the syndrome test we can at once class our patient under group A or B, a classification that helps us to find the cause. In class A, the diagnosis lies between true gout and true rheumatism, and is, therefore, as a rule, comparatively easy, and the treatment is more or less specific. In class B the diagnosis will lie, in nine cases out of ten, between gonorrhœal, rheumatoid, and toxic arthritis; if it is the latter, we may perhaps be able to remove the cause—be it a tooth, an appendix, or an infected gall-bladder—without wasting time in attempting to relieve symptoms. But gonorrhœa as the primary cause is exceedingly common. To this infection I believed I was able to trace 10 per cent. of all my “rheumatic” cases admitted to the Mineral Water Hospital at Rotorua.

The diagnosis of rheumatoid disease is unfortunately generally easier than the treatment, but it is a fairly safe rule that all affections coming under class B require a *tonic* line of treatment, or in other words, that the resistance of the patient to micro-organisms and toxins must be increased. The whole group would appear to offer a peculiarly appropriate field for the use of vaccines, success in the use of which will depend so largely on accuracy in diagnosis.

In classes C and D we can sometimes remove the cause, and sometimes mitigate the symptoms, but, as a general rule, once osteo-arthritis had developed, even removal of the cause will be but a palliative, for it is removed too late, and the mischief already done is permanent. In this condition we may lessen the disability and increase the range of movement by mechanical means, and we may relieve pain, but very often our chief efforts should be concentrated on muscle rather than on bone, on the recuperation of important and essential muscles showing trophic wasting as a consequence of the arthritis.

Suggested Classification of the “Rheumatic” Group of Arthritic Diseases.

A.—Jaw-neck syndrome absent.	1. Gout.	{ Acute. Chronic.	Ending all in D. 10. Osteo-arthritis.
	2. Rheumatism.	{ Acute. Chronic.	
	3. Gonorrhœal.	Arthritis or rheumatism.	
	4. Dysenteric.		
	5. Toxic.		
	6. Rheumatoid.	Arthritis following acute specific fevers—e.g., Measles, Scarlet fever, Enteric, Mumps, Influenza.	
	7. Arthritis following acute specific fevers—e.g.,		
	8. Thyroid arthritis or rheumatism.		
	9. Traumatic arthritis.		
C.—Not rheumatic.			

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BRISTOL MATERNITY HOSPITAL.—On Nov. 11th a hospital of 18 beds for the reception of maternity cases was formally opened by Dr. Janet Campbell. The premises, which have been used for this purpose since February, were purchased from the committee of the Homœopathic Hospital, which has removed its work to larger premises in another part of Bristol. The patients’ fees cover about half the annual expense, the remainder being found by voluntary contribution and Government subsidy. In her speech Dr. Campbell said that the Ministry of Health was in favour of the establishment of a number of small maternity homes rather than of one large hospital.

A METHOD FOR
DIMINISHING MORTALITY IN EMPYEMA
IN INFANCY AND CHILDHOOD.

By F. JOHN POYNTON, M.D., F.R.C.P. LOND.,
PHYSICIAN TO UNIVERSITY COLLEGE HOSPITAL AND HOSPITAL
FOR SICK CHILDREN, GREAT ORMOND-STREET;

AND

F. N. REYNOLDS, M.R.C.S., L.R.C.P. LOND.,
RESIDENT MEDICAL SUPERINTENDENT, HOSPITAL FOR
SICK CHILDREN, GREAT ORMOND-STREET.

EMPHYEMA is recognised as a serious and comparatively frequent event in childhood, and on this account we believe that the results of this investigation into its occurrence in infancy—that is, in the first two years of life—may be of general interest. As will be apparent, the mortality at this early age is high, and we venture to hope that the method employed by us, of which a detailed description, with illustrations, is given below, may be as helpful to others as it has been to us in diminishing that mortality. This method is not new in principle, as the literature clearly shows. In fact, the surgical principle is in itself as clear as daylight, and is maintained when the septic fluid is safely and completely withdrawn from the chest without recurrence. As a step forward in this direction the method has proved of practical service to us in dealing with children of all ages.

Present Position of the Subject.

