoms that a definite clinical diagnosis had not been attempted. The following is a list of the whole series of thirty-three cases, the eight cases already considered in detail being marked with a star.

	Clinical Diagnosis	Roentgenologic Diagnosis	Surgical Findings
CASE I.	GASTRIC ULCER.	Stomach and Cap Normal.	Stomach and Cap Normal.
CASE II.	PERNICIOUS ANEMIA.	Stomach and Cap Normal.	(Post Mortem Findings.) Stomach and Cap Normal.
CASE III.*	GASTRIC ULCER OR CARCINOMA.	Stomach and Cap Normal.	Stomach and Cap Normal. Diagnosis, "Neurasthenia."

	Clinical Diagnosis	Roentgenologic Diagnosis	Surgical Findings
Case IV.	Gall-Bladder Infection.	Stomach and Cap Normal. Negative Diagnosis of Gall-bladder Infection.	Stomach, Cap and Gall-bladder Normal.
Case V.	Pyloric Obstruction.	No Organic Lesion of Stomach or Cap. Prolapse and Slight Dilatation of Stomach.	Stomach and Cap Normal. Slight Dilatation of Stomach.
Case VI.	Gastric Ulcer.	No Organic Lesion of Stomach or Cap. Hypertrophy Gastric Muscularis.	No Organic Lesion of Stomach or Cap. Hypertrophy Gastric Muscularis.
Case VII.	Tumor of Spleen.	Stomach and Spleen Normal. Kidney not Examined.	Stomach and Spleen Normal. Hypernephroma of Kidney.
Case VIII.	Duodenal Ulcer.	Stomach and Cap Normal. Gall-stones. Colon not Examined.	Stomach and Cap Normal. Gall-stones. Colon not Examined.
Case IX.	Gastric Ulcer.	Stomach and Cap Normal. Gall-stones.	Stomach and Cap Normal. Gall-stones.
Case X.*	Gastric Ulcer.	Stomach and Cap Normal.	Stomach and Cap Normal. Cholecystitis.
Case XI.	Duodenal Ulcer.	Stomach and Cap Normal. Adherent Appendix.	Stomach and Cap Normal. Adherent Appendix.
Case XII.	Duodenal Ulcer.	No Organic Lesion of Stomach or Cap. Spasm of Cap and Pyloric Sphincter. Colon not Examined.	Stomach and Cap Normal. Diseased Appendix.
Case XIII.*	Chronic Appendicitis, or Duodenal Ulcer.	Stomach and Cap Normal. Prolonged Gastric Retention.	Stomach and Cap Normal. Chronic Appendix.
Case XIV.*	Duodenal Ulcer.	No Organic Lesion of Stomach or Cap. Spasm of Cap.	Stomach and Cap Normal. Acute Appendicitis.
Case XV.*	Gastric Ulcer.	No Organic Lesion of Stomach, Cap or Colon. Spasm of Cap and Pars Pylorica. Retention in Appendix.	Stomach, Cap and Colon Normal. Diseased Appendix.

	Clinical Diagnosis	Roentgenologic Diagnosis	Surgical Findings
Case XVI.*	Duodenal Ulcer.	No Organic Lesion of Stomach or Cap. Spasmodic Lesion of Pars Pylorica and Cap.	No Lesion of Stomach Cap or Gall-bladder Diseased Appendix.
Case XVII.	Prolapsed Kidney. Reflex Gastric Symptoms.	No Organic Lesion of Stomach or Cap. Spasm of Cap and Pars Pylorica. Gastroptosis.	Stomach and Cap Normal. Adherent Appendix. Prolapsed Kidney.
Case XVIII.	Duodenal Ulcer.	No Organic Lesion of Stomach or Cap. Pylorospasm. Adhesions Involving Caecum and Ascending Colon. Insufficiency of Ileocaecal Valve.	Stomach and Cap Normal. Adherent Appendix.
Case XIX.	Duodenal Ulcer.	Stomach and Cap Normal. Colonic Adhesions.	Stomach and Cap Normal. Appendicular Adhesions.
Case XX.	Gastric or Duodenal Ulcer.	Stomach and Cap Normal. Colon not Examined.	Stomach and Cap Normal. Chronic Appendix.
Case XXI.	Unknown.	Stomach and Cap Normal. Adhesions at Hepatic Flexure. Retention in Appendix.	Stomach and Cap Normal. Adherent Appendix.
Case XXII.	Duodenal Ulcer or Gall-Bladder Infection.	Stomach and Cap Normal. Retention in Appendix.	Stomach and Cap Normal. Diseased Appendix.
Case XXIII.	Cholecystitis.	Lesion of Cap and Pyloric Sphincter. Cause not Determined. Examination Incomplete.	Stomach and Cap Normal. Chronic Appendix.
Case XXIV.	Unknown.	Stomach and Cap Normal. Gastroptosis.	Stomach and Cap Normal. Numerous Adhesions and Kinks of Colon. Atrophic Appendix.
Case XXV.	Duodenal Ulcer.	Stomach and Cap Normal. Adhesions of Caecum and Ascending Colon.	Stomach and Cap Normal. Jackson's Membrane, Involving Colon, Appendix and Duodenum.

	Clinical Diagnosis	Roentgenologic Diagnosis	Surgical Findings
Case XXVI.*	Perforated Gastric Ulcer.	No Organic Lesion of Stomach or Cap. Spasm of Cap. Adhesions Involving Ascending and Transverse Colon.	Stomach and Cap Normal. Band of Adhesions on Ascending Colon.
Case XXVII.*	Gastric or Duodenal Ulcer.	Stomach and Cap Normal. Sigmoid Adherent to Caecum and Ascending Colon.	Stomach and Cap Normal. Adhesions of Caecum and Ascending Colon.
Case XXVIII.*	Gastric Carcinoma.	No Organic Lesion of Stomach or Cap. Spasm of Pyloric Sphincter. Colon not Examined.	Stomach and Cap Normal. Carcinoma of Colon.
Case XXIX.	Colonic Stasis.	Stomach and Cap Normal. Constricted Caecum. Insufficiency Ileo-caecal Valve.	Stomach and Cap Normal. Ulceration Large Bowel. Insufficiency Ileo-caecal Valve.
Case XXX.	Colonic Stasis.	Stomach, Cap and Colon Normal. Colonic Stasis.	Stomach and Cap Normal. Entire Colon Removed.
Case XXXI.	Colonic Stasis.	Stomach and Cap Normal. Colonic Stasis.	No Lesion of Stomach or Cap. Typical Case of Colonic Stasis.
Case XXXII.		Stomach and Cap Normal. Pressure on Stomach from Without. Colon not Examined.	Stomach and Cap Normal. Extensive Adhesions Small and Large Intestines.
Case XXXIII.	Gastric Ulcer.	Stomach and Cap Normal. Chronic Obstruction Duodeno-jejunal Junction.	Stomach and Cap Normal. Obstruction Duodeno-jejunal Junction by Enlarged Retroperitoneal Glands.

In the early days of Roentgenology I well remember the efforts of some men to prove by sawing bones in a zig-zag direction that the negative diagnosis of a fracture of a long bone was of little or no value. Later there was a considerable stir when it was stated that one is justified in making a negative diagnosis of renal calculus. Renal colic and renal calculus were considered synonymous until case after case of renal

colic had been operated upon in spite of the negative Roentgenographic findings, and no calculus found. In both these groups of cases there are and always will be occasional errors, usually due to incomplete examination or careless interpretation of the Roentgenograms. But the remarkable accuracy with which these conditions can be recognized when present has justified one in stating with a reasonable degree of certainty that if they are not shown Roentgenographically, they are not present. Our thirty three consecutive cases, which have beer operated upon for lesions of the stomach o cap in spite of a negative Roentgenologi diagnosis, form a basis for concluding tha the high degree of accuracy attained by th Roentgenologic diagnosis of fractures an renal calculi may also be claimed for th negative and positive diagnosis of surgica lesions of the stomach and cap.

SIR GILBERT BLANE, M.D., F.R.S.,

An Administrator of Naval Medicine and Hygiene.

BY

TEMPORARY SURGEON-GENERAL H. D. ROLLESTON

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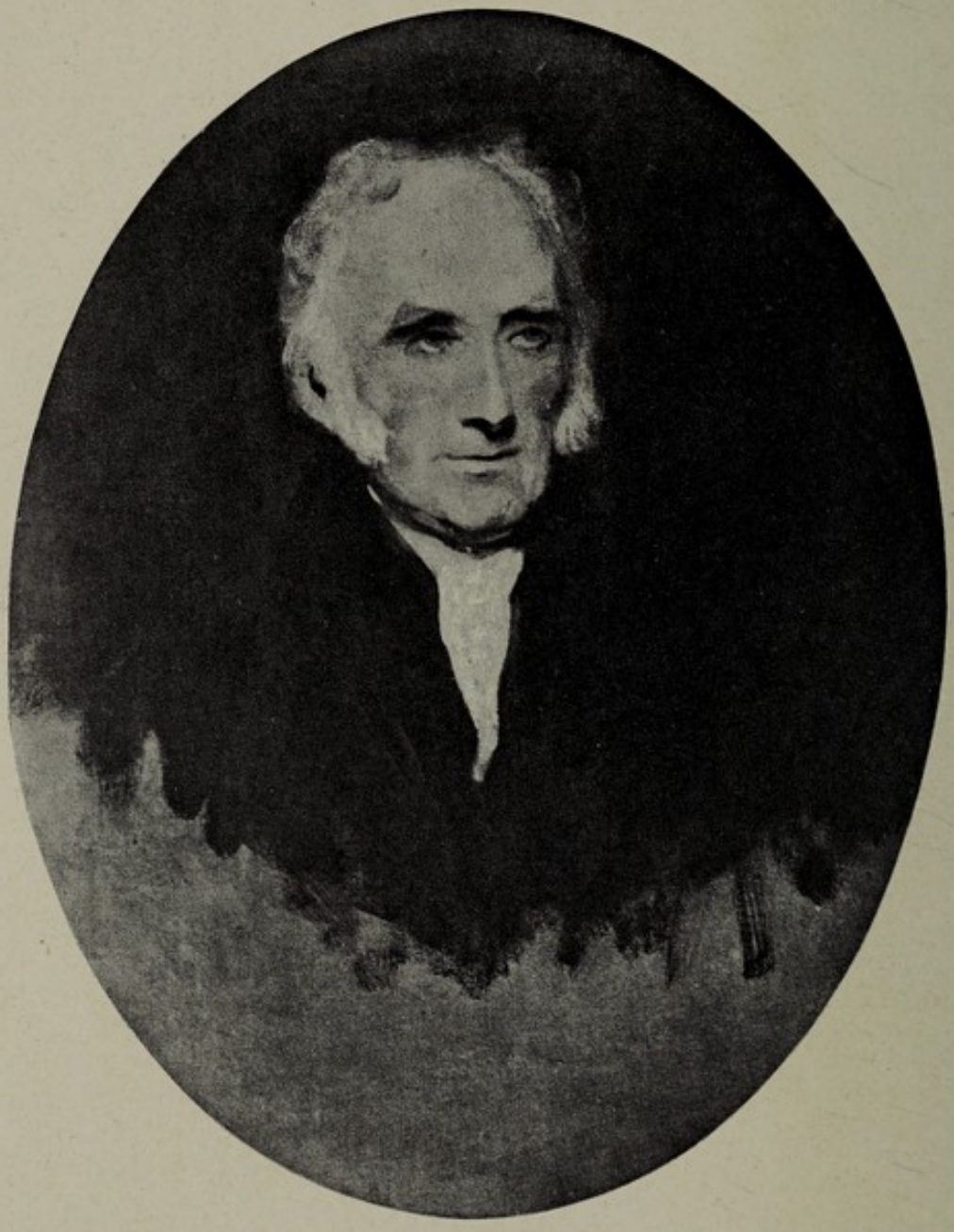

Sir Gilbert Blane, Bt., M.D., F.R.S.

By Sir Martin A. Shee, P.R.A.

Photograph of an unfinished Portrait in the Royal College of Physicians of London.

Sir Gilbert Blane, M.D., F.R.S.

An Administrator of Naval Medicine and Hygiene.

By Temporary Surgeon-General H. D. ROLLESTON, C.B., M.D., F.R.C.P., R.N.

Consulting Physician to the Royal Navy, Haslar Hospital; Senior Physician, St. George's Hospital.

The two great names in the history of our Naval Medical Service are James Lind and Gilbert Blane, both most industrious and conscientious Scotsmen, Lind being the senior and the pioneer, and Blane pre-eminent in bringing Lind's and his own reforms into official use. Some account of Blane's life may, perhaps, form an appropriate sequel to the article on Lind in a previous number of this Journal.[1]

Sir Gilbert Blane was the fourth son of Gilbert Blane, of Blanefield, a small estate in the County of Ayr, and was born on August 29 (O.S.), 1749. His forbears were well-to-do merchants, descended from Thomas Blane (obiit 1620), who had a large estate at Girvan. Originally intended for the Church, he entered the Faculty of Arts at Edinburgh at the early age of 14, and during the next five years obtained a sound education, evidence of which appears in his treatise on "Medical Logick" and in classical allusions and quotations in his other writings. About 1769, however, his inclinations changed and, like William Hunter, his future teacher, he decided to devote his life to the cure of bodies rather than of souls. Accordingly he worked for the next five years in the Medical Faculty of the Northern Athens, and with such success that he was one of the Presidents of the Medical Society in 1775, and delivered an oration on the occasion of its moving into new quarters. Cullen's teaching made a lasting impression on him and was responsible for his opposition later in life to the humoral pathology supported by Boerhaave.[2] He took the M.D. degree at Glasgow on August 28, 1778; but meanwhile (1776) he had migrated to London armed with recommendations from Cullen, Robertson the Scottish historian, and Blair, so familiar as the author of sermons, to William Hunter, whose lectures on anatomy and surgery he attended. Here he probably met Hunter's nephew, Matthew Baillie (1761-1823), who came south in 1779, and, though considerably younger, eventually outstripped him in the race for fashionable practice. Through Hunter's kind offices, Blane became personal medical attendant to the last Lord Holdernesse, an invalid with accomplished tastes and much in favour at Court. He thus gained an introduction to society and to Sir George Rodney, whom he accompanied as private physician, without any official position, in H.M.S. "Sandwich," the flagship of the Fleet dis-

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[1] Vol. i, No. 2, April, 1915.

[2] *Vide* "Elements of Medical Logick," London, 1825, third edition, pp. 190.

patched on Christmas Eve, 1779, to raise the siege of Gibraltar. During the first of the six engagements at which he was present Blane, in the absence of executive officers, was employed by the Admiral to carry orders to the guns, and while thus occupied was slightly wounded. After, and apparently because of, this action he was officially appointed Physician to the Fleet, and in this capacity received a monthly report from each of the surgeons as to the health of the ships. In the autumn of 1780, a tract of 20 pp. from his pen entitled "An Address to the Officers serving in His Majesty's Ships of War in the West Indies and America," was published at New York, where the Fleet often touched. Its subject-matter—the prevention of disease in the service afloat—was mainly derived from James Lind's "Essay on the Most Effectual Means of Preserving the Health of Seamen in the Royal Navy" (1757; second edition, 1762; third edition, 1774). In a letter to William Hunter, describing a hurricane in 1780, which he subsequently investigated at Barbados, he commented on the surprising observation that it apparently cured patients with fevers, dysentery, and acute pleurisy. When ill-health (gout and stricture) and lack of reinforcements obliged Sir George Rodney to return to England in September, 1781, Blane accompanied him, and on December 3 took the licence of the Royal College of Physicians of London. Inspired by his keen insight into the wants of the Navy, he laid before the Board of Admiralty (October 31, 1781) a memorial pointing out the neglect of cleanliness, ventilation and dryness in the ships, the need for a supply of lemon-juice to prevent and cure scurvy, the prevalence of intemperance, the inadequate care of the sick on board ship, the absence of proper bedding and soap, and the desirability of a gratuitous supply of medicines and other necessaries to naval surgeons. These crying needs fell on deaf ears and were not supplied until fifteen or more years later, when, as one of the Commissioners of the Board of the Sick and Wounded Sailors, he was in a position to enforce them. On December 14, 1781, he hurriedly left London with Admiral Rodney, sailing with reinforcements from Plymouth in January, 1782, and remained on active service until the end of the War with the American Colonies. From this Fleet, which consisted of seldom less than twenty, and sometimes more than forty ships of the line, he collected materials for his "Observations on the Diseases of Seamen," thus obtaining a thoroughly practical knowledge of naval medicine and hygiene. He gained the confidence and regard of his Admiral and colleagues so entirely that, on the declaration of peace in April, 1783, the principal officers of the station unanimously petitioned the Admiralty that, as his appointment precluded half-pay, a pension should be bestowed upon him. This was done; and in 1802 the grant, originally of ten shillings a day, was doubled on the recommendation of the Lords of the Admiralty.

In 1783, the year of his return to London, he was elected Physician to St. Thomas's Hospital, largely through the influence of Lord Rodney, then a national hero, and of the professional support of his countrymen, Dr. W. Saunders and Sir Walter Farquhar. At this time the Hospital, which contained 500 beds, was overcrowded, and infectious fevers were so common that in the previous year his two immediate predecessors, one surgeon, and several attendants had succumbed to fevers caught in the wards. The number of beds was accordingly reduced, and new methods

of ventilation and cleanliness were adopted with most salutary results. London now became his permanent home, and on July 11, 1786, he married Elizabeth, only daughter of Abraham Gardner, a London merchant. In 1795 he resigned his post at St. Thomas's after twelve years' hard work at the practical and literary sides of his profession. Some fruits of his hospital labours were embodied in a paper, "On the Comparative Prevalence, Mortality, and Treatment of Different Diseases in London, illustrated by Abstracts of Cases which occurred to the Author at St. Thomas's Hospital (1783-94), and in his Private Practice (1795-1806)." Incidentally, he instituted a comparison between the diseases of the poor and those of the rich, and is sometimes quoted to the effect that gout did not figure among his hospital patients, whereas it constituted one twenty-sixth part of his private practice. This, indeed, is the statement given in the earlier editions of the paper,[1] but in the latest edition twenty-two cases were transferred from the category of "rheumatism" and one from that of "neuralgia" to that of gout, making one in every 126 hospital patients.[2] It is perhaps worth while to notice this change in his statistics, as a reader of his latest estimate might regard a quotation from his original paper as inaccurate. It recent times Blane's experience of the absence of gout from hospital practice has been commented on as exceptional, and possibly similar contemporary criticism led him to revise his case notes. This paper also contains an historical account of old St. Thomas's Hospital, with special reference to the fluctuations of disease and mortality in London during its existence. Though a most industrious worker, he does not appear to have been an equally successful clinical teacher.[3] While a hospital physician he gave the Croonian Lecture before the Royal Society, "On Muscular Movement," on November 13 and 20, 1788, brought out the "Observations on the Diseases of Seamen" (1785), and was doing well in private practice as shown by his appointment successively as Physician Extraordinary to the Prince of Wales (1785), Physician to the Household of the Prince of Wales (1788), and Physician to the Duke of Clarence. His best known work, "Observations on the Diseases of Seamen," which was professedly intended not for the medical profession exclusively, but also for commanders, "upon whom chiefly the prevention of sickness depends," passed into second and third editions in 1790 and 1799. It consists of three parts: a detailed account of the health and diseases of the Fleet during the years (1780-83) that he accompanied it; the causes and prevention of diseases in fleets, in which infection, the influence of ventilation, food, water, clothing, exercise and fatigue are discussed; and the description and treatment of the affections, such as fevers, dysentery, and scurvy, most frequently seen at sea. It is clearly and pleasantly written, well supported by statistics, refers sufficiently and in good taste to other authorities, and fully justified the trust which the Government placed in his hands. In 1790 he wrote an account of the herb *Nardus*

[1] *Med.-Chir. Trans.*, London, 1813, iv, 89; and "Select Dissertations on Several Subjects of Medical Science," London, 1822, p. 150.

[2] "Select Dissertations on Several Subjects of Medical Science," London, 1833, vol. i, p. 205.

