A CONSIDERATION OF THE PROPHYLAXIS OF ACUTE CEREBROSPINAL FEVER.¹

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With the outbreak of the World War, epidemic cerebrospinal fever attacked the mobilized forces with a furore which was almost demoralizing. It became pitifully evident how little we knew about methods of preventing the development and spread of this disease. This appears most unusual when it is considered that the ætiological organism had been established beyond a doubt for many years. Almost two decades have passed since the great test of 1917 and it seems appropriate to review the progress of the past years in the control of this form of meningitis and seriously to ask ourselves a few questions which would need to be answered if to-day we were compelled to mobilize for a great war. Are we better prepared in 1934 to prevent the appearance and limit the spread of epidemic cerebrospinal fever than we were in 1917? Have the lessons of the past years made diagnosis more accurate and treatment more efficient? The discussion of these two questions is of vital importance, for unless they can to a considerable extent be answered in the affirmative, the outlook in the solution of a future problem is not encouraging. To hope that meningitis will be absent as a mobilization problem is to deny the lessons of history and to indulge in an optimism which the facts do not warrant. Can a disease which is a cause of concern in the small commands of peace time be expected to become less of a problem when thousands of recruits are mobilized and hurried through the stress of training?

A review of the history of the disease leads us to define meningitis, from a military standpoint, as an acute infection which occurs in young recruits during the winter season. No facts were more undeniably demonstrated in 1917 than the influence of youth and season on the spread of the disease. The inexperienced youth of the twenties, under the influence of inclement weather, forms the food for the meningococcus. Many other factors contribute to season and render this food more palatable to the causal organism. The combination of these factors, to which is added, of course, the meningococcus, produces the annual curve of incidence of cerebrospinal fever. The curve is usually in the form of an inverted V and covers the bad seasons of the year from October to March. Unseasonable weather in the spring may drag out the decline as far as June. The larger the numbers concerned the more regular the V and the greater the number of months covered by the curve. In the warm days of summer the disease

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disappears. Some authors deny this disappearance, but they do not refer to epidemics. Summer, spring and winter are here used as terms to describe not seasons but weather. A spring with winter weather will not lessen meningitis, as was so well demonstrated in the wintry June of 1917.

With the outbreak of meningitis in 1917, the authorities on this disease gave their approval to three measures which were in their opinion of particular importance in the prevention and control of this form of meningitis. These three measures were:

1. Extreme ventilation.
2. Increase in floor area per man.
3. The isolation and segregation of carriers.

It is proposed to consider these three measures in detail and to determine from past experience the value, if any, which each measure may have.

By ventilation we mean the maintenance of a supply of fresh air adequate to give a plentiful supply of oxygen and to remove the volatile waste products, particularly respiratory, of the human body. The influence of fresh air, of proper temperature and moisture content delivered without the formation of a draught will be admitted by all as a sanitary measure of great importance in the maintenance of health. This was not the idea of the fresh air enthusiast of 1917. He demanded a maximum of air. It mattered not if the air came in a gale at a temperature of 30\(^\circ\) or 100\(^\circ\). It might be laden with moisture or completely dried. The goal sought was always more fresh air. Observers state that at the height of this hysteria windows were removed from barracks and the occupants shivered and pulled their heads under the blankets. Here they breathed and re-breathed their three cubic feet of air, unappreciative of the advantages of ventilation about them. After shivering through a sleepless night they started the day’s work exhausted and facing the prospect of a repetition of such nights and days. A respiratory infection followed and they became easy victims to the meningococcus or the pneumococcus. The conservative sanitary said perhaps there was too much fresh air, but the enthusiast said, “The ventilation should be increased.”

Under conditions similar to those described, one barracks rebelled, nailed their windows shut, and defied anyone to touch them. As an experiment, they were allowed their way, and no cases of meningitis developed. One cannot avoid the conclusion that ventilation which produces discomfort and prevents sleep because of chilling, excessive air currents, and dampness due to the entrance of snow or rain, is not beneficial and may be more injurious than a room which is comfortable although close.