Before we enter upon the analysis of the cases in infants, which we have collected, a short review of the present position of the subject of the treatment of empyema will assist us in presenting the particular points we desire to emphasise. Empyema is recognised as one of the most treacherous and puzzling conditions in pulmonary disease. Some cases are simple and straightforward, but others are almost beyond diagnosis, even with radiological assistance, and empyema must be classified with typhoid fever and with tuberculous meningitis as one of those conditions which may humble the most confident diagnostician. The difficulties, as this analysis shows, are many and diverse, and depend in part on the nature, but still more upon the virulence, of the infection. They also depend upon the age and strength of the child, the regional anatomy of the abscess, and the duration of its existence. Post-mortem studies explain how it is that some empyemata are easy to deal with, some difficult, and some almost impossible. So much is common knowledge, but the question is whether in infants, and still more in older children, we can get rid of the abscess by any method safer and no less satisfactory than the usual incision, resection of a piece of rib, and drainage. Hard things have been said of drainage-tubes in treatment, but a physician will tell a surgeon that if there is one thing likely to cause suffering and harm to a child it is the premature removal of a drainage-tube; and this fact has bearing on the whole surgical aspect of the subject. The slipping of these tubes into the pleura, though unfortunately not an impossible occurrence, does not enter into the present problem; for our purpose it may be classed under “regrettable incidents.” Let us suppose, however, that the pleura is opened without resection, drained, cleansed, and closed at once. If the case is a favourable one, the result is excellent, but if some pus is left behind, or the infection is still active, more pus is formed and the position becomes difficult. Children cannot be operated upon with impunity, and it is hard to decide when and where to explore again, and adhesions, too, may lead to trouble. Except that the wound is not open, the position is then closely akin to premature removal of the drainage-tube. It is not to be supposed that use of the drainage-tube is ideal or cannot be improved upon, but our analysis does not support any reason for a fierce

attack upon it, for infants of 6, 7, 8, 10, and 11 months have recovered under such treatment, and many children owe their lives to its careful use.

Resection of ribs is intimately bound up with the use of drainage-tubes, for it is well known that unless resection is done in the young the ribs will pinch the tube and bring about a condition analogous to premature removal of one tube, or too early closure of the wound.

It is clear from our analysis that, with all its disadvantages, resection and drainage is a valuable operation, and that any method chosen will, in some cases, meet with considerable and possibly unexpected difficulties. It is also apparent that a method which will diminish shock and suffering, and yet be effectual, will be a means of saving life.

Analysis of 71 Cases of Empyema in Infancy.

1. *Age and sex.*—Twenty-one cases were of 1 year and under, the youngest being 4 months of age, and 50 were between 1 and 2 years. Forty-five were males and 26 females.

2. *Mortality.*—The death-rate in the first 12 months was very high. Sixteen of the 21 succumbed, and of the 50 over a year old 23 died. In percentages the death-rate in the first 12 months was 76, and between the first and second years, 46. The total number of deaths was 39, or 55 per cent. These figures closely approximate those given by Spence.¹

3. *Clinical histories.*—It is remarkable, when the histories of these cases are examined, how long a time may elapse between the first signs of definite illness and the discovery of pus in the chest, and how frequently this happens. Allowing for errors and oversights, in many cases the early symptoms are very indefinite, and we are left in doubt as to when the actual development of the empyema occurred. For this reason we have empirically classified these cases into three groups: (1) Acute, with symptoms of under a week's duration, (2) subacute, with a history of from one to three weeks' duration, (3) chronic, with a history of from three weeks' to eight months' duration. There were 13 acute cases (10 deaths); 13 subacute cases (7 deaths); and 45 chronic cases (22 deaths). From this analysis the importance of the virulence of the infection is apparent.

4. *Nature of infection.*—In 31 of the 39 fatal cases the nature of infection was as follows: 21 pneumococcal, 4 staphylococcal, 3 streptococcal, 3 tuberculous. In the remainder the causal agent was not stated. Taking all the cases: 43 were pneumococcal (21 deaths), 7 staphylococcal (4 deaths), 3 streptococcal (3 deaths), 3 tuberculous (3 deaths), and 1 sterile (recovery). In 14 cases the cause was not stated. From these figures it is apparent that the pneumococcal infection easily preponderates in the empyemata of infancy, and that the death-rate from this cause is close upon 50 per cent. In spite of this fact we would here repeat that the histories of many of these cases as gathered from the case-books, often gave indeterminate symptoms. The figures in which we have tried to express this point must not, however, be looked upon as of more than relative value. In 26 cases there was a clear history of pneumonia, in 7 of bronchopneumonia, in 7 of bronchitis; 6 were associated with measles and bronchitis; 1 with chicken-pox, and 3 with whooping-cough. In 20 cases, although respiratory symptoms and signs appeared, no definite name had been given to the illnesses before admission.