[3] *Vide* Life in "Dictionary of National Biography," by J. F. Payne, 1886, vol. v, p. 202.

indica, or spikenard, specimens of which he had received from his brother in India, and described its medicinal uses, especially as an external application for abdominal pain.[1]

Blane's professional life may be divided into three periods: the first while Physician to the Fleet (1780-83); the second when physician to St. Thomas's Hospital and in practice (1783-95); and the third and remaining part of his active life in which he continued to practise, but was frequently consulted by the Government and others on various aspects of public health especially those concerning the Navy. The two earlier phases were a preparation for the third and most important, on which his reputation mainly depends. In 1795, when Lord Spencer was first Lord of the Admiralty, he was appointed to join Dr. Robert Blair as a Commissioner of the Board of the Sick and Wounded Sailors, and was thus enabled to bring about the reforms, designed to improve the sanitary conditions afloat, which he had urged upon the Admiralty fifteen years before. This office he held until 1802, when, as a result of the Peace of Amiens, the Fleets were considerably reduced. Shortly after his appointment, an Admiralty order was issued enjoining the use of lemon-juice in the Navy. This came into force in 1796, and at once banished scurvy from the service afloat.[2] Fresh fruit and vegetables had been known to the Dutch as prophylactic and curative agents for scurvy as far back as 1564, and had also been successfully employed in 1593 by Sir R. Hawkins in the "Dainty," and by Commodore James Lancaster in 1600; but all this had been forgotten until James Lind, afterwards Physician to Haslar, revived it in 1754. Blane, who gave the fullest credit to his senior, used fresh lemons, limes, and oranges in 1782 to cure scurvy in a fleet of twenty-eight ships of the line; and as the result of his advice scurvy was thus entirely prevented in H.M.S. "Suffolk," which made a voyage of twenty-three weeks in 1794. Otherwise Lind's recommendations were almost neglected, and the delay of forty-one years before they were officially adopted might have been greatly prolonged, had it not been for Blane's powerful influence. It is attractive though sometimes fallacious to interpret the speculations of former writers as the prophetic anticipations of modern knowledge. But, with this caution in mind, there is some ground for crediting Blane with the germ of the modern conception that the absence of a vitamine is the essential factor in the ætiology of scurvy. In discussing the proximate cause of this disease, he remarked that its phenomena "are circumstances all of which might naturally be expected from a deficiency of wholesome aliment and an absence of that active state of absorption and renewal, which in health are in constant requisition for the purposes of growth and repair. And it follows from this view of the subject that the operation of citric acid as a remedy is that of a specific stimulus to the absorbents, and not either as nutritious matter, or as a chemical antiseptic, according to the theories of the humoral pathology."[3] The difference between ancient and modern views

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[1] *Phil. Trans.*, London, 1790, vol. lxxx, p. 658.

[2] Scurvy, however, was seen in the merchant service from time to time, and Sir Alexander Armstrong, writing in 1858, stated that in the various Polar expeditions scurvy has always occurred to a greater or less extent ("Naval Hygiene and Scurvy," 1858, p. 7).

[3] "Medical Logick," London, 1825, p. 96.

is often partly one of terms; Blane, of course, did not employ the recently coined word vitamine, but his use of "deficiency" in reference to one of the affections now known as "deficiency diseases" is quite up to date.

By promoting cleanliness and ventilation on ships he did much to diminish the prevalence of infectious fevers. In 1796 he suggested to Lord St. Vincent that an application should be made to the Board of Admiralty to provide soap to the crews of his ships, either gratuitously or by deducting the cost from their pay. A general order was accordingly issued for the supply of soap on the latter footing. As showing the economic value of this obvious reform, it may be mentioned that the cost of an ample supply of soap was estimated to be one-tenth of the expense incurred by the injury to health due to want of personal cleanliness. In 1802 Blane and Count Rumford were asked by Lord Chichester, the Secretary of State for the Home Department, to recommend some means for preserving the life and health of convicts during their passage to Australia, very few of whom survived the journey. Their advice as to proper ventilation of the lower decks by means of wind sails and air tubes was most successful in diminishing the incidence of infectious diseases and the mortality. That to some extent he realized the modern problem of disease carriers is shown by his use of the suggestive phrase "dormant infection" in the following passage: "There is a degree of risk in mixing two different sorts of men, even when there is no actual disease or suspicion of infection; for whether it is from dormant infection, or merely from the circumstances of change of air, such mixtures are known from experience to be sometimes productive of sickness."[1]

A reform, advocated by him fifteen years earlier, was effected in 1796, when naval surgeons were for the first time provided free of expense with the more important drugs; in 1804 this concession was made complete by the gratuitous supply of all medicines. About this time the sick bay was much improved, and was transferred from the ill-ventilated forepart of the lower gun-deck to a position under the forecastle. In this as in other matters of hygiene Blane enforced the views of James Lind. These various reforms were followed by a remarkable improvement in the health of the Navy; thus, in 1782, out of 100,000 seamen and marines, 1 in 3·3 were sent sick to hospital; whereas in 1813 with a corresponding complement of 140,000, the proportion of sick fell to 1 in 10·75.[2] A picturesque description of the mortality among sailors at a much earlier date is given by the Portuguese historian Vieyra: "If the dead who had been thrown overboard between the Coast of Guinea and the Cape of Good Hope, and between that Cape and Mozambique, could have tombstones placed for them, each on the spot where he sank, the whole way would appear a continuous cemetery."

In 1797 he visited officially the Russian fleet then wintering in our ports and much overrun with sickness, which was found to be chiefly frost-bite and gangrene due to cold. His comment that in winter campaigns the Russians suffer more severely than the British, French, Austrians, and Prussians from cold is in rather striking contrast to what

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[1] "Observations on the Diseases of Seamen," 1799, third edition, p. 227.

[2] "A Brief Statement of the Progressive Improvement of the Health of the Royal Navy," London, 1830, p. 11.

is generally believed to have held good recently in Poland. In 1799, the Turkey Company, which controlled the Levant trade, took his advice about the quarantine regulations necessary to prevent the importation of plague from the Mediterranean.

In the autumn of 1809 the Government charged Blane with a special mission to inquire into the exceptional prevalence of disease among the troops on the island of Walcheren, off the coast of Holland, where no less than two-thirds of the total numerical strength of the Army were incapacitated from duty, mainly by malaria. His report, with which the medical officers of the Army concurred, led to the abandonment of the island. In the following year he visited Northfleet at the request of the Admiralty in order to investigate its sanitary suitability for the establishment of a dockyard and other naval works, and reported that there was not any valid objection to this proposal. It is most unusual for the same authority to be consulted by both the Navy and the Army, and this exceptional distinction speaks volumes for the high esteem in which Blane's opinion was held. As a reward for his eminent services a baronetcy was bestowed upon him by the Prince Regent on December 26, 1812.

With advancing years and the prestige of his public services, Blane may well have felt that he was a recognized authority on matters of health; at any rate, some of his later writings came before the larger audience of the public. In 1819 he supported vaccination in a paper fortified with statistics,[1] which, though twenty-one years after the publication of this epoch-making discovery, was extremely opportune, as the severe epidemic of small-pox in 1818 had thrown fresh doubts on the efficacy of vaccination. It was therefore reprinted with some additions in 1820 by the wish and at the expense of Jenner, who arranged for its gratuitous distribution by the public establishments for vaccine inoculation. As early as September, 1800, naval surgeons were directed "to inoculate any of the seamen who were desirous of it," and in 1801 eighty-nine naval surgeons, apparently inspired by Trotter, presented Jenner with a gold medal.[2] It was, however, a long time—probably not until 1858—before vaccination was made compulsory in the Navy.[3] Blane's opinion that cholera was spread by human intercourse, and his opposition to the view that it was caused by aerial influence, were expressed in his letter[4] of January 16, 1825, to the Directors of the East India Company. Later, a year before the great epidemic of 1832, he issued "A Warning and Admonition to the British Public on the subject of Indian Cholera," which the Postmaster-General, the Duke of Richmond, circulated widely among the seaports, especially those on the East Coast, in order to

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[1] *Med.-Chir. Trans.*, London, 1819, vol. x, p. 315.

[2] A reproduction of this medal is given in Trotter's "Medicina Nautica," 1803, vol. iii, p. 121.

[3] According to the "Instructions for the Royal Naval Hospitals" of 1844, vaccination was then voluntary, but was noted as compulsory in the 1866 edition of this work. The Statistical Return of the Health of the Navy for 1858 refers to a circular recently issued by the Director-General instructing the medical officers to vaccinate, on their entry into the Service, all persons who do not present marks of small-pox or of previous vaccination.

[4] *Vide* "Select Dissertations on Several Subjects of Medical Science," 1833, vol. i, p. 346.

prevent the introduction of the disease into this country. The Royal College of Physicians of London, in reply to a letter from Sir W. Pym on behalf of the Government, had previously stated that cholera was communicable and that quarantine was desirable; but there was a popular belief to the contrary, which, as may be seen in the contemporary medical press, was shared by some members of our profession.[1] Unfortunately, this view was adopted by the Local Board of Health at Sunderland, where the quarantine and other preventive measures in force were accordingly abandoned. Almost directly after this change of policy, cholera began to spread from this town throughout the Kingdom, and by an irony of fate Lady Blane was an early victim on July 9, 1832.

In addition to his professional writings Blane published some observations on Naval tactics, particularly on Rodney's method of breaking the line, and brought out a pamphlet to show that corporal punishment in the Navy could not be safely abolished. He also contributed materials to Mundy's "Life of Lord Rodney." In 1831 his interest in human statistics found expression in a tract entitled "Reflections on the Present Crisis of Public Affairs, with an Enquiry into the Causes of the Existing Clamours and Grievances," dealing with the best means not only of preventing famines, but also of guarding against the evils of discontent and riot. The medical aspects of this subject, namely, "the progressive population and health of Great Britain," had previously been discussed by him.

As a writer he was clear, graceful, and anticipated possible criticisms; this was the outcome of the care he devoted to polishing, expanding, and keeping his writings up to date in their successive editions. For example, the collection of previously published articles entitled "Select Dissertations on Several Subjects of Medical Science" (1822 in one volume; 1833 in two volumes) contains references to works and events of much later dates than those of the original papers. "The Elements of Medical Logick, or Philosophical Principles of the Practice of Physick," first appeared in 1819, and in its third edition (1821) was much enlarged so "as to make the whole assume the form of a compendious system of general professional instruction"—an ambitious aim which it can hardly be said to have achieved. It discussed seven causes of error and insisted on the advantages of the inductive method of reasoning. Payne drily summed up "Medical Logick" as containing a good deal of commonsense and some philosophic pedantry. It was appropriately translated into German. As there are but few works on medical logic, it may be mentioned that A. W. Barclay's Lumleian Lectures at the Royal College of Physicians of London (1864), "On Medical Errors," dealt with the fallacies connected with the application of the inductive method to medical science. Blane wrote on mechanical compression of the head as a preventive and cure of hydrocephalus, but his most important contributions to therapeutics were on the uses of pure alkalis and lime-water in disorders of the bladder, stomach and skin,[2] and on the effects of large doses of the carbonates of potash in gravel.[3] The value of

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[1] *Med.-Chir. Rev.*, London, 1832, vol. xvi, pp. 163, *et seq.*

[2] *Trans. Soc. Improvement of Med. and Chir. Knowledge*, 1800, vol. ii, p. 132.

[3] *Ibid.*, 1811, vol. iii, p. 338.

these observations was fully acknowledged by Prout[1] the contemporary authority on urinary diseases, and according to Dr. (afterwards Sir George) Burrows[2] the use of alkalis in urinary affections was an original and definite advance.

He was most anxious to improve the professional attainments and position of naval surgeons, to whom his name is now chiefly familiar in connexion with the two gold medals originally awarded every two years for the best journals kept by them when afloat, but since 1913 given annually to the surgeon who obtains the highest aggregate marks at the examination for promotion to the rank of staff surgeon. These he founded in 1829 by an endowment of £300, the first award being in 1832, the only occasion on which he adjudicated. The great importance he attached to note-taking set an example to naval surgeons, and stimulated Trotter[3] "to imitate Dr. Blane in calling upon the surgeons for occasional remarks." The question whether or not naval surgeons should engage in private practice was discussed by him in 1824.[4] In 1802 the Board of Admiralty ordained that all medical officers of naval hospitals, whether in war or peace, should abstain from civil practice. But only seven years before, in 1795, the Governors of Naval Hospitals had been directed to allow private practice in times of peace; so that abuses, as stated by Trotter,[5] would appear to have crept in very rapidly. Blane, however, argued that, as long as their official duties did not suffer, naval surgeons would advantageously occupy their spare time by increasing their professional experience, and stated that during his seven years' service on the Medical Board of the Navy two instances only of abuse had come before him. As an argument against the "whole time" system he stated that "if any candidate for a vacant situation in the great Metropolitan hospitals were to try to recommend himself by declaring that he would devote his whole time and attention to the duties of the hospital, he would to a certainty be rejected; for the governors as men of good sense would be well aware that he could not find employment to occupy himself the whole day within its walls." This is interesting in connexion with the recent report of the Royal Commission on University Education in London, which contains evidence advocating and condemning the principle of whole-time teachers of clinical medicine. It may be noted that, by an order of November 28, 1913, private practice by naval surgeons is now permitted. That Blane was appreciated by the naval surgeons is shown by their presentation of plate to him in 1821. A strong man, however, can hardly fail to make some enemies, and reading between the lines of Trotter's "Medicina Nautica" it is clear that this less successful reformer of Naval medicine was far from a kindly critic of Sir Gilbert.

Many honours were bestowed on Blane; he was a Fellow of the Royal Societies of London, Edinburgh, and Göttingen, a Corresponding

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[1] "Nature and Treatment of Urinary Diseases," second edition, 1825, pp. 115, 144.

[2] Gulstonian Lectures, *London Med. Gaz.*, 1834, vol. xiv, p. 55.

[3] "Medicina Nautica," 1797, vol. i, p. 2.

[4] "Select Dissertations on Several Subjects of Medical Science," 1833, vol. ii, p. 295.

[5] "Medicina Nautica," 1803, vol. iii, p. 18.

Member of the Imperial Academy of St. Petersburg and of the Institute of France (1826), and an Honorary Member of the Royal College of Surgeons of England (1829), in succession to Sir Humphry Davy. In addition to the Court appointments mentioned elsewhere, he was Physician to George IV and William IV. It is rather surprising that such a distinguished physician should not have held office at the Royal College of Physicians of London, of which he remained a licentiate to the end of his life. He was, indeed, nominated for the Fellowship by the President (Sir Lucas Pepys[1]), in 1810, but did not accept, probably because this recognition came so late. His intellectual peers evidently valued his abilities, for he was President of the Medical and Chirurgical Society in 1813 and 1814 in succession to Sir Henry Halford, and was a Member of the select "Society for the Improvement of Medical and Chirurgical Knowledge," which was founded by John Hunter, and consisted of nine members, including Matthew Baillie, David Pitcairn, and G. Fordyce. Nearly twenty-five years after Blane's death a graceful tribute was paid to his memory by Sir Alexander Armstrong, subsequently Director-General of the Medical Department of the Admiralty, who spoke of his inestimable services to the Navy, and said that he might "justly be termed the Father of Naval Medical Science."[2] His portrait shows a handsome and thoughtful face, full of character. Natural curiosity about his personality may be gratified by a search in the somewhat candid medical press of the time. He appears to have retained the aspect and accent of a Scotsman throughout life, and though much in polished society, his manners were not those of the courtly physician of the period. In one of the fictitious "intercepted letters,"[3] entitled "Advice to a Young London Physician," and intended to parody Sir Henry Halford ("the eel-backed baronet"), Blane is credited with a "certain sanctified, devout, death-like expression of countenance."[4] His obituary notice is therefore probably correct in concluding that "the station he attained may fairly be attributed rather to his talents and industry than to the possession of external graces or artificial attractions."[5] His health began to fail in 1821, when he was attacked by senile pruritus, which caused such distress that increasing doses of opium became necessary, and reached the equivalent of a drachm of the solid drug in the twenty-four hours. Attempts to diminish this exceptional amount were unsuccessful, and in his last illness, in which he suffered from œdematous and ulcerated legs, the daily dose was sometimes 1,000 minims of Battley's solution. His remark towards the end of his life that "there was not a desideratum in practical medicine more important and

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[1] Sir Lucas Pepys, Bt., was Physician-General of the Army Medical Department at the time of the disastrous Walcheren Expedition, and when requested to proceed there to investigate the local conditions, was so ill-advised as to decline, with the result that he subsequently resigned his office.

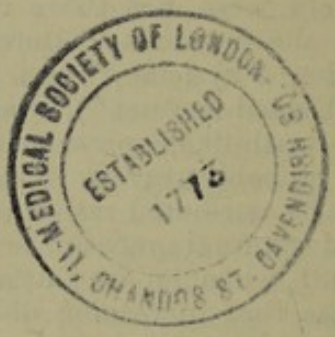
[2] "Observations on Naval Hygiene and Scurvy," 1858, p. 4.

[3] The "intercepted letters" were written by James Wardrop, M.D., Surgeon to George IV (*vide* J. F. Clarke, "Autobiographical Recollections of the Medical Profession," 1874, p. 340).

[4] *Lancet*, London, 1834, vol. i, p. 725.

[5] *London Med. Gaz.*, 1834, vol. xiv, p. 486.

interesting than a monograph treatise on opium"[1] has therefore an intimate personal application. After 1822, although his literary activity remained unimpaired, he began to retire from public life, and probably spent more time at his country house, Culverlands, in Berkshire.[2] He died on June 26, 1834, in the eighty-fifth year of his age, at 8, Sackville Street, Piccadilly, whither he had moved about 1823 from Cleveland Row. An unfinished portrait of him by Sir Martin A. Shee, P.R.A., hangs in the reading room of the Royal College of Physicians of London; for a photograph of this, issued by the Arundel Society about 1860, I am indebted to W. Fleming, Esq.



[1] "Select Dissertations on Several Subjects of Medical Science," 1833, vol. ii, p. 279.

[2] Vide *The Gentleman's Magazine*, 1835, N.S., vol. iii, part 1, p. 92.

With the Writer's Compliments

Cerebro-spinal Fever in the Royal Navy (August 1st, 1915—July 31st, 1916)

BY

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CASES OF CEREBROSPINAL FEVER IN THE ROYAL NAVY.—AUGUST 1, 1915, TO JULY 31, 1916.

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The following analysis of the cases of cerebrospinal fever in the Royal Navy during the second year of the war may serve as an addendum to the Report[1] on those occurring during the previous year. Some of the etiological points dealt with at length in the previous Report, such as overcrowding, the spread of the disease by carriers, the influence of influenza and catarrhal affections and of meteorological conditions, and prophylaxis, have not been taken into consideration again. The present Report contains :—

(1) Remarks on the incidence of the cases.
(2) Remarks on some clinical aspects.
(3) A summary of the results of treatment.
(4) A brief history of the outbreaks at various centres.

(1) Incidence of the Cases.

During the year August 1, 1915, to July 31, 1916, there were 104 cases of cerebrospinal fever in the Royal Navy, as compared with 170 cases during the first year of the war. This fall in the

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[1] This Journal, 1915, vol. i, pp. 373-407.

number of cases must be correlated with the contemporaneous fall in the incidence of the disease both in the civil population and also in the Army in this country.[1] Although the fall in the general incidence of the disease is probably the main factor in the smaller incidence in the Navy, it should be borne in mind that great care has been taken in prophylaxis, and that in the first half of 1916 bacteriological examination of swabs from the throats of new entries was made at Haslar, Chatham, Plymouth, and at Greenwich of non-contacts (new entries and drafts for sea), in order to detect "carriers" (*vide* pp. 13, 16, 17). Out of 10,852 ratings examined, 298, or 2·7 per cent., carriers were thus detected and isolated. Not only has the incidence been smaller but it has been less widespread; for no case occurred at Blandford Camp or in the Akbar Establishment, in both of which there were a few cases during the first year of the war. At the Deal Depot, which was responsible for twenty-five cases during the first year of the war, there were two cases only in the second year. No case of proved meningococcic meningitis has occurred during the last two years at Osborne or Dartmouth.

The monthly incidence with the results is shown below. As in the first year of the War, the largest number of cases and of deaths occurred in February.

		Cases	Deaths	Recoveries
1915.	August	4	2 or 50·0 per cent.	2
	September	4	3 ,, 75·0 ,,	1
	October	3	1 ,, 33·3 ,,	2
	November	6	5 ,, 83·0 ,,	1
	December	8	4 ,, 50·0 ,,	4
1916.	January	8	3 ,, 37·5 ,,	5
	February	26	7 ,, 26·9 ,,	19
	March	20	6 ,, 30·0 ,,	14
	April	7	2 ,, 28·5 ,,	5
	May	7	0 —	7
	June	3	2 ,, 66·7 ,,	1
	July	8	2 ,, 25·0 ,,	6
		104	37	67

Age Incidence.—Among the 104 cases in the Navy 70, or 67·3 per cent., were under 20 years of age (83, or 79·8 per cent., being under the age of 25 years), and the number of cases progressively diminished in the succeeding decades. The percentage

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[1] For this information I am indebted to Surgeon-Colonel R. J. Reece, H.A.C., of the Local Government Board.

of deaths was lower under 20 years than in any of the succeeding decades. The average age of the 104 cases was 20·4 years, of the fatal cases 22·2, and of the recoveries 19·4 years. The extremes of age were 15 and 46 years.