The question of floor space per person embraces not alone ventilation and the amount of air per man, but is of especial importance from the standpoint of mechanically separating the men from each other. The
value of the latter phase of floor space as a means of preventing the spread of disease cannot be denied.

At Great Lakes in 1917 when cerebrospinal fever, pneumonia, and other infectious diseases were raging, an inspection party noted the great crowding in the Public Works Regiment and were surprised to learn that this regiment was practically free from contagion. This incident is not an argument in favour of less floor space, but shows that in the case of these men who were older, a higher age group were able to withstand the bad effects of overcrowding.

If we consider extremes it must be evident that when men maintain at all times a separation of, for example, 100 feet, disease cannot be transmitted. On the other hand, if human beings are packed together as animals in a cattle car conditions must be optimum for transmitting disease. Chances of infection probably vary but little for short distances and at a certain distance begin to decline rapidly and quickly disappear. The actual point of disappearance is unknown, but the distance is probably too great to be compatible with military efficiency. The necessities of a war-time mobilization will probably never allow men to have sufficient room to allow floor space to be a factor in preventing the spread of infection. An artificial separation and a relative increase in floor space may be produced by the use of screens and only by such means will it be possible to allow a degree of separation sufficient to influence appreciably the chances of infection.

Of all measures brought forth for the control of meningitis, without doubt the most promising and the most spectacular was the idea of detecting and isolating the carrier of meningococcus. The plan provided that the carrier should not again associate with his fellow man until free from meningococcus. It was contended that a certain number of human beings harboured in their throats Gram negative diplococci agglutinable by antimeningococcus serum; that these organisms were the meningococci and that the carriers thereof passed these organisms to non-immune persons, causing cerebrospinal fever. The organisms certainly appeared by all tests to be meningococci. It appeared, if the early writers can be credited, that once the technical difficulties of the bacteriology involved were overcome, a great advance in the control of meningitis was in sight. It was assumed, though unproved, that the organism carried was virulent and that the carrier owed his freedom from disease to a natural or acquired immunity. At Great Lakes the theory of the immunity of the carrier was disproved by the appearance of a liberal percentage of cases of the disease among the carriers. The virulence of the organism carried has not been proved, but it must be assumed unless the carrier theory is entirely emasculated. Assuming the organism to be virulent there remains the following proposition, which is at least unusual in medicine, i.e. a virulent pathogenic organism lives and multiplies in the tissues of a non-immune without producing disease. It
is proposed later to consider the question, "Is not the carrier actually suffering from a disease?"

In any consideration of the importance of the carrier theory it is necessary to determine the frequency and the laws, if any, which govern the creation and continued existence of the carrier. In 1919, Short published a chart covering these points and based upon observations of 60,000 cultures over a period of fifteen months. This chart demonstrated the seasonal variation in the percentage of carriers and the relation of the percentage to such factors as rainfall, snowfall, high and low temperature, and particularly sudden changes in weather conditions. In the summer the percentage was as low as 2 per cent, while in the winter it often rose as high as 50 per cent. Recruits on arrival at the mobilizing station showed as high as 25 per cent carriers in the winter. Warm bright weather reduced the percentage, and raw weather, particularly if combined with sudden changes from warm weather, caused a rapid rise. Carriers in an isolation camp cleared rapidly with the warm sunshine of spring and those who remained were usually the chronic cases who form the 2 per cent of the summer time.

These variations in the carrier-rate are of interest when studied in connexion with the percentage incidence of meningitis. If the carrier causes the disease, cause should precede effect and the increase in percentage of carriers should precede the increase of cases. The two curves should be separated by an interval representing the incubation period of the disease. Short's work, however, shows that the two curves almost coincide, with a little tendency for the carrier curve to lag. This would indicate that one condition is not dependent upon the other, but rather that both carrier-rate and disease incidence are affected by the same factors. These factors have been considered in connexion with the carrier-rate and it is proposed later to consider the same factors and additional ones at greater length in relation to disease incidence. Earlier writers believed they established the carrier theory by detecting carriers in groups of men among whom meningitis had developed. If this has value as positive evidence then similar negative evidence must be considered. Upon repeated occasions, groups of men showing over 50 per cent of carriers were free from the disease while groups of men containing less than 10 per cent carriers showed numerous cases of meningitis. In one instance a carrier giving positive cultures for two years lived with 75 men for twelve months and no cases of meningitis developed in the group. There can be little doubt that the carrier work failed to influence the curve of the disease and failed to control the spread of the infection.