5. *Prominent symptoms in the histories.*—The prominent symptoms recorded in the pre-hospital histories were as follows: Cough in 38 cases, vomiting in 24, dyspnoea in 23, wasting in 23, pain in 8, cyanosis in 7, "fits" in 4. Of these the reiteration of vomiting, breathing trouble, and wasting, when coupled with cough, stands out as an indication in infancy for careful consideration of the possibility of the presence of an empyema. We believe that any group of symptoms in these difficult cases, which would help to remind us of empyema, would be of assistance, and we are led to this belief from the record of the prominent signs which were found in this series on admission to hospital.

6. *Signs on admission to hospital.*—In no less than 66 cases definite impairment or complete dullness was discovered in some part of the chest, and almost invariably at one or both bases. In 46 the breath sounds over these regions were absent or diminished. In 18 there was tubular breathing, and in 23 the heart was displaced. Crepitations were noted in a few cases. The well-known fact may here be emphasised that in infancy and childhood tubular breathing is frequently found over the site of an empyema—a fact apt to mislead those unacquainted with the occurrence. It is worthy of note that displacement of the heart is only recorded in 23 of the 71 cases, although it must be allowed that slight displacements in infancy are by no means easy to recognise decisively.

7. *Causes of death.*—The causative factors of death in the 39 fatal cases of our series constitute a question of great importance for prognosis and treatment. In 8 cases there was no post-mortem examination, and these must be set aside, leaving 31, which we divide into three groups.

Group 1.—Twelve cases, in which the empyema was either not detected, or, if it was detected, the child was moribund on admission. In 2 of these cases tuberculous meningitis was found, and in 3 suppurative pericarditis.

Group 2.—Eight cases, all of which were operated upon with resection of a piece of rib, but the necropsies showed the following complications: In 3 cases suppurative meningitis, in 3 suppurative pericarditis, in 1 lateral sinus thrombosis, and in 1 gangrene of the lung. In all these cases the lungs themselves contained either areas of pneumonic consolidation or some collapse. Both suppurative meningitis and pericarditis occurred not only in cases with long histories, but also in acute cases.

Group 3.—Eleven cases in children who either died rapidly from shock and collapse, or rallied for a day or two, and then—the wounds having become unhealthy and the temperature having again risen and persisted—they sank gradually, apparently from a lack of vital power to resist the infectious process. In this group we hoped to gain some success by the method described below, which minimises shock and eliminates the open wound.

In a brief review of this analysis it becomes apparent that failure to detect an empyema is a factor in an adverse prognosis, but we do not presume to criticise this failure, realising well enough how deceptive the symptoms may be and how difficult also the physical signs. We would dwell upon cough, dyspnoea, vomiting and wasting as a combination of symptoms suggestive of an empyema. A certain proportion of these cases demonstrate that a small empyema is only one incident in a profound toxæmia, and is of no practical importance in the face of a virulent infection, damaging not only the lungs and pleuræ, but also the pericardium and meninges. It is, however, the cases that sink and die after operation that require special consideration, and have suggested the need of some method of treatment other than resection and drainage.

The Method of Continued Aspiration.

(A) *Apparatus.*—The apparatus and technique used by us have been devised with the special object of completely emptying the pleural cavity, and maintaining continuous drainage by aspiration without at any time exposing the cavity to the outside air and secondary infection. The apparatus consists of:—

(1) A straight round silver cannula, $\frac{5}{8}$ inch in length, provided with a shield through which tapes are threaded whereby it is kept in position on the chest wall. (Fig. 1A.)

FIG. 1.

Cannula and trocar. A A = Actual sizes of lumen of cannulas. B = Rubber tube. C = Introducer. The trocar and cannulas are made in four sizes by Messrs. Allen and Hanburys, Ltd.

(2) A trocar, with a short point, used for insertion of the cannula.