Age periods	Number of cases and percentage of the total 104 cases	Deaths and percentage in the age periods
15 to 19 ..	70 or 67·3 per cent. ..	20 or 28·5 per cent.
20 ,, 29 ..	24 ,, 23·1 ,, ..	12 ,, 50·0 ,,
30 ,, 39 ..	6 ,, 5·8 ,, ..	2 ,, 34·4 ,,
40 ,, 49 ..	4[1] ,, 3·8 ,, ..	3 ,, 75·0 ,,
	104	37

[1] The case which recovered was invalided, and died suddenly six months later, the coroner's inquest finding pneumonia as the cause of death.

In the first year of the war 60·6 per cent. of the cases were under 20 years of age.

Mortality.—Out of the 104 cases 37, or 35·6 per cent., proved fatal; this contrasts favourably with the mortality of 90, or 52·9 per cent., among the 170 cases during the first year of the war.

Ranks and Ratings.—There were two officers—a midshipman Royal Naval Reserve (aged 18), and a surgeon probationer (aged 21), who both recovered. The 102 ratings were as follows: Boys (seamen class) 39 (7 deaths); seamen 22 (11 deaths); stokers 13 (6 deaths); marines 11 (3 deaths); engine-room artificers 5 (2 deaths); officers' stewards 3 (all fatal, average age 20 years); carpenter's crew 2 (1 death); boy servants 2 (1 death); cook's mate 1 (recovery); plumber's mate 1 (recovery); armourer's crew: wireman 1 (fatal); trimmer 1 (recovery); boy artificer 1 (fatal).

(2) Remarks on some Clinical Aspects.

Onset.—The mode of onset sometimes varied from the common form characterized by fever, malaise, headache and vomiting. Eight patients when first discovered were in an unconscious condition, and three of these had fallen out of their hammocks; one of these with a graze on the forehead, blood about the nostrils, and vomiting, was regarded for some days as a case of fractured base. Of the eight cases with this apoplectiform onset four proved fatal. In four cases in February respiratory symptoms were so well marked as to suggest pneumonia or acute bronchitis. In one case the prominence of abdominal symptoms gave rise to an initial diagnosis of appendicitis.

In eleven cases at least the disease began very shortly (within

three days) after going on leave (six cases), or returning from leave (five cases), and in some instances considerable fatigue must have been entailed by the length of the journeys. In one instance the disease appeared three days after arriving on leave at Gosport from the Grand Fleet. In the five cases in which the disease appeared shortly after returning from leave, the question of infection when on leave arises. In thirteen cases the disease occurred within three weeks of joining the Service and exposure to the trials incident to this change of life. In three cases the disease followed the onset of measles after an interval of about ten days; as these cases were already under observation in hospital, it is improbable that the initial mottled rash of cerebrospinal fever was regarded as measles. In two other cases the disease attacked patients already in hospital, for a lacerated finger and pleurisy respectively. In five cases (four fatal) meningitis, in which the cerebrospinal fluid was proved bacteriologically to contain meningococci, supervened on otitis. In isolated instances drunkenness and head injury (one case), influenza, and vaccination (four cases) immediately preceded the onset. In one case pneumonia and cerebrospinal fever co-existed.

These various factors may have so reduced the bodily resistance as to enable saprophytic meningococci in the nasopharynx to invade the system.

Rashes were recorded in 51, or 49 per cent., out of the 104 cases; in 41 cases the rash was petechial or hæmorrhagic, and 15, or 36·6 per cent., of these proved fatal, a mortality percentage very little higher than that (35·6) of all the 104 cases. In one case with a petechial eruption hæmorrhagic bullæ appeared on the ankles four days after the rash. In five cases there was a macular rash with one death, and in five cases a rose rash with one death. The mortality of the 51 cases with rashes was, therefore, 17, or 33·3 per cent., namely, slightly lower than the mortality of the total 104 cases. In the first year of the War, rashes occurred in 102, or 62·6 per cent., of 163 cases, and the mortality of the cases with rashes was 52 (51 per cent.), or a little lower than that (52·9) of the total 170 cases. Although a very profuse hæmorrhagic rash is extremely ominous, the occurrence of a rash is not necessarily of grave significance. The rash was nearly always noticed on the first or second day of the disease.

Herpes was noted in 21, or 20·2 per cent., of the 104 cases; in 20 cases the herpes was on the lips; in the remaining case it was in the distribution of the nasal branch of the ophthalmic division of the fifth nerve, but the cornea was not affected. In one of the cases with labial herpes there was also

cervical herpes. In 14 cases there was also an initial rash; in 2 cases the rash and the labial herpes both occurred on the second day of the disease; in the remaining cases the herpes appeared later than the rash, on an average on the fourth day of the disease, the extremes being the second and the eighth days. In some instances the labial herpes was very profuse. Of the 21 cases 4, or 19 per cent., proved fatal; this mortality is nearly half that (35·6 per cent.) of the total 104 cases, and thus agrees with the ancient belief that herpes in cerebrospinal fever, as in pneumonia, is a good prognostic. In the previous year herpes labialis was noted in 35, or 21·5 per cent., of 163 cases—almost exactly the same proportion as in the present series.

Rarer Manifestations and Complications.—Ocular symptoms. Photophobia, which has been stated to be rare,[1] was noted in 10 cases; conjunctivitis in 5, conjunctival hæmorrhage in 2, panophthalmitis with loss of an eye in 2, strabismus in 8 (5 fatal); ptosis in 3 (2 fatal); nystagmus on the second day in 1 (fatal), and von Gräfe's sign in 1. Hemiplegia occurred in 1 case and weakness of the arm in another case, both of which were fatal; facial paralysis in 1 (fatal), dysarthria in 1 (recovery), and dysphagia in 1 (recovery). Delirium tremens occurred in 2 cases (1 fatal). Pericarditis was noted in 2 cases, both of which recovered. Recent endocarditis was found after death in 1 case (*vide* p. 12), and transient systolic murmurs were heard in 4 cases which recovered. Status lymphaticus was found after death in 1 case. Hæmaturia due to hæmorrhagic cystitis and pyelitis was seen in 1 case, and 1 patient had polyuria for a few days, passing 8, 6 and 4 pints of urine daily, while the temperature was about 103°F. Epididymitis without any evidence of gonorrhœa occurred once.

Synovitis was noted in 4 cases (2 fatal) on the second, fifth, and sixth days of the disease; in 2 cases the knee was affected, in 1 the ankles and wrists, and in 1 the interphalangeal joint of a finger. All the cases had a petechial or hæmorrhagic eruption; this fits in with the view that when purpura and synovitis are associated, the latter is due to hæmorrhages into the synovial membrane. In the case with arthritis of the wrists and ankles on the fifth day of the disease, pericarditis with synovitis of the wrists, ankles and knees developed on the ninth day; in spite of delirium tremens recovery followed. In the first year of the War there were 8 cases (2 fatal) of arthritis. Acute otitis supervened in 2 cases, both of which recovered.

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[1] Foster and Gaskell: "Cerebrospinal Fever," p. 37. 1916: Cambridge.

Relapses during treatment are said not to be uncommon and generally to occur in cases of chronic hydrocephalus which terminate fatally. There was one case proved to be of this nature in a man, aged 19, the relapse which started after nine days of convalescence being ushered in by a rigor. In one case a true relapse or brief second attack occurred seven weeks after the temperature had been normal, and was followed by recovery (*vide* p. 11).

Mixed infections of the cerebrospinal fluid were reported in three cases; pneumococci in one case without any obvious focus; and streptococci in two cases (one an otitic case, in the other infection occurred through the lumbar puncture).

The manifestations of serum disease are dealt with on p. 10.

Diagnosis.—Only those cases in which meningococci were found in the cerebrospinal fluid have been accepted as cerebrospinal fever. In other words, lumbar puncture and examination of the cerebrospinal fluid have been regarded as necessary for diagnosis. This criterion has very probably led to the rejection of some genuine cases of cerebrospinal fever. But no clinical manifestation is pathognomonic of the disease. Thus a hæmorrhagic rash, though highly suggestive, was present in cases proved bacteriologically to be due to other infections, such as pneumococci, or to be free from micro-organisms. The latter group of cases though unsatisfactory must be recognized.[1]

A fulminating case of meningitis with a profuse hæmorrhagic rash occurred on November 7, 1915, in a cadet at Dartmouth. Bacteriological examination of the cerebrospinal fluid, which was almost clear and contained a few red blood cells and occasional polymorphonuclear leucocytes, by Fleet Surgeon H. W. Whiteside, R.N., failed to show any micro-organisms; the cultures were sterile, and no carriers were detected among thirty contacts. There was no necropsy. A brother died in infancy from meningitis believed to be tuberculous.

Cases with meningeal symptoms, which showed meningococci in the nasopharynx but not in the cerebrospinal fluid, have been ruled out, as they may have been meningococcic carriers with meningism due to some other cause. In this connexion it may be pointed out that during the acute stage of cerebrospinal fever swabs from the nasopharynx are often negative. Out of 33

[1] Among 121 cerebrospinal fluids from cases of meningitis in the French Army, Sacquépée, Burnet, and Weissenbach (*Bull. acad. de méd.*, Par., 1915, lxxiv, 103-105) found six with the features of Widal's "puriform aseptic meningitis" in which no micro-organisms could be found by direct examination or cultivation.

cases of bacteriologically proved cerebrospinal fever meningococci were found in the nasopharynx in 7, or 21·3 per cent., only. This corresponds with von Lingelsheim's figures of 635 cases of cerebrospinal fever with 146, or 22 per cent., positive cultivations from the nasopharynx.[1]

Cerebral symptoms (meningism) accompanying acute infections, such as influenza, pneumonia, enteric, otitis, malaria, may closely imitate cerebrospinal fever, and a certain diagnosis can be made only by lumbar puncture and examination of the cerebrospinal fluid. Even if a patient has signs of pneumonia it is possible, as shown by isolated cases in both the recent epidemics in the Navy, that there is meningococcic meningitis as well.

From other forms of meningitis lumbar puncture and examination of the cerebrospinal fluid constitute again the most reliable method of diagnosis. Even with pre-existing otitis it does not necessarily follow that meningococcic meningitis can be excluded; for, as mentioned on p. 4, in five cases (four fatal) meningitis, in which the cerebrospinal fluid was proved bacteriologically to contain meningococci, supervened on otitis.

Difficulty might arise in the diagnosis from the meningitic form of acute poliomyelitis in which all the symptoms of meningitis may be present, but "on lumbar puncture the cerebrospinal fluid escapes under pressure, is clear, and on cytological examination may be found to contain an increased number of lymphocytes with a normal or sometimes a diminished sugar reaction and an increased amount of albumin" (Batten[2]). An outbreak in Devonshire and Cornwall in 1911 of what was at first thought to be cerebrospinal fever was shown by R. J. Reece[3] to be one of acute poliomyelitis and not one of acute poliomyelitis occurring concurrently with cerebrospinal fever. In July, 1916, there was at Shotley (vide p. 18), an outbreak of fifteen cases with the clinical symptoms of cerebrospinal fever, but four only were proved to be of this nature. Among the remaining eleven cases there was one only which could be regarded as an example of the meningitic form of acute poliomyelitis.

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[1] Quoted in the Report of the Special Advisory Committee upon Bacteriological Studies of Cerebrospinal Fever during the Epidemic of 1915, p. 30.

[2] Batten, F. E.: "Acute Poliomyelitis," p. 68, 1916. John Bale, Sons and Danielsson, London.

[3] Reece, R. J.: "Report of the Medical Officer of the Local Government Board, 1911-12." Appendix A, No. 4, p. 54. 1913.

In acute osteomyelitis of the spine lumbar puncture may give exit to pus from the extradural space. This occurred in two cases in the Royal Navy which will subsequently be published. In neither of these were there definite symptoms of cerebrospinal fever, but Grisel[1] in a review of this form of osteomyelitis states that although in some cases the symptoms of compression are quite definite and disappear when the abscess is evacuated, there are others in which the association with meningitic symptoms and septicæmia renders the diagnosis very difficult.

The sequence of events in the two following cases is, perhaps, worthy of brief mention.

Two brothers from the Fair Isle, Shetland, had measles in September, 1915, in Haslar. One developed cerebrospinal fever thirteen days after the onset of measles and died. The other who had never been well since the attack of measles died in Haslar three months later from tuberculous meningitis. In both cases a post-mortem examination was made.

(3) Summary of the Results of Treatment.

Two out of the 104 cases were discovered after death only and, therefore, were not treated for the disease; 1 case (fatal) received soamin only; and 6 cases, of which 4, or 66·7 per cent., proved fatal, had lumbar puncture only. Therefore, out of 9 cases which did not receive serum 7, or 77·8 per cent., proved fatal.

Among the 95 cases treated by some form of serum the mortality was 30, or 31·6 per cent. This result, which is in striking contrast to the results of serum treatment in the first year of the War—105 cases with a mortality of 64, or 61 per cent.—fully justifies the serum treatment of the disease, and is compatible with the widely expressed view that the serums employed in this country during the first year of the War were largely deficient in antibodies. Flexner's serum, made under his direction at the Rockefeller Institute, New York, was not available during the first year of the War, but after the failure in this country of anti-meningococcic serum in the epidemic of 1915 the Rockefeller Institute reverted to the manufacture of the serum, and most generously placed a supply of a multivalent serum, made from thirty-two strains, at the disposal of the Royal Navy.[2] Other serums employed during this year, and not in the previous year, are Colonel Mervyn Gordon's

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[1] Grisel, P.: *Rev. d'orthop.*, Paris. 1911, 3 sér., tome II, p. 145. For this reference I am indebted to Temporary Surgeon L. Pearce-Gould, M.D., F.R.C.S., R.N..

[2] *Vide* Amoss and Wollstein: "A Method for the Rapid Preparation of Anti-meningitis Serum," *Journ. Exper. Med.*, N.Y., 1916, vol. xxiii, p. 403.

various serums and the Pasteur Institute's multivalent serum. In the early part of the second year of the War, when the new serums were not available, Mulford's serum was given in a number of the cases, and throughout the year use was also made of the Lister Institute serum and of Burroughs, Wellcome and Co.'s serum.

Of the 95 treated with intrathecal injections of serum, 60 did not receive any other form of specific treatment and had a mortality of 18, or 30 per cent., which is a little lower than that (31·6) of the 95 cases. The remaining 35 cases received in addition one or more of the following forms of treatment: hypodermic or intramuscular injection of the serum, of vaccines or of soamin, or hexamine by the mouth, with a mortality of 12, or 34·3 per cent. In 23 out of the 35 cases the additional treatment was the simultaneous subcutaneous (or in a few instances intramuscular) injection of serum; this method was mainly adopted at Plymouth and Haslar; the mortality was 7, or 30·4 per cent. Vaccines were given in 8 cases but did not appear, except perhaps in one or two instances, to exert any decided beneficial effect. The exact figures of the results of treatment are shown in the tabular form below:—

Tabular Summary of Treatment.

	Cases	Deaths	Recoveries
Antimeningococcic Serum—			
Intrathecally	95	30 or 31·6 per cent.	65 or 68·4 per cent.
Alone	60	18 ,, 30 ,,	42 ,, 70 ,,
Combined with serum hypodermically, vaccines, soamin, or hexamine	35	12 ,, 34·3 ,,	23 ,, 65·7 ,,
Combined with serum hypodermically	23	7 ,, 30·4 ,,	16 ,, 69·6 ,,
Combined with vaccine	4	3 ,, 75 ,,	1 ,, 25 ,,
Combined with vaccine, soamin, and hexamine	1	—	1
Combined with vaccine and hexamine	3	1	2
Combined with soamin	2	1	1
Combined with hexamine ..	2	—	2
Vaccines—			
(Never alone, always with intrathecal injection of serum), *vide* above	8	4	4
Hexamine—			
Alone	1	1	—
Combined with intrathecal injections of serum, &c., *vide* above	6	1	5
Soamin—			
Alone	1	1	—
Combined with intrathecal injections of serum, &c., *vide* above	3	1	2
Lumbar puncture (only)	6	4 or 66·7 per cent.	2 or 33·3 per cent.
Symptomatic Treatment (only)	2	2	—

More than three quarters of the 95 cases received serum within the first three days of the disease. From tabulation of 1,211 cases Flexner found that when the serum was given within the first three days the mortality rate was 18 per cent., when between the fourth and seventh days 27·3 per cent., and when later than the seventh day 36·5 per cent., and therefore laid stress on the importance of early injection. In the 95 cases treated with serum in the Royal Navy this influence of time can also be seen :—

	Cases	Deaths	Recoveries
1st to 3rd day	74	22 or 29·7 per cent.	52 or 70·3 per cent.
4th to 7th day	15	5 ,, 33·3 ,,	10 ,, 66·7 ,,
Later than the 7th	6	3 ,, 50 ,,	3 ,, 50 ,,
	95	30 ,, 31·6 ,,	65 ,, 68·4 ,,

The results obtained by the use of the various brands of serum are shown below in a tabular statement. Flexner's serum was employed in 39 cases altogether, with a mortality of 9, or 23 per cent.; in 27 of the 39 cases it was the only serum used, with a mortality of 6, or 23 per cent.; the 12 other cases in which other serums were given as well showed a mortality of 3, or 25 per cent. The other serums were given in much fewer cases. The mortality percentage of the 14 cases that received Burroughs, Wellcome and Co.'s brand (alone or combined with other serums) was slightly lower than that of the cases treated with Flexner's serum ; and the 16 cases treated by Gordon's various serums alone showed an even lower mortality.

The number of occasions on which serum was given intrathecally varied in the 95 cases from one to eight, according to the duration of the symptoms. In some instances the improvement and fall of temperature after the injection of serum were dramatic.

Sixteen cases received one dose only, and 7 proved fatal, 6 being very acute or fulminating cases ; 25 received two doses of serum (8 deaths) ; 22 cases three doses (7 deaths) ; 8 cases four doses (1 death) ; 11 cases five doses (4 deaths) ; 5 cases six doses (2 deaths) ; 4 cases seven doses (1 death) ; and 4 cases eight doses (no death). In many cases lumbar puncture was performed more often than serum was injected ; in 1 chronic case, in which serum was given six times, lumbar puncture was performed on 20 occasions.

Serum rashes, erythematous or urticarial, were mentioned in 22, or 23 per cent., of the 95 cases treated by serum, but may have been more frequent. The rashes and articular manifestations were practically confined to cases treated with Flexner's and Burroughs, Wellcome and Co.'s brands.

Out of the 22 cases 21 received either Flexner's or Burroughs, Wellcome and Co.'s serum ; 12 had Flexner's serum alone, 2 Flexner's and

Gordon's serums, 1 Flexner's and the Pasteur Institute's multivalent serums, 2 Burroughs, Wellcome and Co.'s serum alone, 1 Burroughs, Wellcome and Co.'s and Gordon's serums, and 3 Flexner's and Burroughs, Wellcome and Co.'s serums (only 4 cases had this combination). The remaining case had 70 c.c. of Gordon's serum, and did not have any manifestations of serum disease except the rash. Out of the 95 cases treated with serum, 41 had Flexner's or Burroughs, Wellcome and Co.'s serum, and among them rashes occurred in 21 or 51 per cent.; whereas among the remaining 54 cases treated by serum there was a rash in one case only. Six of the 22 cases with rashes also had serum hypodermically. The average amount of serum received by the cases with rashes was 65 c.c.; and the average amount received by 14 other cases which had Flexner's or Burroughs, Wellcome and Co.'s serum and recovered was 70 c.c., or practically the same.

TABLE SHOWING RESULTS OF TREATMENT BY DIFFERENT SERUMS.

	Cases	Deaths	Recoveries
Flexner's serum alone	27 ..	6 or 22·3 per cent. ..	21 or 77·7 per cent.
Combined with other serums..	12 ..	3 ,, 25 ,, ..	9 ,, 75 ,,
	39	9 or 23 per cent.	30 or 77 per cent.
Gordon's serums alone	16 ..	3 or 18·7 per cent. ..	13 ,, 81·3 per cent.
Combined with other serums..	6 ..	3 ,, 50 ,, ..	3 ,, 50 ,,
	22	6 or 27·3 per cent.	16 or 72·7 per cent.
Pasteur Institute's multivalent serum (3619) alone	9 ..	4 or 44·5 per cent. ..	5 or 55·5 per cent.
Combined with other serums..	5 ..	1 ,, 20 ,, ..	4 ,, 80 ,,
	14	5 or 35·7 per cent.	9 or 64·3 per cent.
Burroughs, Wellcome & Co.'s serum alone	6 ..	2 or 33·3 per cent...	4 or 66·7 per cent.
Combined with other serum..	8 ..	1 ,, 12·5 ,, ..	7 ,, 87·5 ,,
	14	3 or 21·4 per cent.	11 or 78·5 per cent.
Mulford's serum alone	10 ..	5 or 50 per cent. ..	5 or 50 per cent.
Combined with other serums..	2 ..	1 ..	1
	12	6	6
Lister Institute's multivalent serum alone	11 ..	6 or 54·5 per cent...	5 or 45·5 per cent.