Before dismissing this subject, it may be of advantage to call to the attention of those health authorities, to whom the theory of isolation of carriers may suggest brilliant possibilities and an easy solution of the

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meningitis problem, the seriousness of the additional problem which this theory may add to the meningitis question. A health officer once asked me about the best method of detecting carriers. My problem at the time was how to dispose of carriers already detected. Carriers can safely be estimated as ten times as numerous as cases and their final disposition offers a problem inomparably more difficult than the handling of clinical cases of meningitis. Innumerable methods have been devised and recommended for ridding the carrier of his offending organism and permitting his restoration to the society of others. None offer results which are other than confusing and disappointing. Sunshine and warm weather will clear a carrier camp in a few weeks but the same factors will end a meningitis epidemic. However, the problem has not yet been solved. It has merely solved itself until the next season arrives. The routine isolation of large bodies of men in idleness each winter infuriates those involved, disgusts the authorities, and raises doubt in the minds of the friends of public health. Such a measure is only excusable when the efficiency of the method as a preventive measure can be demonstrated beyond a reasonable doubt.

A perusal of the preceding pages might lead one to the conclusion that the outlook for the future was indeed gloomy and that meningitis epidemics of the next mobilization must be allowed to take their course. While the studies of ventilation, floor space, and carriers have not a tendency to cause them to be recommended as a solution of the problem, nevertheless, it is believed that much data have been obtained which if properly applied is of constructive value.

I feel that this subject cannot be introduced more clearly than by quoting Short’s conclusions from his studies:—

“...It is not the intention in this paper, however, to assign the reason for the occurrence or non-occurrence of cerebrospinal fever to meningococcus carriers, but rather to call attention to the multiplicity of factors which may be reasonably expected to operate alone or in combination to influence this incidence, to emphasize that the meningococcus carrier is only one of the factors of which crowding, over-training, immaturity, fatigue, exposure to weather and other factors, discussed in a previous report, are probably equal, if not greater in importance, and that to concentrate our attention on any one factor to the exclusion of a proportionate regard for the others, is to neglect some of the opportunities for controlling the situation.”

It is important to consider minutely some of the factors which Short mentions as influencing the health of the recruit and rendering him more susceptible to disease, especially meningitis.

To appreciate more fully these factors and to understand the changes to which a young man is subject upon becoming a recruit, an attempt will be made to picture the life of the average young man of 18 to 20 years of age in civilian life and then to draw another picture of him after he enters recruit training, showing the numerous and often violent changes in habits of living to which he is subjected within a period of a few weeks.
The average young civilian of 18 is to a large extent his own lord and master. He may acknowledge the authority of his employer or his schoolmaster in that by him his activities during a portion of the day are somewhat limited. In his home he may see fit to obey his parents and govern his habits according to their wishes. It is probable, however, that he is not greatly influenced by the wishes or wisdom of his seniors and has learned to regulate his habits according to his own desires and without relation to the well-being or convenience of others. In the matter of clothing, his sensation of comfort causes him to adopt heavy or light garments at his pleasure. He judges the necessity for an overcoat, rubbers, gloves, or ear muffs. His throat and arms are covered or bare as he pleases, with only due regard for the conventions of dress. At night his bed is in a room which is heated and ventilated to suit his convenience and his bedding is suited to his individual ideas of the needs of the case and all are subject to such change as necessity may indicate is advisable.