(3) A rubber tube (B) 10 inches long, having a slightly larger lumen than the cannula; one end of the tube is completely closed by tying it firmly with a silk ligature, and immediately below this a hole is cut in the tube, $\frac{1}{2}$ inch long, and involving half the diameter.

(4) An introducer (C) for the rubber tube, which consists of a metal rod that will easily pass into its lumen.

(5) A White's suction-pump, as used for suprapubic drainage.

(B) *Method of procedure.*—After a preliminary exploratory puncture the site of operation, which will be referred to later, is anæsthetised with novocaine.

Tapes having been threaded through the shield of the cannula, the latter is introduced into the pleural cavity by means of the trocar, and the tapes are tied securely round the chest wall. The rubber tube is held by the open end, and the metal rod is passed down and pressed against the closed end until the tube is stretched sufficiently to allow it to pass easily through the cannula. The trocar is now withdrawn and a finger, wrapped in gauze, instantly placed over the opening. The tube is taken, stretched on the introducer, and carefully slipped under the finger and through the cannula, being introduced as far as may be thought necessary according to the size of the patient and extent of the empyema (the actual distance, in any particular case, can be ascertained by having marks on the tube at intervals of 1 inch). (Fig. 2.) The introducer is gradually withdrawn and the tube tightly pinched between finger and thumb close to the chest wall. The free end of the tube is connected up with White's pump, and the finger and thumb removed. Continuous gentle aspiration is persisted with until pus has ceased to come from the chest for 48 hours, and physical signs, pulse-rate, and temperature are satisfactory.

Certain points in the above procedure demand special consideration:—

1. *Site of operation.*—The most comfortable place for the patient, and at the same time the easiest for after-treatment, is a rib space as low as possible just anterior to the mid-axillary line. In this position the patient can lie on the affected side without interfering with the tube. If it is necessary or convenient to drain from behind, the patient can easily be placed against a bed-rest, made for the purpose, consisting of a wooden frame with canvas strips at intervals of 4 inches. The tube is passed through a space in the frame, and the patient can then be placed in any required position.

2. *Fixing and keeping cannula in position.*—It is advisable, in addition to the tapes, to place straps of adhesive plaster over and at right angles to the shield on either side of the cannula. A gauze dressing and a firm figure-of-8 bandage are then applied.

3. *Escape of pus.*—In passing the rubber tube through the cannula, care must be taken to avoid any escape of pus whereby the puncture wound may become infected.

(C) *Advantages of the method.*—1. The period of illness is shortened. In cases treated by rib resection the average time before the wound is healed is six weeks; with the method described above the average time between insertion of the cannula and complete healing has been 15 days—a figure which would be much lower but for Case 3 (quoted below) which required four weeks. The explanation of this advantage is that: 2. There is no secondary infection of the pleural cavity. The rubber tube has a larger lumen than the cannula, so that, when released from the introducer, it expands and fits the cannula tightly, preventing any leakage of pus, soiling of the wound, and re-infection backwards to the pleural cavity. Another important point in the shortening of the illness is that osteomyelitis of the rib, so common after resection, does not occur. 3. No anæsthetic is required. The whole procedure can be carried out in a few minutes, causing very little disturbance

and without removing the patient from bed; thus eliminating all the risks attendant upon moving a seriously ill child to the theatre and giving an anæsthetic. 4. Surgical trauma and its consequent shock are reduced to a minimum. The pain and discomfort of inserting the trocar are no more serious than exploration with a needle. 5. No daily dressing is required. Those who have seen what mental and physical suffering so many children endure for weeks after resection of rib will readily appreciate what a relief this method will be to all concerned. 6. The patient can assume any required position without fear that drainage will be interfered with. 7. The drainage is continuous and complete. Pus cannot collect in the bottom of the cavity and depend upon the position of the patient or upon expiratory efforts for its expulsion. 8. Expansion of the lung is assisted. The suction produces a negative pressure of 8 mm. Hg; this being more than the normal negative pressure of the pleural cavity, the lung tends to expand and assume its normal function more readily. 9. The removal of the pus is gradual. The continuous suction causes a steady slow outflow of pus, and it is some hours before the cavity is emptied; a displaced heart is thereby allowed to reassume its normal position quietly and gradually without the suddenness which is bound to occur if incision and drainage are employed. This fact is important when one recalls cases of syncope due to sudden withdrawal of pus and the replacement of a displaced heart.