On an average the rash appeared ten days after the first injection of serum. In a case at Haslar which received one injection of 20 c.c. of Flexner's serum in a relapse seven weeks after the primary attack in Egypt, there was within a few hours an "immediate" serum rash. The patient stated that nine lumbar punctures had been performed in the primary attack, but there is no official information as to the administration of serum.

Of the 22 cases none proved fatal, but as the serum rash occurs after an interval of about ten days, the fulminating and acute cases are obviously excluded, and this observation has no

prognostic value. Six cases had both herpes and a serum rash; nine cases an initial rash and a serum rash; and three cases an initial rash, herpes and a serum rash (in one case on two occasions); presumably in these instances the skin was especially prone to react.

In some cases pains in the joints without effusion accompanied the serum rash, and in two instances effusion into the joints and a temperature of 102° F. coincided with the rash. In two cases at Chatham temporary deafness occurred at the same time as a serum rash and arthalgia, and was regarded by Temporary Surgeon A. C. MacAllister as a manifestation of serum disease.

Grave accidents due to intrathecal injection of antimeningococcic serum were very rare.

In one case lumbar puncture was done directly after admission to the Royal Naval Hospital, Plymouth, and 50 c.c. of turbid fluid containing meningococci spurted out; 15 c.c. of Gordon's multivalent serum was given intrathecally and the same quantity hypodermically. Respiration stopped at once. The necropsy showed fibrinous adhesions and purulent streaks over the cerebral sulci, with but little exudation at the base of the brain. Both lateral ventricles were distended with blood-stained serum. The purulent exudate over the hemispheres suggested that the illness had lasted a week. In another case at Plymouth lumbar puncture on the third day of the disease gave exit to 30 c.c. of turbid fluid, and 15 c.c. of Gordon's multivalent serum were injected intrathecally; five hours later respiration stopped before the pulse. The necropsy showed fibrino-purulent exudate over the base of the brain and much yellowish fibrin over the pons and medulla, turbid and blood-stained fluid in both ventricles, œdema of the cerebellum pressing on the pons, dilatation of the right side of the heart, and recent and old endocarditis of the mitral valve. Although death did not occur until five hours after the injection of serum, this case resembles the first in the presence of blood-stained fluid in the lateral ventricles of the brain. In a third case death occurred suddenly seven hours after injection of serum and the necropsy showed distension of the lateral ventricles and acute congestion and œdema of the cerebellum pressing on the pons.

In a man who had had six lumbar punctures the site of the punctures became inflamed and death rapidly followed; at the necropsy it was found that the lateral ventricles were greatly distended with pus swarming with streptococci.

In two cases lumbar puncture gave rise repeatedly to severe headache, which was partially relieved when serum was injected intrathecally.

(4) History of the Outbreaks of Cerebrospinal Fever at Various Centres.

The Portsmouth District.

The 28 cases treated at the Royal Naval Hospital, Haslar, were drawn from the Royal Naval Barracks, Portsmouth (14 cases); the Royal Marine Artillery Barracks, Eastney (4 cases); the Royal Marine

Light Infantry Barracks, Forton (3 cases), H.M.S. "Excellent" (2 cases); H.M.S. "Fisgard" (2 cases); and isolated cases from H.M.S. "Amphitrite," H.M.S. "Vernon," and from a torpedo boat. Three of the 28 cases arose in the Zymotic Block at Haslar while under treatment for measles.

In the Portsmouth district the monthly incidence of cases in the Royal Navy was as follows: August, 3; September, 3; October, 2; January, 3; February, 5; March, 9; April, 2; and May, 1. As in the first year of the War the largest number of cases occurred in March.

The early cases were treated by Mulford's serum (5 recoveries, 4 deaths); then 6 cases were given the Pasteur Institute multivalent serum or Gordon's serums (4 recoveries, 2 deaths), and in the later part of the year Flexner's serum alone was given (with 9 recoveries, 1 death). Three cases were not given serum (2 recoveries, 1 death). Staff Surgeon Adshead found that lumbar punctures could be performed without discomfort or struggling under the influence of a hypodermic injection of scopolamine $\frac{1}{100}$ gr., morphine $\frac{1}{6}$ gr., and atropine $\frac{1}{100}$ gr., in 5 minims of water given half an hour previously.

Of the 28 cases 8, or 28·5 per cent., died and 20 recovered; this compares favourably with a mortality of 19, or 52·7 per cent., out of the 36 cases treated at Haslar in the previous year.

Dr. P. Fildes found that out of 603 contacts there were 25, or 4·1 per cent., carriers; that out of 2,022 new entries swabbed there were no positive carriers; and that swabs from 16 cases of the disease were in every instance negative.

The Royal Naval Barracks, Portsmouth.—Out of the 14 cases four occurred between August 28 and September 8, 1915. On August 28, 29, 31, cases occurred in three boys who were in contact with a boy who had the disease in April, 1915, and was found in September to be an obstinate carrier. An isolated case occurred on September 8, and then there were no cases until February 10, 11, 16 and 24. On March 4, a case arose in Haslar Camp in a man who left the barracks on February 28; other cases occurred on March 4, 6, 13, 14 and 27, and the last case occurred on April 23. The total number of cases is practically the same as in the previous year (16).

The Royal Marine Artillery Barracks, Eastney.—The first of the four cases (one fatal) from this depot occurred on February 16, and was so atypical that it was not until March 7 that lumbar puncture was performed and proved that the cerebrospinal fluid, which was clear, contained meningococci. It is perhaps worthy of note that about the same date a similarly atypical case, which was not bacteriologically proved until three weeks after admission, arose in the Royal Naval Barracks, Portsmouth, and that both cases recovered without the use of serum. A fulminating case, fatal within thirty-six hours, occurred on March 8, followed by unconnected and non-fatal cases on March 10 and 26. In the first year of the War there were 12 cases with 6 deaths.

The Royal Marine Light Infantry Barracks, Forton.—Of the three cases borne on the books of these barracks one only arose in the barracks. A boy aged 17 went sick on May 5, in a room with an individual space of 600 cubic feet; the origin of the infection could not be traced. Of the other two cases one was remarkable as presenting a relapse after a long interval; a private went sick with the disease on

January 13, at Alexandria, where he was proved bacteriologically to have the disease and, according to his own statement, was tapped nine times. After February 1 the temperature was normal, and on March 20 he was admitted convalescent to Haslar. On March 22 the temperature rose to 101·4° F., he had a violent headache, Kernig's sign, and lumbar puncture yielded 30 c.c. of turbid fluid under great pressure containing meningococci. He received 20 c.c. of Flexner's (1915) serum, and within a few hours had an "immediate" serum rash. The temperature was normal on March 24 and he made a good recovery. The other case was in a private who left his ship for his home in Gosport five days before he went sick; he never went into Forton Barracks and he might have contracted the disease on the journey from the Grand Fleet.

During the previous year four cases, none of which originated in the Barracks, were reported from this depot.

The Plymouth District.

Twenty-eight cases were reported from this depot, as compared with 30 in the first year of the War. Twenty-seven were treated in the Royal Naval Hospital, Plymouth; the remaining case was in a man who joined the Royal Naval Barracks on March 2, 1916, went on leave two days later, died on March 7 in London, and was found at the necropsy to have cerebrospinal fever. The 28 cases were drawn from the "Impregnable" Establishment (13 cases), the "Powerful" Establishment (7 cases), the Royal Naval Barracks (4 cases), H.M.S. "Cambrian" (2 cases), and H.M.S. "Indus" (2 cases).

In the Plymouth district the monthly incidence of cerebrospinal fever in the Royal Navy was: November, 2; December, 4; January, 2; February, 10; March, 4; June, 1; and July, 1. As in the first year of the War the largest number of cases occurred in February.

In the majority of the cases lumbar puncture was performed under a general anæsthetic by Staff Surgeon D. H. C. Given. The first 7 cases, from November 12, 1915, to January 10, 1916, were treated with the Lister Institute serum (3 deaths); after this Pasteur Institute multivalent serum, Gordon's multivalent serum, or Flexner's multivalent serum were used, sometimes alone, sometimes in combination. Out of 6 cases treated solely with Flexner's serum 1 only proved fatal and in this instance there was a secondary streptococcic infection of the nervous system through the lumbar puncture wound. Of 5 cases treated with the Pasteur Institute's multivalent serum 1 only died; of 4 cases treated with Gordon's multivalent serum 1 proved fatal; of 3 cases treated with both Flexner's and the Pasteur Institute serums 1 died; and of 2 treated with Flexner and Gordon's serums 1 died. Of these 27 cases 19, or 70 per cent., recovered and 8, or 30 per cent., proved fatal. This is better than the 36·7 per cent. mortality in the previous year which was remarkably low for that epidemic. The mortality appeared to be determined by the age of the patients rather than by their treatment; for out of 20 boys from the "Impregnable" (13) and "Powerful" (7) Establishments, none of whom were more than 16 years of age, 2, or 10 per cent. only, died; whereas out of 7 men from the Royal Naval Barracks, H.M.S. "Cambrian," and "Indus" 6, or 85·7 per cent., died; the man who recovered was 26 years of age.

Fleet Surgeon H. C. Whiteside found that out of 2,049 contacts of

cerebrospinal fever cases 195, or 9·5 per cent., were carriers; and that out of 2,813 new entries 52, or 1·84 per cent., were carriers. This investigation referring to the first half of 1916 forms the subject of a report by Fleet Surgeon H. C. Whiteside.

In *the "Impregnable" Establishment* the first case occurred on November 12 in "Impregnable I" and proved fatal. Cases then occurred in "Impregnable III" on November 25, December 2 (fatal), 4, and 8, the last two being from the same mess. On December 14 a case occurred in "Impregnable IV" (late "Circe") in a boy who had communication with "Impregnable III." After an interval of seven weeks 3 cases occurred in "Impregnable I" on February 4 and 12 (a case). On February 23 a case appeared in "Impregnable III." After this isolated cases arose in "Impregnable III" on April 21, and in "Impregnable I" on June 8 and July 23. The last case was of rather special interest as the cerebrospinal fluid contained pneumococci as well as meningococci. There was a hæmorrhagic rash, herpes of the nasal branch of the ophthalmic division of the fifth nerve, no evidence of pneumonia, and recovery. The number of cases (13) is larger than during the first year of the War (9), although, from figures kindly provided by Fleet Surgeon L. E. Dartnell, the individual cubic space is now greater than it was a year ago.

The "Powerful" Establishment, which had 2 cases in 1914, and 2 cases in the first year of the War, both on April 10, 1915, in "Powerful I," had 7 cases between February 1 and April 29, 1916. Six cases occurred in "Powerful I" on February 1, 18, 19, March 29, April 2 and 29. One case arose in "Powerful II" on February 4. The increased incidence of cerebrospinal fever in "Powerful I" is due to some undetected factor, for the hygienic conditions have improved since the first year of the War; the upper parts of the doors in the casemates, which are used for classes, have been perforated, thereby increasing the ventilation. The upper deck was roofed over and boys slept there since January 21, 1916; in this way 100 additional cubic feet per boy was obtained, and the incidence of catarrhal fevers forthwith diminished. Nevertheless cerebrospinal fever began on February 1.

The Royal Naval Barracks, Devonport.—A fulminating case occurred on March 22, 1916, followed on March 30 by a case which recovered, and on April 2 by a case which proved fatal with a secondary streptococcic infection from the lumbar puncture (*vide* p. 12). None of these cases had been in contact with cerebrospinel fever patients or with previously recognized carriers. As mentioned above a man attached to this depot died in London of cerebrospinal fever but was in the barracks for two days only. In the first year of the War there were fifteen cases in this depot.

In the "Cambrian" two cases occurred among the stokers on January 10 (a fulminating case) and 30. No cases occurred here during the first year of the War.

In the "Indus" two cases occurred among the engine-room artificers on February 7 and 29. During the first year of the War there were two cases here.

At the *Marine Light Infantry Barracks, Devonport*, no cases occurred. In the first year of the War there were three cases.

Chatham District.

The 18 cases reported were drawn from the Royal Naval Barracks (14), the Royal Marine Light Infantry Barracks (2), and H.M.S. "Egmont" (2), and were treated at the Royal Naval Hospital, Chatham.

The monthly incidence of cases in the Royal Navy in the Chatham District was as follows: November, 1; December, 3; February, 6; March, 6; April, 1; May, 1. In the previous year the largest number of cases occurred in February. During March, 1916, there was an outbreak of the disease among the soldiers in the district.

The treatment of the cases was described by Temporary Surgeon W. H. W. Cheyne,[1] who insisted on the importance of early and frequent injection of mixed serums and of anæsthesia for lumbar puncture and the administration of serum.

Of the 18 cases 9, or 50 per cent., proved fatal; this is an improvement on the mortality of 16, or 76 per cent., out of the 21 cases during the first year of the War; but it is much above the percentage mortality (35·6) for the whole 104 cases in the Royal Navy during the second year of the War. In this connection the following points should be taken into consideration: Two of the fatal cases were complicated with otitis (1 with a large perforation of the tegmentum tympani into the cranial cavity, the other with thrombosis of the cavernous sinus), which appeared to be the lethal lesion; and 3 other fatal cases had one dose only of the Lister Institute serum. Of the remaining 13 cases treated with serums 4 (1 with delirium tremens), or 31 per cent., proved fatal. Of the 9 recoveries, 4 were invalided (2 having lost an eye).

Staff Surgeon S. F. Dudley found that out of 2,548 new entries (March to July, 1916, inclusive) swabbed, 58 or 2·23 per cent., were positive carriers.

Royal Naval Barracks.—The first case occurred on November 28 in a boy servant who had already been fourteen days in a medical ward of the Royal Naval Hospital for right-sided pleurisy. The second case, in a second-class stoker, returned from leave with symptoms of two days' duration on December 4. The third case, in a seaman, aged 37, one of otitis with thrombosis of the cavernous sinus, went sick on December 5, and was bacteriologically proved to be meningococcic at the necropsy only. No further case occurred until February 6, when a seaman, aged 28, had a sharp attack of the disease from which he recovered; it is interesting to note that in July, 1915, he had high fever and meningitic symptoms in the Royal Naval Hospital, Plymouth, where lumbar puncture was done and normal cerebrospinal fluid withdrawn. He had a strongly positive Wassermann reaction, and recovered under anti-syphilitic treatment. On February 17 an officer's steward, third class, who had been in the service nineteen days, went sick. On February 22 a second-class stoker developed the disease, and on February 23 a cook's mate went sick. A close contact of the case on February 22 showed signs of the disease on February 27. Then there was an interval until March 13, when 3 cases occurred among second-class stokers, followed on March 23 by a seaman R.N.R. On March 25 another second-class stoker went sick with the symptoms of the disease, and died when on leave, but as bacteriological examination was not available, he is not included as a case. A fulminating case in an officer's steward, third class, occurred on

[1] Journal of the Royal Naval Medical Service, 1916, vol ii, pp. 325-328.

April 2; and the last case, in a second-class stoker, began on May 30. Thus, out of 14 cases, 8 were among stokers second-class.

In the "Egmont" 2 cases occurred on March 24 and 25 in a midshipman and a shipwright.

At the *Royal Marine Light Infantry Head Quarters* 2 isolated cases occurred on December 1 and February 17.

Crystal Palace.

At this depot between December 28, 1915, and July 1, 1916, there were 8 cases with a mortality of 2, or 25 per cent., as compared with 33 cases and 21 deaths (63·6 per cent.) during the first year of the War. This fall in the incidence of the disease has followed improvement in the hygienic arrangements at the Crystal Palace. The cases were again treated at Croydon Borough Fever Hospital, the Resident Medical Officer of which kindly supplied information about the cases.

The first case occurred on December 28, 1915, at a time when catarrh and mild influenza were prevalent, and was at first regarded as enteric fever. In January, 2 cases occurred on the 24th and 31st; in February, there were 3 cases on the 2nd, 5th and 20th. Isolated cases occurred on June 5 and July 1. These cases all received Burroughs, Wellcome and Co.'s serum; 5 also received a stock vaccine (Parke, Davis and Co.), 6 hexamine, and 3 soamin.

Fleet Surgeon P. W. Bassett-Smith, C.B., found among 46 contacts 3, or 6·12 per cent., positive carriers, and among 4,233 non-contacts (new entries, and drafts for sea who had already done service or had completed their training) examined during the first six months of 1916, 45 carriers, 37 of which occurred in March (8), April (20), and May (9).

Shotley Training Establishment.

There were 11 cases with 4 deaths, or 36·5 per cent., between November 16, 1915, and July 29, 1916, as compared with 7 cases (5 fatal) in the first year of the War. In addition a surgeon probationer (from H.M.S. "Lydiard") was treated in the hospital and recovered.

The first case occurred on November 16, 1915, in a boy who had been in hospital with otitis media and perforation of the drum for twelve days, and was convalescent when symptoms of meningitis arose and lumbar puncture showed that meningococcic infection was present. On November 19 there was a second case, also fatal. No more cases occurred until February 8, 1916, when a boy with otitis passed through an attack of cerebrospinal fever. Seven weeks later on March 31 there was another case in a boy who rapidly recovered, but had a relapse on May 21. Cases also occurred on May 8, 23, and on June 15. After four and a half weeks' interval there was a sudden outburst of cases with the clinical symptoms of cerebrospinal fever in July. Of 15 cases 4 were bacteriologically proved to be due to meningococcic infection. The first positive case occurred on July 19 in a boy who had been in the Service fer one week and had been vaccinated six days before the onset of symptoms. A second proved case of cerebrospinal fever occurred on July 21 in the same dormitory (No. 7) which had an individual cubic space of 600 feet; this patient had joined two and a half weeks previously and had been vaccinated a week before the onset. Two other cases not bacteriologically positive occurred in the same dormitory on July 20 and 21. A third case of cerebrospinal fever arose on July 21 in another dormitory; this boy had

joined the Service the day before and had not been vaccinated. A fourth case occurred on July 29.

Of the 11 cases not proved bacteriologically to be meningococcic, the records of the cytological examination of the cerebrospinal fluid are available in 5 cases; in 2 there was an excess of lymphocytes over polymorphonuclears; neither of these cases showed any subsequent paralysis, and so cannot be regarded as examples of the meningitic form of acute poliomyelitis; further, as there was one case only of mumps during July at Shotley, it is improbable that the meningitis was a complication of that disease. In 1 case the lymphocytes and polymorphonuclears in the cerebrospinal fluid were present in about equal numbers. In 2 cases the polymorphonuclears were in excess of the lymphocytes; in one of these cases there was transient and slight weakness of one leg. Four other cases had persistent headache, 2 showing mental disablement. One case, the cytological report of the cerebrospinal fluid of which is not known, was left with weakness of the right leg, loss of the knee-jerk on that side, tenderness of the posterior tibial nerve, and weakness of control of the bladder. This appears to be the only one of the 11 cases which could be regarded as an example of the meningitic form of acute poliomyelitis. Dr. G. I. P. Stewart, Medical Officer of Health for East Suffolk, has kindly informed me that no contemporaneous outbreak of acute poliomyelitis or of cases of a similar doubtful nature was reported in the county.

Ten cases were treated by intrathecal injection of Gordon's multivalent serum after washing out the spinal cord with 0·5 per cent. of carbolic acid in saline solution as suggested by Captain Sheffield Neave, R.A.M.C.(T). of Ipswich. This method of treatment appeared to be beneficial and certainly no bad effects were ascribed to it.

Deal.

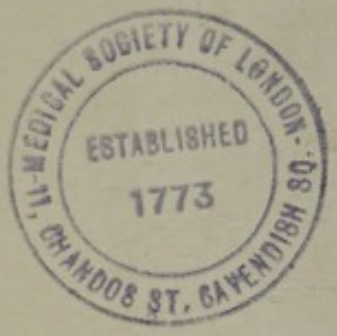
At the Marine Depot 2 cases occurred on January 31 and February 15, both of which recovered. In the first year of the War 25 cases (with 8 deaths) originated at this depot.

Cases in Sea-going Ships.

Ten cases were reported from sea-going ships, but in no instance did more than 1 case arise in the same vessel, a most satisfactory result. The cases occurred in the "Campania" (August 6, 1915), "Torpedo Boat No. 110" (September 9), a mine sweeper "St. Elvies" (September 28), "Shannon" (October 13), "Defence" (November 5), "Bristol" (May 3, 1916), "Conqueror" (May 5), "Royal Oak" (May 23), "Lydiard" (July 8), and "Malaya" (July 27). There were 5 deaths. The average age of all the cases was 23·7 years, of the fatal cases 25·2, and of the recoveries 22·2 years. The high mortality is perhaps explained by the delay that may necessarily occur in obtaining serum treatment. In the first year of the War there were 12 cases with 8 deaths; in only one ship was there more than one case. Thus during the first two years of the War out of 274 cases of cerebrospinal fever 22, or 8 per cent., cases with 13 deaths, or a percentage of 59, occurred in sea-going ships.