In the morning the young man arises at an hour suitable to himself and subject only to the requirements of breakfast and work or school. Breakfast and other meals are what experience has trained his fancy to choose. Work or school only restricts his activities a few hours a day and he can quit either with little punishment or discomfort, covered by checkage of pay or loss of standing. His duties completed, his time until he chooses to retire is his own. He may do as he pleases provided he avoids contact with the police.

How does this picture change when our care-free young man becomes a recruit? His clothing is no longer what he wants or thinks he needs but what years of experience have shown to be best suited for the Navy man in general. Experience has selected wisely but our young recruit has a hard time making the change. His neck is now bare while formerly he always protected it from the cold. All other articles of uniform are prescribed to cover the needs of the majority and not according to the needs of the individual. His duties cover long hours during the day, are severe for one who is not hardened physically, and if he feels indisposed and unenthusiastic he cannot avoid them by accepting a penalty of loss of pay or loss of job. Medically he is either sick enough to be excused from work or well enough to work. His status in this respect is decided by others and not by himself. His food is what hygienists have decided is best for large bodies of men. Experience has shown that it is high in nutritional value, but it is not prescribed for the individual fancy but for the best interests of the many. At night he retires to a hammock which, to one unaccustomed, is not an ideal place for sleep. Blankets are according to estimated needs often estimated by one far away. Ventilation is figured scientifically but is not sufficiently variable to suit the needs of each individual of a large group. If figured by a ventilation enthusiast, it may not suit the desires or needs of any member of the group.

During his first three weeks, while endeavouring to accustom himself to
all these changed conditions of life, the recruit is subjected to the special measures used in the prevention of disease. He is vaccinated against smallpox, receives three injections of typhoid vaccine, and perhaps is also immunized against diphtheria. All these procedures make the man feel below par and must result in a somewhat lowered resistance. To all the excitement and uncertainty must be added the effect of a certain amount of depression and homesickness which cannot help being factors influencing the sense of well-being. It is during this stage of his Navy career that the beginner in the Navy usually develops the acute nasal troubles, respiratory diseases, and cerebrospinal fever. The veteran of several years suffers little from these diseases and in fact the tendency to these infections begins to decrease after several months of service.

We find that some of the conditions mentioned are present when students attend school and are housed in dormitories. Floor space is limited, ventilation is by rule, and carriers are without doubt present. Food, clothing, and the hours and conditions of sleep and work are standard for the entire group. However, there is in evidence the factor of personal supervision which allows a variation of routine to meet emergencies and changing conditions. This personal care operates to correct errors and prevents the serious consequences which would otherwise follow. In the case of the recruit the medical officer can supply much of this supervision, but the one most suited by the nature of his duties to watch these details is the Company Commander. Too often, however, the Company Commander of 1917 disregarded such matters and, without any intention of being negligent, assumed the "hard-boiled" attitude. There is little doubt that the period of training should be lengthened, the "breaking-in" process should be "slowed up," and the recruit should be given an opportunity to "grow into" his new life and that during this critical period he should be under more careful supervision.

It is not the purpose of this article to discuss diagnosis and treatment except in so far as they may be factors of importance in controlling the incidence of the disease and limiting the spread of epidemics. Diagnosis is of special importance as epidemics are usually kept in motion by failures of diagnosis, especially the diagnosis of mild atypical cases.