(D) *Practical difficulties.*—1. Occasional blockage of the tube by masses of fibrinous lymph. It is remarkable how much solid matter will be sucked through, but should blockage occur, it can be remedied by increasing the suction by stretching the tube out between the fingers and expressing its contents into the flask by an action which may be compared with "milking." If this fails the plug of lymph can be washed away by injecting a few cubic centimetres of sterile saline into the tube. This difficulty has, in our opinion, been somewhat exaggerated by previous writers, for in none of our series of ten cases has there been failure to drain the chest by this method. 2. It is obvious that, as has been pointed out in the earlier part of this paper, there will be chronic or unusual cases in which this method will not be suitable.

(E) *Illustrative cases.*—Cases in which we have used this method, all of which recovered, varied in age between 15 months and 11 years. Among these were three under 2 years of age, which, therefore, come within the scope of this paper. The first and second of these show how simple and successful this method may be, while in the third we believe life would have been lost had incision and drainage, with or without resection, been undertaken.

CASE 1.—Fred G., aged 18 months. Admitted to the Children's Hospital, Great Ormond-street, on Jan. 12th, 1921, with an empyema at the right base following broncho-pneumonia. He was a pale wasted infant in very bad general condition. Exploratory puncture confirmed the presence of pneumococcal pus. The chest was drained by the method described for five days, and the child made an uninterrupted recovery.

CASE 2.—Louie B., aged 18 months. Admitted to hospital, May 7th, 1921, with broncho-pneumonia; seven days later empyema developed at the left base. The chest was drained for eight days by aspiration, and two weeks later the child was discharged, quite well.

CASE 3.—Lilian B., aged 18 months. Admitted to hospital, June 7th, 1921, with a large empyema on the left side. The heart was displaced to $\frac{1}{2}$ inch outside the right nipple line. Patient was very ill, with a pulse-rate of over 160, respirations 80 per minute, temperature 100° F., and much cyanosis and dyspnoea. Drainage was commenced and proceeded satisfactorily. Ten days later the lung was expanding well, but there was a copious amount of pus still being aspirated. Unfortunately the tube was twice dislodged accidentally, and there was infection of the soft tissues round the cannula. Four weeks after admission, however, complete healing had taken place. Any serious operative treatment on admission would have been attended with very grave risk. The child made a good recovery, with the affected lung working well.

FIG. 2.

Showing the cannula in position and the tube connected up with White's pump.

This last case illustrates a difficulty which may arise from not fixing the cannula securely; with increasing experience this has not occurred in any other case of our series. In this connexion the nurses should be warned of the importance of seeing that the tube leading from the chest to the pump is quite free, so that, should the child turn over in bed, there will be no pull on the tube, which may dislodge the cannula.

(F) *Some previous investigations into treatment of empyema by aspiration.*—We repeat that the principle of this method is by no means new, for as long ago as 1873 Playfair advised aspiration, and his technique was used and described by Dieulafoy.² In 1891 Bulau³ devised a form of syphonage through a small rubber catheter introduced by means of a trocar, and Perthes⁴ used this method with the addition of a water pump to provide continuous suction. Many modifications have been devised,⁵ some of which are simple and useful up to a point, others too complicated for general use. They all have the disadvantage that they do not prevent secondary infection of the pleural cavity, and this we know, as has been specially pointed out by Holt⁶ in a series of 145 cases, is generally the cause of death by exhaustion from prolonged suppuration. When we consider the high mortality of empyemata in infancy and their frequency at all ages in childhood, we believe that the method of treatment described here will be a real assistance in diminishing the dangers.

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SPORADIC OUTBREAKS OF PLAGUE IN THE UNION OF SOUTH AFRICA.¹

By L. G. HAYDON, D.S.O., M.B., C.M. ABERD., D.P.H.,

ASSISTANT HEALTH OFFICER, UNION OF SOUTH AFRICA.

SINCE January of 1916 occasional cases or small groups of cases of plague have been discovered at irregular intervals in the Orange Free State and neighbouring districts, occurring under circumstances which did not, until recently, disclose the method of the spread of infection. The number of cases and the circumstances under which the outbreaks occurred have from time to time been officially declared. In previous years well-defined epidemics of the disease had occurred at the ports and larger towns in connexion with well proved epizootics in the "domestic" rat population, and following the courses of transit of grain and other foodstuffs in the usual way. These epidemics were satisfactorily dealt with by campaigns against the "domestic" rodents and the other usually effective methods.