In addition to the medical officers incidentally mentioned I beg to express my sincere thanks for courteous help and information to Deputy Surgeons-General H. W. G. Doyne and R. Hill, C.V.O.; Fleet Surgeons W. H. S. Stalkartt, F. Fedarb, M. Rodd, T. D. Halahan, J. A. Campbell, C. J. E. Cock, W. L. Martin, E. A. Shaw, Staff Surgeon L. Warren, and Temporary Surgeons W. H. Watson Cheyne, and E. J. Tongue.

With the Writer's Compliments.



Report on Cerebro-spinal Fever in the Royal Navy (Aug., 1914—Aug., 1915)

BY

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Report on Cerebro-Spinal Fever in the Royal Navy.

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By Temporary Surgeon-General H. D. ROLLESTON, M.D., F.R.C.P., R.N.

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The cases of cerebro-spinal fever in the Royal Navy from August, 1914, to July 31, 1915, have been investigated by order of Sir Arthur May, K.C.B., Director General, with the main object of determining what measures should be adopted to prevent or minimize an epidemic outbreak of this disease in the coming winter of 1915-1916. The enclosed report contains—

(I) A discussion of the etiology of the cases.

(II) A history of the outbreaks at various centres.

(III) A summary of the rarer manifestations and complications.

(IV) A summary of the results of treatment.

(V) Recommendations as to prevention (i) of the disease and (ii) of its spread.

(I) ETIOLOGY OF THE CASES.

The cases of cerebro-spinal fever in the Royal Navy amount to 170, of which 90, or 52·9 per cent., proved fatal.

Incidence.—The cases naturally occurred mainly where large numbers of ratings were collected.

There were 33 cases at the Crystal Palace; 21 cases at the Royal Naval Barracks, Chatham; 25 cases were traced to Deal; 16 occurred in the Royal Naval Barracks, Portsmouth, which at the time was not

over-crowded; there were 15 cases at the Royal Naval Barracks, Devonport; 12 cases at the Royal Marine Artillery Barracks, Eastney; and 10 cases in the "Impregnable."

In some instances, however, large numbers of men were collected together without a corresponding incidence of the disease.

At Blandford, although drafts from infected centres (the Crystal Palace and Deal) were received, six cases only occurred, three of which were in the Deal Battalion, which was isolated from the rest of the camp until February 20, between February 1 and 4, or shortly after their arrival from Deal, and must therefore be regarded as having originated at Deal. At the Royal Marine Light Infantry Barracks, Forton, no cases really originated, although four cases were borne on the books. On the "Powerful I" there were two cases only, both on April 10, when there were 600 boys.

The disease may occur in sudden outbursts, so as to suggest a virulent focus or the presence of carriers inside a barracks, or may crop up in an intermittent or isolated fashion, so as to point to infection contracted outside.

Thus at Deal 13 cases occurred between January 19 and February 4, and no cases after March 14. In the "Impregnable" 5 cases occurred between February 8 and 12, and none between February 24 and May 30. At Eastney 4 cases, 3 of which could be traced to a probable source of infection in the barracks, occurred between January 18 and 20.

On the other hand, at the Royal Naval Barracks, Portsmouth, 16 cases occurred in six months (January 27 to July 31), the most in any one month (March) being 4. In addition, 2 men went sick with the disease shortly after leaving the barracks.

In the Royal Naval Barracks, Chatham, the cases occurred in such continuity from January 27 to March 17 as to suggest an internal origin; after that date there were 3 cases only, and of these 2 could be traced to outside infection. At the Royal Naval Barracks, Devonport, there were 7 cases between February 12 and March 4, and then no more until infection was introduced from outside on March 21. Twelve cases occurred in sea-going ships, and in one instance only did two cases occur in the same vessel (the "Biarritz").

The monthly incidence with the results is shown below. The largest number of cases and of deaths occurred in February:—

Month	Cases	Deaths	Invalidings	Recoveries
November	1	0	1	0
December	2	1	0	1
January	27	16 or 59 per cent.	1	10
February	60	35 ,, 58 ,,	1	24
March	35	15 ,, 42·8 ,,	3	17
April	24	8 ,, 33·4 ,,	0	16
May	12	8 ,, 66·7 ,,	1	3
June	6	4	—	2
July	3	3	—	—
	170	90		

The Question of the Communicability of the Disease.—It has been authoritatively stated that a very definite feature of epidemics of cerebro-spinal fever is the isolation or want of ascertained contact between the cases of the disease, and it has even been suggested that it is not more communicable than pneumonia, and in this connexion the extreme rarity of infection of medical officers and nurses in hospital might be mentioned. This is an important point, for if the etiology of the disease is on the same plane as that of pneumonia, it would not be worth while to attempt isolation of meningococcic carriers.

Out of the 170 cases some evidence of infection was traced in 59, or rather more than a third; this is by no means convincing proof of the communicability of the disease, but it should be stated that the opportunities for tracing the infection, which appears to be largely conveyed by carriers, varied in different places, especially as to contact with carriers. At Chatham infection was traced in 12 out of 24 cases, whereas among 33 cases at the Crystal Palace the infection was traced in 8 only, and among 20 cases at Deal a connexion was forthcoming in three instances only. It is obvious that the more the cases can be investigated the larger the number in which the source of infection is traced.

The following points noticed among the cases in the Navy are in favour of the view that the disease is spread from one individual, either suffering from the disease or a carrier, to another.

(1) Spread of the disease from an infected focus.—A draft of men of the Naval Brigade from Deal carried the disease to the camp near Blandford, where at least one man, who was in billets and went sick, appeared to have communicated the disease to a civilian living in the house. In Portsmouth where there was one civilian case in 1914, as contrasted with sixty-two in 1915 up to June 22, the first civilian case was in a child aged 4½ years on February 11, who attended the Royal Naval Artillery School, Eastney, in which recruits were also taught. By this time six recruits from Eastney had gone down with cerebro-spinal fever, the last on February 9. During the following eight days four other children of about the same age in the neighbourhood of Eastney became infected.

(2) The way in which outbreaks appear to be stopped by isolation of contacts and mild disinfection of the throat.

In the "Impregnable" 5 cases occurred between February 8 and 12; on the two following days 123 contacts were removed to the Royal Naval Hospital, Plymouth, and of these 31 were found to be carriers, 2 of which

developed the disease on February 15 and 19 respectively. On February 19, a boy on leave developed the disease, but otherwise no case could be traced to the "Impregnable" until a boy, who left that ship on April 3, developed the disease on the following day in the Royal Naval Barracks, Portsmouth. On April 10, 2 cases of cerebro-spinal fever occurred in the "Powerful I" in a mess where a carrier was afterwards found, who, fifty-six days previously had had "influenza in a severe form" (possibly cerebro-spinal fever) at Liverpool. Fifty-five contacts were segregated (15 carriers), and no further cases occurred. At the Royal Naval Barracks, Chatham, 5 cases occurred among the engine-room artificers, between February 1 and March 17; 130 men were examined; 30 of these had nasal or faucial catarrh, and of these 3 were found to be carriers and were isolated. After this no more cases occurred among the engine-room artificers. At Deal all the men using the swimming bath sprayed their throats with a mild antiseptic before bathing, and no case occurred after March 14.

(3) The difference between the incidence of the disease in barracks and institutions in the same port.

In the Portsmouth district at the Royal Marine Light Infantry Barracks, Forton, no case originated (although 4 cases were borne on the books), whereas at the Royal Marine Artillery Barracks there were 10 cases at least, and at the Royal Naval Barracks, Portsmouth, 16 cases. On the hypothesis that cerebro-spinal fever is not more infectious than pneumonia its incidence, other things being equal, should be in proportion to the number of men in the respective barracks, namely, the Royal Marine Light Infantry Barracks, 1, the Royal Marine Artillery Barracks $1\frac{1}{4}$, the Royal Naval Barracks, Portsmouth, $5\frac{3}{4}$. This proportion was not shown, for at the Royal Marine Artillery Barracks, Eastney, where there was, as already mentioned, an outburst of cases suggesting an internal focus of infection, there was relatively a great excess over the other two. At the Royal Naval College, Osborne, no case has occurred.

(4) The detection of carriers who have been in contact with cases of the disease and have formed a bridge between them. This was shown to occur in several instances at the Royal Naval Barracks, Chatham, by Deputy Surgeon-General C. J. Mansfield, M.V.O.

The experience of the cases of cerebro-spinal fever in the Navy is therefore in favour of the usually accepted opinion that the disease is communicable, and that precautions to prevent infection are necessary.

The spread of the disease depends in the first instance on infection from (*a*) carriers, (*b*) abortive and undetected cases, (*c*) patients recognized to be suffering from the disease. The first two are the most important, whereas the last is so obvious as not to require discussion. An attack of the disease, however, may be

followed by a chronic carrier state, which may possibly be periodic or intermittent, with positive and negative bacteriological results alternating.

A case of cerebro-spinal fever at the Crystal Palace had been in contact with a man who, after recovering from the disease, had returned to duty; on bacteriological examination he was found not to be a carrier (*vide* p. 22); in this instance the spread of infection was not proved, but possibly he was a periodic carrier. In September, after the period covered by this Report, an outbreak of three cases of cerebro-spinal fever among boys in the Royal Naval Barracks, Portsmouth, was traced to a boy who had recovered from the disease and returned to duty; bacteriologically he was proved to be a carrier (Fairer).

(*a*) *Carriers.*—This is a most important and difficult question in connexion with the spread of the disease. If carriers could be entirely eliminated the disease would be abolished, and the prophylaxis of cerebro-spinal fever is largely concerned with the detection, isolation, and sterilization of carriers (*vide* p. 32 *et seq*). It is probable that under conditions which depress their resistance carriers would be become attacked by the disease, and this reasonable assumption would explain the occasional occurrence of very long incubation periods.[1] It is therefore remarkable how rarely known carriers contract the disease; among 170 cases of cerebro-spinal fever there were 3, or 1·7 per cent., in recognized carriers under treatment; these 3 cases occurred among the 227 carriers detected around 120 cases, or a percentage of 1·3. The importance of carriers is therefore mainly that they may convey the disease to others.

The difficulties lie in (1) the detection of healthy carriers; this could only be attempted by the examination of every man in the Service, and as the carrier state is usually of short duration (about three weeks), and as some carriers are intermittent, showing the presence and absence of meningococci alternately, the work thus involved would be prohibitive.

(2) The discrepancy as to the numbers of carriers among contacts. Thus some authorities, for example Flügge, have found that as many as 70 per cent. of close contacts are carriers, while others have estimated the percentage as low as 7 (von Lingelsheim). In the Navy the results have varied considerably; this probably depends on the employment of different standards in the bacteriological diagnosis at various centres.

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[1] The French memorandum states that the incubation period may be as long as thirty-six days (vide *Brit. Med. Journ.*, 1915, i, p. 521).

At Plymouth, out of 402 close contacts 97, or 24 per cent., were positive, and out of 1,056 remote contacts 74, or 7 per cent., were positive (Whiteside). At Deal, among 97 close contacts 16 were positive, while of 35 remote contacts none were positive (E. A. Shaw). Out of 122 close contacts from the Crystal Palace 12, or 9 per cent., were positive (Bassett-Smith). At Chatham, out of 243 who were sleeping next to or in the same mess as a case of cerebro-spinal fever, 20, or 8·5 per cent., were positive (Dudley). At Portland, out of 58 close contacts 5, or 8·6 per cent., were positive (Shand and Hitch). Out of 222 close contacts examined at the Royal Naval Hospital, Haslar, there were 2, or 0·9 per cent., positive (Dudding).

(3) The present state of our knowledge as regards the morphology of the infective agent of cerebro-spinal fever. It has recently been suggested that the meningococcus is only a phase in the cycle of a pleomorphic micro-organism which causes the disease.[1] If so, this would bear on the failure to recognize carriers and so to limit the spread of the disease.

(4) The possibility that the disease may be conveyed by carriers other than human beings, such as lice, fleas and other parasites, the virus passing direct into the circulation, is at present hypothetical, but it is worth consideration from the point of view of prophylaxis.

(*b*) *Abortive Cases.*—The existence of such cases is likely to be detected only when an epidemic is in progress; at other times they may be regarded as "influenza" or "catarrh." Such cases may occur among those in contact with the sick, and their occurrence among relatives, nurses, and medical attendants should be borne in mind. The first or catarrhal stage of cerebro-spinal fever may be prolonged, and during this period be indistinguishable from influenza; some of the cases in the Navy have been of this nature and have been instrumental in spreading the disease.

At the Crystal Palace three cases occurred among the Public Schools Battalion between February 10 and 14; one of them had been ill with catarrh since Januury 28, and among his contacts three positive cases were found.

The disease may abort in the catarrhal stage, and these cases are more active in the spread of the malady than the cases which run the characteristic course and are therefore isolated.

A man in the Naval Brigade at the Crystal Palace went sick with what was thought to be influenza on March 16. He went home, and subsequently his wife and child died of cerebro-spinal fever. On

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[1] Hort, Lakin and Benians, *Brit. Med. Journ.*, 1915, vol. i, pp. 541, 715.

March 31 he was admitted to the Croydon Hospital, where he was regarded as a case of cerebro-spinal fever, although lumbar puncture was not performed.

The coincidence of a high sick-rate of catarrhal affections (influenza, catarrh, tonsillitis, sore throat) with the occurrence of cases of cerebro-spinal fever has been noted in several though not in all instances, and it may be pointed out that not only may catarrhal affections dispose to meningococcic infection, but that some patients regarded as "catarrh" or "influenza" may be abortive cases of cerebro-spinal fever.

Conditions which may favour the Spread of the Disease.— (1) Overcrowding is a recognized factor in favouring the outbreak of the disease. It appears to act by increasing the number of carriers, and probably by spreading other diseases, such as influenza and catarrh, which weaken the patient's resistance and thus favour the carrier state or virulent meningococcic infection.

In connexion with the influence of overcrowding on the incidence of cerebro-spinal fever attention may be drawn to the Royal Naval Barracks, Devonport, where twelve out of the fifteen cases of the disease occurred in the blocks with the lowest cubic space (*vide* p. 18.)

The danger of overcrowding must not be estimated solely in terms of cubic space, for in summer, when men are more in the open and are less tempted to circumvent proper ventilation, overcrowding is less productive of cerebro-spinal fever than in winter. Overcrowding to an extreme degree may occur without cerebro-spinal fever, provided infection is obviated. Thus in both the "Powerful" and the "Impregnable" there is great overcrowding, but in both, on the appearance of the disease, isolation of contacts and removal of carriers were followed by stoppage of the outbreak. Conversely an outbreak may occur in the absence of overcrowding; thus at Eastney five cases occurred between January 15 and 20, when the number of men was considerably under the full complement.

(2) Catarrhal affections—catarrh, influenza, tonsillitis, and sore throat—were numerous during the early months of 1915, and their prevalence roughly coincided with the outbreak of cerebro-spinal fever. The greater prevalence of catarrhal affections in the first quarter of 1915 as compared with the first and last quarters of 1914, as shown at Deal and Shotley, suggests some connexion with the cerebro-spinal epidemic.

In some barracks and establishments the maximal incidence of

cerebro-spinal fever occurred in the month during which catarrhal affections were most numerous.

At the Royal Marine Artillery Barracks, Eastney, both catarrhal affections and cerebro-spinal fever were at their maximum in January; at the Royal Naval Barracks, Chatham, at the Crystal Palace, and in the "Impregnable" this occurred in February.

At these centres there was some evidence that carriers existed among the occupants, and it is therefore justifiable to suggest that the prevalence of catarrhal affections favoured the carrier state and facilitated infection. In support of this contention it may be mentioned that at the Royal Marine Light Infantry Barracks, Forton, catarrhal affections were few and no cases of cerebro-spinal fever originated in the barracks. In the "Powerful," where two cases only occurred on April 10—a month which had a small incidence (68) of catarrhal affections as compared with the preceding month (March having 136, the highest for the first half of the year)—15, or 27 per cent., carriers were found among 55 contacts; at first sight it might appear that these circumstances militate against the view that a high incidence of catarrhal diseases favours the carrier state. But reflection shows that as the two cases and the detection of carriers occurred early in April, the influence of the high incidence of catarrhal diseases in March was still active.

In the Royal Naval Barracks at Portsmouth and Devonport, there was no exact relation between the incidence of catarrhal diseases and of cerebro-spinal fever. In both of these instances there was a dearth of evidence of a focus of infection inside the barracks, and it is perhaps reasonable to suppose that the cases were mainly introduced from without.

In conclusion, there appears to be a relation between the incidence of catarrhal affections on the one hand and of cerebro-spinal fever cases on the other.

(3) Age incidence. In civilian practice cerebro-spinal fever is pre-eminently a disease of childhood and adolescence. Among the 170 cases in the Navy, 103, or 60·6 per cent., occurred under 20 years of age, and the number of cases progressively diminished in each successive decade while the mortality percentage rose. This is shown in the following table :—

Age-periods	Number of cases and percentage of the total 170 cases	Deaths and percentage in the age-periods
15—19 ..	103 or 60·6 per cent. ..	45 or 43·7 per cent.
20—29 ..	43 ,, 25·3 ,, ..	27 ,, 62·8 ,,
30—39 ..	13 ,, 7·6 ,, ..	10 ,, 76·9 ,,
40—49 ..	8 ,, 4·8 ,, ..	6 ,, 75·0 ,,
50—59 ..	3 ,, 1·7 ,, ..	2 ,, 66·7 ,,

It must, however, be remembered that there was a very large number of young recruits in the Navy, and that there are probably special factors at work which dispose them to cerebro-spinal fever.

(4) Recent enlistment. Newly joined recruits were specially attacked by the disease.

At the Royal Naval Barracks, Devonport, there were 15 cases of cerebro-spinal fever; of these 1 had been in the Service over a year, and the remaining 14 were recent recruits with an average of thirty days' service. Of 21 cases at the Royal Naval Barracks, Chatham, 11 were recent recruits with an average service of twenty-four days (7 with less than twenty days' service, and 1 with eighty-eight days' service).

Youth is generally recognized as a factor favourable to the incidence of cerebro-spinal fever, but in addition the following factors lower the vital resistance of recent recruits: (*a*) Depression and home-sickness, comparable with that of a boy during his first term at school; (*b*) vaccination on entry and antityphoid inoculation in the Naval Brigade; (*c*) fatigue and over-exertion due to drills and marches. The effect of fatigue was shown in the Deal Battalion, which left Deal on January 24 to march to Maidstone, stopping the first night at Littlebourne, the second at Charing, and the third at Bearsted; the next day (January 27) three men went sick with cerebro-spinal fever at Maidstone. The battalion then went by train to the camp near Blandford, where three more men went down with the disease on February 1, 3, and 4.

In the following case, investigated by Fleet-Surgeon R. Hill, C.V.O., the three factors—overcrowding, the depressing effect of antityphoid inoculation, and fatigue—were all present. A private, aged 19, who occupied a room with 250 cubic ft. of space in Upper Walmer, was inoculated against typhoid fever on February 22, 1915; next day, although feeling out of sorts, he did a hard day's work, and at 7 p.m. went by train to Sandwich, where there had recently been an outbreak of cerebro-spinal fever. On February 24, he felt ill and stayed in bed, and on the following day was delirious and found to have cerebro-spinal fever.

(5) Meteorological conditions might naturally be expected to exert some influence on the incidence of cerebro-spinal fever. Thus east and north winds and a low atmospheric temperature, or a sudden fall of temperature, might, by reducing the resistance to bacterial invasion, lead directly to meningococcic infection, or by favouring other infections of the naso-pharynx dispose to the carrier state. During the epidemic it appeared to many medical officers that cases came under observation in connexion with a cold snap, and were less frequent when the weather was warm and calm. It therefore seemed worth while to investigate the relation, if any,

between the direction of the wind and the daily temperature, on the one hand, and the occurrence of cases of cerebro-spinal fever on the other. It may be said at once that the results do not justify any definite conclusion.

In the first instance the monthly incidence of cerebro-spinal fever was compared with the prevailing winds, and it appeared that there was some evidence to support the preconceived view that northerly and easterly winds favour the occurrence of the disease. At Portsmouth, Plymouth, and Deal cases of the disease followed in the wake of north and east winds, but at Chatham no decided conclusion as to the influence of winds was forthcoming. The direction of the wind on (*a*) the day of onset of the disease and (*b*) on the three previous days was then plotted out for 93 cases occurring at Portsmouth, Plymouth, Chatham, and Deal. On the actual day of onset the wind was more or less east or north in 50 cases, and south, west, or calm in 43. On the three days before the onset of the disease the wind was more or less east or north in 47, south or west in 35, and in 11 cases varied during the three days. On the whole, there is not sufficient evidence that east and north winds play an important part in causing an outbreak of the disease.