What constitutes a case of acute cerebrospinal fever or an infection due to the meningococcus? If the books on internal medicine of two decades ago are studied it would appear that infection with the meningococcus is synonymous with cerebrospinal fever. The textbooks of 1916 recognized no meningococcus infection except that characterized by inflammation of the meninges, that type of the disease which in 1904 gave a mortality of 80 per cent and a mortality of about 20 per cent after the introduction of antimenningococcus serum. At that time there appears to have been no conception of the possibility of a mild infection involving other tissues and not involving the meninges. The experiences during the war demonstrated a pure septicemic form, without meningeal involvement. It seems worth
while inquiring if this conception of milder forms of infection may not be extended. Is there not in existence a still milder, more localized form of meningococcus infection involving the walls of the nasal and pharyngeal cavities and the accessory sinuses? Is it not possible that the so-called "carrier" who increases in numbers so rapidly under unfavourable climatic conditions represents not a mere carrier condition but rather an individual with a local pathological condition who is suffering from the mildest local form of meningococcus infection? This conception of the carrier would explain some of the points observed in studying the incidence of both carriers and cases, namely, the increase in the carrier index at the same time and under the same conditions under which the meningitis index increases, and the practical disappearance of the carrier during the seasons when meningitis is absent. The situation during an epidemic would resolve itself into a widespread infection with the meningococcus, the majority of the cases representing a local infection with few symptoms to distinguish the complaint from acute coryza, acute bronchitis, and especially that hazy clinical entity so common in bad-weather seasons, acute catarrhal fever or common winter influenza. A small percentage of cases would show symptoms of septicaemia with the meningococcus in the blood and a still smaller number would represent true acute cerebrospinal fever with cerebrospinal symptoms and bacteriological findings. Richmond (Naval Medical Bulletin, February, 1926), reports 21 cases of which 14 were of meningeal type while 7 never passed beyond the septicaemic stage. He calls attention to the very great importance of blood cultures and white cell counts in distinguishing the septicaemic form from confusing diseases. In studying the same epidemic Minter in the United States (Naval Medical Bulletin, July, 1926) isolated 31 carriers who apparently had sufficient disturbance in the naso-pharyngeal region to afford temporary lodging for the meningococcus. During this period he reports an outbreak of mild influenza (catarrhal fever, acute) totalling 148 cases. The epidemic of influenza, the cases of meningitis and continuation of the carrier stages, cover about the same period, and all conditions cleared up at about the same time.

It would seem advisable to consider a rise in the monthly rate of acute bronchitis, acute catarrhal fever and acute tonsillitis as the first signal to be on the watch for cases of meningococcus infection. Instances of sinus and throat pathology especially, if showing the meningococcus in the secretions, should stimulate the watch for the septicaemic form. The appearance of the septicaemic type with a high white count and a positive blood culture makes it only a question of a short time until a true case of acute cerebrospinal fever will appear. In this chain of events, each suspicious circumstance will cause the search for the next step to be strengthened. Measures may be instituted to correct hygienic defects and faulty methods of living. Early recognition of the septicaemic and meningeal forms will allow early diagnosis and early treatment, and early treatment means low mortality.
CONCLUSIONS.

(1) In the future it does not seem advisable to place too much faith in the detection and isolation of carriers as a controlling measure. A study of the carrier situation is an instructive scientific study and impresses the public, both lay and medical, but it consumes much time better used for other measures of control. It also introduces the difficult problem of the final disposition of the carrier.

(2) Adequate floor space and proper ventilation should be given due consideration but it is unwise to become hysterical on the subject and to assign to these measures an importance which may not be warranted and which may even produce harmful and dangerous results.

(3) Spectacular procedures have a value in combating certain phases of the situation but they should never monopolize the field to the exclusion of tested and valued hygienic measures.

(4) The recruit should be under constant supervision during the first months of his Navy life as it is during this period that he is hypersusceptible to infection and to faulty hygienic conditions.

(5) Ample time should be allowed for "hardening" and "seasoning" the recruit and during this critical period he should receive maximum protection against inclement weather, overwork and fatigue.

(6) The importance of typhoid prophylaxis and smallpox vaccination as a means of undermining resistance should be kept constantly in mind. These measures are necessary but their accompanying bad effects should be minimized by special care and a lightening of other duties.

(7) The value of increased monthly rates for other diseases, namely acute bronchitis, acute tonsillitis and winter influenza as a warning of the appearance of conditions favouring the advent of meningococcus infection should be kept constantly in mind.

(8) Cases with cerebral symptoms represent only a certain percentage of cases with meningococcus infection. The pure septicemic type is common and further study will doubtless show that a type involving the nasal and pharyngeal cavities and the accessory sinuses is quite common.

(9) The medical officer should always keep in mind the possibility of meningococcus infection and the conditions under which it may appear, in order that the cases appearing may have the benefit of early diagnosis and early treatment with a resulting lowered mortality.