The occurrences since 1916 have differed in character from these well-defined epidemics in the following particulars:—

(1) The outbreaks were confined to persons or small groups of persons living in rural areas less densely populated than the bulk of South Africa, and remote from larger towns and villages.

(2) Investigation and the closest inquiries failed to elicit the existence of "domestic" rodents at or anywhere near the scene of the outbreaks. The nature and structure of

the farm-houses and native huts in which many of the cases lived was such as not to favour the existence of domestic rodents.

(3) The time intervals between adjacent groups of cases was irregular, being in some instances a few weeks, and in other instances as much as many months. The distances between the scene of such outbreaks as would at first sight appear to have a common source of infection were in some instances as great as 50 miles, the intervening population remaining unaffected and the closest investigation failing to elicit any connexion, personal or through verminous fomites, between the groups of cases. Many of the cases occurred in persons living on isolated farms of several thousand acres, and having limited intercourse with their neighbours.

The Central Health Department was faced with the problem of discovering either the source of infection common to these outbreaks, or the means of transference of infection from one case or group of cases to the next, over varying intervals of time and space in the unusual circumstances stated. The theory tentatively held, that latent infection could remain in ambulatory human cases to reappear and be passed on in virulent form after a considerable interval, had under the circumstances to be revised, and as the series of small detached outbreaks continued to occur up to 1921, Dr. Mitchell, the Secretary for Public Health, decided to have close investigation made into the species, habits, and morbidity (if any) of the wild rodents of the affected area, and for that purpose enlisted the aid of experts trained in the capture and classification of African wild animals. The following results were arrived at in the early months of 1921:—

The area of country involved with a radius of about 150 miles may be roughly described as flat or gently undulating plains intersected by watercourses which only contain flowing water for a few months of the year, but in the valleys of which occasional pools may remain longer. These valleys are fringed with low scrub and vegetation, varying from a few to several hundred yards in width. The soil generally is a light sandy loam. The indigenous vegetation is grass, patches of low scrub, wild melons and cucumbers and the like, which usually grow in such latitudes in plains with scanty rainfall. The area is divided into farms of from 1000 to 5000 acres, and is mostly concerned with the raising of sheep and the production of maize and other cereals. The human population, both white and native, is very sparse and widely separated. The conditions generally favour the existence of the smaller wild animals, especially rodents, which find harbourage by burrowing under the roots of grass and the low scrub.

The animals captured were as set out in the following list:—

Common name.	Name as determined by an official of the Transvaal Government Museum.
Gerbill or gerbil	Tatera lobengulæ.
Large-eared mouse	Malacothrix typicus.
Fat mouse	Steatomys pentonyx.
White-tailed mouse	Mystromys albicaudatus.
Tree mouse	Dendromys melanotis.
Dwarf mouse	Leggada deserti.
Striped field mouse	Rhabdomys pumilio.
Multimammate mouse	Rattus coucha.
Namaqua rat	Rattus namaquensis.
Golden rat	Rattus chrysophilus.
Ground squirrel or meer kat	Geosciurus capensis.
Spring hare	Pedetes caffer.
Yellow hare	Lepus ochropus.
Kolhaas	Lepus zuluensis.
Red hare	Pronolagus.
Suricate	Suricata.
Stender mongoose	Galerella caai.
Yellow mongoose	Cynictis penicillata.
Muishond	Ictonyx striatus.

Considerable difficulties were encountered in their capture and in the investigation of their habits, owing to the fact that many of them are strictly night animals and burrowers, necessitating the careful tracking of small spoor in the early mornings to and from water-holes and feeding-places. The burrows are often of considerable depth and extent, branching in several directions, while the ordinary heap of earth which one looks for as indicating a burrow inlet may be absent, the earth removed in burrowing being used to block up the passage behind the burrower. Entrances and outlets may be numerous and carefully concealed under overhanging bunches of grass or bush. It was, moreover, found to be a

¹ A paper presented at the Royal Society of Medicine, Section of Epidemiology and State Medicine, on Oct. 28th, 1921.