The question of the atmospheric temperature was gone into. In some, but not in all instances, the months with the lowest average daily temperature showed the largest number of cases of the disease, but the difference in the average daily temperatures was so comparatively small that no conclusion as to its influence is justified.

In the Portsmouth district the larger number of cases occurred in January (T. = 46° F.) and March (T. = 46° F.), and fewer in February (T. = 49° F.) and April (T. = 54·4° F.). At Chatham more cases were seen in February (T. = 38° F.) than in January (T. = 40° F.), March (T. = 42° F.), or April (T. = 49° F.). At Deal 7 cases occurred in January (T. = 44·4° F.), 10 in February (T. = 45° F.), and 3 in March (T. = 48° F.). At Plymouth, however, no such relation existed.

As a sudden fall of temperature might reduce the vital resistance to infection, this question was investigated. The temperatures (day and night) for three days before the onset of the disease in 93 cases from Portsmouth, Plymouth, Chatham, and Deal were examined in order to see if there was a sudden fall of temperature of 10° F. or more within this period. Out of the 93 cases there was such a fall in 37 only, and not in the remaining 56. There is, therefore, no reason to believe that a sudden fall of the atmospheric temperature causes an immediate outbreak of the disease.

Finally an enquiry was made as to the relation between the

prevailing wind and the average daily temperature combined and the incidence of cerebro-spinal fever. Consideration of the monthly incidences of 82 cases of cerebro-spinal fever with the prevailing winds and the average daily temperature for January to March at Portsmouth, Plymouth, Chatham, and Deal shows that practically half the cases occurred in February, during which the prevailing wind was south-west and the average daily temperature 43·5° F., whereas in January the wind was west or south-west in the first half and north or north-east in the second half, and the average daily temperature 43·7° F.; in March the prevailing wind was north-east and the average daily temperature 45° F. There is not, therefore, any real evidence that north and east winds and a low atmospheric temperature play a causal part in the outbreaks of cerebro-spinal fever.

January, 20 *Cases*.

Portsmouth	10	cases;	the coldest month there	(46° F.);	prevailing wind		1st half	
Deal	7	,,	,,	,,	(44·4° F.)	,,	,,	W. & S.W.
Chatham	3	,,	not the coldest month there		(40·8° F.)	,,	,,	2nd half
Plymouth	0	,,	,,	,,	(45° F.)	,,	,,	N. & N.E.

February, 40 *Cases*.

Chatham	9	cases;	the coldest month there	(38° F.);	prevailing wind	S.W.	
Plymouth	17	,,	cold month there	(43·8° F.)	,,	,,	,,
Portsmouth	4	,,	not the coldest month there	(49° F.)	,,	,,	,,
Deal	10	,,	,,	,,	(45° F.)	,,	,,	,,

March, 22 *Cases*.

Plymouth	3	cases;	cold month there	(43·8° F.);	prevailing wind	N.E.	
Chatham	5	,,	not the coldest month there		(42° F.)	,,	,,	S.W.
Portsmouth	11	,,	,,	,,	(47° F.)	,,	,,	N.E.
Deal	3	,,	,,	,,	(48° F.)	,,	,,	,,

(II) HISTORY OF THE OUTBREAKS OF CEREBRO-SPINAL FEVER AT VARIOUS CENTRES.

The Portsmouth District.[1]

The 36 cases treated in the Royal Naval Hospital, Haslar, were drawn from the Royal Naval Barracks, Portsmouth (16 cases), the Royal Marine Artillery Barracks, Eastney (12 cases), the Royal Marine Artillery Barracks, Forton (4 cases), and 3 isolated cases from the "Excellent," the "Vernon," and the "Fisgard" respectively.[2]

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[1] A report on 31 cases treated at the Royal Naval Hospital, Haslar, was made by Staff-Surgeon B. S. Robson, R.N., and Temporary Surgeon L. Pearce Gould, R.N., in the Journal of the Royal Naval Medical Service, 1915, vol. i, No. 3, pp. 255-269.

[2] One case, admitted on March 1 to Haslar from the Royal Naval Barracks, Portsmouth, with German measles, developed cerebro-spinal fever on March 10; as the medical officer who attended this patient also looked after the cerebro-spinal cases, and

In Portsmouth the total number of cases among civilians (including the dockyard cases) up to June 22 was 62. At the Alexandra Hospital, Cosham, which serves a large military area, there were 49 cases of cerebro-spinal fever from January 1 to August 14. The first naval case in the Portsmouth district was a private at the Royal Marine Artillery Barracks, Eastney, on January 15; the first military case was reported on January 19 in the Royal Field Artillery, Hilsea; and the first civilian case on February 11, in a boy aged 4½ years, close to Eastney Barracks, and probably infected from that source (*vide* p. 3). Out of the 36 cases treated at the Royal Naval Hospital, Haslar, the source of infection was traced in 17. Of the 36 cases, 19 proved fatal, a mortality of 52·7 per cent.

In the Portsmouth district the monthly incidence of cases in the Navy was as follows: January 10, February 4, March 11, April 3, May 4, June 3, July 1. This incidence was compared with the following meteorological conditions, forwarded by Fleet-Surgeon G. T. Broatch: the direction of the wind, the saturation of the atmosphere with water, and the day and night temperatures from January 1 to April 30. Up to January 15, when the first case occurred, the wind was west and south-west; for the rest of the month it was north and north-east. In February the prevailing winds were west and south. In March the winds were west up till March 6, after this they were mainly east or north. In April the wind was mainly south-west. It therefore appears that north and east winds favour the incidence of cerebro-spinal fever, whereas south and westerly winds do not. The average daily temperature in January was 46° F.; in February 49° F.; in March 47° F.; and in April 54·4° F. A lower daily temperature, with east or north wind, appears to coincide with an increased incidence of cerebro-spinal fever. The saturation of the atmosphere with moisture and the difference between the day and night temperatures did not appear to exert any influence on the incidence of the disease.

The Royal Naval Barracks, Portsmouth.—The first case of cerebro-spinal fever occurred on January 27, and at this time there was little, if any, overcrowding. The only mess in which a certain amount of overcrowding has been unavoidable, namely, that of the chief petty officers, has never had any case of cerebro-spinal fever. In March, 1915, arrangements were made to allow 500 cubic feet space to each man.

Sixteen cases occurred in the barracks in six months (January 27 to July 31), the most in any one month (March) being 4. This sporadic incidence and the evidence as to the source of infection, as far as it goes, justify the conclusion that the disease was in most instances contracted outside. In addition to these 16 cases, two men developed cerebro-spinal fever shortly after being drafted from the barracks. Most of the cases were in young recruits; 13 of the patients were under 20 years of

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had a bad cold at the time, it is just possible that he acted as a carrier, and that the infection was contracted in Haslar and not at the Royal Naval Barracks, where the last case occurred on February 24, in a signalman who left the Crystal Palace on February 20. On the other hand, the occurrence of German measles may have either converted the patient, supposing he was a carrier, into a case of cerebro-spinal fever, or have prolonged the incubation period of cerebro-spinal fever. As there is this doubt about the origin of infection, the case is not included among those originating in the barracks.

age (with seven deaths); the remaining 3 were between 20 and 30 years of age, and were all fatal. The average age of all the cases was 18·5 years, and of the 10 fatal cases 19·9 years.

The probable source of infection was traced in 8 cases. The first case, on January 27, contracted the disease at Chichester. In the second case, on January 30, the source of infection was not traced. There were 3 cases in February; the third (February 5) was not traced; the fourth (February 9) was in the same mess as the first case (January 27), and the fifth (February 24) had arrived four days before from the Crystal Palace, where there had been 11 cases in the first sixteen days of February. There were 4 in March; 1 was not traced, 2 probably contracted the disease in Gosport, where there was a small outbreak at the time, and the other may have caught the disease from the fifth case. Up to the end of March there were 9 cases, of which 7 proved fatal and 1 was invalided, whereas after that date there were 7, with 3 deaths and 1 invaliding. In April there was 1 only—a boy, who arrived the day before from the "Impregnable III" where, however, there had not been any case since February, and none occurred till May 30; moreover, he came from a mess in which no instance of the disease had appeared. In May, 2 cases occurred in boys drafted from the "Impregnable III" from a mess in which a case occurred on February 11, seven and fourteen days previously. One of them was left permanently blind. In June there were 3 cases, on the 10th, 25th, and 28th, which could not be traced; and there was another on July 30.

A tabular statement of the monthly incidence of influenza, catarrh, tonsillitis and sore throat did not reveal any relationship between their prevalence and that of cerebro-spinal fever. This negative evidence may be correlated with the view that there were not many active carriers in the barracks, for prevalence of catarrhal affections would tend to favour the carrier state and the outbreak of cerebro-spinal fever.

Month	Cases of cerebro-spinal fever	Cases of influenza, catarrh, tonsillitis, sore throat
January	2	185
February	3	203
March	4	157
April	1	204
May	2	172
June	3	133

Out of 132 contacts examined bacteriologically, only one was positive (Dudding).

Royal Marine Artillery Barracks, Eastney.—As the first case in the Portsmouth district occurred in these barracks on January 15, and as it was suggested that the infection was introduced into the barracks by a Canadian team which came to play football against the barracks on January 9, this question was discussed in a previous report which may now be summarized. It is known that four cases of cerebro-spinal fever occurred in the camp at Valcartier, in Canada, that there were three cases during the voyage to this country, and many in their camp on Salisbury Plain; but none of this Canadian team is known to have been a carrier or to have had the disease, and none of the opposing Eastney team contracted cerebro-spinal fever. Swabs from the throats of the Eastney team sent

to Greenwich were found to be negative by Fleet-Surgeon P. W. Bassett-Smith, C.B. The Canadian team slept in a separate room with some sergeants, none of whom had cerebro-spinal fever, and for the most part kept to themselves. They were, however, shown round Portsmouth by a member of the Eastney team, who was a friend of the private who first contracted the disease and was also in daily contact with two men who went down with it on January 20. It was impossible to trace this line of infection any further. If any connexion is to be maintained between the Canadian and the Eastney epidemics it must be assumed that there were at least two undetected carriers, one among the Canadian team, who transferred the infection to a member of the Eastney team—probably the one who showed them round and was a friend of the private who first manifested the disease. On the other hand, the almost simultaneous outbreak of cases in other parts of the country and the weakness of the assumption of two hypothetical carriers make it probable that the epidemic was due to some undetected chronic carrier, and that the Canadians cannot be held responsible for the infection.

There was no evidence of overcrowding in the barracks, which, together with the School of Music, has an individual cubic space of 560 ft.; at this time all the rooms, except one, from which cases of cerebro-spinal fever came were below their normal complement.

Influenza and catarrh were severe in January; the total of such entries for the weeks ending January 16, 23, 30, during which there were 6 cases of cerebro-spinal fever, numbered 52 and 56, as compared with 36 and 41 for the whole of February, during which there was 1 case only of cerebro-spinal fever, and 22 and 41 in March, during which there were 3 cases of cerebro-spinal fever. These catarrhal conditions, by facilitating infection of the throat by meningococci, and so the existence of carriers, might favour an outbreak of the disease.

Investigation of the places visited by the men during Christmas leave did not show any evidence that the disease was contracted elsewhere.

Of the 12 cases there were 6 in January (5 occurring between January 15 and 20), 1 in February, 3 in March, and 2 in May. Of the 6 cases in January, 5 died, whereas of the 6 subsequent cases 1 only proved fatal.

The infection was traced in 5 out of the 12 cases. The second and fourth were infected from the first case; the fifth was infected from the third case; the tenth was in the sick bay with the ninth case and showed symptoms of cerebro-spinal fever three days later; the eleventh case probably contracted the disease in Birmingham.

Of the 12 cases, 7 were under 20 years of age with 3 deaths, 2 between 20 and 29 with 2 deaths, 2 between 30 and 39 with no deaths, and 1, aged 42, fatal. The average age of all the cases was 23·2 years; of the fatal cases, 24 years; and of the recoveries, 22·2 years.

Forty close contacts were examined and all found to be negative.

Royal Marine Light Infantry Barracks, Forton.—Four cases of cerebro-spinal fever were reported from this depot, but in none of them did the infection originate in the barracks. In January, two occurred in privates, who had quite recently (three and five days) been drafted from Deal, and almost certainly brought the disease with them. A quartermaster who worked in the barracks contracted the disease on March 9; he lived in Gosport, and cases of the disease occurred at that time in the immediate

neighbourhood of his house, and on March 11 his son was attacked with a rash and a temperature of 105° F. The fourth case was that of a man who, though nominally in the barracks, had been lent to the anti-aircraft guard in Weevil's Yard, and had not been in the barracks for some months. He slept in a crowded and ill-ventilated room in Weevil's Yard, and four days before the onset of cerebro-spinal fever returned from leave at Farnham, Surrey, where there were instances of cerebro-spinal fever among the troops.

It is suggestive that there was very little influenza, catarrh, sore throat, or tonsillitis in the barracks. From January 1 to May 1 there were 27 cases of influenza, 63 of catarrh, 36 of tonsillitis, and 4 of sore throat. There was no overcrowding in the early part of this year.

Out of 20 contacts 1 was found to be positive (Dudding).

Isolated cases were sent into the Royal Naval Hospital, Haslar, from the "Vernon," the "Excellent," and the "Fisgard." In none of these was the source of infection traced. The contacts were all negative.

Royal Naval Barracks, Chatham.

In the spring of 1914, two cases occurred (on March 2 and April 22) among the stokers in the "Pembroke." In August, 1914, the cubic space fell to 210 ft. per man. The first case of cerebro-spinal fever to occur during the War was a stoker in the "Pembroke," on October 29, and the third, on January 15, was in the same ship; the occurrence of cases in the "Pembroke" raises the possibility of a chronic carrier in that vessel, though the intervals are long. The second case arose on January 10, and the source of infection was not traced. The fourth case occurred on January 27 and was followed by 14 cases (9 in February) at short intervals up to March 17, so as to suggest infection from within the establishment, and more than half of these cases were traced to carriers, or to infection from previous cases. After this date 3 isolated cases occurred; 1 in the "Pembroke" was not traced, the other 2 probably contracted the disease outside, making 21 in all, with an average age of 26 years. Eleven of the 21 cases were in recruits, many of whom had recently joined; their average age was 21 years, and their duration of service twenty-four days (7 having less than twenty days' service, and 1 as long as eighty-eight days). Five had been recently vaccinated, 2 had shortly before the onset received a blow on the head, and 2 others had recently had scarlet fever—factors which, by reducing resistance, would favour infection. Between February 1 and March 17 there were 5 cases among the engine-room artificers. One hundred and thirty of these men were then examined; 30 were found to have nasal or faucial catarrh, and from among these 3 carriers were isolated. The mess was then divided into two, so as to give more air space, and after this there were no more cases among the engine-room artificers.

Ninety-two contacts were sent to the Royal Naval Hospital, Chatham, and 12 carriers were isolated. One of the carriers developed the disease while isolated and died. Of the 21 cases, 5 were definitely traced to healthy carriers by Deputy Surgeon-General C. J. Mansfield, M.V.O. All these 21 cases were transferred to the Royal Naval Hospital, Chatham, and 16 died, or 76 per cent. As the mortality rises with each decade up to 50, it might be assumed that this high mortality was due

to the fact that 10 of the patients were over 30 years of age. But this was not so in this instance, for of the 11 patients under 30 years of age 8 died, as against 8 deaths among the 10 patients over that age. In addition, 3 cases from other sources (Shotley 1, the "Biarritz" 1, H.M. Dockyard 1) were treated at the Royal Naval Hospital, Chatham.

Cases of Influenza, Catarrh, Sore Throat and Tonsillitis from January 1 to June 30, 1915, at the Royal Naval Barracks, Chatham.

Disease	January	February	March	April	May	June
Influenza ..	109	101	74	96	45	13
Catarrh	154	204	111	103	72	37
Sore throat ..	90	30	29	19	16	14
Tonsillitis ..	40	78	136	88	68	61
	393	413	350	306	201	125

The maximum incidence of cases of cerebro-spinal fever (9) and of catarrhal affections of the throat (413) occurred in February, and the large number of catarrhal affections (393) in January might be thought to have favoured the carrier state and so to have been instrumental in leading to the comparatively large number of cases of cerebro-spinal fever in the following month. The incidence of cerebro-spinal fever (5) and of catarrhal affections (350) in March corresponded with the observation that three cases of the former appeared to be due to infection in the barracks (two by the same carrier). In April, although the number of catarrhal cases was not much less (306), the activity of meningococcic infection in the barracks had ceased, the only case of cerebro-spinal fever having contracted the disease in West Ham.

The direction of the wind and the day and night temperatures from January 1 to April 30 were examined in relation to the incidence of cerebro-spinal fever. In January the wind was mainly west or south-west for the first half of the month, and north and north-east in the second half of the month; two cases occurred in the first half and one in the second half. The average daily temperature was 40·8° F. February, during which there were 9 cases, was cold (average temperature 38° F.), although the wind was almost always south-west. In March there were 5 cases, all before March 17, and up to this date the wind was more often west or south-west than north or east. In the second half of the month there was rather more north and east wind than in the first half. The average temperature for the first seventeen days and for the last fourteen days was, in each case, 42° F. In April there was one case of cerebro-spinal fever (on April 5). The direction of the wind was on the same lines as in January, but the average daily temperature was 49° F.

So far, therefore, the occurrence of cerebro-spinal fever would appear to be associated much more with west and south-west winds than with east and north-east winds; but examination of the direction of the wind on the three days preceding the occurrence of cases during January to April shows that in about half the cases south and west winds, and in the rest east and north winds, prevailed. No decided conclusion, therefore, is justified as to the influence of the direction of the wind on the incidence of the disease. The largest number of cases occurred in February, which had the lowest average daily temperature, namely 38° F.

Plymouth District.

In the summer of 1914 there were 7 cases, 5 in the "Impregnable" and 2 in the "Powerful." Sporadic cases began to arise among the civilian population in January, the first naval case having occurred on December 22, when on leave.

Thirty cases are considered here; 27 were treated in the Royal Naval Hospital, Plymouth, and the remaining 3 went sick when on leave. A man from the "Ajax" was also treated in the Royal Naval Hospital, but is not included here. Of the 30 cases, 15 arose in the Royal Naval Barracks, 9 in the "Impregnable," 3 in the Royal Marine Light Infantry Barracks, 2 in the "Powerful," and 1 in the "Indus." One boy borne in the "Indus" was in the Royal Naval Barracks, and is therefore included under that heading. A boy who left the "Impregnable" on April 3, where there had not been cases since February 12, developed cerebro-spinal fever the next day at Portsmouth (*vide* "Portsmouth District," p. 13).

Two cases occurred in December, 1914 (on December 22 and 25); none in January; 17 in February, of which 8 were in the "Impregnable"; 3 in March; 6 in April; and 2 in the last two days of May. There was an interval of five weeks between the cases in April and those in May; there was a corresponding freedom from the disease among the military and civil population until the end of May, when there was a recrudescence.

Up to March 1 there were 19 cases with a mortality of 9, or 47·3 per cent., whereas among the 11 subsequent cases there were 2 deaths only. The total mortality of 11 out of 30 cases, or 36·7 per cent., is very low. This is probably related to the fact that 25 of the patients were under 20 years of age and that none were over 30, for though the disease specially attacks the young, the mortality increases with age (*vide* p. 8). The average age of the 30 cases was 18 years (of 19 recoveries 17·7 and of fatalities 18·3 years). Out of the 30 cases the source of infection was traced in 11.

Overcrowding occurred at the Royal Naval Barracks, in the "Impregnable," and in the "Powerful."

In December, 1914, in which cases occurred on the 22nd and 25th, the wind was south-west for the first nine days, then easterly until the 14th, and northerly on the 22nd, 23rd, 24th. Although not convincing, the occurrence of east and northerly winds before the onset of the disease is suggestive. In January, in which there were no cases, the wind was easterly or north-east from the 21st to the 29th, and thus preceded the outbreak of 17 cases of cerebro-spinal fever in February, during which the wind was mainly south-west. In March there were 3 cases only and there was a good deal of east and north wind, especially from the 22nd to the 29th. On April 5, a man who had been in close contact with a case, and had had catarrh for some days, showed meningeal symptoms; possibly the cold winds at the end of March may have been instrumental in his illness. For the first seven days of April the wind was south-west, and for the remainder of the month mainly northerly; cases of the disease occurred on the 14th, 21st, and 26th. There was therefore some evidence that the disease is prone to follow in the wake of east and north winds.

The comparison of the average daily temperature with the monthly

incidence of cerebro-spinal fever did not show any striking correspondence between a low temperature and the incidence of the disease.

Month		Average daily temperature	Cases of cerebro-spinal fever
1914	December ..	44·4° F. ..	2
1915	January	45·0° ..	0
	February ..	43·8° ..	17
	March	43·8° ..	3
	April	48·5° ..	5

Fleet-Surgeon H. C. Whiteside found that out of 402 close contacts 97, or 27 per cent., were carriers. Two of these carriers developed the disease. Remote contacts were also examined; out of 389 from the Royal Naval Barracks (where there were 15 cases) 45, or 11·6 per cent., were carriers; out of 667 from the Youths' Training Establishments 29, or 4·35 per cent., were carriers. Of the 1,458 contacts, close and remote, 171, or 12 per cent., carriers were found.[1] Close contacts were persons who had slept in close proximity to a patient, or were in the same mess, or otherwise brought into close relationship with him. Remote contacts were all those who slept in the same room or were in the same training class as a patient.

The Royal Naval Barracks, Devonport, contain five blocks (A, B, C, D, E); A block contains three rooms with a normal cubic capacity per man for messing accommodation of 293 cubic feet, and for sleeping accommodation 354 cubic feet. B block contains four rooms with corresponding cubic spaces of 302 and 355 cubic feet. C, D, and E blocks each contain four rooms with corresponding cubic spaces of 216 and 274 cubic feet. It is noteworthy that of the 15 cases there were 12 in blocks D and E, and only one in B block. This is compatible with the view that deficient cubic space favours the spread of the disease. Further, in February, when there was overcrowding in the barracks, the largest number of cases (6) in any one month occurred. Out of the 15 cases 1 had been in the Service over a year, the other 14 were recent recruits with an average service of thirty days.

The figures given below show that the incidence of catarrhal affections (influenza, catarrh, sore throat, and tonsillitis) in the barracks was highest in January and February; and that, though the maximal incidences of the catarrhal affections and of cerebro-spinal fever both occurred in February, the correspondence in other months was far from exact. It might be thought that the high incidence of catarrhal affections in January, during which month there were no cases of cerebro-spinal fever, was instrumental, by favouring the carrier state in the occurrence of 6 cases beginning on February 12.

Month	Cases of catarrhal affections	Cases of cerebro-spinal fever
1914—December	195	2
1915—January	355	0
February	364	6
March	210	2
April	124	4
May	100	1
June	97	0

[1] Fleet-Surgeon H. C. Whiteside dealt with the bacteriological examination and treatment of contacts at the Royal Naval Hospital, Plymouth, in the JOURNAL OF THE ROYAL NAVAL MEDICAL SERVICE, 1915, vol. i, No. 3, pp. 248-254.

Two cases occurred in December in men who were in the same room and came from Ashburton. The first, who had not been home for some time, was taken ill in the barracks on December 22, and infected the second, who went sick when on Christmas leave on December 25. In January there were no cases. The next case was on February 12 and was followed by cases on the 14th, 18th, 23rd (two cases), and 26th, and on March 4. Then, after an interval of seventeen days, a man who had come to Plymouth the day before was taken ill on March 21, and obviously brought the infection with him; he travelled down with a man who, after attending the sick quarters for some days, manifested meningeal symptoms on April 5. In the meanwhile an untraced case occurred on March 31. Cases cropped up on April 14, 21, and 26. Then there was an interval of thirty-three days until the last case occurred on May 29. It is noteworthy that both in the civil and military population of the district there was a corresponding freedom from the disease with a recrudescence at the end of May.

Fleet-Surgeon H. C. Whiteside examined 78 close contacts and found 15, or 19·2 per cent., positive; and 389 remote contacts with 45, or 11·6 per cent., positive—a high percentage.

The "Impregnable" establishment consists of three ships, and has no official complement; the number of boys varies greatly with recruiting. The following estimate of the cubic space is provided by Fleet-Surgeon F. Fedarb. "Impregnable I" has a cubic space in the sleeping compartments varying from 175 to 291, and averaging 244 cubic feet per boy; "Impregnable II" has a cubic space in the sleeping compartments varying from 167 to 258, and averaging 203 cubic feet per boy; "Impregnable III" has a cubic space in the sleeping compartments varying from 210 to 497, and averaging 313 cubic feet per boy. There is, therefore, very definite overcrowding in all three ships. I inspected the ships by day on July 9; and the boys' class-room in "Impregnable II," which has, I understand, been already condemned, was obviously stuffy. I also went over the "Impregnable" that night at 10 p.m. with the expectation of finding the air in the sleeping compartments offensive. It was a quiet fine night and the ports were open; the only place in which the air seemed offensive was the boys' class-room, which is used as a sleeping compartment for twenty-eight boys, with a cubic space of 183 ft. per boy, but on that night held twenty boys with a cubic space of 256 ft. per boy.

In the summer of 1914 there were 5 cases of cerebro-spinal fever in the "Impregnable." Between February 8 and 12, 1915, 5 cases of the disease occurred, 4 being from "Impregnable III," though from different messes, and one from "Impregnable II." On February 13 and 14, contacts to the number of 123 were removed to the Royal Naval Hospital, Devonport, and 31 carriers were detected. The carriers were detained and 2 of them developed cerebro-spinal fever on February 15 and 24. On February 19, a boy from "Impregnable III" went on leave to Torquay and developed the disease. The outbreak then stopped, and it may be concluded that the isolation of the contacts played a part in this, especially as two of them subsequently went down with the disease while in hospital. On April 3 a boy was drafted from "Impregnable III," where he was in a mess which had not contributed any case of cerebro-spinal fever, to the Boys' Training Establishment, Royal Naval

Barracks, Portsmouth. He developed the disease the next day. On April 24, two boys from a mess in which a case of cerebro-spinal fever occurred on February 11 were transferred from "Impregnable III" to the Royal Naval Barracks, Portsmouth. They developed the disease on May 1 and 8 respectively. The last case occurred on May 30, in "Impregnable I," where no cases of cerebro-spinal fever had previously arisen. He joined the "Powerful" on March 23, was transferred on April 3 (the same day as the boy referred to above) to the Royal Naval Barracks, Portsmouth, where he was in the same room and in an adjacent mess to the two boys drafted there on April 24 from "Impregnable III." He was discharged to the "Impregnable" on May 21.

February, during which the outbreak of 8 cases of cerebro-spinal fever occurred, had the highest incidence of catarrhal affections (catarrh, sore throat, tonsillitis and influenza).

	Month	Cases of catarrhal affections	Cases of cerebro-spinal fever
1914	December	27	0
1915	January	75	0
	February	88	8
	March	42	0
	April	54	1*
	May	47	3†
	June	60	0

* This boy was drafted from the "Impregnable" on April 3, and developed cerebro-spinal fever next day at Portsmouth.

† Two of the boys, drafted seven and fourteen days previously from the "Impregnable," developed the disease at Portsmouth. The other boy was drafted to the "Impregnable" from Portsmouth eight days before he went sick.

The "Powerful" establishment consists of two ships—"Powerful" I and II. The boys are distributed in these two ships according to their work. "Powerful II" is stated not to be overcrowded, but "Powerful I" is certainly overcrowded; on April 10, when the two cases of cerebro-spinal fever occurred, there was a cubic space of only 225 ft. in the sleeping compartments. The hammocks are within 18 in. of each other, and the casements, in which classes of about twenty boys are held, have a cubic space of from 1,690 to 1,705 ft., or 85 cubic feet per boy. Catarrhal affections are common, as is seen by the following table for the first six months of 1915, furnished by Fleet-Surgeon Oswald Rees :—

Month	Catarrh	Sore throat	Tonsillitis	Total cases	Total of days' sickness
January	31	42	18	91	377
February	37	51	35	123	697
March	41	57	38	136	677
April	19	30	19	68	370
May	16	11	40	67	320
June	25	18	26	69	380
	169	209	176	554	2,821

Practically all the cases of sore throat and tonsillitis have been isolated in casements, and this would tend to prevent their spread. This isolation has not been adopted with the cases of catarrh.

In 1914 two cases of cerebro-spinal fever occurred in the "Powerful." In 1915 two cases occurred on April 10 in the same mess in "Power-

ful I." Fifty-five contacts were examined, and fifteen carriers, or 27 per cent., detected. In this mess a carrier was found who had had "influenza in a severe form" at Liverpool fifty-six days previously, and was probably the source of infection. After this no further cases occurred. With conditions so favourable to an epidemic, the arrest of the disease is striking and remarkable.

Royal Marine Light Infantry Barracks, Devonport. — Three cases occurred in these barracks, on February 3, 16, and 24. The men were not friends, and they slept and ate in different rooms. Two of them belonged to the same company and, though in the same house, were not in rooms that opened on to the same passage-way. Fleet-Surgeon J. Andrews, R.N., could not discover any contact between the men, or that they had visited infected houses, but he was inclined to the view that the infection might have been acquired in picture halls which they visited. There were, however, comparatively few cases of cerebro-spinal fever in the civilian population. Dr. O. Hall, the Medical Officer of Health for Plymouth, informs me that during the first six months of this year, seventeen civilian cases of cerebro-spinal fever were notified. Adequate precautions were taken at the barracks and no more cases occurred.

"*Indus.*"—Two cases occurred in boy artificers borne in the "Indus," but one of them had been billeted in the Royal Naval Barracks until two or three days before the onset of the disease on February 23, and should therefore be considered as belonging to the Royal Naval Barracks. The other case had been billeted in the Royal Naval Barracks until three weeks before the onset on March 4. Of 18 contacts from the "Indus," 3, or 16·6 per cent., were found to be carriers.

Crystal Palace.

At the Crystal Palace there were, between January 16 and the end of July, 33 cases of cerebro-spinal fever, with a mortality of 21, or 63·6 per cent. Up to March 1 there were 17 cases, of which 14, or 82 per cent., were fatal; after March 1 there were 16 cases, of which 6, or 37·5 per cent., were fatal. A falling mortality in the course of epidemics is generally recognized, but it should be pointed out that the cleanliness and ventilation of the men's quarters were much improved in the later part of the outbreak. The cases were mainly among young recruits; the average age of all the cases was 23 years; 16 were under 29 years of age, and 27 under the age of 25. Of 16 under 20 years of age, 8 proved fatal: of the 27 under 25 there were 16 deaths, while of 6 cases over the age of 25 years, 5 died. While, therefore, the majority of the cases were young patients, the mortality ratio increased steadily with the age.

The first case occurred on January 16 in a boy who returned from Christmas leave (December 30 to January 6); he had been to Aberdeen, where there had been a case of cerebro-spinal fever in a Canadian, fatal, on December 5, but none since; he may also have visited Glasgow, where cases had occurred. The second case, on January 20, was not traced; then after an interval 2 occurred on January 29 and 1 on February 1, 2, and 3. Fifteen contacts from these cases gave uniformly negative results. After an interval of four days the ninth case occurred in the Officers' Training Corps on February 7. Two days later a man who

slept in the same dormitory as Case 7 developed the disease, and 1 of his 4 contacts was found to be a carrier. Between February 10 and 14 4 occurred in the Public Schools Battalion, and among the contacts of 1 case that had had catarrh since January 28, 3 carriers were found. Some weeks later, 30 men from this battalion were found to be negative bacteriologically. Two occurred among the Officers' Training Corps on February 14 and March 1, their contacts being negative. Isolated cases occurred on February 23 and March 1. Then on March 14 to 15, 3 arose in B Company, 1st Battalion, the contacts of 1 case giving 2 carriers, one of whom was positive for three weeks. Isolated cases occurred on March 15 and 16, and then there was a lull till March 23, when a sporadic case appeared. On March 27 there were 2 cases in the same company. Five occurred in the first thirteen days of April, and then there was none until July 8, when a man who had been in contact with Case 26, who had returned to duty, went sick. A fresh bacteriological examination of faucial swabs from Case 26 proved negative.

Altogether the infection was traced in 8 cases out of the 33, or 24 per cent. The close proximity of the Crystal Palace to London no doubt favoured the introduction of the disease from outside infection.

The contacts, 122 in number, were examined by Fleet-Surgeon P. W. Bassett-Smith, C.B., who found 12, or 9·9 per cent., positive.

Deal.

The barracks consist of three groups of buildings some distance apart and with separate blocks in each. An increase in the number of men was naturally accompanied by an increase in the sick list; thus in the January to March quarter of 1914 there were 115 cases of catarrh, as compared with 292 in the corresponding quarter in 1915, but while the number of men was about doubled the cases of catarrh were nearly trebled. Overcrowding therefore increased the incidence of catarrh, which would favour the spread of meningococcic infection. For some years at least there had not been any case of cerebro-spinal fever in the barracks.

The origin of the outbreak was not discovered. There were no civilian cases in Deal or Walmer, but there were some at Sandwich, eight miles off. A man who went sick on February 1 had spent his Christmas leave (December 23 to 28) at Salisbury (town), where, the Medical Officer of Health (Dr. Fison) informs me, the first case of cerebro-spinal fever occurred on December 13, in a nurse (engaged to a Canadian officer) in the hospital, the second on December 20, and the third on December 23. Analysis of the rooms, squads, and companies of the cases showed a wide distribution of the disease, and did not explain how the infection spread; but as the canteen, the recreation and billiard rooms are common ground, contact may have occurred there.

The outbreak in the barracks of what was subsequently (February 5) determined to be cerebro-spinal fever really began on January 20, and fresh cases followed almost daily until February 13, when there was an interval of twelve days; 2 cases then occurred on February 25 and 27; and then after another interval 3 cases on March 10, 12, 14. After this there were no more cases. The cessation of the epidemic may possibly have been connected with the fact that all the men using the warm swimming bath sprayed their throats before bathing.

The Deal Marine Depot was apparently responsible for 25 cases; 17 were treated in the infirmary and 3 developed at Maidstone among the 1,000 men who marched there from Deal. The 20 cases are considered here. In addition 2 occurred at the Royal Marine Light Infantry Barracks, Gosport, on January 19 and 24, within a few days (five and three respectively) of leaving Deal (*vide* Report on Portsmouth district), and 3 occurred among the Deal Battalion shortly after their arrival at Blandford (*vide* Report on Blandford).

Of the 20 cases, 6 proved fatal. Out of 17 before March 1, there were 6 deaths, whereas the 3 cases after that date recovered. This percentage of deaths (30) is the lowest in any of the groups of cases, though that of 36·7 per cent. in the Plymouth district approximates to it. All the patients were under 20 years of age, the average age being 17·6 years (for 14 recoveries 17·8 years, and for 6 fatalities 17·2 years). The remarkably low death-rate at Deal is probably due to the fact that all the cases were under 20, for, as shown elsewhere, the mortality is less under 20 years of age than at any other period of life; thus the mortality (45) of all the cases in the Navy (103) under 20 years of age was 43·7 per cent., as compared with 62·8, 76, 77, and 66 per cent. for four succeeding decades.

The disease did not spread to non-commissioned officers or to the children of married men living in barracks, but the schoolroom for these children was no longer used at other times by the men.

One hundred and thirty-two contacts were examined; of these, 97 were close contacts with 16 positive results, and 35 remote contacts, all negative. The percentage of positive results among the 132 contacts was 12·1 (E. A. Shaw).

During the first fifteen days of January the wind was with one exception west or south-west; on January 16 and 17 north-west winds preceded the outbreak of the epidemic; from January 19 to 21 the wind was west, and for the rest of the month mainly east or north-west. During February, in which 10 cases of cerebro-spinal fever occurred, the wind was south or south-west on twenty days, and north-west on the remaining eight days. But 8 of the cases occurred in the first thirteen days, that is, after the north-west winds at the end of January; the other 2 cases occurred directly after the north-west winds on February 23 to 25. In March, north-east and north-west winds on the 7th, 8th, and 9th preceded the appearance of the last 3 cases of the disease on March 10, 12, 14. The occurrence of north and east winds was thus followed by the incidence of cerebro-spinal fever cases.

The following shows a comparison between the average daily temperature and the monthly incidence of cases of cerebro-spinal fever:—

	Average daily temperature	Cases of cerebro-spinal fever
January	44·4° F.	7
February	46°	10
March	48°	3

Blandford.

The camp was opened in January, 1915, and the first case of cerebro-spinal fever occurred on February 1 in the Deal Battalion. On February 3 two cases occurred, one in the Deal Battalion and the other in the

"Collingwood" Battalion which was in the Blandford Camp. On February 4 another man in the Deal Battalion went sick. After an interval of a fortnight a man in the "Howe" Battalion manifested the disease. The sixth and last case—a sporadic one—occurred on April 9 in the "Benbow" Battalion.

At the Marine Depot at Deal an outbreak of cerebro-spinal fever really began on January 20, though its nature was not absolutely settled until February 5. In the meanwhile 1,000 men marched on January 24 from Deal *en route* for the Blandford Camp; they stopped the first night at Littlebourne, the second at Charing, the third at Bearsted, and the following morning (January 27) entrained from Maidstone, where three men went down with the disease. On its arrival in Dorset the battalion was isolated for three weeks at Durweston and Stourpaine, some miles from the main camp at Blandford; the men were billeted in cottages, and two of them developed cerebro-spinal fever; in one instance the infection spread from one of these men to a girl in the same cottage. Four other civilian cases occurred.

Of the six cases four died. Four cases were under 20, one was 24, and one aged 34. The average age of all the cases was 22 years, of the fatal cases 22·7 years, and of the two recoveries 21 years. The cases were transferred for treatment to the Royal Naval Hospital, Portland, where 58 contacts were examined; 4 were positive on the first examination, and negative afterwards. One sick berth attendant was positive on two occasions (Shand and Hitch).

Meteorological records were not kept at Blandford. January and February were both very wet.

Shotley Barracks.

There are fifty-two dormitories, each with a cubic space to each boy of 476·6 ft. Some of these dormitories are usually empty in preparation for drafts which are constantly arriving. During the War, each dormitory has had an individual cubic space of 400 ft. The beds are now arranged with the head and foot alternately. In one dormitory (No. 17) there have been as many as sixty-seven occupants, with a cubic space of 356 ft., but no case of cerebro-spinal fever occurred in it. The boys do not live or eat during the day in these dormitories. The "gymnasium dormitory," which contains 105 boys, who live, eat, and sleep in it, is used for isolating drafts from barracks, usually for ten days. The class-rooms, which take classes of about twenty-five each, appeared to be well ventilated, with, in most instances, a cross draught. There does not, therefore, seem to be any reason to consider that overcrowding has been responsible for the cases.

The seven cases of cerebro-spinal fever occurred in newly joined boys, on an average, twenty-five days after entering the service; the shortest period (two cases) was seventeen days and the longest forty-two days after joining. A case of cerebro-spinal fever in a man aged 28 was treated in the hospital, but is not included here; he came from the "Queen Victoria" and had not been ashore for one month.

The first case occurred on January 23 and was transferred to the Royal Naval Hospital, Chatham, proving fatal on March 20. After an interval of five weeks three cases appeared between February 28 and

March 4; two of these cases (onset February 28, March 4) joined the same day (February 13) from different parts of the country and slept for one night only in the same dormitory. In the home of the other boy (onset March 1), who joined the barracks on February 8, some soldiers had been billeted. The other three cases occurred on April 26, May 29, and June 10. Analysis of the dormitories and classes of the seven cases did not reveal any evidence of the spread of infection. Three of the cases had been recently vaccinated, the interval between vaccination and the onset of cerebro-spinal fever being twelve, seventeen, and seventeen days respectively.

In the Felixstowe district there were thirty cases of cerebro-spinal fever between January 21 and July 6, and eighteen before February 28; and no cases between April 23 and June 27. It is therefore improbable that the last two cases at Shotley (on May 29, June 10) were imported from the Felixstowe district. There was one case of the disease in 1914, on October 28, in a child aged 1 year 10 months. The incidence at Shotley of catarrh and tonsillitis during the first half of 1915 was much higher than in the corresponding period of 1914. Thus from January to March, 1915, there were 203 cases of catarrh and 33 of tonsillitis as compared with 35 of catarrh and 47 of tonsillitis in January to March, 1914. From April to June, 1915, there were 99 cases of catarrh and 139 of tonsillitis as compared with 52 and 69 in the April to June quarter of 1914. In the last quarter of 1914 (no cases of cerebro-spinal fever) there were 18 cases of catarrh and 86 of tonsillitis as compared with 203 and 33 in the first quarter of 1915 (4 cases of cerebro-spinal fever). A high incidence of catarrh therefore coincides with the occurrence of cerebro-spinal fever. From the monthly return of catarrh and tonsillitis it is seen that the high incidence of catarrh (85) in February preceded the small outburst of three cases of cerebro-spinal fever, February 28 to March 4.

1915	Catarrh	Tonsillitis
January	58	10
February	85	7
March	60	16
April	62	37
May	25	52
June	12	50

Contacts were examined by Staff-Surgeon Dudley at the Royal Naval Hospital, Chatham, and some were examined by Dr. Sheffield Neave, who was doing bacteriological work at Ipswich; the latter arrangement obviated the risk that the swabs might fail to reveal the meningococcus because of the delay in conveying them to Chatham. One positive contact only was found.

Cases in Sea-going Ships.

Twelve cases occurred in sea-going ships, and in one vessel (the "Biarritz") only was there more than one case, a most satisfactory result. The cases occurred in the "Changuinola" (January 20), "King George V" February 19), the "Implacable" (February 23), the "Ajax" (March 11), the "Queen Victoria" (April 4), the "Norma" (April 22), the "Bellerophon" (April 23), the "New Zealand" (April 25), the "St. Vincent"

(May 9), the "Biarritz" (May 19), the "Liverpool" (May 25), and the "Biarritz" (July 19). The probable source of infection was traced in 3 cases. The average age of the 12 cases was 26 years, of the 8 fatal cases 28·5 years, and of the 4 recoveries 21·5 years.

Naval Sick Quarters, Wicklow.

One fatal case of cerebro-spinal fever occurred in a chief petty officer, who contracted the disease from a carrier from Cork.

"Akbar" Establishment.

The "Akbar" establishment consists of three hulks, moored side by side. The men on board are civilians engaged in engineering work. In two hulks the ventilation is deficient, but especially in one, the lower deck of which only provides an individual cubic space of 220 ft. for men messing and sleeping. In the other hulk the arrangements appear to be adequate. Four cases of cerebro-spinal fever occurred in the "Akbar" establishment on March 26, April 11, April 22, and June 5. They were all treated at the Dingwall Hospital and recovered.

For the most willing and courteous help in this investigation, I offer my sincere thanks to the medical officers of the hospitals, barracks and establishments which it has been my privilege to visit; in addition to those incidentally mentioned above I must refer to the following: Deputy Surgeons-General H. W. G. Doyne, V. G. Thorpe; Fleet-Surgeons M. Rodd, J. A. Campbell, C. L. W. Bunton, W. J. Colborne, J. C. Ferguson, C. Strickland, F. W. Parker, R. Hickson, R. Hill, C.V.O., W. H. S. Stalkartt; Staff-Surgeon B. Pick; Surgeons C. H. Gimlette, J. C. Baggs, J. A. Fairer; and to Dr. J. J. Jervis (Croydon Borough Hospital). Dr. F. Ford Caiger (S.W. Fever Hospital), Dr. Mearns Fraser (M.O.H., Portsmouth), Dr. Linton (M.O.H., Tunbridge Wells), Dr. A. K. Chalmers (M.O.H., Glasgow), Professor M. Hay (M.O.H., Aberdeen), Dr. J. Robertson (M.O.H., Birmingham), Dr. Dunlop (M.O.H., Torquay), Dr. G. I. P. Stewart (M.O.H., East Suffolk), Dr. Conford (M.O.H., Felixstowe), Colonel Caldwell and Lieut. M. Culpin, R.A.M.C. (Alexandra Hospital, Cosham).

(III) SUMMARY OF THE RARER MANIFESTATIONS AND COMPLICATIONS.

More or less complete notes of 163 out of the 170 cases were obtained and abstracted. But as comparatively little interest would attach to an analysis of all the constant or common symptoms, such as fever, headache, rigidity of the neck, retraction of the head, Kernig's sign, delirium, and vomiting, the rarer symptoms and complications will be briefly mentioned here. But before summarizing the rarer symptoms it may perhaps be permissible to refer to the rashes, which are rare in sporadic cases, at least as far as

my experience goes, and were striking in this epidemic. Rashes were noted in 102 out of 163 cases, or in 62·6 per cent. In a few of these 102 cases the rash was papular, but in the rest it was petechial or purpuric. Fifty-two cases died and 50 recovered. The rashes with large hæmorrhages were specially fatal. The rash came out early in the septicæmic stage, being comparable with the rose spots of enteric, and was commonly present when the patient was first seen; in some instances a hæmorrhagic rash recurred before death. Herpes was noted in 35 cases; in 18 of these there was also a rash; in 5 the rash and the herpes occurred together. In 13 the herpes followed the rash, usually after an interval of four days. In a few instances the herpes extended to the ears, or was very extensive. Serum rashes were mentioned in the notes of 19 cases, but very likely were commoner than this, and in a few instances were accompanied by pains in the joints.

Strabismus was recorded in 21 cases; it was often transient or intermittent, but one man was invalided out of the Service for persistent diplopia. Of the 21 cases, 12 proved fatal.

Photophobia was noted in 21 cases, and conjunctivitis in 9, in 1 of which double hypopyon and blindness resulted. Optic neuritis was reported in 4 only, but the number of cases examined was not large. Nystagmus was observed in 5 cases, and ptosis in 7 (6 fatal). Definite paralysis was noted in 16 cases, hemiplegia being the most frequent (in 8 cases), then facial paralysis without hemiplegia (in 5 cases); bulbar paralysis, palatal, and pharyngeal paralysis were noted in 1 case each, but the last two paralyses may easily have escaped observation in many cases. An extensor plantar response was noted in 11 cases, and was sometimes double, sometimes unilateral. Ankle clonus, opisthotonos, and general rigidity were recorded in a few cases. Deafness was prominent in 11 cases (2 due to otitis). Pericarditis with friction and effusion was noted in one case that recovered, and pericarditis was found in 3 other cases after death. Synovitis occurred in 8 cases, 6 of which recovered; in 2 of these cases the meningeal symptoms were absent or very slight, and it has been stated that the prognosis is good in cases with articular manifestations, because the joints receive the meningococci and so divert them from the meninges. The synovitis was usually multiple and transient, and never suppurated. In addition, 1 case had a synovial effusion after serum. Otitis was observed in 4 cases, 1 of which was associated with suppurative parotitis. In 2 cases (1 fatal) epididymitis occurred. Hæmaturia was noted in 1 case, and melæna in another. In

2 cases clinically presenting the features of pneumonia, meningococci were found in the cerebro-spinal fluid at the necropsy, which also showed pneumonia. In another case of pneumonia, also at Deal and fatal, meningococci were found in the cerebro-spinal fluid obtained by lumbar puncture. These cases are important as showing that meningococcic infection may co-exist with pneumonia, for pneumonia may produce meningismus with a clear and sterile cerebro-spinal fluid. In one case of cerebro-spinal fever at Chatham, aspiration pneumonia was found at the necropsy. In one case pleurisy without pneumonia was observed clinically (no necropsy), and in another case severe broncho-pneumonia with a patch of pleurisy was found after death.

(IV) SUMMARY OF THE RESULTS OF TREATMENT.

This summary is abstracted from the notes of 163 cases, 89, or 54·6 per cent., of which proved fatal. The prolonged and unsatisfactory cases naturally received more varied treatment than the fulminating cases, some of which died shortly after coming into hospital. As will be seen by the tabular statement, various forms and combinations of treatment were employed, and the most noticeable point is the failure of the generally approved intrathecal injection of anti-meningococcic serum.

Anti-meningococcic serum from various sources (Burroughs Wellcome and Co., the Lister Institute, Mulford ~~(Flexner)~~), was employed.[1] In 105 cases the treatment consisted of lumbar puncture and intrathecal injection of the serum, either alone (62 cases) or with the addition of vaccines, soamin, or hexamine (43 cases). Of these 105 cases 64, or 61 per cent., died ; and 41, or 39 per cent., recovered. Of the 62 cases treated by lumbar puncture and intrathecal injection of serum death occurred in 43, or 69·4 per cent., and recovery in 19, or 30·6 per cent. ; whereas of 43 cases treated in addition by vaccines, soamin, or hexamine 20, or 46·5 per cent., were fatal, and 23, or 53·5 per cent., recovered. It is therefore obvious that the cases treated by the intrathecal injection of serum, and especially those in which this was the only specific treatment adopted, had a higher death-rate than that (54·6 per cent.) of the whole series of 163 cases. Flexner[2] has laid much

[1] In one case at Deal, 10 c.c. of blood serum from a patient convalescent from the disease was injected intrathecally the day before death.

[2] Flexner, *Journ. Exper. Med.*, N.Y., 1913, vol. xvii, p. 553.

stress on the importance of injecting anti-meningococcic serum intrathecally as early as possible in the disease; and in a table dealing with 1,211 cases he shows that when the serum is injected

	Cases	Deaths	Per cent.	Recoveries	Per cent.
Anti-meningococcic serum—					
Intrathecally	105	64	61	41	39
Alone	62	43	69·4	19	30·6
Combined with vaccines, soamin, hexamine, or serum hypodermically	43	20	46·5	23	53·5
Combined with scamin	18	11	61	7	39
Combined with an auto-vaccine ...	11	2	18·2	9	81·8
Combined with hexamine... ...	7	5	71·4	2	28·6
Combined with serum hypodermically	7	2	28·6	5	71·4
Hypodermically	19	6	31·6	13	68·4
Alone	4	1		3	
Combined with intrathecal injection of serum	7	2		5	
Combined with auto-vaccine and intrathecal injection of serum	4	1		3	
Combined with an auto-vaccine ...	3	2		1	
Combined with soamin	1	0		1	
Autogenous vaccine (never alone) ...	16	4	25	12	75
Combined with serum intrathecally ...	6	1		5	
Combined with serum intrathecally and hypodermically	4	1		3	
Combined with serum intrathecally and soamin	1	0		1	
Combined with serum hypodermically	4	2		2	
Combined with soamin	1	0		1	
Soamin	43	19	44	24	56
Alone	21	7	33·3	14	66·7
Combined with serum intrathecally ...	18	11	61	7	39
Combined with serum intrathecally and hexamine	1	1		0	
Combined with serum intrathecally and vaccine	1	1		0	
Combined with serum hypodermically	1	0		1	
Combined with an auto-vaccine ...	1	0		1	
Lumbar puncture (alone)	13	4	30·8	9	69·2
Symptomatic treatment (only)	14	10	71·5	4	28·6

within the first three days the mortality-rate is 18 per cent., when between the fourth and seventh days 27·2 per cent., and when later than the seventh day 36·5 per cent. The following tabulation

of 105 cases treated in the Royal Navy has been made on the same lines for comparison:—

	Cases	Deaths	Recoveries
1st to 3rd day ...	70	42 or 60 per cent.	28 or 40 per cent.
4th to 7th day ...	24	14 „ 58·3 „	10 „ 41·7 „
Later than 7th day	11	8 „ 72·7 „	3 „ 27·3 „

The failure of anti-meningococcic serum to reduce the mortality was therefore not due to its being given too late, for in 66·7 per cent. of the 105 cases it was administered within the first three days of the disease. The serum treatment, which was so successful in America (Flexner, Sophian), Belfast (Robb), and elsewhere, was given a thorough trial and proved most disappointing. In very few instances was there the critical improvement which is said to occur in about 30 per cent. of the cases that recover (Flexner[1]). Possibly the meningococci were "fast" to the action of the serum or were para-meningococci. In consequence of its apparent inertness intrathecal injection of serum was in the latter part of the epidemic largely replaced by or combined with other methods, such as the intramuscular injection of soamin. It is true that the mortality naturally diminishes towards the end of epidemics; and this may to some extent explain why, as shown by the tabular statement, the results of intrathecal injection of serum compare badly with those of almost all the other methods and combinations of methods. There is, for example, a remarkable contrast between the effects of intramuscular injections of soamin, (*a*) when given alone to 21 cases with a mortality of 33·3 per cent., and (*b*) when combined with intrathecal injection of serum in 18 cases, with a mortality of 61 per cent. It must be recognized that when dealing with small numbers fallacies easily creep in, but merely from these figures the addition of intrathecal injection of serum would appear to have coincided with an increase of mortality in the cases treated with soamin. The high mortality can hardly be explained by the suggestion that it was due to the bad effects of lumbar puncture, for in 13 cases in which lumbar puncture alone was employed there were 9, or 69 per cent., recoveries; and in 91 per cent. of the 163 cases lumbar puncture was performed, and in many cases repeatedly, to relieve symptoms referable to increased intrathecal pressure. Alarming symptoms directly after the intrathecal injection occurred in 2 cases only, thus showing that the gravity method of administration, which was not in vogue in the Royal Navy, is hardly necessary provided due care be taken.

[1] Quoted by Heiman and Feldstein, "Meningococcus Meningitis," 1913, p. 282.

Anti-meningococcic serum was given hypodermically in 20 cases, but as in 4 cases only was it the sole form of specific treatment employed, no conclusions as to its influence can be drawn.

An autogenous vaccine was given in 16 cases, mainly by Fleet-Surgeon H. C. Whiteside, R.N., at Plymouth, where the mortality (36·7 per cent.) was remarkably low. The cases to which auto-vaccines were given all received other specific remedies (in 11 cases intrathecal injections of serum), and showed the very low mortality of 25 per cent. But as the numbers are small this result—though a further stimulus to its more extended use—must not be insisted on.

As already mentioned, soamin appeared to give good results; its beneficial effect in the septicæmic stage of the disease was noticed by Staff-Surgeon B. S. Robson, R.N., at Haslar, and has also been mentioned by others.[1] In one case at Portland Hospital as much as 42 gr. of soamin were given. Optic atrophy was not noted in any instance.

Hexamine was given by the mouth in 7 cases in the hope that, as it is secreted into the cerebro-spinal fluid, it would exert a bactericidal action on the meningococci, but as it did not appear to have any effect clinically, it was soon abandoned.

Lumbar puncture, which is such an important means of diagnosis, was performed in 149 out of 163 cases, or in 91·4 per cent. In 38 cases lumbar puncture was done once only, but 14 of these cases died soon after they came under observation; 6 other cases, tapped once, died. Of 22 cases, tapped twice, 8 proved fatal, 2 being very acute; 3 tappings were done in 20 cases (9 deaths), 4 in 24 (15 deaths), 5 in 15 (9 deaths), 6 in 6 (3 deaths), 7 in 7 (4 deaths), 8 in 3 (2 deaths), 9 in 4 (all fatal), 11 in 5 (2 deaths), 13 in 1 (fatal), 15 in 1 (fatal), 16 in 1 (fatal), and 17 in 2 (both recoveries). Lumbar puncture appears to be a palliative rather than a curative remedy and to relieve for a time symptoms due to increased intra-thecal pressure. In 13 cases, of which 4 proved fatal, it was the only form of treatment other than the ordinary symptomatic remedies employed.

In 14 cases, 10 of which proved fatal, symptomatic remedies only (such as morphine for pain) were given.

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[1] Batten, *Lancet*, London, 1915, vol. i, p. 966.

(V) RECOMMENDATIONS AS TO THE PREVENTION (i) OF CEREBRO-SPINAL FEVER AND (ii) OF ITS SPREAD.

(i) *In order to Prevent the Appearance of the Disease* the ideal is obviously to avoid the introduction of carriers into barracks, establishments, and ships; but as it is impossible to examine bacteriologically all the men at such frequent intervals, so as to detect intermittent carriers (*vide* below), this cannot be attained.

Before the occurrence of cases and the isolation and examination of their contacts, the only promising procedure for the detection of carriers would be bacteriological examination of swabs from boys or men who for the following reasons—the presence of nasal or pharyngeal catarrh associated with headache or fever, or the occupation of overcrowded quarters—might possibly be carriers. The boys' training establishments, especially those such as the "Impregnable," the "Powerful," and Shotley, where outbreaks have previously occurred, are more likely to harbour carriers and originate cases of the disease. It might therefore be advisable to examine bacteriologically those boys who develop catarrhal symptoms. This investigation should be undertaken some little time before an epidemic may be expected, and, judging from recent experience, the most suitable time would be in the month of December. In order to avoid the risk of intermittent carriers, namely, those who are alternately positive and negative bacteriologically, *it would be advisable to invalid out of the Service all those who have recovered from an attack of cerebro-spinal fever.* It is true that such persons have usually been proved to be negative before leaving the hospital, and that the carrier state generally lasts for a short time only—commonly three weeks. On the other hand, periodic or intermittent carriers are known to exist, and if these can be eliminated at the comparatively small cost of invaliding those who recover from the disease (about 74 would be the loss between August, 1914, and August, 1915), a distinct advantage would be gained.

Overcrowding should be prevented, and a cubic space of 800 ft. per man when the men live, mess, and sleep in the same room, and of 600 cubic ft. when they sleep only in the room, should be maintained. Steps to remedy the overcrowding in the "Impregnable" and "Powerful," and at the Royal Naval Barracks, Devonport, should be taken without delay. Further, when catarrhal diseases break out, the cubic space should be increased by diminishing the number of men in the infected rooms. Constant and adequate

ventilation of the sleeping rooms should be assured by the system of night patrols, who see that the windows and ventilators are not closed during the night.

As recent recruits are specially picked out by the disease, the depressing conditions to which they are liable should as far as possible be mitigated. The risk of over-fatigue from unaccustomed drills and route marches should be borne in mind, and especially avoided after vaccination or antityphoid inoculation.

As catarrhal diseases, such as influenza, catarrh, tonsillitis, and sore throat, appear to play some part in favouring the outbreak of cerebro-spinal fever, and often precede its appearance and coincide with its prevalence, every effort to limit their spread should be made. Special care should be taken to prevent the common use of handkerchiefs and towels. Isolation when possible should be carried out and, as already mentioned, the cubic space in the infected rooms should be increased. The throats and noses of the patients should be douched or sprayed with a mild antiseptic lotion, such as warm solution of permanganate of potassium, 1 in 1,000. When convalescent the men should be carefully protected from fatigue.

(ii) *Measures to Prevent the Spread of Cerebro-spinal Fever when the Disease has appeared.*—During the late epidemic this problem, which is rendered specially difficult by the exigencies of the Service in war-time, was thoroughly taken in hand, and it is therefore unnecessary to reiterate the details and the established routine, such as the closing and disinfection of the dormitory in which a case occurs, the sterilization of the clothing, beds, mattresses, pillows, sheets, blankets, towels of the patient and of his immediate contacts, and the isolation and bacteriological examination of contacts.

The evidence that carriers spring up freely around a case has raised the question if the usual number of contacts sent for bacteriological examination—namely six (the two who sleep and the two who mess on each side of the patient, and his two most intimate friends)—is sufficiently large to catch all the infected contacts. Examination of remote contacts has therefore been carried out in some instances in which isolation of close contacts did not arrest the outbreak. The success which attended this step at Plymouth and Chatham (*vide* pp. 3, 4) justifies the belief that a more extended examination of contacts is desirable. This extension might consist in inspection of the remote contacts in the same dormitory and mess-room, and the isolation of those found to have naso-pharyngeal

catarrh until they have been swabbed and proved bacteriologically not to be meningococcic carriers. A list of the friends of the patient might also be made the basis for an extension of the examination of contacts. It would probably be wise to examine ten to twelve contacts as a matter of routine, even when an isolated case occurs. When the contacts are isolated it would be advisable to segregate those with naso-pharyngeal catarrh—and therefore more prone to be carriers—from those in ordinary health. This would tend to prevent the extension of the carrier state among the contacts during their ten days of quarantine. Contacts, and especially carriers, with catarrh should be instructed not to swallow the naso-pharyngeal mucus, which should be carefully collected and burnt. The urine should be dealt with so as to avoid any risk of infection from this source.

The douching of the nose and throat of contacts and carriers twice or thrice daily should be carried out under medical supervision, and it is important that mild antiseptics only, such as warm permanganate of potassium solution, 1 in 1,000, dilute saline solution, or dilute boracic acid solution, should be employed, and that the more powerful antiseptic solutions, which may impair the resistance of the naso-pharyngeal mucous membrane and so favour persistence of the carrier state or lead to cerebro-spinal fever in a carrier, should be avoided. The isolated contacts and carriers should sleep in well-ventilated wards, rooms, or tents, with ample cubic space, should be as much in the sun and fresh air as possible —exposure to cold, east and north-east winds being avoided—receive a generous diet, and their general hygiene should be carefully supervised. As long as the contacts are isolated in good circumstances, it is not essential that they should be actually in hospital, and a camp or buildings, preferably in the neighbourhood of a medical establishment, would meet the case.

When an outbreak of cerebro-spinal fever is recognized, any case even possibly of this nature, such as toxæmia and severe influenza, especially of the nervous or gastro-intestinal types, should be isolated from the sick bay; and catarrhal conditions, such as influenza, catarrh, tonsillitis, and sore throat, dealt with in the manner described above.

It is advisable that swabs from the throats of the surgeons, nurses, and sick berth staff in attendance on the patients should be periodically examined so as to detect carriers; and that cases of catarrh, sore throat, malaise, or headache among those in contact with the patients should be promptly isolated and examined

bacteriologically, as some of them may be examples of abortive cerebro-spinal fever. Lieut. M. Culpin, R.A.M.C., F.R.C.S., has mentioned to me cases of this abortive form of the disease among the orderlies in the wards for cerebro-spinal fever at the Alexandra Hospital, Cosham.

The arrangements for the quarantine of men before being drafted from infected barracks have been amply justified, for it is most remarkable that from the beginning of the War until August 1, 1915, there were only twelve cases on sea-going ships. In the light of this successful result the quarantine, which leaves a wise margin for variation in the probable length of the incubation period, should not be relaxed.